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Personnel Advancement Systems As Related To Management Effectiveness

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PERSONNEL ADVANCEMENT SYSTEMS AS RELATED TO MANAGEMENT EFFECTIVENESS

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THESIS

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BY
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ABSTRACT OF THESIS

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ABSTRACT

The study of personnel advancement systems as related to management effectiveness in research and development (R&D) laboratories was chosen because of its relevance in this period of change in attitudes toward science and the scientific community. This change involves a shift in interest from basic scientific research to scientific and technological advances that have practical applications. Also, there is increased concern by legislators that facilities involved in federal R&D programs demonstrate sure fiscal responsibility and efficient operating methods.

The personnel advancement systems discussed in this thesis are the single - and dual - ladder systems. The single - ladder system is one in which advancement is based on employees, professional and nonprofessional, assuming positions of more supervisory responsibility. The dual - ladder system is one in which, (1) supervisory personnel advance up the managerial ladder and (2) scientists and engineers are provided advancement opportunities based on professional competence, with benefits equivalent to those available to management personnel, but without having to assume supervisory responsibilities.

This study considers the hypothesis that federal laboratories which employ the single - ladder system meet management effectiveness expectations as measured by evaluation of specified performance indicators and compared with established standards.

A search of the literature revealed that most studies approached the subject of advancement systems from the standpoint of describing preferences of the professionals, scientists and engineers, and the resultant laboratory benefits. A common trend was for the authors and analysts, in expressing approval of the dual - ladder system, to imply that the single - ladder system does not serve the best interests of either professional employees or the laboratories and that the single - ladder system has a reductive effect on management effectiveness.

Sandia Laboratories - Albuquerque and White Sands Missile Range were selected as data points for the research, primarily, because it was found, in a recent study at these facilities, that a considerable number of professionals who rated themselves as administrators expressed a preference for the dual - ladder system and, also, because both laboratories employ the single - ladder system.

The approach used was to take standard or commonly accepted performance indicators (absenteeism, longevity, disciplinary actions, resignations, safety, security consciousness, management training, and evaluations by the responsible government agency or the higher headquarters) which, when analyzed and compared with standards, could be assumed to present an overall indication of management effectiveness of the laboratories. It was also postulated that if management at a laboratory was shown to be effective, a desired level of productivity could be assumed.

Based upon criteria established, the hypothesis was proved. However, the premise regarding productivity was not proved, it remains assumptive.

The final conclusion was that the single - ladder system does not have a reductive effect on the management effort in federal laboratories. The research showed that both advancement systems have drawbacks. The most prominent are: (1) Under the single - ladder system it is usually necessary for professionals to leave active practice of their disciplines in order to advance; therefore, this system is wasteful of professional talent. (2) Under the dual - ladder system ambiguous status exists because there are no universal meanings to titles. This system could result in stresses in identification both inside and outside the organization, with a resultant failure to achieve satisfaction of egoistic needs by those who advance by way of the professional ladder.

Chapter 1 covers the significance of the problem, background information, and research design. In the section on background information the salient points of the single - and dual - ladder systems are discussed. Chapter 2 provides the reader with physical description, organizational make-up, and general missions of the two laboratories. Chapter 3 presents results of the study. The performance indicators and comparison standards are discussed and results of the comparisons are tabulated. Chapter 4 summarizes the thesis and offers conclusions.

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Chapter 1

INTRODUCTION

General

Laboratories devoted to federal research and development (R&D) programs require more than a skilled group of professionals, a work force, physical facilities, and a set of program directives to achieve effectiveness in the R&D effort in today's environment. In response to current attitudes and growing concern by legislators over the rising costs of scientific and technological programs, top management of these laboratories recognizes a need for a competent staff of managers as well as skilled professionals and competent nonprofessionals.

The "setting" for this thesis is that very special type of organization, the R&D laboratory. Research and development facilities are distinct because of the esoteric qualities of scientific work and the multidisciplinary nature of the professional staff.[1] They can be managed in a businesslike way, but not in a way like other businesses.[2] The term R&D covers a wide range of activities. Research embodies a quest for knowledge and understanding, a pushing back of the unknown. Within this generalization, the distinction between basic research and applied research is often made,

principally in terms of what motivates the research. Basic research is conceived of as being primarily concerned with achieving fuller knowledge or understanding for its own sake, whereas applied research has the practical objective of applying the understanding. Development draws on the results of research for the design and production of new or improved products and processes, usually to meet well-defined specifications. It applies scientific and technological knowledge to the production of materials, devices, systems, and methods, as well as to the design and development of prototypes and processes.

Astute management of these scientific enterprises includes orderly planning, decision making, directing, and using modern human motivational techniques to achieve desired results. Because R&D organizations are multidisciplinary, managers at all levels have a need for special management techniques to be effective in coordinating and supervising their subordinates. There is increased emphasis on quality management and on the special skills needed by the managers in R&D laboratories. A factor which bears heavily upon the attainment and maintenance of quality management is the type of advancement system in use by the laboratories. As stated by O. Glen Stahl, the policy which an organization establishes for promotion of its personnel should be one which insures that the best talent is advanced and utilized.[3] The systems most often used by R&D facilities are the single - and the dual - ladder systems.

Many studies have been conducted and much has been written on the two systems. The results of one of the more recent studies are used as a backdrop for this thesis. This particular study was conducted by Nicholas J. Oganovic and Harold H. Leich during the winter of 1968-69. It was published in "Human Resources for Science Administration: Can Quality Be Enhanced," which is to be included as Chapter II of a book soon to be published, Issues in Public Science Policy and Administration: A Symposium.[4] The Oganovic-Leich study followed the traditional approach of determining the preferences of professionals regarding the two advancement systems. Sampling for their study was conducted at Sandia Laboratories - Albuquerque (SLA) and White Sands Missile Range (WSMR). Both employ the single - ladder system. This thesis contains data obtained through research at these facilities.

The concern of the present study, however, is personnel advancement systems as related to management effectiveness. The single - and the dual - ladder systems are comprehensively described, but comparison of the two systems for the purpose of making a determination as to which is better is not central to this thesis and is beyond the scope of the research conducted.

Explanation of Terms

The work force of a R&D facility includes a combination of professional and nonprofessional employees. The term professionals for purposes of this

thesis refers to scientists and engineers.

Scientists are all persons engaged in scientific work at a level which requires a knowledge of physical, life, engineering, or mathematical sciences equivalent at least to that acquired through completion of a 4-year college course with a major in one of these fields. Scientists in research/development, production, management, technical service, technical sales, and all other positions which usually require a scientific background are included. Psychologists and social scientists are excluded.

Engineers are all persons engaged in engineering work at a level which requires a knowledge of engineering, physical, life, or mathematical sciences equivalent at least to that acquired through completion of a 4-year college course with a major in one of these fields. Metallurgical, mechanical, chemical, electrical and all other types of engineers engaged in research/development, production, management, technical sales, and all other positions which usually require an engineering background are included.[5]

Here the terms managers and administrators are used interchangeably. Technical differences are recognized but those differences have no significance in this thesis. Managers/administrators are defined as all persons who are responsible for decision-making, planning, work relationships, task assignment, and accomplishment of organization goals through effective relationship with subordinate members of their groups and

effective utilization of resources provided.

References to personnel advancement systems do not pertain to testing for promotion purposes, seniority systems, or other technical concerns. Its usage is in terms of describing the framework of policies and procedures established by an organization, within which its employees are promoted or advanced from their entry level to more authoritative positions or to positions which provide increased financial or other extensive reward. Two personnel advancement systems are discussed: (1) The single - ladder system, in which advancement carries with it additional supervisory responsibility. Generally, under this system there is no provision for promotion based on professional competence. (2) The dual - ladder system, in which professionals are provided with promotion opportunities based on professional competence. Supervisory personnel have promotion channels, separate from the professional, in which advancements are based on their management skills and their ability to apply those skills.

The term facility is used in referring to a company, corporation, firm, or laboratory. It is an operating establishment, an independently functioning organization composed of a hierarchy and a regularly employed work force.

Those R&D laboratories involved solely in federal programs are referred to as federal laboratories. It is recognized that a contractor

operated laboratory is not a federal laboratory insofar as employees and general operating procedures are concerned.

Problem Definition

Studies such as the one conducted by Oganovic and Leich have shown that, in laboratories involved in federal R&D programs, a sizable number of scientists and engineers who rate themselves as administrators express a preference for the dual - ladder system of personnel advancement.[6] Similar studies, such as the one by William Kornhauser in 1959-60, have been conducted in the private sector.[7] Conclusions from these studies also show that professionals prefer the dual - ladder system and that utilization of the dual system results in a net benefit to the laboratories as a result of the strengthening of professional incentives. Incentives are strengthened, according to William Kornhauser, as a result of laboratories recognizing, protecting, and promoting deserving research-minded scientists.[8] An additional conclusion found in the studies is that the staff of administrators also is strengthened by the channeling of only those of managerial competence into the laboratory hierarchy.

Does the employment of the single - ladder system of personnel advancement result in reduced management effectiveness in laboratories involved in federal R&D programs? An implication that it does seems to be present in most of the study conclusions relative to single - and dual - ladder systems.[9,10,11] There is also the implication in the literature

that the single - ladder system has a reductive effect on the quality of management.[12,13,14]

Even though separate studies on the subject reflect general agreement that some benefits accrue as a result of the utilization of the dual - ladder system, it remains debatable whether those R&D laboratories which use the single - ladder system fall short of meeting management effectiveness norms.

Hypothesis

Federal laboratories which employ single - ladder systems of personnel advancement, meet management effectiveness norms as measured by evaluation of specified performance factors and compared with established standards.

FOOTNOTES

[1]Fremont E. Kast and James E. Rosenzweig, Science, Technology and Management (New York: McGraw-Hill Press, 1963), p. 73.

[2]Ibid.

[3]O. Glen Stahl, Public Personnel Administration (New York: Harper and Row, 1971), p. 158.

[4]Nicholas J. Oganovic and Harold H. Leich, "Human Resources for Science Administration: Can Quality be Enhanced?" (1969). This writing to be included, as Chapter II, within a book to be published, Issues in Public Science Policy and Administration: A Symposium.

[5]This definition was taken from the "Scientific and Technical Personnel In American Industry," National Science Foundation Pamphlet Series, (NSF 60-62).

[6]Oganovic and Leich, "Human Resources."

[7]William Kornhauser, Scientists In Industry (California: University of California Press, 1962), p. 143.

[8]Ibid., 147.

[9]Ibid., 148.

[10]Robert M. Page, "Motivation of Scientists and Engineers," Personnel Administration, Vol. 21, No. 5, (September-October, 1958), pp. 30-31.

[11]C. Wilson Randall, "The Problems of R&D Management," Harvard Business Review, Vol. 37, No.1, (January-February, 1959), p. 135.

[12]Kornhauser, Scientists In Industry, p. 137.

[13]Page, "Motivation of Scientists and Engineers," p. 31.

[14]Randall, "The Problems of R&D Management," p. 135.

Chapter 2

BACKGROUND INFORMATION

General

Most observers agree that there are important differences between managing federal R&D facilities and managing other types of enterprises, although they debate the extent and nature of these differences[1] and it is generally agreed that the differences are sufficiently great to warrant special study.[2] The distinctive characteristics of R&D laboratories contribute to conflicts. H. Dudley Dewhirst states that one area of conflict and accommodation is the contest between the professional's desire to practice science or engineering and the desire of the organization for him to become a manager.[3] Both government and private industry are constantly seeking professionals with managerial skills, and powerful pressures are exerted to encourage the young professional to direct his ambition toward administrative posts. According to William Kornhauser, professional people are being increasingly attracted to these pursuits because the extrinsic rewards are greater there than they would be if they remained on the scientific or engineering side and because the work may be more challenging.[4]

Other conflicts stem from the fact that professionals in government laboratories are often subjected to the process of structuring. This structuring involves a more or less rigidly defined hierarchy of authority; a high degree of directed activity at all levels; and a proliferation of formal policies, written regulations, job descriptions, and other regulations.[5] Structuring and required adherence to published regulations are commonplace in government facilities. Professionals, however, are accustomed to less-restricted activity. Although the constraints of structuring are disagreeable to them, according to R. Sanders and F. K. Brown, "professional adaptation mechanisms" permit them to pursue objectives in accord with professional values and modes of behavior in organization contexts such as the federal R&D laboratory.[6] A factor which is quite objectionable to many professionals is that quality control of their work is ordinarily exercised by management using programmatic guidelines rather than allowing them to judge the work in terms of internalized professional standards.

These conflicts are predictable, and they are not irreconcilable. Some facilities reduce the conflict by giving professionals opportunities to advance into management (single - ladder system), where they become involved in the control of research programs.[7] Other facilities provide a parallel channel for the upward mobility of the professional so that he

may remain in his profession and advance to levels paralleling those in management (dual - ladder system).[8]

The question of which system is the more desirable for R&D laboratories has been a continuing one among laboratory managers. It has been the subject of much discussion in writings by such analysts as William Kornhauser,[9] Albert F. Siepert,[10] and John J. McNab.[11] The many studies conducted to determine preferences of professionals include one by Oganovic and Leich[12] and one conducted in 1965 by a committee under Dr. Allen V. Astin, then Director of the National Bureau of Standards, for the Federal Council of Science and Technology.[13] Also significant is the study conducted in 1965 by the Organization and Manpower Planning Division, SLA.[14]

The following discussion of the two advancement systems describes their salient points and, in so doing, points up some of the advantages and disadvantages of each.[15] No attempt has been made to compare them for purposes of making any conclusive judgments.

As Oganovic and Leich stated in their conclusion in reference to the selection of management personnel, "The answers are still suggestive rather than definitive, and clearly much additional thought and effort need to be applied to this important problem."[16]

Single - Ladder System

A look at the two systems shows that the system most easily recognized is the single - ladder system in which advancement is on the basis of the employee assuming positions of more supervisory responsibility. Under this system professionals and nonprofessionals compete for positions in the organization hierarchy.

The system is simple to administer. The promotion ladder does not have professional or nonprofessional labels on the rungs; however, in some instances, eligibility for advancement to the next higher rung requires technical competence. This requirement would be a disadvantage for the nonprofessional. A universal quality of the single - ladder system is that the attendant supervisory responsibilites tend to become increasingly heavy at each ascending rung and, thus, burden professionals with the need to demonstrate managerial ability in order to compete successfully for promotion, regardless of their professional ability.

The single - ladder system is disrelished by many professionals because it generally means that, in order to advance, they must leave the active practice of their disciplines.

On the other hand, in referring to the attraction which advancing in management holds for some professionals, a study at a Naval R&D laboratory concluded that, "within the professional group, research goals

decrease in importance as prestige increases.[17] The most serious criticism of the single - ladder system is that it is wasteful of the laboratory's scientific resources.

Under the single - ladder system an organization does not offer promotion possibilities solely on the basis of technical competence. On the contrary, the emphasis is on managerial talents.

The one who knows the most about the technical operations of an organization or one who is held in high esteem within his discipline is not necessarily the best qualified to provide for the broader needs and activities of the organization. The criterion for advancement is generally an understanding of the essential processes of the organization, its task environment, as well as its motivational resource requirements and their relationships to organizational objectives.[18] The ability to see these relationships must be joined to the previously mentioned basic or general understanding of technical processes. In addition to the perception of relationships, the ability to synthesize these relationships into plans of action is needed.

Under this single - ladder system professionals who opt to move into management roles gain prestige and influence, as well as power to influence or make decisions about programs in which they have an interest. For professionals there are a host of other extrinsic rewards associated with management. For the laboratory, the system provides representation of technical competence at various levels within the organizational hierarchy.

The system can stifle the professional by the overburden of supervisory responsibilities. Studies indicate that professionals consider the duties associated with supervisory assignments as most constraining.[19] They report that, upon moving into management, they have little time or opportunity to continue active involvement in their disciplines.[20] A common observation is that when a good scientist is made a manager, a good scientist is lost, and any gain is unpredictable. The possibility exists that the professional would not be gifted with management abilities, which could prove disastrous for both the professional involved and the organization.

Conversely, Lynton K. Caldwell, in viewing management development training, observes that administrative development necessarily must be, in large degree, self-development.[21] He sees the function of formalized development programs as a means of broadening personal capabilities.

Dual - Ladder System

The dual - ladder system is gaining increasing interest from managers of laboratories. It is often referred to by such titles, usually suggestive of separated career channels, as other technical career program, parallel progression system, parallel path system or parallel paths, and professional classification plan. Regardless of title, the objective is the same: to provide the professional with a nonsupervisory technical career program offering advancement opportunities equivalent to those available for supervisory personnel.

This system is referred to singularly only because of the singularity of its objective, for there are several approaches to its operation. It has been described both as formal and as informal, with the formal having the following characteristics:[22]

1. The program is publicly announced.
2. There is an established professional ladder of positions.
3. Titles, status, salary, and benefits equal to or comparable with supervisory positions are officially established.
4. Appointments and promotions are appropriately announced.

The informal system is characterized as follows:

1. The program is not publicly announced.
2. Progress is not recognized in titles and status.
3. No standard salary scale is in effect.
4. Professional positions are not always equal or comparable to supervisory positions.

The system is also described by structure.[23] The "Y" type is one in which personnel enter the organization at the base and progress through a set number of levels before branching out to either the administrator side or the professional side. The "U" type is the pure separate system which utilizes two distinct ladders at the outset for employees, one for

the professional and one for the administrator.

The dual - ladder system was introduced as an improved management tool designed to encourage maximum productivity from scientists and engineers.

One of the foremost advocates of the dual system, William Kornhauser, cites some of the principal advantages of this system as: (1) The provision of greater freedom for professionals; (2) the creation of a more suitable climate for them to interact with colleagues; (3) the provision of a promotion path for professionals who may be outstanding in their disciplines, but poor as managers; (4) the provision of promotional opportunities when r anagement positions are full; (5) an increase in professional incentive with resultant increases in initiative, innovation effort, and creativity.[24]

Karl R. Van Tassel, observed that the dual system encourages the professional to devote full time and effort to scientific enterprises, without dilution of his efforts by administrative burdens.[25]

Role satisfaction generated by his satisfaction with the job environment appears to benefit the organization by increasing productivity as a result of the professional being more highly motivated.[26]

Dr. Howard M. Vollmer, in discussing professionalism and bureaucratization in scientific enterprises, stated that once the professional

has what he considers an adequate salary and fringe benefits, nonmonitary incentives, especially challenging work within his discipline, have more motivational impact on his performance than the offer of status and prestige associated with management.[27] This pertains more to those professionals engaged in basic research; it applies to those at the development end of the R&D spectrum to a lesser degree.[28]

A benefit which the laboratory may realize as a result of utilization of the dual system is a possible improvement in the quality of management personnel. The employment of a dual - ladder system, of necessity, creates a clearer avenue upward for the qualified management specialist. Those individuals with special skills in organizing, staffing, directing, and decision-making, plus the ability to understand and to motivate people, can achieve advancement without being challenged by technical competence as a criterion. Additionally, the dual system allows the laboratory to be more precise in the selection of those whom they advance in management roles and whom they identify as future managers.

The disadvantages of the dual - ladder system, however, are more numerous than one may imagine. Herbert A. Shepard feels that the professional ladder may prove to be a convenient place for management to shove unwanted staff members.[29] This "putting out to pasture" can be a dominant factor during the period of transition from the single to the dual

system. Shepard also states that the assignment of an individual to the professional ladder may be construed by associates to mean that he lacks the broad knowledge required of those in management, and this may serve to discourage the professional from striving for excellence.[30] This system can be divisive or, at least, create a strained relationship between those on the professional side and those at the various supervisory levels. Observers state that R&D managers must take into account the professional's questioning attitude toward organizational policies and procedures, his insistence on freedom, and his dislike for any diversionary influences.[31] Professionals are said to be difficult to manage because of their natural inclination toward independence and freedom from regulatory constraints.[32] An especially difficult situation arises when the supervisor is a lower paid employee.

C. West Churchman states that professionals are inconsistent in their attitude toward management. He observes that they prefer that management make no decisions regarding technical aspects of research projects, yet they have an appreciation for the importance of the management effort.[33]

Frank D. Leamer, expressing concern over titles, states that the career programs tend to confuse titles denoting authority with titles denoting merit.[34]

According to the study done in 1965 by the Sandia Laboratories Organization and Planning Division, the dual - ladder system has moved only little beyond the point of being theory or, at most, an experimental personnel plan.[35]

Some of the problem areas are: (1) Lack of understanding of what professionals really want, freedom to function within their discipline or simply freedom from supervisory responsibilities, "professional retreat;" (2) absence of proven models to use in studying the system; (3) absence of standard titles for the different steps, or "rungs," of the professional ladder; and (4) absence of a commonly recognized title for the system.[36]

The study, "The Use of Technical Career Programs in Large Research and Development Laboratories," includes a comprehensive analysis of the advantages, disadvantages, and problem areas associated with the dual system.[37] This highly relevant analysis is incorporated into this thesis as Appendix B.

The advocates of the single - ladder system proclaim that the prestige associated with being a part of management and the fringe benefits that are provided to those in the management hierarchy are sufficient to motivate scientists and engineers to strive for excellence in the anticipation of advancement into management channels.[38] On the

other hand, those who favor the dual - ladder system insist that contributions of scientists and engineers are improved quantitatively and qualitatively under this system because of professional incentives and the opportunity to advance and yet remain with their disciplines.[39]

From the foregoing, we can conclude that although the dual - ladder system may have some merit, it is not problem -free. Likewise, problems exist in the single - ladder system. The advantages, disadvantages, and problem areas presented in this chapter are only a few of those which need investigation.

Significance of the Problem

Traditionally, in the old-style industrial or federal laboratory, advancement in grade and status came chiefly by promotion into supervisory and managerial posts.[40] As mentioned previously, this situation led excellent professionals to leave the field of their competence to flounder unhappily in their new management jobs.[41] The foregoing typifies the analysis of the single - ladder system of personnel advancement by such writers on the subject as Oganovic and Leich, Kornhauser, and Vollmer.[42, 43, 44] There is an apparent trend to herald the dual - ladder system as a long-overdue change in personnel administration. By implication it establishes a premise that the single - ladder system falls short of providing adequate advancement opportunity and motivational factors for

professionals in the laboratory. A second implication is that there has been neglect in the cultivation of administrative talent.

The tendency to focus so completely on which of the systems of personnel advancement is more satisfying often obscures the basic reason that laboratory managers seek the "better" system. Their unrelenting concern is to use that system which will give them increased probability for maximizing productivity. However, one of the real predicaments facing R&D laboratories is the doubtful adequacy of methods being used for evaluations of effectiveness of performance relative to expectations, cost, and productivity. There are important reasons why there is need for these evaluations. Foremost is the fact that R&D is competing in the national arena for program funding, and it is reasonable to assume that those persons or agencies controlling the allocation of funds are more favorably impressed if they are shown that the facilities involved are judged, under some criteria, to have effective management.

In looking at productivity in R&D laboratories, there are several factors to consider. Productivity is generally accepted as an end-result variable.[45] Its measurement usually provides neither adequate information about the causes of the desired or undesired results nor the best clues to guide decisions regarding which processes to delete, modify, or emphasize to bring about increases.[46] In laboratories the problem is made more complex

by the inability to establish a reliable scale by which to measure productivity, or end results. In many cases the objective sought cannot be counted or measured. Achievement often can be assessed only in terms of progress toward a scientific solution or contribution toward the accomplishment of a technological process. Productivity viewed as end results of R&D laboratory efforts cannot be regarded in the same light as the productivity one sees in a production plant. The measurement of effectiveness must be based on different criteria.[47]

The output, or results achieved in a laboratory, is a manifestation of the efforts contributed by the work force, particularly the professionals, and reflects responses to goal-setting, decision-making, directing, and the leadership provided by management.[48] By deductive reasoning the premise is established that if effective organizational management exists within a laboratory, a desirable level of productivity also exists.

One can assume that enlightened R&D laboratory managers recognize a need to cultivate role satisfaction among professionals because of its reputed effect upon productivity.[49] Likewise, one can assume that managers recognize the importance of an effective staff of subordinate managers. To provide for both, they are often driven to experimenting with various advancement systems to find one which will meet the needs of the organization in both respects. The selection of the proper system

allows for a greater probability of maximizing productivity.[50]

Research Design

In planning the direction of research for this thesis, it was understood that the measurement concept to be employed had limitations; the resultant findings should be recognized as data dedicated to future considerations rather than as criticisms or oblique commentaries on existing systems.

Research was designed and executed as follows:

1. The Nicholas J. Oganovic and Harold Leich study of scientist and engineer preferences with regard to the single - or dual - ladder system of personnel advancement was used as a basis for this study because it established that a sizable number of professionals at Sandia Laboratories - Albuquerque and White Sands Missile Range, SLA and WSMR, who rated themselves as managers expressed a preference for the dual - ladder system. (This study is included as Appendix A.)

2. The above-cited study was conducted at SLA and WSMR. These facilities employ basic single - ladder systems of personnel advancement which were used as data points for this study.

3. Factors, or indicators, used to determine the effectiveness of

organizational management are: absenteeism, longevity, management training, and evaluations by responsible government agencies.

4. Research accomplished at the selected facilities utilized statistics compiled on laboratory-wide performance. The research centered in the offices of managers of Personnel, Security and Safety. Pertinent observations of managers at the director level down through the first-level supervisors were obtained through both interview and conversation. Additionally, it involved a review of records and statistics published by the responsible government agency (United States Atomic Energy Commission for SLA) or headquarters (Test and Evaluation Command; Army Materiel Command, Department of Army for WSMR).

Research Methods

Through a measurement of efficiency of operations in R&D laboratories, we can arrive at an objective assessment of management effectiveness.[51] A recognized procedure for measuring efficiency is to analyze profits.[52] The foregoing is true in the private sector where the profit motive provides the main impetus and profit data are available for use as a measuring scale. Our concern here, however, was with laboratories

devoted wholly to federal R&D programs. These laboratories are expected to operate within normal standards of efficiency; however, it is not unusual that situations occur where certain objectives must be achieved with no regard for cost or economy.

Denied profits as a tool for evaluation, we adopted a different approach to measure management effectiveness: We took standard or commonly accepted performance factors which, when analyzed, could be assumed to present an overall indication of the quality of management.

For the purpose of this thesis, management effectiveness in the organizations under study is defined as being composed of the following elements: motivation, job or role satisfaction, initiative, and congruence of individual and organizational goals.[53] Specific factors used as indicators of the existence of management effectiveness are:

1. Absenteeism
2. Longevity
3. Disciplinary Actions
4. Resignations
5. Safety
6. Security Consciousness
7. Management Training
8. Evaluations by Responsible Government Agency or Headquarters.

Some analysts would prefer to take the organization statistics relating to the above factors and compare them with national statistics to determine management effectiveness. This method would have the natural advantage of basing the comparisons on norms established by a broad base. Another method, the one selected for this research, is to compare the statistics of the facility with statistical norms created by the responsible government agency or headquarters of the operating organization. For Sandia Laboratories (SLA), these norms are based on the periodic inspections conducted by the U. S. Atomic Energy Commission (USAEC) through the Albuquerque Operations Office (ALO); for White Sands Missile Range, by the Department of Army (DA), the U. S. Army Materiel Command (AMC), or the Army Test and Evaluation Command (TECOM). This method has the advantage of using norms which are rooted in national statistics but modified to fit the particular laboratory. An added advantage of this method is that, as a result of frequent inspections by the responsible government agency or headquarters to exploit apparent program strengths and to correct program weaknesses, the norms can be constantly updated.

It is assumed that the periodic inspections and appraisals by the USAEC, DA, AMC, and TECOM produce valid findings and that the recommendations and ratings are factual and reasonably value-free.[54]

The research involved an examination of current and historical statistics compiled on a laboratory-wide basis. It centered in the offices of the managers of Personnel, Safety and Security, where the records and statistics are maintained and where illuminating information to supplement the hard data could be obtained by interviews with the managers or their representatives. Additionally, it involved a review of records and statistics published by the offices of the AEC and TECOM, where the bases for norms are established and where records of observations, inspections, surveys, and appraisals are maintained.

The descriptions in Chapter 3 provide a better understanding of the physical make-up and organizational structure of SLA and WSMR. Chapter 4 contains the measurement and analysis of the factors to determine the degree of management effectiveness. Chapter 5 comprises the summary and conclusions.

FOOTNOTES

[1]E. S. Kescocks, Laboratory Administration (New York: Macmillan and Co., Ltd., 1956), p. 47.

[2]Ibid., p. 47.

[3]H. Dudley Dewhirst, "Impact of Organizational Climate On The Desire to Manage Among Engineers and Scientists," Personnel Journal, (March, 1971), 196.

[4]William Kornhauser, Scientists In Industry (California: University of California Press, 1962), p. 139.

[5]W. Richard Scott, "Reactions to Supervision in a Heteronomous Professional Organization," Administrative Science Quarterly, Vol. 10, (April-June, 1960), p. 65.

[6]Ralph Sanders and Fred K. Brown, Science and Technology: Vital Assets. An article prepared for the Industrial College of the Armed Forces, Washington, D. C., (1966), p. 34.

[7]Information received by the Author through interviews with professionals at SLA and WSMR.

[8]Ibid.

[9]Kornhauser, Scientists In Industry, p. 143.

[10]Albert F. Siepert, "Creating the Management Climate for Effective Research in Government Laboratories," The Management of Scientists (Ohio: Beacon Press, 1964).

[11]John J. McNab, "Preparing Scientists for Management," The Bridge Between Science and Management, (October 1964).

[12]Nicholas J. Oganovic and Harold H. Leich, "Human Resources for Science Administration: Can Quality be Enhanced?" (1969). This writing to be included, as Chapter II, within a book to be published, Issues in Public Science Policy and Administration: A Symposium.

[13]Allen V. Astin Committee. The Astin Committee conducted this study for the Federal Council of Science and Technology in 1965.

[14]This study was conducted among 99 large research and development laboratories (each having at least 250 professionals) by the Organization and Manpower Planning Division, SLA. The study was published under the title, The Use of Technical Career Programs in Large R&D Laboratories.

[15]This discussion generally summarizes the assertions found in the writings of previously named authors and in conclusions of aforementioned studies.

[16]Oganovic and Leich, "Human Resources," p. 76.

[17]Clovis Shepherd and Paula Brown, "Status, Prestige and Esteem in a Research Organization" Administrative Science Quarterly, Vol. 1, (January-April, 1956), p. 352.

[18]Lynton K. Caldwell, "Identification and Development of Administrative Talent," (1969), p. 33. This writing to be included as Chapter III, within a book to be published, Issues in Public Science Policy and Administration: A Symposium.

[19]Most studies reviewed, particularly the ones conducted by Kornhauser in 1959-60 and Oganovic and Leich in 1969-70, concluded that the assignment of management functions to professionals placed constraints on them and de-emphasized professional concerns in favor of organizational concerns. Additionally, a common conclusion noted was that once separated from their basic professions, following management assignments, professionals participated very little in active practice of their basic profession.

[20]Ibid.

[21]Caldwell, "Identification and Development of Administrative Talent," p. 28.

[22]Taken from a paper written by personnel of the Organization and Manpower Planning Division, SLA, The Dual Ladder System, (1965).

[23]Ibid.

[24]Kornhauser, Scientists In Industry, p. 145.

[25]Karl R. Van Tassel, "Managing Research and Development," Research Management, Vol. VIII, No. 3, (1965).

[26]This is the Author's opinion, based primarily on interviews and conversations with managers at SLA and WSMR. A common assertion was that above average programmatic progress could be expected from highly motivated professionals. This was more frequently stated by managers involved in engineering and developmental projects than by those involved in research.

[27]Howard M. Vollmer, "A Preliminary Investigation and Analysis of the Role of Scientists in Research Organizations." An article published by the Sanford Research Institute for the Air Force Office of Scientific Research, (1962), 47-55.

[28]Ibid.

[29]Herbert A. Shepard, "The Dual Hierarchy in Research," Research Management, (Autumn, 1958), p. 37.

[30]Ibid.

[31]This viewpoint was expressed by several of the managers at SLA and WSMR during interviews and conversations with the Author. It appeared to be common consensus that professionals incline toward independence and self-motivation.

[32]Ibid.

[33]C. West Churchman, "Task Setting and Goal Achievement in Techno-Scientific Missions." This writing to be included, as Chapter VIII, within a book to be published, Issues in Public Science Policy and Administration: A Symposium.

[34]Frank D. Leamer, "Professional Administrative Ladders: The Advantages of Broad Job Classification in a Research Organization," Research Management, (Spring, 1959), p. 119.

[35]Organization and Manpower Planning Division, SLA, The Use of Technical Career Programs, Appendix D, (1965).

[36]Ibid.

[37]Ibid.

[38]Shepard, "The Dual Hierarchy in Research," p. 37.

[39]Ibid.

[40]Oganovic and Leich, "Human Resources," p. 28.

[41]Ibid.

[42]Ibid.

[43]Kornhauser, Scientists In Industry, p. 136.

[44]Vollmer, The Role of Scientists, p. 48.

[45]Rensis Likert, The Human Organization (New York: McGraw-Hill Book Company, 1967), p. 131.

[46]Ibid., p. 133.

[47]The literature on management and productivity is extensive. The following works contain useful analysis of the subject: George P. Bush and Lowell H. Hattery, Scientific Research: Its Administration and Organization (Washington, D.C.: The American University Press, 1950). Rensis Likert, The Human Organization (New York: McGraw-Hill Book Company, 1967). James B. Quinn, "How to Evaluate Research Output," Harvard Business Review, (March-April, 1960).

[48, 49, 50]Ibid.

[51]Quinn, "How to Evaluate Research Output," pp. 69-80.

[52]Ibid.

[53]In searching literature this Author found that, in assessing the effectiveness of management effort, motivation, job or role satisfaction, initiative and congruence of individual and organization goals were objective factors frequently used. Specific indicators such as absenteeism, longevity, disciplinary actions, resignations, safety, etc., had characteristics for measurement and thus provided a means for assessing management effectiveness.

[54]USAEC, through its Albuquerque Operations Office, provides oversight for SLA. The Albuquerque Operations Office conducts periodic appraisals of SLA operations. WSMR has three higher headquarters, immediately higher is TECOM, next is AMC and then DA. All of these higher headquarters make periodic inspections of WSMR.

Chapter 3

PROFILES OF SANDIA LABORATORIES AND WHITE SANDS MISSILE RANGE

Introduction

In 1968-69 Oganovic and Leich completed a study designed to "throw some light" on the attitudes of scientists and engineers, working in management positions, toward the single and dual hierarchy.[1] The laboratories chosen for the study were Sandia Laboratories - Albuquerque and White Sands Missile Range. Using the findings and conclusions of that study as a backdrop, this researcher sought to evaluate SLA and WSMR personnel advancement systems as related to measurable management effectiveness.

To provide for a better appreciation of the environment in which SLA and WSMR managers function, we examine, in this chapter, the organizational structures of the two laboratories.

In order to accomplish their objectives, laboratories are divided into a network of jobs and positions into which individuals are fitted. This structuring is a management tool in itself, because it is a means of integrating the efforts of those who make up the organization. If the structuring is such that coordination and communication between elements

is difficult or that the efforts of the work force cannot be integrated, the result will be lowered productivity.

To complete the picture of the environmental setting, this chapter includes descriptions of the physical make-up, some historical data, and the established missions of the two laboratories.

Sandia Laboratories

Sandia Laboratories - Albuquerque is located at Kirtland Air Force Base - East (formerly Sandia Base), about five miles east of downtown Albuquerque. The laboratory facilities are the property of the U. S. Atomic Energy Commission and are operated by SLA on a contractual basis. SLA is the corporate headquarters of the Albuquerque laboratory; the Livermore laboratory, Livermore, California; and the Tonopah Test Range at Tonopah, Nevada.

This contractual relationship was established in 1949 when the University of California, which was operating both the Los Alamos Scientific Laboratory and the laboratory at Sandia Base, declined to renew its contract for the Sandia operation. The Bell System agreed to take over the operation on a cost reimbursement, no-fee, no-profit basis. Sandia Corporation (later redesignated Sandia Laboratories) was formed as a wholly owned subsidiary of the Western Electric Company for the purpose of operating the laboratory. The contract between Western Electric and

the AEC was dated October 6, 1949.

The contract, symbol AT(29-1)-789, has continued in effect since that date. Its terms require renewal every five years, with the current expiration date December 31, 1973.

Physical Description

At Kirtland AFB - East, the laboratory occupies 2,065 acres, arranged in four fenced areas: Area I contains the main offices and main laboratory; Area II (45 acres) contains facilities devoted to explosive research; Area III (1,893 acres) comprises environmental research test facilities and a seven-acre training area. Use is also made of 750 acres of unfenced AEC property and approximately 35,500 acres available through agreements with the Department of Defense.

The R&D activities at the laboratory in Albuquerque are conducted in 180 buildings containing 2,215,000 square feet of work area. Fifty percent of the buildings, containing 80% of the work area, is located in Area I.

Tonopah Test Range at Tonopah, Nevada, occupies 634 square miles. It is devoted to field testing of atomic weapon shapes, components and research rockets. Data presented on SLA include Tonopah statistics, but do not include information on the laboratory at Livermore.

Mission

SLA is one of three AEC nuclear weapons laboratories. As a design laboratory, it is responsible for the design of shapes, the structures, and the electrical and mechanical components which convert nuclear systems into weapons which meet Department of Defense requirements. Its responsibilities in ordnance engineering involve: (1) basic and applied research into new weaponry concepts, (2) systems engineering and component development, (3) testing (development, full-scale, destruction, and non-destruction) both in the laboratory and in the field, (4) manufacturing and engineering; (5) quality assurance and stockpile surveillance to guarantee reliability and safety, and (6) military liaison and training. In summary, the SLA mission is to conduct research in electronics, aerodynamics, solid state physics, and in devices needed to assure quality of weapons which can survive all the environments presented by operational requirements and enemy challenge.

Organizational Structure

SLA is organized on the basis of classical line/staff structure, with a president as the chief executive. The president, executive vice president, nine vice presidents, and two managing directors constitute the policy-making body referred to by SLA management as the "small staff." The "small staff" plus 33 directors make up a lower policy-making group referred to as the "large staff."

Reporting to the directors are the department managers. Reporting to the department managers are division supervisors, who generally constitute the first level of supervision. However, to reduce span of supervisory control, certain large nonprofessional, nonstaff departments (e.g., Maintenance, Personnel) do establish sections and designate section supervisors, who report to division supervisors.

A firm line relationship exists, and normally the channels established by the line-type organization are adhered to vertically (upward and downward). To a large extent, interactions between organizational units are between individuals on equivalent levels.

Functional groupings, regardless of the level, are identified by organization number. For example, the office of Vice President, Personnel, is identified by Organization Number 3000. He is responsible for the administration of all organizations in the 3000 series; likewise, the office of a director who reports to him, identified by Organization Number 3100, is responsible for all organizations in the 3100 series. This numerical designation continues down through the lowest grouping. A common practice at SLA is to refer to the functional groupings by organization number rather than by titles.

Compensation

Compensation often figures into the debate over personnel advancement systems. SLA employs a pay system which is arranged into three

categories, based on how employees are rated (annually, monthly, weekly, or hourly) and how they are paid (monthly or weekly). The categories are: annually rated, monthly paid; weekly rated, weekly paid; and hourly rated, weekly paid.

TABLE 1

SANDIA LABORATORIES PERSONNEL STATISTICS[2]

Category	Supervisory	Nonsupervisory	Total
Professional Technical Staff (scientists and engineers)	295	1270	1565
Laboratory Staff (administrators)	190	550	740
Subprofessional Technical Staff (technicians)	--	1130	1130
Laboratory Staff (Administrative assistants)	--	520	520
Operations (general supervisors of graded employees)	170	10	180
Graded Employees (office and clerical, craftsmen, operators, laborers, and service workers)	--	2165	2165
TOTALS	655	5645	6300

White Sands Missile Range

White Sands Missile Range is a government owned and operated facility, qualifying as a developmental laboratory because of the nature of its mission. It is one of three national missile ranges; the others are Pacific Test Range and Cape Kennedy. In terms of land area, WSMR is the largest.

WSMR is located approximately five miles south of US Highway 70-82, not quite midway between Las Cruces, New Mexico, and Alamogordo, New Mexico. Actually, this is the location of the WSMR headquarters and technical areas (not the total WSMR), for the entire range covers in excess of one million acres, extending northward almost to Soccorro, New Mexico. Safety zones do, in fact, extend to Soccorro.

WSMR, designated as White Sands Proving Grounds, came into existence in 1945. One cannot describe White Sands without taking the backward glance to mid-July 1945, when the historic blast at Trinity Site shook the world. This detonation of the world's first atomic device occurred just one week after the establishment of the Proving Grounds. Aside from providing site support as well as some administrative support, White Sands played only a small part in that drama, but it set the tone for the future of the facility. The Proving Grounds was redesignated White Sands Missile Range in 1958. Today it is probably the most complex and sophisticated weapons testing laboratory, with more varied capabilities,

in the world. It supports missile development and test programs for the Army, Navy, Air Force, National Aeronautics and Space Administration (NASA), and other government agencies.

WSMR is a Department of Army facility and operates as a subordinate of the Army's Test and Evaluation Command (TECOM), which has headquarters at Aberdeen Proving Grounds, Maryland. TECOM reports to the Army Materiel Command, Headquarters, Washington, D.C.

Physical Description

WSMR controls 1,838,783 acres of land, or roughly 4,000 square miles. Unlike Sandia, there is no simple identification of specific areas. At WSMR there are in excess of 1,000 instrumented ranges, observation and tracking sites (e.g., optical, radar, photo), launch complexes, maneuver areas, telemetry sites, etc. Data from these areas, ranges and sites, and from recovered debris are funneled into the "Technical Area," where the laboratories are located and where scientists, engineers, and technicians evaluate the inputs. The Nuclear Effects Laboratory, which explores in the sphere of interest that its name implies, is located in an area separate from the Technical Area.

Mission

A general mission statement of WSMR is that it: (1) provides and operates a national missile range in accordance with Army Test and

Evaluation Command directives; (2) conducts engineering tests and evaluations; (3) supports the conduct of, and directs other tests on, rocket and guided-missile systems and other material as assigned, including Army Air Defense Fire Distribution Systems and associated equipment; (4) conducts research and development pertaining to range instrumentation as directed; and (5) conducts other activities as directed.

The mission was given to WSMR when it was established in 1958 and has been modified only slightly since then.

Organizational Structure

To accomplish its mission, WSMR is organized in directorates. It is a military facility, resulting in a combination of military and civilian personnel, with military personnel assigned as directors of the seven directorates and functioning as managers of other major activities.

The structure is a rather flat hierarchy of three levels. At the top are the commanding general and his deputy plus the top civilian executive, whose office is designated Technical Director and Chief Scientists. The first level below these offices is the director level. The directors are military personnel with what amounts to civilian counterparts; in some cases, the role of the military person in the hierarchy is one of oversight rather than of one in which he is the primary responsible operator. On the same level with the directors are chiefs and managers of separate

offices (e.g., information, safety, plans, security), some of which are managed by military personnel and some by civilian personnel. Reporting to the directors are the branch supervisors, who constitute the first level of supervision at WSMR. The system does provide for the organization of sections and units, with section chiefs and unit leaders, in large directorates (e.g., Logistics) and in large functions such as communications.

The relationships between organizations and offices generally follow channels established by the hierarchial arrangement; however, operational considerations or task requirements allow departures from any established channels.

The organizations and offices are referred to by their function titles at WSMR. An organization number system is not employed.

Compensation

The compensation systems at WSMR are dictated by the different employment sources: (1) Military personnel are paid according to their rank; (2) employees holding General Scheduling (GS) ratings are paid on the basis of their ratings and time in grade; (3) wage grade employees, sometimes referred to as wage board or as blue collar workers are paid hourly wages based on determinations made in accordance with federal directives.

TABLE 2

PERSONNEL STATISTICS, WSMR [3]

Category		Total
Professional (scientists and engineers)		570
Professional and Subprofessional (lawyers, accountants, doctors, technicians, and personnel in other career programs)		353
Subprofessional (clerical, draftsmen, some craftsmen, service personnel, and other GS employees)		1511
Wage Grade Employees (craftsmen, maintenance, and service personnel)		1209
Civilian Personnel	3643	
Military (officers and enlisted)	1076	
TOTAL	4719	
GRAND TOTAL		4719

Both SLA and WSMR are well-established, mature organizations. Both employ the single - ladder system of personnel advancement within standard line and staff organizational structures.

FOOTNOTES

[1]Nicholas J. Oganovic and Harold H. Leich, "Human Resources for Science Administration: Can Quality be Enhanced?" (1969), pp. 50-73. This writing to be included, as Chapter II, within a book to be published, Issues in Public Science Policy and Administration: A Symposium.

[2]Adapted from personnel statistical data compiled and maintained by the SLA Personnel Data Systems Division. The figures are as of June 30, 1971, rounded to the nearest five.

[3]Adapted from the WSMR Annual Report on Civilian Personnel Management Program (FY 1971).

Chapter 4

MEASUREMENT AND ANALYSIS OF ORGANIZATIONAL MANAGEMENT EFFECTIVENESS

General

It may be observed, through man's history, that fundamental decision-making and other relevant actions associated with management have been essential to progress and accomplishment. However, we can trace to relatively recent times the identification of management as a distinct function performed by uniquely talented individuals. This is especially true with regard to the management effort in the scientific community.

Prior to the Second World War, scientific enterprises were so small and their projects so limited that requisite management was well within the capabilities of those who themselves were engaged in the research processes.[1] However, following the giant strides that science began during the Second World War and continued in the immediate postwar years, laboratory management gained recognization as an essential ingredient to successful operation.

As "development" became consistently coupled with "research," the term research and development (R&D) came into general use.

Research and development is a composite term which covers a wide range of scientific and technological activities extending from the most esoteric and abstract theories to completed devices for tests and evaluations. Laboratories have become more and more multidisciplinary. Their missions have grown tremendously and today some facilities have work forces that number in the thousands.[2] They have all the appearance and characteristics of large industrial plants.

This increase in size and in scope of operations, incorporating a vast mixture of professionals, technicians, and skilled and unskilled workers, has resulted in the need for application of all the modern management concepts and practices in the laboratories, especially relative to human and social aspects. Research indicates that latent potentialities for higher productivity among this mixed work force may be expected if effective management exists in the organization.[3]

Why, one may ask, this great concern over laboratory management? The answer lies in changing eras. The scientific revolution, like the industrial revolution before it, has reached its inevitable peak. The amounts of money that this country has been spending under the heading of R&D during the past 30 years is nothing short of spectacular. Now, dimensions have been established. In government owned and operated laboratories, such as WSMR, and government owned, contractor operated

laboratories, such as SLA, funding is a major concern. Favorable budgetary considerations, in this era of scarce dollars, are often based on critical evaluations and judgments of operational effectiveness with regard to productivity. As previously mentioned, it is reasonable to assume that those persons or agencies controlling the allocation of funds are more favorably disposed to allocate requested funds to facilities that are judged, under some criteria, to have effective management effort.

Harbison and Myers state that management is the key element affecting the productivity of labor.[4] Chris Argyris challenged management to provide an organization environment in which everyone has a chance to mature by satisfying his own needs while working for the success of the organization.[5]

In analyzing the management effectiveness of SLA and WSMR, it is assumed that the variations of work, of physical and climatic conditions, of other natural features of the geographical areas, of social characteristics of the respective locations, and of other environmental factors have no lesser or greater influence on personal decisions regarding occupation than the same factors have in other geographical areas.

To determine whether SLA and WSMR meet management effectiveness norms, we have measured their management effort by the analysis of their performance relative to specified performance indicators: absenteeism,

longevity, disciplinary actions, resignations, safety, security consciousness, and management training, and evaluations by headquarters or the responsible government agency. These indicators are selected because they are commonly accepted by such government agencies as the AEC and the Department of Defense as indicators of the adequacy of overall management performance at R&D laboratories for which they have responsibility.[6]

Government agency or headquarters records and reports from which the data for this thesis were taken are replete with comparative statistics and averages relating to the performance of contractor operated, or subordinate, facilities. These statistics are used, in this thesis, as standards against which the averages of the facilities being examined are measured.

The statistics on SLA employee performance relative to the performance indicators are averages obtained from the SLA Personnel Data Systems Division, the Security and Safety Standards Department, and the Organization and Manpower Development Division.

The standards to which the SLA averages are compared were adapted from data obtained at ALO, which is the responsible government agency for SLA and seven other major prime contractor facilities operated under contractual agreement with the AEC. The statistics depict either averages from all seven of the facilities or samplings sufficient to assure a

representative average. These averages are shown in the tables as "standards (for comparison)."

The statistics on WSMR employee performance relative to the indicators are averages obtained from records and statistical data in the WSMR Technical Services Branch, Civilian Personnel Division; the WSMR Security Office; and the office of the WSMR Provost Marshal.

WSMR reports directly to the U. S. Army Test and Evaluation Command (TECOM). TECOM reports to the Army Materiel Command (AMC), which in turn reports to the Department of Army (DA). The standards to which WSMR statistics are compared were adapted from data compiled in annual reports published by these headquarters.[7] Only data on civilian personnel were extracted for use.

In examining the performance of these laboratories, there has been no attempt to apply behavioral theories or theories on motivation and attitudes or to make any critical analyses in those respects. The concern here is for an evaluation of management effectiveness, further described as a comparative overview of performance as measured by the performance indicators named in Chapter 1.

SLA and WSMR were selected as data points primarily because they were previously sampled in a similar study and because they both employ

the single - ladder system of advancement. Their physical features, security requirements, organization, mission, and operational aspects are completely different. The reader should bear this in mind, and not attempt to make comparisons between the two laboratories in reviewing the tables that follow.

Absenteeism

O. Glen Stahl has observed that the whole process of production is a cooperative venture between workers and management.[8] Economic losses are suffered within a facility because of absenteeism and they may be multiplied because of the repercussive effect on the overall work force.

TABLE 3

COMPARISON OF SICK LEAVE USAGE AT SLA
(hours per employee)

SLA	57.6
Standard (for comparison)	58.2

TABLE 4

COMPARISON OF SICK LEAVE USAGE AT WSMR
(hours per employee)

WSMR Civilian Employees	66.0
Standard (for comparison)	68.4

Aside from an employee's own values regarding absenteeism, prime factors that are significant in controlling his attendance are job satisfaction and attitudes toward management and his immediate supervisor. The statistics used in this comparison are sick leave usage. It is a logical measure because of constant concern by federal agencies over sick leave abuses. Statistics represent the average number of sick leave hours used, per employee, for FY 1971.

Longevity

There are many explanations for individuals remaining on a job. Only by careful study of particular situations can it be determined what factors are predominant at any particular facility. High on the list of reasons applicable at most facilities, however, is perceived role satisfaction. Effective management contributes to this role satisfaction.

TABLE 5

COMPARISON OF LONGEVITY AT SLA
(years)

SLA	12.0[9]
Standard (for comparison)	12.0

TABLE 6

COMPARISON OF LONGEVITY AT WSMR
(years)

WSMR Civilian Employees	16.8[10]
Standard (for comparison)	13.1

Disciplinary Actions

Policies relating to disciplinary action are necessary in all organizations because of the inevitability of occurrences which require the application of disciplinary measures. These policies are usually parts of a program of penalties for the violation of rules, nonperformance of duties, abuses of privileges, or other types of offenses. However, any organization which has a record of disciplinary actions which, upon examination, appears to be excessively high has cause for concern. Excessive use of punitive measures within an organization indicates a possible weakness in management policy and a strong possibility that employees lack concern and respect for management. These types of actions are usually recorded in the personnel record of the individual punished. Not included are verbal admonitions, for minor offenses, handled by first-level supervisors. At SLA written or oral admonitions for security infractions are not recorded by the personnel organization.

TABLE 7

COMPARISON OF DISCIPLINARY ACTIONS AT SLA
(actions per 1,000 employees)

SLA	5.2
Standard (for comparison)	8.1

TABLE 8

COMPARISON OF DISCIPLINARY ACTIONS AT WSMR
(actions per 1,000 employees)

WSMR Civilian Employees	2.9
Standard (for comparison)	9.1

Resignations

The concern here is for the voluntary "quit." A high rate in this category is a danger signal because of the impairment of morale which is likely to accompany a high turnover rate. A high turnover rate may indicate that a general condition of low morale exists within the organization. All other factors being equal, the well-managed work force shows a low turnover rate. Tables 9 and 10 show the percentage of the total work force which terminated employment at WSMR and SLA for their own personal reasons in 1971.

TABLE 9

COMPARISON OF RESIGNATIONS AT SLA
(voluntary quit)

SLA	4.0%
Standard (for comparison)	5.0%

TABLE 10

COMPARISON OF RESIGNATIONS AT WSMR
(voluntary quit)

WSMR Civilian Employees	3.1%
Standard (for comparison)	5.8%

Safety

An accident prevention and safety program not only reflects concern for the well-being of the employees, but is a management tool designed to eliminate production losses. A safety program requires the full participation and support of the entire work force. A successful program is indicative of employee response to the direction provided by management.

TABLE 11

COMPARISON OF ACCIDENTS PER CAPITA AT SLA
(based on work force totals)

SLA accident rate (motor vehicle)*	1.32
Standard (for comparison)	8.50

TABLE 11 Continued

SLA disabling injury frequency rate**	3.09
Standard (for comparison) (3-year average) disabling injury frequency rate)**	1.26

*Rate = $\frac{\text{accidents} \times 100,000}{\text{miles driven}}$

**Number of injuries per million man-hours.

TABLE 12

ACCIDENTS PER CAPITA
(based on work force totals)

WSMR Civilian Employees	0.0019
Standard (for comparison)	0.0030

Security

It was estimated by one organization that it cost $6.14 to provide the prescribed protection for just one Top Secret document for one year.[11] The overall costs which facilities pay for the protection of classified documents, information, and material are staggering.[12] It is all for naught, however, if the work force is prone to be careless in everyday security practices. It is generally believed that security consciousness among a work force is the result of positive response by the work force to management's guidance in this regard. Minor security infractions, are, in most cases, the result

of carelessness on the part of employees. These breaches of regulations usually result in some type of disciplinary action being taken against the offender (admonition, written reprimand, or suspension for a day or two). A well-managed work force has a low incidence of security lapses.

TABLE 13

COMPARISON OF SECURITY INFRACTIONS AT SLA
(totals for CY 1971)

SLA	62
Standard (for comparison)	57

TABLE 14

COMPARISON OF SECURITY INFRACTIONS AT WSMR
(totals for FY 1971)

WSMR Civilian Employees	4
Standard (for comparison)	3

Management Training

Formal management development training (which includes Civil Service Commission conducted courses, agency seminars, conferences, and training programs in universities) is credited with having a strong influence on the improvement of the quality of management within a facility. It is especially useful in assuring continuity and providing for the transition of the professional into management.

Another school of thought is that, in developing managerial talent, opportunity and guided exposure to the challenges of management are more important than the learning of fundamentals and techniques in a classroom situation.[13] Lynton K. Caldwell stresses this philosophy and emphasizes that self-development and on-the-job experience are vital to the development of managers.[14] Conferences and seminars in support of the on-the-job experience, however, should increase the effectiveness of this type of training, as well as provide opportunities for refresher training and keeping abreast of modern management concepts.

One can assume, therefore, that forward-looking organizations seek to maintain quality management by, among other things, establishing management development programs.

The Department of Army and WSMR place emphasis on formal management development training utilizing the conducted courses and university program approach. WSMR also conducts conferences and seminars designed to broaden the skills of its managers, but statistics on seminars and conferences were not available at the time of this study. The statistics shown represent the percentage of management personnel (executive and middle management) who completed, in FY 1971, formal training courses designed to broaden their management skills.

SLA, by emphasizing on-the-job management development training, follows the philosophy expressed by Lynton K. Caldwell. Every five years

all managers at the department level and above attend three-to-four-day conferences which include subjects designed to broaden their managerial skills, although this is not the main goal of the conferences. Conferences and seminars on special management subjects (e.g., EEO, managing the new work force) are held on an as-needed basis. Statistics on the special seminars and conferences were not available at the time of this study. The statistics shown reflect the percentage of vice presidents, directors, and department managers attending either a three-or four-day manager's conference in CY 1971. It should be noted that SLA encourages employees to enroll in on-duty or off-duty university courses, to include management development courses. The standard to which SLA is compared includes seminar-and conference-type training in combination with formal course, management development training.

TABLE 15

COMPARISON OF SLA MANAGEMENT PERSONNEL
RECEIVING MANAGEMENT TRAINING
(totals for CY 1971)

SLA	93%
Standard (for comparison)	77%

TABLE 16

COMPARISON OF WSMR MANAGEMENT PERSONNEL
RECEIVING MANAGEMENT TRAINING
(totals for CY 1971)

WSMR Civilian Employees	15.7%
Standard (for comparison)	10.9%

Evaluation by Responsible Government Agency or by Headquarters

White Sands Missile Range

Recent evaluation of overall performance by WSMR is covered in two reports: The Program Survey Report, April 1971, October 1971, and the TECOM Manpower and Force Development Survey Report, October 1971. WSMR performance is identified as "satisfactory" in all areas and, according to the TECOM Report, the program can, with minor adjustments, very easily move into the "outstanding" category. The Program Survey Report credits WSMR efforts in the area of stability and composition of the work force as "successful," and in the area of training and development as being "most effective and unusually strong."

Sandia Laboratories - Albuquerque

Periodic appraisals of the effectiveness and efficiency of SLA administration and operations are made by staff personnel of ALO. The appraisal includes evaluations of administrative and financial operations,

as well as those technical activities performed in direct support of the ALO atomic weapons production mission.

Overall performance by SLA was labeled "commendable." Outstanding performance was indicated for 12 activities, and in all but three other areas, SLA met established objectives. The ALO personnel responsible for the appraisal expressed the belief that SLA would experience little difficulty in eliminating the minor shortcomings.

Both SLA and WSMR received favorable assessments from the respective offices responsible for the conduct of operational oversight. The tables show that SLA met or exceeded the standards in all areas except security consciousness and safety (disabling injuries),[15] and that WSMR exceeded the standards in all of the areas that were examined. From the data presented in this chapter we can draw the conclusion that management effort at both of these facilities is effective, and the hypothesis, federal laboratories which employ single - ladder systems of personnel advancement meet management effectiveness norms as measured by evaluation of specified performance factors and compared with established standards, is proved to be valid.

FOOTNOTES

[1]See, for example, Don K. Price, The Scientific Estate (New York: Oxford University Press, 1965); Michael D. Reagan, Science and the Federal Patron (New York: Oxford University Press, 1969); William R. Nelson, The Politics of Science (New York: Oxford University Press, 1968).

[2]See, for example, Marshall E. Dimock, Administrative Vitality (New York: Harper, 1969); Douglas McGregor, The Human Side of Enterprise (New York: McGraw-Hill Book Company, 1960); Rensis Likert, New Patterns of Management (New York: McGraw-Hill Book Company, 1961).

[3]Ibid.

[4]Frederick Harbison and Charles A. Myers, Management in the Industrial World (New York: McGraw-Hill Book Company, 1959), pp. 25-26.

[5]Chris Argyris, Integrating the Individual and the Organization (New York: Wiley and Sons, Inc., 1964), p. 278.

[6]DA, AMC and TECOM show command averages of the various program areas in the reports of their inspections. The comparative statistics for SLA were located at ALO where feeder reports from the other contractor operated facilities provided the source for the averages.

[7]The averages with which WSMR performance is compared are shown in the tables as "standards (for comparison)."

[8]O. Glen Stahl, Public Personnel Administration (New York: Harper and Row, Inc., 1971), p. 240.

[9]The SLA statistics may include some employees with service performed when the University of California operated the laboratory prior to 1949. Such service is credited toward SLA longevity. There are only a few such cases, since efforts were made to control this during the sampling.

[10]The WSMR statistics include some employees with government service performed with other agencies prior to their current employment. There are only a few such cases, since efforts were made to control this during the sampling.

[11]This figure was reported in a Classified Document Cost Study by Lockheed Missile and Space Company in 1964.

[12]For example, the cost of safeguarding classified documents at AMC for CY 1970 was computed and found to be $9,330,534.23 (from information contained in records of the Provost Marshal, WSMR).

[13]Lynton K. Caldwell, "Identification and Development of Administrative Talent," (1969), p. 28. This writing to be included, as Chapter III, within a book to be published, Issues in Public Science Policy and Administration: A Symposium.

[14]Ibid.

[15]It was explained by the responsible office at ALO that although the incidence of infractions appears high, there was improvement in 1971 performance over 1970.

Chapter 5

SUMMARY AND CONCLUSIONS

Summary

Basic to the integrity of a study on the subject of personnel advancement systems is the recognition and acknowledgment of the fact that "real life" organizations seldom have clean lines and sharp division points for upward movement of personnel. There are usually exceptions. These exceptions are "reinforcing crossmembers" of the promotion framework. Although SLA and WSMR have basic single - ladder systems, it is perhaps the "reinforcing crossmembers" in their promotion framework which allow the system to work well for both of them.

A search of the literature revealed that none of the studies reviewed related the systems of personnel advancement directly to employee performance. Most of the literature described preferences of professionals and enumerated the advantages to be realized by laboratories because of assumed increased professional motivation.[1] Frequent assertions found in many of the writings are that professionals need the freedom which the dual - ladder system provides and that they are most productive when free of constraints, particularly the constraints which they feel when assigned supervisory duties.

During the research for this thesis, an interesting observation regarding this freedom was made by a professional currently working in a management capacity. He stated that an often-overlooked fact is that, in government laboratories, there is a relatively small amount of freedom for scientists, regardless of which advancement system he is working under and that there is little opportunity for scientists to explore because they are generally limited to funded programs with very narrow boundaries. The instances are rare, if ever, he concluded, when the government scientists experience the feeling of freedom to search for truth. The observation poses questions regarding one of the dominant prosyllogisms for the dual - ladder system.

In Chapter 1 it was explained that for purposes of this thesis, management effectiveness would be evaluated on the basis of a measurement of the following elements within the organization: motivation, job or role satisfaction, initiative, and congruence of individual and organizational goals. Specific factors used as indicators of the existence of the elements were identified as: absenteeism, longevity, disciplinary actions, resignations, safety, security consciousness, management training, and evaluations by the responsible government agency or headquarters. Also covered in Chapter 1 was the significance of the problem, described in terms of the basic reasons for the concern over utilization of the better system of advancement. Productivity in R&D laboratories contrasted

with that of private industry is discussed. It was in this discussion that the premise was established that effective management produces a desirable level of productivity. The section on Background Information includes descriptions of the single - and dual - ladder systems. Advantages and disadvantages of the systems are noted.

The profiling of SLA and WSMR in Chapter 2 provided the reader with details of the physical make-up, organizational structure, and general missions of the two laboratories used as data points for this study. As summarized in the conclusion of Chapter 2, both SLA and WSMR were found to have standard line/staff structures with no excessively wide spans of controls. Both employ the single - ladder system of personnel advancement.

The results of this research are covered in Chapter 3. A narrative explanation of the performance indicators and the standards precedes the tables in which the comparisons are presented.

Based on the favorable evaluations and the satisfactory results of the performance indicator, comparisons, the hypothesis that federal laboratories which employ single - ladder systems of personnel advancement meet management effectiveness norms when measured and compared as described is proved to be valid. The data produced, however, do not

support the premise regarding the relationship between management effectiveness and productivity, so it remains assumptive.

Conclusions

One thought which was common to all of the writings, interviews, and conversations included in the research for this thesis is typified under the heading "Need for Better Personnel Data on Science Manpower" in the Oganovic and Leich study. They state that, "Despite the many statistics and studies cited in this chapter, there is still a serious lack of current information on science manpower and its use in the United States."[2]

The increased emphasis upon cost, efficiency, and program direction has created a demand for improved R&D management philosophies and practices. In some instances, unique approaches are needed; in others, more commonly used concepts remain appropriate.

The central concern of this study of the single - ladder system of personnel as it relates to management effectiveness was whether the use of that system would have a deflating effect upon the management effort of a federal laboratory. The issue made it necessary to examine briefly the two predominant systems of advancement in use in federal laboratories, the single - ladder system and the dual - ladder system.

The research established that the single - ladder system does not have a reductive effect upon the management effort. However, to allow

the conclusion to rest here without an inclusion of some remarks regarding a viewpoint on relative merits of the systems seems inappropriate. Conclusions based on the research and on the literature are that the selection of an advancement system should be based upon existing environment at the particular laboratory, in the light of study findings, rather than soley upon theory. Although the single - ladder system is shown to be not detractive, it appears that a dual hierarchial system does have sufficient merit to be considered. However, it should be a refined system, designed to fit the particular facility. Top management of R&D facilities should make a conscious effort to avoid rewarding professional competence by promotion into management channels. Logically, professional competence should be recognized and, without some type of dual system, reward might be impossible. There appears to be no justification for de-emphasizing the quest for quality management talent. However, professionals who have managerial ability and the inclination to move into management should be provided opportunities for the promotion on the same basis as others; being professional should not in itself be a preclusive factor.

The hypothesis that federal laboratories which employ the single - ladder system meet management effectiveness norms as measured by evaluation of specified performance factors and compared with established standards has been proven valid; however, this thesis offers only a partial answer. Much more research, and many more studies in much more depth

on this subject are needed. However, even partial answers have value in that they add to the foundation on which final solutions will be built.

FOOTNOTES

[1]Most of the literature listed in the bibliography carry useful analyses of this subject and include descriptions of professional preferences, discussions of the advantages of the dual system, and assertions regarding the need for freedom which the professionals feel.

[2]Nicholas J. Oganovic and Harold H. Leich, "Human Resources for Science Administration: Can Quality be Enhanced?" (1969), p. 73. This writing to be included, as Chapter II, within a book to be published, Issues in Public Science Policy and Administration: A Symposium.

APPENDIX A

REPORT OF A SPECIAL STUDY OF SCIENTISTS AND ENGINEERS

Taken from Nicholas J. Oganovic and Harold H. Leich, "Human Resources for Science Administration: Can Quality Be Enhanced

Report of a special study of scientists and engineers

To throw additional light on many of the points discussed in this chapter, the authors conducted an informal questionnaire survey, with the cooperation of Professor Albert H. Rosenthal[112] of the University of New Mexico, during the winter of 1968-69. The questionnaires were circulated in several Federal laboratories and in the Sandia Laboratories, a private corporation having extensive government contracts.

Usable responses were received from 193 Federal scientists and engineers who rated themselves as administrators and from 195 who rated themselves as individual professional workers. The survey should not be taken as representative of all Federal scientists and engineers, since it was heavily weighted in favor of engineers and physical scientists, omitting the life sciences, and in favor of a few developmental laboratories rather than research laboratories. (More than half of the responses came from the Army Department's White Sands Missile Range, New Mexico.) As to levels of responsibility, the respondents represented lower and middle rather than top levels.

From the Sandia Laboratories, 161 usable responses were received from scientists and engineers who rated themselves as administrators and 144 from those who rated themselves as indi-

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[112]Professor Rosenthal is the Director of the Program for Advanced Study in Public Science Policy and Administration.

vidual professional workers.

The results are reported separately for Federal administrators, Federal individual workers, Sandia administrators, and Sandia individual workers. The small number of cases precludes any definitive conclusions, but within the limitations mentioned, the study may throw some light on the characteristics and attitudes of administrators as opposed to individual professionals.

1. Salary differences

As might be expected, the administrators as a group were clearly ahead of the individual workers in salaries. Sandia respondents were substantially ahead of the Federal ones in both groupings. The approximate median salaries were as follows:

193 Federal administrators	$18,760
161 Sandia administrators	22,720
195 Federal individual workers	13,280
144 Sandia individual workers	16,400

2. Highest degree

The Sandia respondents in both groupings showed a marked edge in level of educational attainment over the Federal groupings. This fact may explain, in part, the salary advantages shown in item 1 above.

HIGHEST DEGREE	ADMINISTRATORS				INDIVIDUAL WORKERS			
	193 FEDERAL		161 SANDIA		195 FEDERAL		144 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
BACHELOR	129	66	74	47	152	78	58	40
MASTER	37	19	43	27	30	15	51	35
PH. D.	13	7	44	27	3	2	35	24
NONE	10	5	0	0	6	3	0	0
NO RESPONSE*	4	2	0	0	4	2	0	0

*RESPONDENTS WERE TOLD TO OMIT ANSWERS TO ANY QUESTIONS THEY REGARDED AS INAPPROPRIATE.

3. Year of highest degree

The administrators are definitely the older group, judging by the year of attaining highest degree. This may, in part, explain the salary advantage of administrators over individual workers noted in item 1 above. No marked differences are apparent between the Federal and the Sandia respondents.

YEAR OF HIGHEST DEGREE	ADMINISTRATORS				INDIVIDUAL WORKERS			
	193 FEDERAL		161 SANDIA		195 FEDERAL		144 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
1930 – 39	15	8	3	2	5	2	4	3
1940 – 49	45	23	45	27	12	6	20	14
1950 – 59	90	47	74	47	62	31	42	29
1960 – 68	31	16	39	24	104	53	77	53
NO RESPONSE	12	6	0	0	12	6	1	1

4. Professional field of highest degree

This study agrees with many predecessors in indicating how few technological administrators come from non-technical disciplines. The four groups are all heavily weighted towards engineering, with the individual Federal workers showing a high proportion in physics and mathematics as well.

PROFESSIONAL FIELD OF HIGHEST DEGREE	ADMINISTRATORS				INDIVIDUAL WORKERS			
	193 FEDERAL		161 SANDIA		195 FEDERAL		144 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
ENGINEERING	118	60	107	66	88	45	100	69
PHYSICS	24	12	32	20	46	24	23	16
MATHEMATICS AND STATISTICS	23	12	8	5	45	23	5	3
OTHER NATURAL SCIENCES	11	6	13	8	7	3	15	10
SOCIAL SCIENCES, HUMANITIES	6	3	1	0	3	2	1	1
NO RESPONSE	11	6	0	0	4	2	0	0

5. Does organization have plan for selecting and training technological administrators?

This question was put to the sample groups in different ways: The administrators were asked about the situation when they made the initial move into administration; while the individual workers were asked about the situation in their present organization. Thus the responses are not directly comparable, although the results are very close. It seems clear that the great majority of respondents were skeptical about the existence of a systematic plan.

DID/DOES YOUR ORGANIZATION HAVE A SYSTEMATIC PLAN FOR SELECTING AND TRAINING ADMINISTRATORS IN SCIENCE AND TECHNOLOGY?	ADMINISTRATORS				INDIVIDUAL WORKERS			
	193 FEDERAL		161 SANDIA		195 FEDERAL		144 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
YES, A SYSTEMATIC PLAN	11	6	5	3	17	9	7	5
SOME PLAN, LESS THAN SYSTEMATIC	76	39	43	27	75	39	43	30
NO SUCH PLAN	103	53	111	69	94	48	86	60
NO RESPONSE	3	2	2	1	9	5	8	6

6. Does organization have plan for advancing individual workers to higher levels without taking on administrative duties?

This question was asked in the same two ways as item 5 above. Again, the great majority reported the absence of a systematic plan. The Sandia administrators were somewhat stronger than the individual workers in feeling that there was no such plan.

DID/DOES YOUR ORGANIZATION HAVE A SYSTEMATIC PLAN FOR ADVANCING INDIVIDUAL PROFESSIONALS CONTRIBUTORS TO HIGHER LEVELS WITHOUT TAKING ON ADMINISTRATIVE DUTIES?	ADMINISTRATORS				INDIVIDUAL WORKERS			
	193 FEDERAL		161 SANDIA		195 FEDERAL		144 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
YES, A SYSTEMATIC PLAN	9	3	5	3	23	12	19	13
SOME PLAN, LESS THAN SYSTEMATIC	75	39	39	24	58	30	37	26
NO SUCH PLAN	104	54	114	71	106	55	82	57
NO RESPONSE	5	2	3	2	8	4	6	4

7. Importance of a "two-track" system

The questionnaire briefly defined the "two-track" system in the same terms as discussed earlier in this chapter, and asked respondents to rate its importance. No great difference is shown among the four groups of respondents; the great majority affirmed the desirability of having such a system.

IN YOUR OPINION, SHOULD A SCIENTIFIC OR TECHNOLOGICAL ORGANIZATION PROVIDE A SYSTEMATIC "TWO-TRACK" SYSTEM OF ADVANCEMENT FOR ITS PROFESSIONALS?	ADMINISTRATORS				INDIVIDUAL WORKERS			
	193 FEDERAL		161 SANDIA		195 FEDERAL		144 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
YES, AN IMPORTANT FEATURE OF A GOOD PLACE TO WORK.	159	82	122	75	170	87	119	83
NOT TOO IMPORTANT	13	7	19	12	14	7	20	14
UNDESIRABLE	7	4	7	4	5	2	2	1
NO RESPONSE	14	7	13	8	6	3	3	2

8. Extent to which organization provides for a "two-track" system

The responses to this item indicate that despite numerous articles in the literature recommending a "two-track" system, most respondents in several Federal laboratories and in a major industrial laboratory did not think such a system existed in their organization.

The responses to this item, compared with those in item 7 above, hint at potential dissatisfaction among the individual workers. That is, most of them rated the importance of a "two-track" system as being high in responding to item 7, yet a majority in responding to item 8 reported that their present organization does not provide for one.

The responses of the individual workers to this item may be compared to their responses under item 6 above, which asked the question in a different way. This internal test of consistency of responses seems to yield satisfactory results.

DOES THE PERSONNEL SYSTEM IN YOUR ORGANIZATION ADEQUATELY PROVIDE FOR THE "TWO-TRACK" SYSTEM? (CAN CHECK MORE THAN ONE)	ADMINISTRATORS				INDIVIDUAL WORKERS			
	193 FEDERAL		161 SANDIA		195 FEDERAL		144 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
YES, FULLY PROVIDED FOR	33	17	15	9	12	6	13	9
PERSONNEL OFFICE SHOULD MAKE GREATER EFFORT TO PUBLICIZE THE PROGRAM.	50	26	19	12	43	22	26	18
NOT PROVIDED FOR	87	45	105	65	115	59	88	61
CAN'T GET TOP GRADES AS INDIVIDUAL WORKER*	14	7	4	2	10	5	0	0

*THESE RESPONSES WERE "WRITE-INS".

9. How should technological administrators be selected and trained?

The four groups of respondents were in very close agreement on two methods of selecting and training administrators: more than half of each group favored an informal "try out" by assigning candidates to minor administrative duties, and a quarter of each group favored periodic screening of candidates by a committee of senior professionals. Regarding the three other choices offered to respondents, there was no detectible pattern in the answers of the four groups.

WHAT ARE THE SOUNDEST WAYS IN WHICH A SCIENTIFIC OR TECHNOLOGICAL ORGANIZATION CAN SELECT AND TRAIN CURRENT PROFESSIONAL EMPLOYEES TO BECOME ADMINISTRATORS? (CAN CHECK MORE THAN ONE).	ADMINISTRATORS				INDIVIDUAL WORKERS			
	193 FEDERAL		161 SANDIA		195 FEDERAL		144 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
LET THE EMPLOYEE'S APTITUDE AND PREFERENCE FOR ADMINISTRATIVE DUTIES SHOW THEMSELVES IN THE NORMAL COURSE OF HIS EMPLOYMENT, WITHOUT A SPECIAL PROGRAM.	80	41	95	59	56	29	48	33
TEMPORARY ASSIGNMENT TO MINOR ADMINISTRATIVE DUTIES (ACTING AS UNIT CHIEF, COORDINATOR, COMMITTEE MEMBER, ETC.) ON AN INFORMAL "TRY OUT" BASIS.	112	58	91	56	112	58	77	53
PERIODIC SCREENING OF POSSIBLE CANDIDATES FOR ADMINISTRATIVE WORK BY A COMMITTEE OF SENIOR PROFESSIONALS.	52	26	40	25	45	23	35	24
PERIODIC ANNOUNCEMENT OF OPPORTUNITIES TO ENTER A SELECTION AND TRAINING PROGRAM FOR ADMINISTRATIVE WORK.	78	40	22	14	96	50	51	35
SPECIAL TRAINING OR COACHING FOR ADMINISTRATIVE DUTIES, PRIOR TO OR FOLLOWING FIRST ADMINISTRATIVE ASSIGNMENT.	108	56	61	38	91	47	61	42

10. Should the manager spend some time on his own research?

A large majority of all four groups voted "yes" on this question, with the individual workers showing a somewhat larger affirmative response than the administrators. Some respondents wrote in qualifications to their answers. The general tenor of these comments was to the effect that the administrator must keep up with his field, if not by doing research then in other ways.

IN GENERAL, IS IT DESIRABLE FOR THE SCIENCE OR TECHNOLOGICAL ADMINISTRATOR TO BE ABLE TO SPEND SOME TIME ON HIS OWN INDIVIDUAL INVESTIGATIONS OR RESEARCH?	ADMINISTRATORS				INDIVIDUAL WORKERS			
	193 FEDERAL		161 SANDIA		195 FEDERAL		144 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
YES, HIGHLY DESIRABLE	125	64	105	65	143	74	99	69
DOESN'T MATTER TOO MUCH	30	15	31	19	17	9	17	12
UNDESIRABLE	11	6	5	3	13	7	10	7
DEPENDS ON LEVEL OF JOB*	8	4	9	6	9	5	3	2
OTHER WAYS TO KEEP UP (READING, ETC.)*	6	3	3	2	2	1	1	1
NO RESPONSE	13	7	8	5	11	6	14	10

*THESE RESPONSES WERE "WRITE-INS".

The following six questions were addressed to administrators only:

11. Research time available

Almost half of the administrators reported no research time available, although a majority rated individual research as highly desirable under item 10. Here again is a hint of potential frustration.

RESEARCH TIME AVAILABLE	ADMINISTRATORS			
	193 FEDERAL		161 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT
NO RESEARCH TIME AVAILABLE	92	47	68	42
10% OR LESS	23	12	9	6
11 – 20%	33	17	31	19
21 – 30%	19	10	21	13
31 – 40%	3	2	9	6
41 – 50%	6	3	6	4
MORE THAN 50%	13	7	17	10
NO RESPONSE	4	2	0	0

12. Kinds of professional employees supervised

An attempt was made to have respondents assess the extent to which their employees were in the same field as themselves, in related fields, or in different fields.

PROFESSIONAL FIELDS SUPERVISED	ADMINISTRATORS			
	193 FEDERAL		161 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT
ALL EMPLOYEES SUPERVISED IN SAME PROFESSIONAL FIELD AS THE ADMINISTRATOR	52	27	27	17
IN SAME AND RELATED FIELDS	75	39	77	48
IN SAME, RELATED, AND DIFFERENT FIELDS	30	15	40	25
ALL IN RELATED OR DIFFERENT FIELDS	20	10	14	9
NO RESPONSE	16	8	3	2

13. Entrance into first administrative assignment

The leading method by which the administrators who responded first came into administrative work was through suggestions by supervisors or other officials, followed by their taking the initiative themselves.

HOW DID YOU HAPPEN TO ENTER UPON YOUR FIRST ADMINISTRATIVE ASSIGNMENT IN SCIENCE OR TECHNOLOGY?	ADMINISTRATORS			
	193 FEDERAL		161 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT
SUGGESTED BY SUPERVISOR OR OTHER OFFICIAL	82	43	105	65
TOOK INITIATIVE IN SEEKING SUCH ASSIGNMENT	71	37	41	26
"HAPPENSTANCE"	23	12	8	5
OTHER	13	7	7	4
NO RESPONSE	4	2	0	0

14. Advancement to present level

Administrators were asked whether they could have advanced to their present levels as individual workers. A majority replied that they could not have done so, thus in a sense verifying their responses under items 6 and 8 above.

IN YOUR OPINION, COULD YOU HAVE ADVANCED AS AN INDIVIDUAL WORKER TO YOUR PRESENT LEVEL?	ADMINISTRATORS			
	193 FEDERAL		161 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT
YES	72	37	45	27
NO	111	58	97	60
NO RESPONSE	10	5	19	12

15. Training received

A majority of administrators replied that they had received no special training or coaching on beginning their first administrative assignments. This points to the need for management action to insure that new supervisors are properly prepared for their changed responsibilities.

WHEN YOU BEGAN YOUR FIRST ADMINISTRATIVE ASSIGNMENT IN SCIENCE OR TECHNOLOGY, DID YOU RECEIVE ANY SPECIAL TRAINING OR COACHING IN YOUR NEW RESPONSIBILITIES?	ADMINISTRATORS			
	193 FEDERAL		161 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT
YES	60	31	59	37
NO	110	58	101	63
NO RESPONSE	23	12	1	0

16. Courses of value to administrators

The administrators were queried as to the courses that had assisted them in preparing for administrative roles, and in addition, as to the university graduate-level courses they would recommend to prepare people for such roles. The replies were by free answers rather than check-lists, and some grouping of related courses has been done in the following summary. As to recommended courses, the responses of the Federal and the Sandia administrators are surprisingly similar. Judging from this study, an ideal curriculum to train new administrators would concentrate on such subjects as organization and management (preferable in the context of technological organizations), supervision, leadership, personnel management, psychology, communications skills, and possibly finance.

NAME OF COURSE	WHAT UNIVERSITY COURSES OR PROGRAMS HAVE YOU PARTICIPATED IN THAT HAVE ASSISTED YOU IN PREPARING FOR ADMINISTRATIVE, MANAGEMENT, OR ADMINISTRATIVE POLICY POSTS IN THE FIELD OF SCIENCE ADMINISTRATION?				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?			
	193 FEDERAL		161 SANDIA		193 FEDERAL		161 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
ORGANIZATION, MANAGEMENT, BUSINESS ADMINISTRATION	56	29	14	9	52	27	31	19
MANAGEMENT OF TECHNICAL ORGANIZATIONS	–	–	5	3	18	9	13	8
SYSTEMS/INDUSTRIAL ENGINEERING	4	2	3	2	2	1	6	4
TECHNICAL COURSES IN SCIENCE AND ENGINEERING	2	1	11	7	5	2	7	4
SUPERVISION, LEADERSHIP, HUMAN RELATIONS, PERSONNEL	14	7	5	3	41	21	33	20
PSYCHOLOGY	16	8	4	2	19	10	28	16
OPERATIONS RESEARCH	3	2	0	0	12	6	3	2
COMPUTER	2	1	3	2	1	0	3	2
ECONOMICS	8	4	5	3	8	4	11	7
LAW	4	2	0	0	1	0	3	2
SPEECH	6	3	1	0	5	2	10	6
WRITING	2	1	2	1	7	4	9	6
ACCOUNTING/FINANCE	3	2	2	1	5	2	13	8
MATH/STATISTICS	3	2	0	0	2	1	0	0
PHILOSOPHY	–	–	1	0	2	1	4	2
OTHER LIBERAL ARTS AND SOCIAL SCIENCES	1	–	2	1	2	1	10	6

17. Preference for administrative v. individual professional work

Finally, the individual workers were asked whether they had ever made a definite choice between administrative and individual work, and were asked to amplify their responses. The great majority replied that they had not made such a decision, and nearly half (exactly the same percentage of the Federal and the Sandia respondents) said they would welcome an opportunity to move into administration. This result differs from the findings of other studies reported earlier in this chapter.

HAVE YOU AT ANY TIME MADE A DELIBERATE DECISION TO CONTINUE IN INDIVIDUAL PRODUCTIVE WORK IN YOUR PROFESSION RATHER THAN GO INTO THE ADMINISTRATIVE CHANNEL?	INDIVIDUAL WORKERS			
	195 FEDERAL		144 SANDIA	
	NUMBER	PERCENT	NUMBER	PERCENT
NO (WITHOUT FURTHER AMPLIFICATION)	40	20	23	16
NO – WOULD PROBABLY NOT BE INTERESTED IN ADMINISTRATIVE WORK IF AN OPPORTUNITY OPENED UP	31	16	34	24
NO – WOULD WELCOME OPPORTUNITY TO MOVE INTO ADMINISTRATION	91	47	68	47
YES – PRIMARY APTITUDES AND INTERESTS ARE FOCUSED ON MAKING INDIVIDUAL CONTRIBUTIONS RATHER THAN ON ADMINISTRATION	27	14	13	9
YES – BETTER OPPORTUNITIES IN INDIVIDUAL PRODUCTIVE WORK	5	2	1	1
OTHER	2	1	4	3

APPENDIX B

SUMMARY OF ADVANTAGES, DISADVANTAGES AND PROBLEMS AREAS FOR THE DUAL LADDER SYSTEM

Taken from a study of the use of technical career programs in large R&D Laboratories, conducted by Sandia Laboratories in 1965

APPENDIX D - SUMMARY OF POTENTIAL ADVANTAGES, DISADVANTAGES, AND PROBLEM AREAS FOR TECHNICAL CAREER PROGRAMS AS INDICATED IN THE GENERAL LITERATURE

Potential Advantages	Potential Disadvantages	Problem Areas and Prerequisites
Danielson, 1957-8 (Ref. 1) and Danielson, 1960 (Ref. 11), Bureau of Industrial Relations, University of Michigan. See also Riegel of the same bureau as Danielson (Ref. 10).		
1. Recognizes that engineers are a changing breed. No longer is technical aspect paramount; they are motivated by other factors also.	1. Viewed as "dead end" in comparison to management because used as "bone pile" for unsuccessful managers.	1. Must educate within and without company as to new opportunities.
2. Allows for anticipated increase in output of technically trained from schools (i.e., better utilization).	2. Over-emphasis could lead to making administrators merely "doers", thus weakening balance in control of society.	2. Requires establishment of relationships between T-C and existing organizational hierarchies.
3. Aids in attraction of new, qualified personnel because career paths are clearer.		3. Must resolve appraisal, compensation, recognition problems.
		4. Requires re-evaluation of assignments of existing technical staff.

Potential Advantages	Potential Disadvantages	Problem Areas and Prerequisites
Herman, 1958 (Ref. 2), Personnel Research Division, Sandia Corporation.		
1. Improves communication by indicating management's acceptance of the value of technical contributions.		1. Requires identification of skill areas, i.e., technical, managerial, or both.
2. Quantitatively and qualitatively improves contributions by encouraging technical specialization vs. realizing net loss resulting from trying to mimic management to gain approval and from becoming a manager having less time to devote to technical matters.		
3. Results in advancement path not limited by openings in management hierarchies.		
Shephard, 1958 (Ref. 3), Division of Organizational Sciences, Case Institute of Technology.		
1. Quantitatively and qualitatively improves contributions (best scientists are	1. Role Definition - T-C man may experience loneliness, rejection, or feeling of	1. Opportunity aspect should be stressed over reward. Chance to do independent

Potential Advantages	Potential Disadvantages	Problem Areas and Prerequisites
lost when made managers; best scientists may be poor managers).	not belonging. Loss in productivity results from inadequate supervision.	work suggests that position should be temporary rather than permanent.
2. Makes practice of research rewarding or attractive as management.	2. Reward vs. Opportunity - newly found freedom may reveal lack of independence and commitment.	2. Selection criteria should favor worker who identifies with profession rather than company.
	3. Shelf Tendency - isolation makes T-C a convenient "shelf: for outmoded or unwanted staff members.	3. Training in consulting skills and providing consulting opportunities are useful aids in maintaining influence.
	4. Ambiguous Status - there is no universal meaning for T-C titles. This results in stresses in identification inside and outside the company.	4. Extreme care in selecting candidates for T-C is necessary to avoid relegation of "dead wood". Good technical workers must be willing to join T-C.
	5. Proof of Inadequacy - promotion to T-C is evidence of lack of leadership (i.e., a stigma).	5. Transferring from one structure to another can aid in removing stigma discussed in Disadvantage 5.

Potential Advantages	Potential Disadvantages	Problem Areas and Prerequisites
	6. Restricts Mobility - move to T-C is to point to no future in management.	
	7. Shortage of Positions - some laboratories have but one or two T-C levels vs. many for management. Ceiling may be too high for some or too low for others.	
	8. Lesser Security - creativity in T-C is of the essence. Since output of T-C man is assessed easier than that of manager, T-C man is in a spotlight.	
Leamer, 1959 (Ref. 4), Personnel Director, Bell Telephone Laboratories		
	1. T-C programs result in artificial fences or boundaries for creative technical work. Flexibility in assignments is reduced. Means other than T-C are available ("broad" classifications).	1. Procedures for administrating salary and status rewards are complicated and fraught with more dangers than benefits.

Potential Advantages	Potential Disadvantages	Problem Areas and Prerequisites
	2. Titles are ambiguous. There is no universal meaning. Validity is time-dependent, even within a given company.	2. T-C programs tend to confuse titles denoting authority with titles denoting merit.
	3. Failure to be selected for T-C would result in even greater frustration than for failure to be selected for management. This results from degraded recognition by peers.	
Stanford University, 1959 (Ref. 5), Graduate School of Business		
1. Offers opportunity to provide recognition and incentive without sacrificing individual's technical ability by adding administrative burdens.		1. Positions on T-C structure not actually on same level as corresponding ones in administrative structure. Salary often equivalent, but other elements of prestige are not.
2. Offers a personal freedom for technical people to work on projects of their own choice (act as consultants).		2. Sometimes program is not widely publicized, weakening possible recognition and incentive.

Potential Advantages	Potential Disadvantages	Problem Areas and Prerequisites
		3. Management may view as device for taking care of a few problem individuals.
		4. Difficult to decide to which administrative level a technical person can transfer when he desires to switch structures.

Farr, 1961 (Ref. 6), Consultant in Industrial Psychology, as applied to high management and staff levels.

	1. Calling the need-satisfying potentials of T-C and management equal by definition does not make it so. Researchers may try for management or may stay in research and produce mediocre results because of poor motivation.	1. Rewards should be comparable, but not necessarily equal.
	2. Motivators may be chosen correctly but be of incorrect intensity. Freedom inherent in T-C may not motivate in research situations.	2. Success in research could be rewarded by sabbatical years, by leaves for specialized training, or by freedom from accountability backed up by a staff of research assistants.

Potential Advantages	Potential Disadvantages	Problem Areas and Prerequisites
Kornhauser, 1962 (Ref. 7), Associate Professor of Sociology, University of California, Berkeley.		
1. Provides promotional openings for technical personnel when management positions are full.	1. T-C programs introduce problems for line management in supervising T-C people given much independence.	1. Assignment to T-C may isolate scientist from organization.
2. Provides alternative promotion path for good technical person judged poor in administration.		2. Assignment to T-C may be way of "shelving" those lacking in managerial ability.
3. Enables "top scientists and specialists to advance in rank and salary without taking on management or supervisory functions."		3. Tendency for shortage of levels on T-C structure. Ceiling on advancement in T-C below that of administration.
4. Provides greater freedom in scientific research. Participant is free to discuss subjects with colleagues at universities without restraints imposed on the managers.		
Raudsepp, 1963 (Ref. 8) Director of Psychological Research, Deutsch & Shea, Inc., New York.		
	1. Technical professionals regard titles as placating device to deflect their concern with trappings of status and higher salaries.	1. Concept of advancement by T-C programs has not yet gained foothold, and the only higher positions are still the managerial ones.

Potential Advantages	Potential Disadvantages	Problem Areas and Prerequisites
	2. Titles occasionally have had a disruptive effect by creating complaints about unfair distinctions and divisions.	
Schoner and Harrell, 1965 (Ref. 9)	Schoner - Doctoral candidate at Graduate School of Business Administration, Stanford University Harrell - Professor of Applied Psychology, Stanford University	
1. T-C personnel agreed that having a title gives some satisfaction.* (*Results of morale and attitude survey in a division of an electronics company.)	1. In the eyes of the two groups, T-C and managers, the T-C program did not succeed in conferring equal prestige and salary treatment.	1. T-C programs may be based on misconception of what technical people want from their jobs.

Note: T-C = Technical-Career Program

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