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THE ROLE AND CAREER DEVELOPMENT OF THE SCIENTIFIC AND ENGINEERING OFFICER IN THE AIR FORCE

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Stanford Research Institute
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PREFACE

This is a monograph based in part on data obtained during a two-year study of applications of the behavioral sciences to research management, sponsored by the Office of Aerospace Research (OAR) of the United States Air Force. The first monograph resulting from this study is titled Applications of the Behavioral Sciences to Research Management: an Initial Study in the Office of Aerospace Research. This second monograph is published by the authors separately from the technical report to the agency that sponsored the background research, because the authors believe that the data, concepts, and conclusions that have resulted mainly from this study ought to be made available to a wide audience of management and social science personnel. It should be clearly understood, however, that these are the conclusions of the authors of this monograph, and do not necessarily reflect the policies or opinions of the management of the agency that sponsored the research.

More specifically, we believe that the concepts that are newly developed in this monograph--such as the characterization of the Air Force as becoming more and more a special kind of "technology management organization" and the distinctions between three main kinds of management roles: (1) the "technology management generalist," (2) the "technical manager," and (3) the "administrative manager"--can be applied to understanding changes that are now occurring in a wide variety of both government and private organizations under the impact of increasing complexities in technology. Using these concepts, for example, the need for some managers who are essentially technical specialists and for other managers who combine a career of technical with operational experience can be more clearly recognized.

We maintain herein that it is this latter integrating or "coupling" role that is the particular role that can be performed best by scientific and engineering (S&E) officers in the context of the Air Force. We also suggest that "technical manager" and "administrative manager" roles can more often be most appropriately assumed by civilian employees, although military personnel must also be able to serve in these roles (e.g., perhaps as "dual deputies" to civilians) in preparation for assuming the "technology management generalist" role. To determine how many S&E officers are currently performing each kind of role would require a separate study of military manpower assignments.

We believe that a general acceptance of these role distinctions would help to lessen career development conflicts between military and civilian personnel. (Perhaps this would also apply to conflicts between technical personnel and operating personnel in other kinds of organizations.) Such conflicts sometimes lead to emotional forms of expression that can hinder the effectiveness of technology management organizations. For example, the conclusions we have drawn from our analysis have not always been considered objectively or dispassionately. We have been criticized by some military personnel (but not all) because our conclusions do not support the point of view that all management positions in a military organization are most appropriately filled by military personnel. Conversely, we have also been criticized by some civilians who feel that our analysis places too much emphasis upon the importance of military (i.e., operational) experience in the technology management activities of an organization like the modern Air Force. In reply, we can only point out that this has been an independent attempt to analyze a controversial topic in the light of behavioral sciences theory and research findings on organizations, especially on military organizations. Therefore, we have had to "call it as we see it" in the light of the perspective taken.

This study was conducted within the context of the Technology Management Programs of Stanford Research Institute. These programs include studies of the structure, organization, and dynamics of the R&D industry in the United States and other countries; the management of R&D organizations; technology utilization and transfer; professionalization and professional organizations; technical manpower; and systems analysis and other methodologies as foundations for investigations of R&D processes and organization.

The authors of this monograph greatly appreciate the assistance, advice, and criticism of many Air Force officers and civilians, both inside and outside the Air Force, which made this analysis possible.

The pilot will not always be the key to airpower. For the present, yes. For the immediate future, yes. But even now mechanical gadgets are fast encroaching on the pilot's domain. We are entering the era of the guided missile. Some day, perhaps in our own time, the man holding my job will meet here with a staff of scientists, and they will wear no pilot's wings on their chests. That insignia will cease to be the yardstick of Air Force achievement. That's something for you to think about.

-- General H. H. Arnold, 1945

We find ourselves in a situation of unprecedented technological challenge. The resources which we have to do our job with are far less relative to the size of that job than what we have had in the past. Unprecedented technological challenge does not necessarily mean that we have better ideas coming along every day and that more revolutionary changes will come even faster. Revolutionary changes such as the hydrogen bomb, ballistic missile, and nuclear submarine do not appear every day.

-- Doctor Harold Brown, 1962

Only a continuing U.S. effort and success in broad technological advances can we maintain our capability to defeat aggression. This requires research personnel, research institutions, and military planning staffs oriented toward integrating science and strategy. There may be additional breakthroughs of the magnitude of the nuclear weapon, but long-range capabilities are likely to rest on an everexpanding technological base.

-- General Curtis E. LeMay, 1964

The things we are concerned with here today, that are most critical to the Air Force capabilities, are research and development and people. The weapons we have in the 70's will depend upon the decisions we make today in research and development. Similarly, the leadership we have in the Air Force in the 70's and beyond, will depend upon the decisions we make today in the fields of education, housing, promotion opportunity, and pay of the people who make up the Air Force.

-- The Honorable Eugene M. Zuckert, 1964

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Chapter I

INTRODUCTION AND GENERAL CONCLUSIONS

Introduction

In every organization policy is ordinarily the result of compromise. Although in theory, policy is the implementation of organizational objectives or mission, in practice, it is most often an expression of points of agreement among the often diverse interest groups that constitute and shape various organizations. Thus when policy is made on the utilization of scientific and engineering (S&E) officers in an organization like the Air Force, for example, this policy is likely to reflect--in greater or lesser degree, depending on circumstances at a particular time--some kind of compromise among the expressed interests of at least the following important groups: the professional military personnel; civilians in the civil service; civilian contractors; and, above all, the elected officials of the federal government and their appointed agency directors and advisors. Scattered through all of these groups are members of other professional groups that have had an increasingly powerful voice in government circles in recent years--the professional scientists.

It is a common aspect of human nature that each interest group strives to influence policy in terms of what it sees as the interests of its own group. The military tends to maximize the importance of its role in the management of defense research and development, as in other aspects of defense activity. In contrast, civilian employees of defense agencies often maintain that they are capable of handling many assignments now filled by military personnel, except for strictly combat assignments. Civilian contractors, in turn, are likely to assert that they could do most things better, or more efficiently, than government employees. Scientists, wherever they are employed, are likely to judge the appropriateness of any division of responsibilities and allocation of resources in terms of what they see as its effects on work in their particular scientific discipline. Elected officials must remain ever mindful of, and sensitive to, the desires of the people who elected them.*

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* A discussion of various "specific group biases" in professional groups is contained in Robert M. MacIver, "The Social Significance of Professional Ethics," The Annals of the American Academy of Political and Social Science, 297 (January 1955), pp. 118-124, a paper that first appeared in The Annals in 1922 and is reprinted in H. M. Vollmer and D. L. Mills, Professionalization: Readings in Occupational Change (Englewood Cliffs, N.J.: Prentice-Hall, forthcoming).

Under such circumstances, policy decisions are purely political, reflecting compromises among the interest groups concerned. Although such political considerations in policy making can never be eliminated (nor would most people consider this desirable), these political considerations can be modified by the introduction of findings, and theoretical interpretations of findings, from behavioral sciences research on organizations. Insofar as these findings are taken into account, along with relevant political considerations, policy making may become more rational. Findings from organizational studies cannot always supply certain answers to policy problems, but when brought to the attention of policy makers and "factored into" their decisions, along with all relevant information from other sources, these findings may be expected to provide a more sure and more defensible rationale for policy decisions when they are made.

This report attempts to provide information relevant to policy concerning the role and career development of the Air Force S&E officer. To do this, we shall draw on findings and theories from three areas of behavioral sciences investigation that are somewhat overlapping in their focuses, but each of which contributes an additional increment in understanding the role and career development of S&E officers. These are: (1) sociological studies of the changing characteristics of military organizations, (2) studies of the process of professionalization as it has affected a wide variety of occupations, and (3) studies of research and development organization and processes in a variety of contexts.* Information from these three areas of investigation does not supply any simple or automatic answers to problems connected with the role and career development of S&E officers. However, it does provide a basis for additional understanding of, and a rationale for, the fundamental importance of the role of S&E military officers in relation to the changing organizational character of the U.S. "defense establishment," the need for mechanisms and means for supporting the professionalization of this role, and the need for a clearer recognition of different components in this role and its relationship to other important military and civilian roles.

General Conclusions

At present there are pressures on the Department of Defense to assign military personnel to "strictly military" positions, and to fill all other positions that do not appear to require military personnel with civilians.

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* During the period of this study and that of the previous study (approximately two years), the principal investigator has had opportunity to be a close observer of the management activities of S&E officers in OAR. For a discussion of this observation method, see H. M. Vollmer, Applications of the Behavioral Sciences to Research Management: An Initial Study in the Office of Aerospace Research (Menlo Park, Calif.: Stanford Research Institute, a report to AFOSR, 1964), Chapter II.

These pressures have been justified most recently in terms of requirements for military personnel in the Viet Nam action Although this justification has a strong immediate appeal, the findings of this report would suggest a reappraisal of the desirability of this policy in the light of the long run objectives and changing organizational characteristics of the Department of Defense, in general, and the Air Force, specifically. Such a policy reappraisal is suggested by the following general conclusions of the analysis that is presented in more detail in the following chapters:

1. The defense establishment in general, and the Air Force in particular, has become more like a "technology management organization."

2. The defense establishment is a special kind of technology management organization--one that has the dual objectives of (a) combat readiness and military capabilities second to that of no other nation in the world and (b) scientific capabilities and technological advancement also second to none.

3. To accomplish these dual objectives, the defense establishment requires "technology management generalists" who embody in their experience and training a thorough knowledge and understanding of the values and techniques of science and technology, as well as an understanding and knowledge of military affairs.

4. To acquire and retain such technology management generalists, components of the defense establishment such as the Air Force must be able to utilize S&E officers in sequences of assignments (a career) that enable them to keep current both their scientific and technical management skills and their military skills.

5. The low retention rate of Air Force S&E officers at present indicates that the Air Force, like the other services, has not been completely able to retain and properly utilize these personnel in the recent past.

6. To do this more effectively in the future, the Air Force must develop means to enhance the professional status and recognition of its S&E officers by paying more attention to such matters as: (a) appropriate assignments, (b) appropriate salaries, (c) a flexible "below zone" promotion system, and (d) other professional necessities (see Chapter V).

7. The placement of S&E officers in Air Force in-house laboratories, provides an appropriate context for certain kinds of assignments to develop the kind of technology management generalists that the Air Force needs.

8. The placement of S&E officers in middle management positions could be accomplished more easily by the use of "dual deputy" assignments in conjunction with civilian technical managers and administrative managers in Air Force in-house laboratories.

Organization of the Report

Chapter II draws on studies of the U.S. defense establishment to show how it is becoming a military technology management organization--especially the Air Force. Chapter III reviews findings of studies of various technology management organizations, showing the main roles of management in these kinds of organizations and emphasizing the key importance of technology management generalists in an integrating role in them. Chapter IV provides examples of Air Force S&E officers who have themselves moved in the direction of becoming technology management generalists of the type discussed, thus providing models of the type of career officer sought. Chapter V reviews various studies of the limited ability of the Air Force to retain and utilize such officers under present policies, and also reviews suggestions of ways to improve this retention and utilization in the future.

Chapter II

THE AIR FORCE AS A MILITARY TECHNOLOGY MANAGEMENT ORGANIZATION

In examining the role and career development of S&E officers in the Air Force, it is important to understand the structure and dynamics of the surrounding environment. What fundamental changes are occurring in the modern American defense establishment? What has been the Air Force response to these changes? How has this response affected the role and career development of Air Force S&E officers?

The Changing Defense Establishment

By the "defense establishment" is meant the total complex of government agencies and private corporations, both profit and nonprofit, that design, develop, produce, maintain, and utilize the weapons and weapon systems that constitute the defense capabilities of the United States. The core of the defense establishment is the agencies of the Department of Defense--the Army, Navy, and Air Force. This core, in turn, is supported in many vital ways by the defense contracting system, which currently finances sizable proportions of the total activity in the aerospace, atomic energy, and electronics industries, especially. The success of the defense establishment depends on the effective coordination of the activities of these military and civilian components.

The civilian component of the defense establishment is highly technical in its manpower characteristics. A preliminary report of a continuing study of the structure and dynamics of the defense-related research and development industry in the United States, being conducted by Stanford Research Institute for the Directorate of Defense Research and Engineering of the Office of the Secretary of Defense, has reported:

> One-third of the national R&D workforce is employed on DOD projects. One-half of the defense R&D industry's workers are salaried workers. Over one-fourth of the defense R&D industry's workers are classified as scientists and engineers--technical professionals. Between 50 and 60 percent of the industry's salaried workers hold college degrees.*

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* See A. Shapero, R. P. Howell, and J. R. Tombaugh, <u>An Exploratory Study of the Structure and Dynamics of the R&D Industry</u> (Menlo Park, Calif.: a Stanford Research Institute report to ODDR&E. 1964), p. 3.

This reflects a considerable change in the manpower characteristics of the defense R&D industry during recent years. This change was accelerated particularly in the latter 1950s, when a large segment of the aerospace industry converted from aircraft production to the development and production of missile systems under federal government contracts, as may be seen in Table 1, drawing on data collected by the Institute in a report to the Aerospace Industries Association. This table shows the marked increase during this period not only for scientific and engineering employees, but also for middle-level (line) management and administrative staff personnel in activities connected with defense R&D.

Table 1

MANPOWER COMPOSITION OF SELECTED AEROSPACE ACTIVITIES
1947, 1955, and 1961

	1947	1955	1961
Total manpower in activities surveyed*	50,288	311,611	399,384
Hourly employees as percent of total	77.5%	76.0%	54.4%
Salaried employees as percent of total	22.5	25.0	45.6
Engineers and scientists (salaried) as percent of total	10.2	9.8	16.3
Other salaried employees as percent of total	12.3	14.2	29.3

* Nineteen companies reported manpower data for 26 activities for 1961; 18 of the same companies reported comparable data for 23 activities for 1955; 9 of the same companies reported comparable data for 9 activities for 1947.

Source: Stanford Research Institute.

In this regard, the report concluded:

The demand for personnel in managment, scheduling and control, procurement, and related services has increased 163 percent between 1955 and 1961, as compared with 113 percent for scientists and engineers. A significant part of this increase in "other salaried" employees can be laid to the growing accumulation of regulations, audits and management liaison and control systems, such as PERT, associated with government procurement.*

Parallel to the increasingly technical character of the defense R&D industry has been a shift toward a more technical orientation in the military services themselves. This shift shows up clearly when one examines changes over the last 100 years in the occupational composition of the enlisted personnel in the armed forces. Thus, for example, Table 2 shows that the proportion of enlisted personnel in technical and scientific categories shifted from 0.2 of 1 percent at the time of the Civil War to 3.7 percent in World War I, and then showed a more than fourfold increase to 15.8 percent by 1954.† The table also shows that somewhat similar increases occurred for those enlisted personnel who are mechanics or repairmen, and also for those who are in administrative and clerical assignments. A marked decrease has occurred over the same time period for the proportion of those who are classified in strictly military occupations, e.g., combat infantrymen.

Table 2 also shows that, comparing the 1954 military data with the 1950 and 1960 data for members of the total male labor force, the armed services appear to be more technically and managerially oriented than is true for civilian industry in general. The armed forces have higher proportions of their enlisted personnel in technical and scientific assignments, in mechanics and repairman assignments, and in administrative and clerical assignments, having had a total of 51.2 percent of their enlisted personnel in such assignments by 1954, compared with 29.0 percent in the same categories for the entire male labor force in 1960.

Another indicator of the trend of the armed services toward becoming technology management organizations has been the increasing ease with which commissioned officers in support activities, rather than those primarily involved in strictly military operations, have been increasingly able to move into higher level positions. Van Riper and Unwalla report

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* See G. T. Hayes, The Industry-Government Aerospace Relationship, Vol. 1 (Menlo Park, Calif.: a Stanford Research Institute report to the Aerospace Industries Association of America, Inc., 1963), p. 52; for more data on the same subjects, see A. Shapero and H. M. Vollmer, "Technical Profile of the Industry," appearing as Appendix H in Vol. II of the same report.

† Later comparable data on enlisted military personnel were not available at the time of publication of this report, but it can be assumed that the long run historical trend described above has been continuing.

Table 2

ENLISTED MANPOWER COMPOSITION OF THE ARMED FORCES AND OF THE U.S. MALE LABOR FORCE

Civil War to 1960

	Enlisted Personnel in the Armed Forces						U.S. Male Labor Force		
Occupational Category	Civil War*	Spanish-American War*	World War I	World War II	Korean Action	1954	1940	1950	1960
I Technical & scientific	0.2%	0.5%	3.7%	10.4%	12.7%	15.8%	6.1%	7.3%	10.3%
II Administrative and clerical	0.7	3.1	8.0	12.6	18.1	17.1	9.9	11.8	13.6
III Mechanics and repairmen	0.6	1.1	8.5	16.6	15.3	18.3	2.4	4.2	5.1
IV Craftsmen			13.0	5.9	4.7	6.0	12.7	14.4	14.4
V Service occupations	2.4	6.5	12.5	9.6	12.4	12.1	6.1	6.0	6.1
VI Operatives and laborers	2.9	2.2	20.2	6.1	6.5	5.4	26.9	28.2	26.8
VII Military or civilian occupations not classified above	93.2	86.6	34.1	38.8	30.3	25.3	35.3	27.0	19.2
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.4%†	98.9%†	95.5%†

* The Civil War and Spanish-American War data are for Army enlisted personnel only; the other military data are for enlisted personnel in all the U.S. Armed Forces.

† Because of variations in the number whose c cupation was not reported, the percentage is less than 100.

Sources: M. Janowitz, The Professional Soldier (Glencoe, Ill.: Free Press, 1960), p. 65 and K. Lang, "Technology and Career Management" in The New Military: Changing Patterns of Organization, M. Janowitz (ed.) (New York: Russell Sage Foundation, 1964), p.46, derived from studies for the U.S. President's Commission on Veterans' Pensions and data of the U.S. Bureau of the Census.

from a study of the careers of 2,077 officers of the rank of colonel or naval captain up through full general and admiral that:

> . . . while the chances for high rank have been greatest, and the avenues to the military "executive suite" most clearly open to those in operations, it is also obvious that the opportunities for those who chose a support activity for a career have not been poor. Indeed, the heterogeneous character of the officer corps in support activities has probably made it easier for a non-academy officer with few of the traditional attributes of a "military man" to attain reasonably high rank. Certainly the prospects for officers in support activities are improving.* (Emphasis added)

In comparing the main branches of the armed forces, Table 3 shows that the Air Force appears to require the most emphasis on technical and administrative assignments in the accomplishment of its particular mission within the defense establishment. By 1954, the Air Force had the highest proportions of its enlisted manpower assigned to technical and scientific, mechanics and repairmen, and administrative and clerical positions, compared to the other two services. These assignments, in turn, have required an increasingly higher level of general mental abilities on the part of the enlisted personnel in all branches of the service, and especially in the Air Force, as is shown in Table 4. Moreover, in the decade between 1961 and 1971, it has been estimated that the Air Force needs to more than double its officers in R&D assignments--from 2,600 to 5,900--to keep pace with technical requirements.†

In summary, the Air Force especially has become more like a technology management organization, responsible not only for in-house efforts in the development of new technologies related to national defense, but also responsible under the defense contracting system for the efforts of the many contracting organizations that also make up the defense establishment.

It is characteristic of technology management organizations to develop a bulge in their assignment of manpower of both middle-grade technician levels and middle-grade management levels, in contrast to the typical pyramid structure of decreasing numbers of personnel at higher grade levels, which is commonly found in conventional organizations. Proportionately fewer unskilled workers or common laborers are needed, and more skilled repair mechanics and technicians are required in technologically oriented organizations. Similarly, proportionally fewer first level supervisors and

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* See Paul P. Van Riper and Darab B. Unwalla, "Military Careers at the Executive Level," Administrative Science Quarterly, Vol. 9 (1965), p. 435.

† See W. E. Simons, "Officer Career Development" Air University Quarterly Review, Vol. 13 (Summer 1962), p. 101.

Table 3

ENLISTED MANPOWER COMPOSITION OF THE ARMED FORCES
BY BRANCH OF SERVICE
1954

	Occupational Category	Marine Corps	Army	Navy	Air Force
I	Technical & scientific	8.9%	14.5%	13.4%	21.7%
II	Administrative and clerical	18.9	17.4	8.0	23.7
III	Mechanics and repairmen	17.4	12.5	22.2	24.5
IV	Craftsmen	5.6	8.0	3.7	4.8
V	Service occupations	6.2	10.4	6.4	20.7
VI	Operatives and laborers	7.2	8.4	*	4.6
VII	Military-type occupations not classified above	35.8	28.8	46.3	*
	Proportion in categories I and III	26.3	27.0	35.8	46.2

* Where no percentages are shown, the services classify this type of personnel in alternative groups; therefore, the occupational classifications were not completely identical and the distributions should be understood as approximations.

Source: K. Lang, op. cit., p. 43.

Table 4

ENLISTED PERSONNEL IN MENTAL CLASSIFICATIONS OF "AVERAGE" AND "ABOVE AVERAGE" 1943, 1957, and 1959

Service	1943	1957	1959
Army (ground and service forces)	64.0%	73.6%	83.4%
Navy	*	76.7	83.5
Marine Corps	*	80.2	84.2
Air Force (Air Corps)	73.1	84.9	90.0

* No comparable data were available.

Source: K. Lang, op. cit., derived from R. E. Palmer, et al., The Procurement and Training of Ground Combat Personnel (Washington, D.C.: War Department, 1948), and U.S. House of Representatives, Committee on Armed Services, Hearings Before the Subcommittee on Utilization of Military Manpower, 86th Congress, 2nd Session (Washington, D.C.: GPO, 1960).

more middle management personnel are required to perform staff functions and to coordinate the wide variety of activities that occur in technologically oriented organizations. Tables 5 and 6 show that the Army and the Air Force have begun to develop such a bulge in the middle levels of their enlisted personnel grade structure and in their commissioned officer grade structure. For both the Army and the Air Force, the proportions of enlisted personnel at the E-3, E-4, and E-5 levels now exceed the proportion at the two lower levels. For the Army and the Air Force, the proportions of officers who are majors and lieutenant colonels are now higher than has been true in the past. A similar trend has occurred in the Navy. Critics have referred to this as a "grade creep," but Morris Janowitz, the prominent sociologist and student of military organization, has pointed out:

> The changed pattern of rank gives the impression of an inflation in rank, and a corresponding diminution of authority. A comparison of the actual rank distribution in the Army and Navy in 1920 and in 1950 shows that the "upper middle ranks" of colonel and lieutenant colonel (of captain and commander in the Navy) have increased proportionately, while the lowest officer ranks have respondingly declined. This parallels the changing pattern

Table 5

GRADE DISTRIBUTION OF ENLISTED PERSONNEL OF THE ARMY AND THE AIR FORCE
1935 to 1962

Rank	Both Services 1935	Both Services 1945	Army 1948	Army 1952	Army 1962	Air Force 1948	Air Force 1952	Air Force 1962
E-9	%	%	%	%	0.2%	%	%	0.5%
E-8	0.8				1.0			1.2
E-7	0.9	1.5	5.0	3.0	4.0	6.8	5.3	5.2
E-6	1.3	2.9	5.1	5.4	8.4	6.1	6.4	9.4
E-5	3.6	8.3	10.3	11.4	14.6	13.4	15.0	20.2
E-4	9.4	14.3	14.9	22.6	21.5	16.4	18.8	19.9
E-3	9.0	20.9	19.4	28.5	24.4	18.4	21.3	22.8
E-2	25.5	29.8	28.2	20.4	11.7	27.8	26.9	17.9
E-1	49.5	22.3	17.3	8.6	14.1	11.2	6.4	3.0

Source: K. Lang, op. cit., derived from Secretary of War, Annual Report, 1935; U.S. Army, Adjutant General's Office (for 1945); Statistical Services Center, Office of the Secretary of Defense (for 1948, 1952, and 1962 data).

Table 6

GRADE DISTRIBUTION OF OFFICERS OF THE ARMY AND THE AIR FORCE
1920 and 1962

Grade	Army 1920	Army 1962	Air Force 1962
General	0.4%	0.5%	0.3%
Colonel	4.1	4.9	3.6
Lt. colonel	4.7	11.7	8.9
Major	14.9	16.6	22.0
Captain	35.9	31.2	38.4
Lieutenant	40.0	35.1	26.8

Source: M. Janowitz, op. cit., p. 67; K. Lang, op. cit., p. 69, derived from data provided by Statistical Services Center, Office of the Secretary of Defense.

of civilian social structure, where the upper middle class proliferates because of the expansion of new professional and skill groups. In part, this represents an effort to raise the status and income of the soldier. In part, it represents a tendency of organizations to grow internally Basically, this expansion of the middle strata of ranks--officers and enlisted men--is a typical manifestation of organizations which have grown more complex.

Janowitz has summarized his studies of the changing character of modern military organizations by referring to three basic trends: (1) the "democratization" of the officer recruitment base; (2) a shift from direct "domination" to indirect "manipulation" in the basis of military authority; and (3) a narrowing of the skill differential between military and civilian elite groups. Under these categories, he has made the following comments:

> "Democratization" of the officer recruitment base. Since the turn of the century, the top military elites of the major industrialized nations have been undergoing a basic social transformation. The military elites have been shifting their recruitment from a narrow, relatively high-status social base to a broader, lower-status, and more representative social base. The broadening of the recruitment base reflects the demand for large numbers of trained specialists. As skill becomes the basis of recruitment and advancement, "democratization" of selection and mobility increases. . . . The United States Air Force, with its large demand for technical skill, has offered the greatest opportunity for rapid advancement.
>
> Shift in the basis of organization authority. It is common to point out that military organization is rigidly stratified and authoritarian in character because of the necessities of command. . . . It is not generally recognized, however, that a great deal of the military establishment resembles a civilian bureaucracy, as it deals with problems of research, development, supply, and logistics. Even in those areas of the military establishment which are dedicated primarily to combat or to the maintenance of combat readiness, a central concern of top commanders is not the enforcement of rigid discipline but rather the maintenance of high levels of initiative and morale. This is a crucial respect in which the military establishment has undergone a slow and continuing change since the origin of mass armies and rigid military discipline.
>
> Narrowing the skill differential between military and civilian elites. The consequences of the new tasks of military management imply that the professional soldier is required more and more to acquire skills and orientations common to civilian administrators and even political leaders. . . . This is not to imply that these skills are found among all the top military professionals, but the concentration is indeed great and

seems to be growing. The transferability of skills from the military establishment to civilian organizations is thereby increased.*

At the same time that Janowitz appears to support the thesis that modern military organizations are largely becoming technology management organizations with many characteristics similar to those of technologically oriented civilian corporations, he also recognizes one crucial difference in the military technology management organization--the total military organization must maintain combat readiness. At any moment, it must be prepared to change its overall character from what is, in considerable part, a research and development and systems-building and maintaining organization to a fighting unit in defense of the nation. In this regard, Janowitz has written:

> In the long run, under either the democratic or the totalitarian model, the military establishment cannot be controlled and still remain effective by civilianizing it. Despite the growth of the logistical dimensions of warfare, the professional soldier is, in the last analysis, a military commander and not a business organization administrator. The democratic elite model of civilian supremacy must proceed on the assumption that the function of the professional military is to command soldiers into battle.†

These considerations provide the underlying rationale for the strong need for the role of the military S&E officer, who in himself acts as a "transfer agent." He provides a link between, and is capable of acting in both, the world of science and technology and the world of military affairs. At the same time, the increasing tendency of the military components of the defense establishment to become more and more like other civilian technology management organizations has reduced the perceived advantages of a military career for officers with advanced technical training. It has made it more difficult for scientific and engineering officers to foresee a series of continuously challenging roles for themselves at levels of increasing responsibility in the military service when they may be able to have many more technical management career opportunities in civilian life.

Research and Development in the Air Force

How is the Air Force organized to meet its responsibilities in the face of rapidly advancing military technology? What general roles do S&E officers play in this organizational structure?

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* See M. Janowitz, The Military in the Political Development of New Nations (Chicago, Ill.: University of Chicago Press, 1964), pp. 117-121.

† Ibid., p. 124.

On April 1, 1961, the Air Force Research Division of the Air Research and Development Command was separated from its parent command and established as the Office of Aerospace Research (OAR). OAR was given the status, although not the title, of an independent major command. This establishment was part of a general reorganization of the Air Force research and development activities that also saw the reorganization of the Air Research and Development Command into the Air Force Systems Command (AFSC). Part of the Air Material Command (AMC) was also merged with AFSC at this time. OAR was given the main responsibility for the conduct of basic research and a few assigned exploratory development tasks for the Air Force. The organizational separation of research from development within the Air Force in this manner is in accord with advanced practices in leading academic research organizations and in large private corporations, such as North American Aviation, Inc.; the Ford Motor Company; and the Bell Telephone Laboratories.*

As in most technologically oriented organizations, development activities in the Air Force Systems Command are much larger in scope, and hence in manpower requirements, than the basic research activities in OAR. At present, about 29,300 military personnel and 37,000 civilian personnel are assigned to the Systems Command and about 550 military personnel and 1,400 civilians are assigned to OAR.† Until recently, it was estimated that the total number of Air Force officers assigned to professional level research and development activities in these two commands would increase to 9,300 by 1971, constituting 8.4 percent of the total officer force in the Air Force, and that the total number of spaces for civilian scientists

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* For a further discussion of the rationale for, and advantages of, the organizational separation of fundamental research activities from applied research and development, see H. M. Vollmer, The Fundamental Research Activity in a Technology-Dependent Organization, a selection of papers presented at the Tenth Institute on Research Administration sponsored by American University, to be published by the Air Force Office of Scientific Research, 1965, especially the appendix on "Data on the Organizational Separation of Research from Development"; see also H. M. Vollmer, Work Activities and Attitudes of Scientists and Research Managers: Data from a National Survey (Menlo Park, Calif.: Stanford Research Institute, a report to the Air Force Office of Scientific Research, 1965).

† U.S. Air Force, Secretary of the Air Force, Office of Information, Internal Information Division, Questions and Answers about the United States Air Force (Washington, D.C.: Government Printing Office, April 1965), pp. 78 & 81.

and engineers would increase to 20,390.* It is now estimated, however, that the numbers of military personnel assigned to research and development activities may be decreased, because of the new policy regarding the assignment of military personnel to "strictly military" positions.

Further information regarding the variety of S&E assignments may be derived from a review of the research and development activities of the Air Force in terms of the six major DOD RDT&E program elements: (1) research, (2) exploratory development, (3) advanced development, (4) engineering development, (5) operational systems development, and (6) management and support. Figure 1 shows the approximate size of each effort, in terms of fiscal year 1965 budget allocations, and the interrelations of these elements.

Research (basic) in four scientific areas (physical sciences, environmental sciences, engineering sciences, and life sciences) is performed primarily under OAR direction. OAR consists of three main in-house laboratories--the Air Force Cambridge Research Laboratories (AFCRL) at Hanscom Field, Mass.; the Aerospace Research Laboratories (ARL) at Wright-Patterson AFB, Ohio; and the F. J. Seiler Research Laboratory (FJSRL) at the Air Force Academy, Colorado--as well as the AFOSR in Washington, D.C., which sponsors research under grants and contracts in universities, research institutes, and other outside organizations. The OAR also administers other research support activities, such as the Office of Research Analysis, the Churchill Research Range, and several domestic and overseas liaison offices. The F. J. Seiler Research Laboratory is staffed predominantly by military personnel associated with the Air Force Academy. Other Laboratories and offices, as well as the OAR Headquarters in Washington, D.C., are staffed by a mixture of military and civilian personnel. From 75 to 80 percent of the research tasks under OAR management are carried out by external organizations, such as universities and nonprofit corporations, and about 20 percent are conducted in-house.

Exploratory development consists of activities directed toward the solution of specific technical problems short of the development of hardware for experimental or operational testing. The Systems Command is responsible for exploratory development in the Air Force through three main activities: (1) the Research and Technology Division, responsible for the larger portion of exploratory development; (2) the Aerospace Medical Division, responsible for exploratory development in the life sciences

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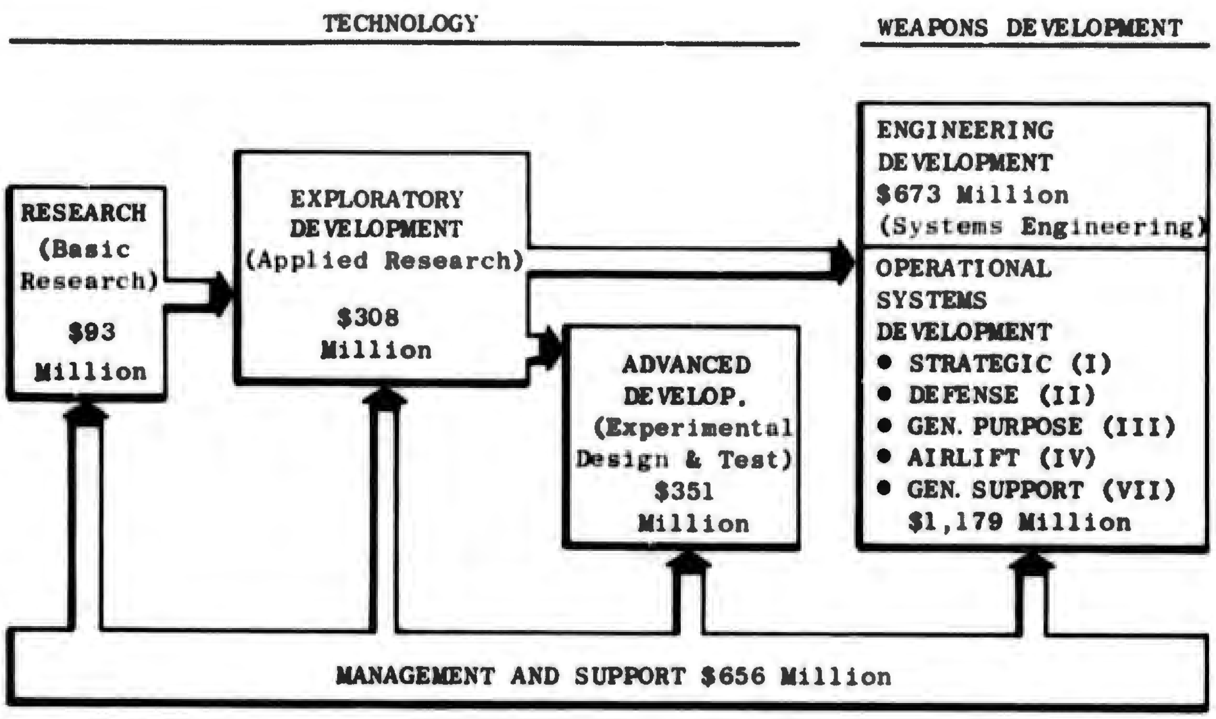
* George M. Williams, An Analysis of the Problems Encountered by the United States Air Force in the Motivation and Retention of Military Scientists and Engineers (Washington, D.C.: a thesis for the degree of Master of Engineering Administration in the library of the George Washington University, February 1965), p. 15, derived from "Scientists and Engineers," Department of Air Force All Commands Letter, AFPRC-13-3, 1 Nov. 1962, and "Ten Year Management Look, FY62 to FY72, Department of the Air Force, DCS/P, Directorate of Personnel Planning.

Figure 1

R&D PROGRAM ELEMENT RELATIONSHIPS



NOTE: The size of each of the blocks is representative of the amounts requested in each area. On the basis of similarity of goals and methods, the five major elements can be grouped into two general categories: Research, Exploratory, and Advanced Development under the heading of Technology and Engineering and Operational Systems Development under the heading of Weapons Development. Management and Support provides for operation of R&D facilicilities including test centers, ranges, labs, and contractor support. Also included are operating funds for AFSC Divisions and Centers and OAR.

Source: Plans Division, Directorate of Personnel Plans and Training, DCS/P, HQ Air Force Systems Command.

area; and (3) specific exploratory development tasks delegated to OAR. The main laboratories and facilities of the Research and Technology Division include: Rome Air Development Center, New York; Rocket Propulsion Laboratory, Edwards AFB, California; Air Force Weapons Laboratory, Kirtland AFB, New Mexico; Aero-propulsion Laboratory, Wright-Patterson AFB, Ohio; Avionics Laboratory, Wright-Patterson AFB; Air Force Flight Dynamics Laboratory, Wright-Patterson AFB; Air Force Materials Laboratory, Wright-Patterson AFB; Systems Engineering Group, Wright-Patterson AFB; and the Directorate, Armament Development, Eglin AFB. The main laboratories and facilities of the Aerospace Medical Division include the School of Aerospace Medicine, Brooks AFB, Texas; Aeromedical Research Laboratory, Holloman AFB, New Mexico; Arctic Aeromedical Laboratory, Seattle, Washington; Aerospace Medical Research Laboratory, Wright-Patterson AFB; Personnel Research Laboratory, Lackland AFB, Texas; and the Epidemiological Laboratory, Lackland AFB.

In accord with the requirements of its particular mission, the Air Force Weapons Research Laboratory has a larger concentration of military personnel than the other laboratories. About 85 percent of the total Air Force exploratory development effort is conducted by universities and industrial firms under contract and about 15 percent is conducted in-house.

Advanced development is directed toward producing major hardware items for experimental test or engineering feasibility demonstrations. This category includes projects that have advanced to a point where the development of experimental hardware for technical or operational testing is required before the determination of whether the items should be produced for operational use. These items are not weapons systems. They are one-of-a-kind components, subsystems, or test vehicles that are built to test ideas to provide the kind of technical data that are needed for subsequent engineering design efforts. Almost all of this work is done by private industry under contracts managed by the following divisions of AFSC: the Aeronautical Systems Division, the Ballistics Systems Division, the Electronics Systems Division, and the Space Systems Division.

Engineering development includes programs that are being engineered for Air Force use, but have not yet been approved for production and deployment. The basic orientation in this category is engineering rather than scientific in the sense that technological data used by the design engineer have already undergone extensive experimental testing in exploratory and advanced development phases. The objective is to build and to test rather than to explore. The main task in this category is to identify, select, and assemble components, subsystems, and promising design ideas and put them together into a coordinated weapon system design that will serve a specific military purpose.

Responsiblities for the performance of these engineering development or "systems engineering" activities have been assumed largely by contractors under AFSC management, as follows: Aerospace Corporation for the Space Systems Division, Space Technology Laboratories for the Ballistics

Systems Division, Mitre Corporation for the Electronics Systems Division, and Systems Engineering Group at Wright-Patterson AFB for the Aeronautical Systems Division.

While in engineering development, the focus is on systems engineering, in <u>operational systems development</u> the focus is on the manufacturing, production, and deployment of weapons systems for the Air Force under its systems program offices (SPO). In the operational systems development phase, the Air Force enters into full scale operational test and evaluation of weapons systems approved for use and deployment. Toward this objective, Air Force systems project officers work in close cooperation with many aerospace industry contractors.

The <u>management and support</u> category in the total DDR&E effort is primarily a fiscal category, set up to provide AFSC and Headquarters, OAR with funds required for the pay of civilian personnel, supplies, equipment, utilities, minor maintenance, and other services needed to accomplish the missions of the above RDT&E categories. However, this does not include the OAR laboratories, AFCRL, ARL, AFOSR, and FJSRL, which are provided management and support funds under the research program element.

This brief review of the organization of research and development activities in the Air Force points to the following conclusions:

1. Throughout its research and development activities, the Air Force has put together an Air Force-industry team to conduct activities that are mostly performed by outside contractors working under Air Force contract management through AFSC and OAR; hence, the appropriateness of designating AFSC and OAR as, of necessity, the most technological-management-oriented parts of the total Air Force, which was earlier identified as a "military technology management organization."

2. Air Force S&E officers play vital roles in translating problems of military technology into problems for research and development, on one hand, and in translating findings and innovations from research and development into considerations that can modify and redirect military strategy and planning, on the other hand, at all stages of the RDT&E process.

3. Various stages of the RDT&E process require different skills and talents on the part of S&E officers, as will be shown further in the following section.

<u>Similarities and Variations in S&E Officer Roles</u>

Air Force officers can be divided into three major assignment categories, according to their Air Force specialty codes: (1) operations officers (e.g., pilots, navigators, weapons officers, missile officers, safety officers), (2) technical officers (e.g., officers in security, intelligence, information, administrative/personnel, comptroller, or materials assignments), and (3) S&E officers (e.g., officers in civil engineering, electronics and maintenance, and scientific and engineering development categories). This report is especially concerned with those in S&E categories, and especially with those in scientific and development engineering (S&DE) fields within the larger scientific and engineering field. The fiscal year 1965 Air Force requirement has been for approximately 7,000 S&DE officers to accomplish its research and development missions.*

Table 7 shows that at the higher Air Force officer ranks (lieutenant colonels and colonels), proportionately more officers are required in technical (management staff) categories and proportionately fewer are required in line operations categories, which reflects the bulge in middle management categories that was pointed out earlier as being characteristic of technology management organizations. This bulge can be seen also when one looks at Table 8, showing that higher proportions of majors and lieutenant colonels than of lower grade officers are required in R&D management categories within the S&DE field.

The scientific utilization field (Air Force Specialty Code [AFSC] 26XX) includes those who are directing or performing duties as staff scientists, mathematicians, physicists, chemists, metalurgists, nuclear research officers, behavioral scientists, and others. Although it is important to point out that scientists are not interchangeable with regard to their subject matter specialties, officers in this career field engage in the same functional activities, i.e., basic research, applied research, and research testing.

The development engineering utilization field (AFSC 28XX) includes those who are directing or performing duties as staff development engineers, electronics engineers, mechanical engineers, astronautical engineers, aeronautical engineers, aerospace research flight test officers, and special development engineers in other categories. Again here, it is important to point out that development engineers are not ordinarily interchangeable with regard to their subject matter specialties, but they have in common the performance of similar functions, such as design studies, advanced development, and test and evaluation.

The research and development manager field (AFSC 27XX) includes two specialties: (1) research and development directors, who administer, monitor, evaluate, and coordinate research and development programs and projects for scientific and technological application to strategic and

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* U.S. Air Force, The Road Ahead for Scientific and Development Engineering, Phase IIA (Washington, D.C.: U.S. Air Force, AFPDP, 1964), p. 4, as corrected.

Table 7

REQUIREMENTS FOR AIR FORCE OFFICERS BY GRADE AND BY MAJOR OCCUPATIONAL CATEGORY
1965

	All AF Officers	Lieutenants and Captains	Majors	Lt. Colonels	Colonels
Operations categories	46%	47%	49%	43%	38%
Technical categories	29	27	28	33	37
Scientific and engineering categories	25	26	23	24	25
Total	100%	100%	100%	100%	100%

Source: The Road Ahead, Phase II (Washington, D.C.: U.S. Air Force, AFPDP, 1964), p. 4.

Table 8

REQUIREMENTS FOR AIR FORCE OFFICERS IN THREE S&DE CATEGORIES, BY GRADE
1965

	All S&DE Officers (6,986)	Scientific (AFSC-26XX) (1,112)	Development Engineering (AFSC-28XX) (3,980)	R&D Management (AFSC-27XX) (1,894)
Lieutenants	15.1%	25.1%	18.9%	1.5%
Captains	39.6	44.3	49.8	15.5
Majors	23.8	21.3	23.3	26.3
Lt. colonels	14.8	8.2	7.5	34.0
Colonels	6.6	1.1	0.5	22.7
Total	99.9%	100.0%	100.0%	100.0%

Source: The Road Ahead, Phase IIA (Washington, D.C.: U.S. Air Force, AFPDP, 1964), p. 4., as corrected.

tactical requirements, and (2) research and development officers, who manage research and development support activities. The latter are primarily administrative support managers, the former are primarily line managers in R&D activities, with at least a bachelor's degree in a science or engineering field, or completion of an Air Force Institute of Technology (AFIT) two-year undergraduate resident engineering course as a mandatory educational prerequisite.

Officers in the above three categories manage or conduct activities in the Air Force research, exploratory development, advanced development, and engineering development fields. Officers in the systems program management (SPO) field (not included within the S&DE field) manage operational systems development activities. These include systems project managers, staff officers, and specialists in various other aspects of Air Force weapons systems. A summary of the minimal educational and experience requirements and typical grade spread for S&DE and SPO officers is shown in Figure 2.

This brief review of the various roles of Air Force officers in the RDT&E process, described earlier, leads to the conclusions that:

1. There are a wide variety of specialties among Air Force officer assignments along the RDT&E spectrum requiring highly specialized skills that are not readily interchangeable, except in the middle level (major through colonel) R&D management and weapons systems management positions, where the officer is typically required to have at least a bachelor's degree in some scientific or engineering field and an appropriate amount of experience in R&D or weapons systems activities to qualify him for this higher level management position.

2. From a career development standpoint, the Air Force is developing S&DE officers into R&D <u>managers</u> and weapons systems specialists into systems project <u>managers</u>, recognizing that to progress, officers in neither category will be expected to remain in bench-level nonsupervisory positions.

3. At first view, there are essentially two kinds of R&D managers in terms of their functions and requisite career development background-- (a) R&D directors with direct line responsibility for the management of R&D programs and (b) R&D officers with responsibility for managing the administrative support services necessary to accomplish R&D missions. (The following chapter will point out that there are also two main kinds of R&D directors--"technical managers" and "technology management generalists.")

4. Recognition that the fundamental responsibility of an Air Force officer in R&D activities is likely to become, sooner or later, a management responsibility is in accord with the thesis developed earlier that the Air Force, especially, among all the armed

Figure 2

DUTIES AND REQUIREMENTS FOR S&DE AND SPO SPECIALTIES

Utilization Field Title	Examples of Specialties	Education	Experience	Usual Grade Spread
Scientific Utilization Field (26XX)	Mathematicians Physicists Chemists Metallurgists	bachelor's degree in appropriate scientific field mandatory	24 months experience in scientific field mandatory	2nd lt. through lt. col.
Development Engineering Utilization Field (28XX)	Electronics engrs. Mechanical engrs. Aeronautical engrs. Astronautical engrs.	bachelor's degree in appropriate engineering field mandatory	24 months experience in engineering field mandatory	2nd lt. through lt col
Research and Development Management Field (27XX)	1. R&D directors 2. R&D officers (support)	1. bachelor's degree or AFIT equivalent mandatory 2. same	1. 3 years R&D experience, and 1 year R&D mgmt. 2. 2 years experience in R&D budgeting, contracting, etc.	1. lt col. and colonel 2. 1st lt. through lt. col.
Systems Program Management Field (29XX)	1. SP staff officers 2. SP managers 3. Electronics, missile, avionics, munitions, aircraft maintenance specialists	1. bach. degree mand. 2. bach. degree mand. 3. no mandatory degree required	1. 18 mo. in SPO 2. 18 mo. as SPO director or deputy 3. 12-18 months in qualifying position	1. major-colonel 2. lt. col.-colonel 3 warrant officer through major

Source: Stanford Research Institute based upon Officer Personnel Classification Manual, AFM 36-1D, 15 June 1964.

services, is becoming more and more a military technology <u>management</u> organization.

The S&E Officer Retention Problem

The next chapter will go into more detail on the functions of R&D management and how it differs from other kinds of management, as further background for this examination of the role and career development of S&E officers in the Air Force. First, however, a brief review will be made of the magnitude of the S&E officer retention problem in the Air Force.

Although the Air Force is primarily a technology management organization--in fact, a technology management organization of a special kind--one which must maintain combat readiness as well as technological expertise--the Air Force capability to maintain its dual competence in this regard has been reduced by its low retention rates for S&E officers. The fiscal year 1963 retention rates for all Air Force officers in the operations categories was 56 percent; for all officers in the technical management categories, 26 percent; and for all officers in the scientific and engineering categories, 27 percent.* The retention rates for rated officers† is ordinarily high (e.g., more than 60 percent), but the retention rates for nonrated AFROTC graduates, many of whom have qualifications for R&D management positions, run as low as 20 percent. Because of these low retention rates among technically highly qualified young officers and because of the large requirements for officers in the middle management scientific and engineering categories, as shown in Tables 7 and 8, the Air Force is becoming increasingly hindered in maintaining, let alone enhancing, its capabilities as a military technology management organization.

Several studies have provided clues on why the retention rates of officers in the scientific and engineering and in the technical management categories have been so low. Thus, an ongoing study by Charles H. Coates has reported that:

> The technological revolution in warfare has greatly altered the criteria for recruitment and retention of military personnel. The narrowing of the differential between military and industrial skills has placed the military establishment in direct competition with civilian business and industry for qualified manpower. As a result, the armed services find themselves faced with serious problems of attacting and retaining military careerists. . . .‡

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* U.S. Air Force, <u>The Road Ahead</u>, Phase II, p. 6.

† Those who have qualified in flying status.

‡ See C. H. Coates, "The Influence of Sociological Factors on the Acceptance or Rejection of Military Careers," a paper presented at the annual meeting of the American Sociological Association, 1965.

Preliminary findings from this study have indicated that the factor that is most predictive of whether an officer will decide to remain in a career in the Army, Navy, Marines, or Air Force is the socioeconomic background from which he has come; those who have come from the middle, lower middle, and working classes of American society are more likely to decide on a career as a military officer, while those who have come from upper and upper middle class backgrounds are more likely to resign from a military career.* This is in spite of the degree to which military organizations are increasingly becoming technology management organizations, in which individuals of advanced training, cultural sophistication, and leadership abilities--characteristics often associated with upper and upper middle class status--are increasingly required. The truth of the matter is that, as a current study by Biderman and Sharp has shown, officers with higher education (i.e., college graduates) are more likely to believe that their abilities will be used to better advantage in civilian careers than in military careers, while the reverse is more often true among officers of less education.† Officers' perceptions of civilian careers are, in turn, affected by civilian labor market demands. A study conducted by the U.S. Department of Labor in 1961 has indicated that the demand for scientists and engineers in the civilian economy is climbing and will continue to climb in practically all occupational areas.‡

The Air Force has several alternatives in attempting to solve the retention problem for officers of higher educational attainments, as are required in its more technically oriented activities.

1. To reduce its department-level technology management capabilities, while attempting to maintain its strictly military combat readiness capabilities, allowing other "more civilianized" agencies (e.g., a defense R&D agency at the OSD level) to attempt to maintain defense R&D capabilities. The main disadvantage of this alternative would be to increase the organizational distance between the agency that needs to use new advances in technology--the Air Force--and the agencies that would be producing the technology, a centralized R&D agency and its contractors.

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* Ibid. For similar findings, see also F. Ewing and R. W. Alford, USAF Career Decisions: Predictability of Initial Career Intent (Lackland AFB, Texas: Personnel Research Laboratory, 1965).

† See A. D. Biderman and L. M. Sharp, "The Convergence of Military and Civilian Occupational Structure," a paper presented at the annual meeting of the American Sociological Association, 1965. For similar findings, see also F. D. Harding, R. L. Downey, and R. A. Bottenberg, Career Experiences of AFIT Classes of 1955 and 1956 (Lackland AFB, Texas: Personnel Research Laboratory, 1963).

‡ U.S. Department of Labor, Bureau of Labor Statistics, The Long Range Demand for Scientific and Technical Personnel (Washington, D.C.: National Science Foundation, 1961).

2. To keep R&D activities within the Department of the Air Force structure, but to "civilianize" them by giving civilians primary management responsibilities (in contrast to performance responsibilities) in AFSC and OAR, while using military personnel primarily for military operational assignments. The main disadvantage of this alternative would be to decrease the value of military personnel as integrators or "couplers"--the human links between military technology and research and development. No civilian groups combine within themselves the same degree of appreciation for military requirements and scientific and technical possibilities as do those who are <u>both</u> professional military men <u>and</u> professional scientists or engineers.

3. To seek ways and means to increase the retention rate of th kind of scientific and engineering officers that the Air Force needs most to maintain its military technology management capabilities; that is, by making their career opportunities in the Air Force more challenging than alternative civilian careers. This report will examine this latter approach in detail.

Chapter III

MANAGERIAL ROLES IN A TECHNOLOGY MANAGEMENT ORGANIZATION

In its "ideal type" or "model" form, a technology management organization differs from a traditional form of bureaucratically administered organization in several important respects, all of which have consequences for managerial roles. Here, these models will be discussed, recognizing that the Air Force, or any other specific organization, in reality shares characteristics of both models.

The ideal type of administration identified in the literature as "bureaucratic" is characterized by the following: (1) there is a clear cut division of labor into job positions along functional lines; (2) there is a hierarchy of managerial positions structured into a pyramid of increasing generality of authority over subordinate positions; (3) work activities are governed by a consistently applied system of formal and informal rules generated from organizational practice (i.e., precedent); (4) impersonality characterizes the performance of job requirements, e.g., a man is fitted to the characteristics of a job, rather than vice versa; and (5) a career progression is provided for entrants at the bottom level, moving upward through the management hierarchy as increasing experience is acquired by an individual at each managerial level.*

A technology management organization, in its extreme or ideal type form, is almost the exact opposite. It is characterized by the following: (1) there is a somewhat blurred division of labor, with activities often organized along project lines in ways that intersect functional divisions in the organization; (2) there is a dual hierarchy of authority in which technical authority resides essentially in one chain of command (ordinarily a short chain) and administrative authority resides essentially in the other chain of command (ordinarily a longer chain); (3) the work activities of technical professional personnel are governed by largely informal rules generated from professional practice, which transcend, and for professional personnel take precedence over, rules generated in the employment relationship with their employing organization; (4) job content is determined by, or at least markedly affected by, the characteristics, abilities, and interests of the job occupant; and (5) there is a "dual ladder" of career

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* This is an adaptation of Peter M. Blau's elements in the concept of bureaucracy appearing in Bureaucracy in Modern Society (New York: Random House, 1965), pp. 28-31, which is, in turn, derived from Max Weber, The Theory of Social and Economic Organization (Glencoe, Ill: Free Press, 1947), and Max Weber, From Max Weber, Essays in Sociological Theory (New York: Oxford Univ. Press, 1946).

opportunities, one being a short ladder for those in essentially technical positions, generally ending at the position of technical project manager; the other being a longer ladder for those in administrative positions, leading from the lowest level administrative management positions to the highest level management positions in the technology management organization. In such a dual ladder, technical professional personnel can move from essentially technical management positions into administrative management positions, but not without taking on increasing administrative responsibilities at higher levels that prevent them from exercising and maintaining their own technical capabilities in the manner that would be possible if they were to remain in technical positions.

The contrast between a bureaucratic administrative form of organization and a technology management form can be highlighted by the paradigm of managerial authority shown in Figure 3. In a bureaucratic administrative form of organization, management typically has a small amount of

Figure 3

AMOUNT OF DISCRETION IN MANAGERIAL AUTHORITY AS CHARACTERISTICALLY FOUND IN BUREAUCRATIC AND TECHNOLOGY MANAGEMENT ORGANIZATIONS

	Amount of Discretion Allowed to	
Area of Authority	Bureaucratic Management Ideal Type or Model	Technology Management Ideal Type or Model
Authority to initiate actions of subordinates by means of		
Selective hiring	Small amount	Large amount
Specific work orders	Large amount	Small to large amount
Authority to evaluate actions of subordinates in terms of		
Technical quality	Large amount	Small amount
Achievement of administrative requirements	Large amount	Large amount

Source: Stanford Research Institute.

discretion in hiring personnel because personnel are selected to fill prespecified job requirements, and this can be done in an essentially routine manner by matching individual qualifications from a list of names on a register with job requirements, as is ordinarily done in the Civil Service and in the military assignment systems. In a technology management organization, however, prespecified job requirements characteristically do not exist in any great detail, and management must use a large amount of discretion in hiring any technical professional person, in terms of management's assessment of the unique contributions that would be expected from his employment. In a bureaucratic organization, management is expected to give detailed and specific work orders to subordinates, but in a technology management organization, management may or may not be expected to give detailed and specific work orders, depending on the type of function managed (e.g., a basic research function in contrast to applied research or development).

Perhaps the key difference between the bureaucratic form of organization and a technology management organization is in the amount of authority that higher level management is ordinarily given to evaluate the technical quality of subordinates' performance. In the bureaucratic form of organization, all management has the direct responsibility to evaluate the technical quality of subordinates' performance. In a technology management organization, higher level management has the indirect responsibility to evaluate the technical quality of subordinates' performance (but it is ordinarily exercised through the judgments of technically qualified project managers or technically qualified consultants or members of advisory groups).*

In both kinds of organization, however, all levels of management can exercise a large amount of authority in evaluating the degree to which subordinates' efforts meet the administrative requirements of the employing organization, e.g., the degree to which performance requirements are achieved, time schedules are met, administrative rules and regulations are adhered to, and budget allocations are not exceeded.

What has been presented here is the outline of the ideal type or model of a technology management organization, showing how such an organization, especially in its dealings with technical professional personnel, differs from the more familiar form of bureaucratic administrative organization. However, as was indicated earlier, most organizations that could be designated by many criteria as being of the technology management type--the Air Force, for example--are in reality mixed forms of organization that include

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* There have been proposals for systematic approaches to the evaluation of technical quality not based on expert judgments; see, for example, H. M. Vollmer, "Evaluating Two Aspects of Quality in Research Program Effectiveness," a paper presented before the Second Conference on Research Program Effectiveness, sponsored by the Office of Naval Research, 1965. Until such an approach is generally accepted, however, the evaluation of technical aspects of performance in technology management organizations still tends to be an indirect matter of qualitative judgments by experts.

both bureaucratic and technology management elements. This mixture is implemented by the three main managerial roles to be found in technology management organizations: (1) the technical manager role, (2) the administrative manager role, and (3) the technology management generalist role. The following sections of this chapter discuss the main characteristics of each of these roles and compare them in terms of available data. Finally, they indicate where Air Force scientific and engineering officers can best fit into the managerial structure and can make their most significant contributions.

The Technical Manager Role

Technical managers are key personnel contributing to project or program effectiveness within a technology management organization. As a report of a National Academy of Sciences committee has pointed out:

> The effectiveness of a project team appears to depend very largely upon the abilities of the few men who form its nucleus or core. As shown in the case studies of Titan II and the Naval Tactical Data System that were prepared for this Committee, the technical and administrative management of the system development process at both government and industry levels was performed by a handful of key individuals. . . . The early identification, development, and assignment of men capable of playing key roles in the technical direction of big projects is one of the most important responsibilities of top management in companies engaged in large-scale research and development.*

It is often claimed that the role of the technical manager has been created by the requirements of "big science" and complex technology, which require technical project managers to act in a role somewhat analagous to that of a symphony conductor:

> The big projects and great laboratories are gradually leading to a new kind of creativity in science. By pooling their individual talents and efforts in a common purpose, the members of such organizations are able to attempt new ventures with a boldness and on a scale far beyond the scope of the individual It is a collective creativity, rather like that involved in, for example, producing an opera or a ballet. In these one needs not only the Stravinsky's and Benjamin Brittens but also all the various orchestralists, soloists, chorus, designers, costumers, and producers. They all create as individuals, but

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* See Committee on Utilization of Scientific and Engineering Manpower, Toward a Better Utilization of Scientific and Engineering Talent, a Program for Action (Washington, D.C.: National Academy of Sciences, 1964), p. 25.

to the common purpose; and it is the result of all their efforts, the collective creation, that is the finished work of art. Many modern laboratories are striving to achieve the same sort of thing in science.*

However, the characteristics of the technical manager role originate in the relationship of university faculty scientists with their students before most of these students, or faculty scientists, have had any contact with what they ordinarily identify as "big science" in complex laboratories on the outside. Thus Professor Warren Hagstrom, who has studied this subject extensively, has pointed out:

> In laboratory sciences in U.S. universities, the assistance of graduate students and postdoctoral fellows is indispensible to a professor's research. A large proportion of the articles in such periodicals as the Journal of the American Chemical Society are jointly written by a professor and his students. Thus an experimental physicist could answer the question, "Does having students contribute to your own research?" by saying "Yes--they do it," without being too facetious.†

Hagstrom goes on to point out that the relationship between professors and students in their scientific activities is not one of free collaboration, but rather one more like that of a master and apprentice. He reports that a majority of the faculty in physics and chemistry departments he studied said that the professor really selects most dissertation topics among his students, and he cites a previous study by Bernard Berelson indicating that only 2.5 percent of the latter's sample of scientists said that students select most dissertation topics.‡ Students may elect to work under professors who have similar interests, but once the students enter into the master-apprentice relationship, they proceed to work on topics under the direction of faculty "technical managers."

Thus scientists learn early to play a role of providing technical support to lead scientists, in the first instance, their faculty advisors. Also leading scientists learn in universities to conduct research requiring the technical assistance not only of semiskilled and semiprofessionalized technicians, but also of highly trained professional assistants, e.g., postdoctoral fellows in many cases.§

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* See A. H. Cottrell, "Scientists: Solo or Concerted?" in The Sociology of Science, ed. by B. Barber and W. Hirsh (Glencoe, Ill.: Free Press, 1962), p. 391.

† See W. O. Hagstrom, The Scientific Community (New York: Basic Books, 1965), p. 125.

‡ Ibid., p. 131.

§ In scientific research activities in the largest universities, there is now an almost even ratio of faculty to nonfaculty research associates; see H. M. Vollmer, T. R. LaPorte, W. C. Pedersen, and P. A. Langton, Adaptations of Scientists in Five Organizations: a Comparative Analysis (Menlo Park, Calif.: a Stanford Research Institute report to the Air Force Office of Scientific Research, 1964), p. 14.

In industry and other nonacademic contexts, multidisciplinary teams are often required to work on problems of interest to the sponsoring corporation under the direction of technical managers, who operate in a role analogous to that of faculty and students, or at least to faculty and postdoctoral fellows. Where access to complex equipment, such as nuclear reactors or particle accelerators, is required to conduct research, pressures toward organization into project teams under leading scientists as technical managers are increased. An informal code of ethics has developed out of common practice to assign credit and responsibility for the results of such collective efforts for which one individual has assumed the major responsibility for technical management:

> Although collaborators in this type of joint work may share in the recognition given the published papers, they may make the division of labor altogether clear. Usually the scientist who initiates the problem will sign his name first, assuming the major responsibility for the results, and the scientist whose technical assistance was sought will sign his name second.*

Although the scope of technical managers' duties and the numbers of professional and subprofessional personnel assigned in large systems development projects and programs ordinarily greatly exceed those in smaller research projects, the main responsibilities of technical managers in both kinds of activities are essentially the same in nature: (1) planning the research design, or the system development design, from its initiation through to its final completion in final form and (2) controlling the project activities both in terms of (a) achieving administrative requirements and (b) achieving technical quality requirements. Thus, although it was pointed out earlier (see Figure 3) that overall management in a technology management organization ordinarily exercises a small amount of direct control over the technical quality of the work of its technical professional employees, this is not the case with those members of management in what are described here as technical management roles. Technical managers typically exercise a great deal of control over the technical quality of project work under their supervision. They are charged with this responsibility by the overall management of their employing organizations. What is more, their subordinates expect this. Even scientific personnel, who are widely noted for their desire for freedom from managerial control, willingly submit to the control of technical managers on specific research projects. They have been trained to accept this kind of authority from the time they were students in a university. They can accept this authority because technical managers are more likely than not to be senior professional scientists.

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* See Hagstrom, op. cit., p. 117.

The Administrative Manager Role

Technical managers have the direct responsibility for the technical functions in a technology management organization, but administrative managers in such support functions as budgeting, contracting, planning, scheduling, personnel administration, technical information, and public information also make vital contributions to the successful operation of a technology management organization. In fact, as was indicated in the previous chapter (see Table 1), an increasing number of nontechnical administrative personnel is characteristic of organizations as they become more and more technology management organizations. This also accounts for much of the characteristic bulge in middle management in these organizations.

Todd LaPorte has studied extensively the role of administrative managers in the research activities of a leading aerospace corporation. LaPorte found that in their role, administrative managers are most likely to emphasize skills in organizational matters and human relations. The main organizational skill called for is a knowledge of company policies and procedures, along with general business skills and the ability to handle large quantities of details.* This contrasts with the role of technical managers, whose primary emphasis is on technical skills and competences.†

A clear picture of differences between the technical manager role, and the kinds of qualifications required to fill it, and the administrative manager role and the different requirements for its incumbents, emerges from these findings.

Differences in the functions of the two roles and in the kinds of individuals required to fill them can, in turn, lead to disruptive conflicts within technology management organizations. Such conflicts have been noted in Vollmer and Pedersen's study of a university research organization. The study concluded that a fundamental source of this conflict was in the fact that administrative managers, because of the nature of their work, often desired a more ordered or bureaucratized form of organization than was predominant in their loosely structured university laboratory environment.‡

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* See Todd R. LaPorte, Organization for Research: Conditions of Strain and Accommodation in an Industrial Research Organization (Stanford, Calif.: a doctoral dissertation in the Stanford University Library, 1963), p. 63. These findings on the role of administrative specialists have been confirmed in further case studies of a university research laboratory and a private industrial laboratory in the atomic energy field; see Adaptations of Scientists in Five Organizations: Methodology and Technical Appendix, pp. 28, 40, and 63.

† LaPorte, op. cit., p. 56.

‡ Adaptations of Scientists in Five Organizations: a Comparative Analysis, pp. 25-26. Conflicts between staff and line officials have been noted also in the earlier literature; see, for example, Melville Dalton, "Conflicts between Staff and Line Managerial Officers," American Sociological Review, Vol. 15 (1950), pp. 342-351.

Laboratories and other centers of R&D activity in universities and outside often embody principles both of a technology management organization and of a bureaucratic administrative organization, focussing these principles in the technical manager and the administrative manager roles, respectively. What is required, in addition, is a third managerial role to integrate both principles. This leads us to a discussion of the role of technology management generalists.

The Technology Management Generalist Role

The basic requirements for the technology management generalist role are suggested by the following comments in a paper written by Gen. Bernard A. Schriever:

> Most people think of management in terms of running a specific program. This is natural. Obviously the purpose of management is to deliver usable end products--missiles, aircraft, electronic systems, or consumer goods.
>
> But management is more than this. It is far more than the effort involved in running a single program or even running a number of programs. For example, if you add together all the many systems that are managed by AFSC, you get only a partial picture of our management responsibilities. . . .
>
> Instead of starting with systems, let us start with resources and mission. Our management responsibility can then be stated in the following terms: (as of 1962) we have an annual budget in the neighborhood of $8.5 billion; we have about 64,000 people--both military and civilian; and we possess facilities worth approximately $2 billion. Our mission is to build, on a timely basis, the necessary aerospace strength for the United States. Now, how do we utilize all our resources most effectively to accomplish this task?
>
> The answer to this question involves much more than just managing a number of system programs. Actually three areas of responsibility are involved. First of all, we must ensure that all our programs are being run efficiently and effectively. This is basic. Secondly, because our resources are limited, we must make certain that they are allocated in the best possible manner. . . . The third area of responsibility is in many ways the most crucial. This is the responsibility for deciding when and how to initiate new programs. In today's environment of rapidly advancing technology, it is our most difficult decision area.*

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* See Gen. Bernard A. Schriever, "The Air Force Systems Command Programs," Science, Technology, and Management, ed. by F. E. Kast and J. E. Rosenzweig (New York: McGraw-Hill, 1963), pp. 182-183.

Thus, the role of the technology management generalist is primarily an integrating role. The role of technical managers in specific projects or programs is primarily oriented toward achieving technical quality as well as meeting administrative requirements (with regard to time, cost, etc.) through the planning and control of research and development projects, and the role of administrative managers is primarily oriented toward providing necessary support services. The role of technology management generalists is primarily oriented toward integrating administrative support services with technological project activities, and both with the overall mission or goal of the sponsoring organization or corporation. This role is shown schematically in Figure 4. As General Schriever has pointed out, this role involves the making of key management decisions regarding (1) the administrative effectiveness and efficiency of projects or programs (e.g., in terms of meeting schedule, cost, and performance requirements); (2) the allocation of manpower, time, money, and facilities resources to be made to ongoing projects; and (3) the initiation of new projects or programs.

It is evident that the technology management generalist role is more likely to be performed by individuals who are in at least second level, or higher, management positions in a technology management organization; first level supervisors are more likely to be acting as technical managers. It is also evident that the technology management generalist role requires individuals with somewhat different characteristics and abilities than are required of technical managers. Whereas technical managers must be primarily outstanding in their own technical abilities with regard to the type of project being managed, technology management generalists at higher levels must combine at least basic familiarity with the technical areas under their general management with basic understanding of administrative matters in their employing organization.*

Moreover, in a technology management organization, there is no clear career continuity between first level supervisors (mostly technical managers) and higher level supervisors (mostly technology management

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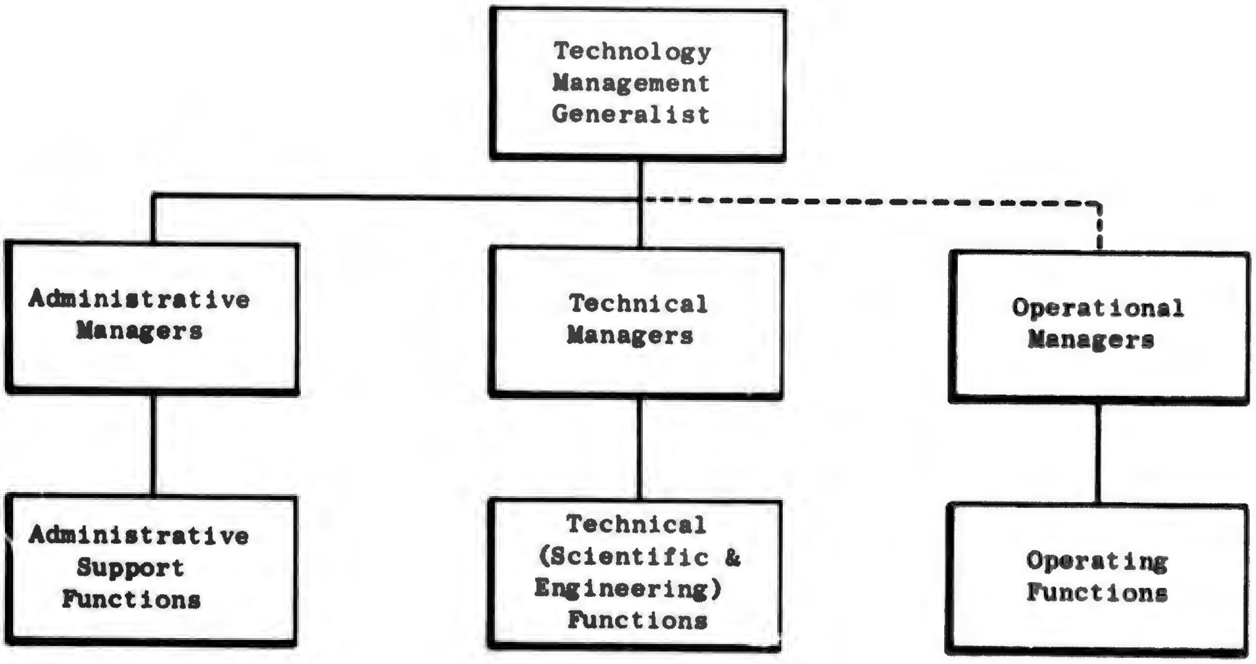
* A conclusion of a content analysis study of 825 R&D management jobs occupied by officers in the Air Force Systems Command is: "Since R&D management officers are primarily managers and not scientists or engineers, they must have thorough knowledge and understanding of research and development policies, procedures, and management practices. The specialized training in management needed suggests the advisability of graduate work in management or business administration." J. E. Marsh, M. J. Giorgia, and J. M. Madden, A Job Analysis of a Complex Utilization Field: The R&D Management Officer (Lackland AFB, Texas: Personnel Research Laboratory, 1965).

Figure 4

THE ROLE OF THE TECHNOLOGY MANAGEMENT GENERALIST



Source: Stanford Research Institute.

generalists).* Many technical professionals aspire to a technical manager role where they believe that they can have a maximum amount of freedom in exercising their technical abilities and making decisions regarding technical matters. They are often not interested in advancing to a higher level technology management generalist position, where they must, of necessity, become more concerned with general management and leadership responsibilities and less involved in purely technical matters. Thus, data from a national survey of scientists just completed by the Institute indicate that 71 percent of all the scientists surveyed who are now in nonsupervisory positions say they desire to remain in nonsupervisory positions for at least the next ten years, and only 18 percent desire to move into supervisory responsibilities. Furthermore, 16 percent of those who are currently in research management positions say they desire to move back into bench-level positions without supervisory responsibilities.† Engineers are more prone than scientists to desire a career in management, but a national survey conducted by the Professional Engineers Conference Board for Industry indicates that only about 50 percent of the engineers are positively oriented toward a career in general management.‡

Therefore, in summary, the roles of the three key types of management positions in a technology management organization are so different in their requirements that they lack any clear cut career continuity between them. Technology management generalists, administrative managers, and technical managers each require their own particular pattern of career development.

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* In fact, the lack of career continuity between lower level and higher level managerial responsibilities noted in a technology management organization can also be found in conventional military activities. Morris Janowitz has written: "The organizational dilemmas linked to career development form a basic theme of military life. The dominant role conflict is the conflict between tactical combat skills and the requirements of higher command. Often this is stated as the clash between staff and command. But a close examination of the military establishment seems to indicate that the dilemma is between differing leadership skills. The skill of organizing and directly controlling small tactical units where the demonstration of technical skill is paramount gives way to the skill of organizing larger and more complex units where the elements of stress are more indirect and subtle. The military is no different from other institutions, in that the higher the position the less important specific technical skills are, and the more important are general interpersonal skills." M. Janowitz, Sociology and the Military Establishment (New York: Russell Sage Foundation, 1959), p. 59.

† See H. M. Vollmer, Work Activities and Attitudes of Scientists and Research Managers: Data from a National Survey (Menlo Park, Calif.: a report by Stanford Research Institute to the Air Force Office of Scientific Research, 1965), pp. 32-33.

‡ See Professional Engineers Conference Board for Industry, Career Satisfactions of Professional Engineers in Industry (Washington, D.C.: PECBI, 1962), p. 16.

A final comment is perhaps in order: What is being described here as the "technology management generalist role" should not be confused with what others have described as a "general purpose manager." A general purpose manager is one who has been trained only in principles of management on the assumption that this qualifies him to manage anything. In contrast, a technology management generalist is one who has appropriate training and experience in (1) a technical field and (2) an operational field, along with additional training in (3) management principles and methods. It is his role to serve as an integrator of technical and operational fields within his employing organization. To maintain that a general purpose manager can manage anything is as false as to claim that one who has only had a background of training in the general principles and practices of education can teach any subject.

Career Development in the Three Roles

As was pointed out in Chapter II, the Air Force now recognizes the need for a career development pattern for R&D officers in support categories (or what we have called "administrative managers" in the present chapter) that differ from the career development patterns for R&D directors with direct line responsibility for the management of R&D programs (in the AFSC 27XX field). To become administrative managers, R&D officers must have at least two years prior experience in R&D budgeting, contracting, or some other appropriate support field, in addition to a bachelor's degree. In contrast, to become R&D directors (line managers), it is presently required that officers have at least three years in R&D bench experience as a scientist or engineer and at least one year's experience as a project director or manager, in addition to a bachelor's degree. Thus the Air Force promotion plan for R&D directors assumes that technical management generalists will mostly come up through the ranks of scientists or engineers and through technical manager roles (e.g., project directors) into general R&D management.

In R&D organizations, higher level technology management generalists ordinarily come up through the technical ranks in the organization. It is commonly believed that it is easier to develop administrative skills among engineers and scientists than it is to develop a very complete understanding of science and engineering among professional administrators who have had no bench-level scientific or engineering experience, but it must also be recognized that the vast majority of scientists and many engineers have no managerial ambitions when they are at the peak years of their technical activities, as was pointed out in Chapter II. This is why many technology management organizations attempt to develop some form of dual ladder to allow increased responsibility and rewards to those who wish to remain in strictly technical positions, in contrast to those who wish to take on general administrative responsibilities which involve the coordination of technical, support, and other line activities within the larger technology management structure.

The Air Force does not now provide such a dual ladder to any great extent. For example, scientists and development engineers who remain in purely technical activities in their fields can only advance to the lieutenant colonel level at most (in the AFSC 26XX and 28XX fields). Young S&E officers are generally aware of this and realize that if they are to remain as strictly scientists and engineers they will have much better opportunities as civilians. Thus, S&E officers who hold doctor's degrees, and are therefore most highly trained in their technical fields and most likely to have been highly imbued with the values of remaining in their technical fields, have retention rates that are even lower than for S&E officers who are not doctors. Nevertheless, concern is often expressed in Air Force circles about the fact that the Air Force is losing these "most highly qualified" S&E officers, without recognizing that these officers are indeed highly qualified in a technical sense, but, by the same token, might in many cases be less highly qualified for the mixed technical-administrative types of technology management generalists that the Air Force most needs in its higher officer grades.

In support of this latter contention, data from a nationwide survey of scientists and research managers have shown that scientists with less than a doctor's degree (most of these have master's degrees in their scientific fields) are much more likely than the doctors to say that they are identified with their employing organization (rather than with their scientific profession), that they are looking forward to a career in management, and that they are especially interested in "helping to translate research findings into useful applications."* In contrast, however, it should also be noted that this same study showed that those scientists who have doctor's degrees and are now in research management positions are also generally more likely to say that they are identified with their employing organizations and that they want a management career than are those who have doctorates but are not in research management positions.† In other words, there are <u>some</u> scientists with doctor's degrees who are indeed able to adapt themselves to managerial responsibilities.

Therefore, these data seem to suggest that it would be desirable for an Air Force career development program to attempt to identify early those scientists and engineers in its officer categories with a "mixed orientation" toward their careers--those who have a basic technical education and competence but are also looking forward to assuming managerial responsibilities. Such individuals are more likely to be found among those who have master's degrees, but a few may also be found among those with their doctorates. (There is some suggestion from S&E officers interviewed during the course of this study that more mature officers who have received their doctorates after a considerable tour of duty in Air Force assignments are more likely to be retainable and to be prepared for general

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* See <u>Work Activities and Attitudes of Scientists and Research Managers: Data from a National Survey</u>, pp. 134, 140.

† <u>Ibid</u>., pp. 134, 135, 140, 141.

management responsibilities than those who came into the Air Force with their doctorates.)

When methods are developed to identify such officers with a mixed orientation appropriate for management generalists, it would seem desirable to sustain and enhance this orientation by a career promotion plan that allows for the following types of training and experience:

1. A basic education in military science, to be accomplished at the Air Force Academy, in the ROTC program, or in other officer training programs.

2. A basic education in a field of physical science or engineering at the bachelor's level initially, to be supplemented by advanced training in a field of physical science or engineering at the master's level. The advanced training could directly follow the initial education at the Academy or a university, or could be given later through AFIT

3. Assignments of at least three-year duration in an operating command of the Air Force to develop further military skills and a sensitivity to military requirements.

4. Assignments of at least three-year duration to bench-level and then technical manager level activities in research, development, test, or engineering activities to develop a basic understanding of technical and scientific requirements.

5. Periodic training and retraining in principles of technology management by means of special seminars, etc., throughout the course of the above assignments.

6. Assignments in technology management generalist positions in operating, logistics, and R&D support commands (AFSC and OAR) in which the main function of the officer is to integrate military requirements with scientific and technological advances.

There are Air Force officers who have been able to assume the management generalist role and, through plan or coincidence, have passed through the career development elements described above. Examples of such cases are given in the following chapter.

Chapter IV

EXAMPLES OF S&E OFFICERS IN DIFFERENT MANAGERIAL ROLES

In this study, it was decided that it would be useful to supplement data collected from previous studies with new information on the characteristics, career experiences, and attitudes of a variety of S&E officers who might be considered as typical examples, or living models, of individuals who are performing the managerial roles described in the previous chapter. For this purpose, the commanders of five Air Force laboratories or R&D installations (two in the OAR and three in the Systems Command) cooperated by designating some "outstanding S&E officers" within their organization for an interview by one or the other of the authors of this report. A total of 22 officers were interviewed. From these 22 interviews, seven cases are described in detail in this chapter.

In accord with the purpose of these interviews, it should be recognized that those interviewed cannot be considered to constitute any kind of representative sample of Air Force S&E officers. Instead those interviewed, and especially those cases reported in this chapter, should be considered to be more or less typical examples of S&E officers performing one or the other of the management roles described previously. These are illustrative cases, showing that the behavior patterns and attitudes that make up each role tend to differ markedly from one role to the other, although some of the individuals described herein will also be shown to be in transition from one role to another. Also in line with the previous discussion, particular emphasis in these examples will be placed on those who are now performing, or who are moving toward the performance of the technology management generalist role, in contrast tc the technical manager and the administrative manager roles.

To provide guidance for the information collected in the interviews and to allow some assurance of comparability between them, the Interview Schedule shown as the appendix to this report was used for each interview. On the average, each interview took about one hour to complete. To provide a reasonable degree of anonymity to the responses of each officer interviewed, some of the personal characteristics data have been masked or slightly altered in this chapter. In no case, however, do these changes make any substantial differences in the background characteristics, role attributes, career patterns, or expressed attitudes of any individual described here.

A Technology Management Generalist

"Colonel A" is an example of a technology management generalist. Colonel A is a rated officer, having served early in his career in the

Aviation Cadet Program. When he entered the military service at the beginning of World War II, he already held a bachelor's degree in a physical sciences field. During the war, he served as a combat pilot and as an aircraft maintenance officer. After the war, he attended a leading civilian institute of technology under AFIT sponsorship and attained the M.S. degree in a physical science field. A few years later he also attended a major university and received the M.B.A. degree, again under AFIT sponsorship.

Since then he has served tours of duty of at least three years each (1) as a bench-level scientist or engineer, (2) as an"administrative manager"in R&D program planning, and (3) as a technical manager of an R&D program. At present, he is a director of large and important R&D activity with technical managers and groups of technical personnel serving under him. In his present activities, Colonel A says that he is concerned with technical programs "that industry would not invest dollars in by themselves, but are necessary for future Air Force Systems."

When asked about the major kinds of decisions he has to make in his job, Colonel A says that "number one is regarding personnel--I have to keep the civilian employees happy and satisfied and I have to help educate the young second lieutenants, getting them an exposure to a wide variety of things and, if possible, converting them to 'regulars'; and number two is technical--I have to decide what to do about project overruns and how to manage multimillion dollar expenditures." (Colonel A states that his program includes several hundred active projects at any time and can total over $50,000,000 in contracts at any one time.) In his program, he reports that a new project can either be initiated by the scientists and engineers within the program, or from requests from other parts of the Air Force, and that he is personally involved in the approval of any major project effort, "and most of the minor ones." At the same time, Colonel A also reports that in day-to-day technical decisions "I leave as much as possible to my group chiefs; I stay out of daily decisions. . . . The group chiefs reporting to me have a great deal of freedom, but they can come to me for advice any time. I'm almost what you might call the 'hands off' type supervisor in technical matters."

When asked about the principal satisfactions he gets from his work, Colonel A said: "I like to see the accomplishment of successful new techniques, processes, and hardware; I like <u>applied</u> research. Also I like to see the growth of young technical people in spite of the small amount of guidance it is possible to give them--they are thrust into a big responsibilities very rapidly in the Air Force."

When asked about the important career decisions that he has made over the course of his military career, Colonel A reported that he did not think he would be staying in the service as a career at the time he first entered the service. "After the war, however, I wanted to continue flying. Also I guess I just liked the military. Furthermore, I found I could do <u>both</u> engineering and flying in the Air Force. If I had this choice, I would do it all over again. In the Air Force, I believe a young man can have significant experiences sooner than he would in industry. I think also that the young man should want to go into R&D management--that's the future in the Air Force."

Colonel A's opinions on what could be done to improve the retention of S&E officers in the Air Force include the following suggestions:

"1. S&E officers should be assured that they will have a chance to pursue an R&D career, even though they also go into operations for a while.

2. They should work on the wives; sometimes the wife's attitudes scuttle the man.

3. There should be pay raises. Most of the conflict here is between civil service and military pay scales, not in comparing military with industry levels. When I entered the service, it was rare to see a lieutenant who was married; now it's rare to see one who is not. I think this makes quite a difference in the need for pay. I married at age 35, and by then my pay was adequate. People won't wait today, nor should they have to."

In summary, Colonel A reports satisfaction with the way his own career has worked out in the Air Force and states that he plans to remain as a 30-year man.

Another Technology Management Generalist

Not all technology management generalists have master's degrees in both a scientific and engineering field and in business administration; there are some with all their advanced degrees in science, but also with enough operational experience and with present job responsibilities to justify their being designated as "technology management generalists." Lt. Colonel B is an example of this type of technology management generalist.

Lt. Colonel B, like Colonel A, became a rated officer initially through his participation in the Aviation Cadet Program in World War II. He served as a navigator on combat missions both in World War II and in the Korean action. Lt. Colonel B held a B.S. degree at the time of his entry into the service at the beginning of World War II. He also received a master's degree in a scientific field at a private university under self-sponsorship at the end of World War II. At the end of the Korean action, he took further graduate work at a leading university, and received his Ph.D. in a scientific field under AFIT sponsorship. Following this, he had technical assignments in radiological defense, administrative assignments in research planning, and is at present the director of an R&D activity. In relation to his present responsibilities, Lt. Colonel B says, "My job is to generally administer science. I have grown away from the bench, on one hand, and from the operating part of the service, on the other. I recognized that I couldn't ever go into the higher ranks, such as full colonel, by staying at the bench."

In thinking about his career, Lt. Colonel B says, "How did I get through the system? In the first place, I recall that after I got the M.S. degree, the Air Force offered me $5,100 (with flight pay). At that time, I thought I wanted to go into public school teaching, but the public schools only offered $2,100. Industry offered me $3,600. So the money was better for me inside."

"Then, I've had several consecutive 'below-zone' promotions. This was unusual recognition for me. I know I've been helped in this by the recognition of my work by people senior to me, like Generals W and X and Colonels Y and Z. I suppose the fact that I have a Ph.D., along with operating experience, has helped on these promotions."

In view of these considerations, Lt. Colonel B also expects to remain in the Air Force for a further career in the future. In fact, he has already been informed that he will be moving to a position of increased management responsibility in the near future. He expressed his opinions on what could be done to improve the retention of young S&E officers as follows:

"1. There should be supplementary pay for those with advanced degrees after individuals have had time to use them in Air Force assignments, similar in principle to the supplementary pay given medical officers. For example, a Ph.D. might receive a $100 increment after one year, $200 after three years, and $250 after five years. Similar increments for those with master's degrees might vary from $50 to $150.

2. Those with advanced degrees ought to be brought in at a higher grade. To some extent they do this now, but it is not enough.

3. There should be 'promotion list' service credit for officers working on advanced degrees--for example, two years for the M.S. and four years for the Ph.D.

4. Also there should be more flexibility in assignments in terms of the officer's abilities and interests."

<u>From Technical Manager to Technology Management Generalist</u>

Some S&E officers are not now performing a technology management generalist role, but are definitely oriented toward moving into such a role as they advance in their Air Force careers. They may see themselves moving into a technology management generalist role from any one of three principal directions: (1) from a technical manager position, (2) from an administrative manager position, or (3) from a military operations position. Major C is an example of an S&E officer who is now performing essentially a technical manager role but who also is looking forward to a broader Air Force career, eventually to become a technology management generalist.

Major C received a bachelor's degree in engineering from a civilian technical institution and entered the Air Force through the ROTC at the time of the Korean action. He later received a master's degree in engineering from AFIT and a doctor's degree in engineering from a leading civilian institution under Air Force sponsorship. During his Air Force career, he has served in both bench-level scientific or engineering assignments and in technical management assignments. At present, he is the technical director of an R&D laboratory program. In describing the most important decisions he makes in his present assignment, Major C says, "First is technical direction and program planning; second is personnel." Major C also reports that he actually participates in some of the technical work under his direction, acting as a coworker on some projects.

The principal satisfaction that Major C gets out of his work is "A chance to pursue a science management career." He says, "I'm not wedded to the bench. I think I have a chance to become a general officer some day. I don't love science enough to pass that up." At the beginning of his Air Force career, Major C served for several years in a technical assignment overseas. Then he reports that "After five years I was offered a master's degree and after seven years a doctor's degree--I finally succumbed to 'educational blackmail.' Now I see myself in an Air Force career from which I can eventually retire and enter industry at the vice president level."

Along with a colleague, Major C has written down some of his views about the role and career development of S&E officers in the Air Force. Following are some extracts indicating how he sees this subject:

> "The need for S&E officers rests strongly on our management philosophy, since the typical Air Force officer career is expected to progress toward management. . . . We assert that the ideal commander uses the tools of management to bring greater effort to bear on problems which in principle he himself knows how to solve. By this we mean that a commander should have had actual experience at various levels in organizations similar to the one he is managing. . . .This view of a commander is consistent with the traditional concept of a military officer.
>
> We view an Air Force officer career as starting with some professional specialization and developing as experience and talent dictate into broad executive responsibility. Early specialization immediately benefits the Air Force by providing an in-house capacity for accomplishing specialized jobs. It also contributes to mental growth by demanding detailed thought directed to the solution of specific problems, and it lays the foundation for sympathetic understanding of other specialties by developing an appreciation for the effect of little details on the big picture."

At the same time Major C recognizes that.

"To be effective at higher command and staff levels, it is essential that S&E officers obtain broadening experience in operations. This can come from participation in large scientific projects such as nuclear tests, from liaison duty with operational organizations during the break-in phase for new equipment from work as a senior military tech rep' identifying the technical basis for operational restrictions or limitations of existing equipment, or from assignment to operational units in maintenance, accident investigation, unsatisfactory report control, or other similar technical jobs. The transition to executive management should occur only after a reputation for competence has been established in a specialty and at least the beginning of an understanding of broad Air Force problems has been achieved."

He also recognizes the dangers in attempting to become a technology management generalist too early in one's career:

"Full time contract management should be avoided early in an S&E career since it can contribute little to professional growth; however management of a contract in conjunction with in-house work would be beneficial. We visualize junior S&E officers doing part-time contract management closely related to their laboratory work and more senior and experienced S&E officers doing full-time contract management or heading up management groups."

In Major C's recommendations, he takes account of the distinction between what has been described herein as the "technical manager" role and the "technology management generalist" role, and proposes that the former could be mainly a civilian role while the latter is more appropriately the role of the more senior S&E officers.

"While the group of qualified S&E officers is being built up, a corollary action must be taken. That is to establish dual civilian-military staffing for many key executive positions. One hopes that in this, an officer-commander would provide overall program balance, his own technical specialty, administrative management, and a responsiveness to change as needed by the Air Force, the civilian counterpart would provide continuity in detailed program and personnel knowledge, be responsible for the overall technical quality of the work, and be the prime contact with the scientific community.

The crux of the S&E problem lies in the answer to one question. Does the Air Force really believe that officers must <u>control</u> the Air Force R&D effort? (We emphasize the distinction between 'control' and 'watch.') An affirmative answer requires that officers be developed who can match credentials with industry representatives at all levels. To this end the Air Force must determine valid standards of competence for S&E officers at all levels, must designate suitable jobs in which S&E officers can grow in the desired directions, must institute an adequate records system for assignment and career monitoring, and must provide an environment which will attract qualified young officers to the S&E career area."

From Administrative Manager to Technology Management Generalist

Although, as Major C pointed out, it is important for technology management generalists to have had at least some technical experience themselves, the career development pattern for some officers can include, in addition, sizable amounts of experience and education in administrative management. In this regard, Major D is an example of an S&E officer of this type. Although he has had technical training and experience, his last degree and his most recent assignment have been in the more administrative aspects of R&D management. He is, however, now becoming a technology management generalist.

Major D entered the Air Force through the Aviation Cadet Program after a tour of duty as an enlisted man. He served as a pilot during World War II. After being discharged at the end of World War II, he received a bachelor's degree in a physical science field and served for several years in technical sales work for a civilian company. At the time of the Korean action, he was recalled by the Air Force and served again as a pilot and then as a personnel officer. Under AFIT sponsorship, he was then sent to a civilian university where he received the M.S. degree in a physical science field, following which he served as a project scientist in an Air Force laboratory. Under AFIT sponsorship again, he was sent to a civilian university and obtained an M.B.A. degree. Since then he has served in technical planning functions in an R&D activity and is now the director of an R&D program. He has kept up his flying status, even when attending the university as a civilian.

In looking back on his own career experiences, Major D days, "Anything that you work at is valuable experience, but some of the best I've had was my years in personnel work. I hated the assignment when they gave it to me. Yet today I look back and see that no other thing helps me so much in my present job and what I think I will be doing in the future. My decisions are now largely 'people decisions' and decisions regarding the allocation of resources."

Major D is also of the opinion that "A man in my job should be rated. It helps him understand the Air Force and how to handle people." On further questioning, however, he also said that he felt that time in a missile silo would be just as helpful as time in the cockpit.

In his present assignment as manager of an R&D program, Major D states, "I don't pretend to be the technical superior of my R&D groups.

The group chiefs give me progress reports, but I give them technical freedom. I devote my energy to handling the administrative side of life.' Major D says that his main satisfactions in his assignment derive from "handling personnel and administrative matters in such a way that the scientists and engineers achieve their goals and that important work for my country gets done."

When thinking about whether to continue in the Air Force as a career, Major D sees both "pros" and "cons." The "pros" are "I like serving in uniform and I feel I am doing important work." The "cons" are "low pay--I am paid much less than civilians doing the same kind of work" and the fact that "time in commissioned service is the only thing that counts toward my next promotion--they give no credit for enlisted status." Major D believes that the career development of S&E officers would be improved if the Air Force would:

"1. Free up promotion opportunities and expand the number of S&E assignments Air Force-wide--they should not create a separate S&E corps. The Officer Grade Limitation Act needs revision.

2. Improve pay--giving pay supplements for advanced degrees when officers enter active duty. Also they should give either pay supplements or promotion credits for AFIT degrees."

From Military Generalist to Technology Management Generalist

A third route into a technology management generalist role is from the role of a professional "military generalist." The careers of several officers discussed previously follow this pattern somewhat, but Major E's experiences appear to exemplify this career pattern most clearly.

Major E is a graduate of the United States Military Academy, and transferred to the Air Force. He attended pilot training school and served as a combat pilot for four years during the Korean action. He then attended a civilian university under AFIT sponsorship, obtained an M.S. degree in a scientific field, and subsequently served as an instructor in an Air Force technical school. He then attended another civilian university, again under AFIT sponsorship, and obtained the Ph.D. degree in a field of physical science. At present, he is the director of an R&D program.

From the time he was a small boy, Major E reported that he had aspired to a professional military career. He now sees himself staying in the service for more than twenty years, saying that his primary motivation is "to serve my country." The principal satisfactions that Major E says he gets from his present assignment as a director of an R&D program are: "(1) Opportunity to help steer the course that Air Force R&D will take. I believe I will shape this course even more in the future. (2) Opportunity to meet scientific and industrial leaders and to try to figure out how to use them to the advantage of my mission. Also, of course, I enjoy meeting them as persons and professionals. (3) I enjoy helping younger men develop, and the future holds this for me."

In describing his present job duties, Major E sounds like a technology management generalist, in that he reports that the professionals under him usually make decisions on the day-to-day technical conduct of the work, but Major E takes responsibility for "consolidating the mission of the program and reorienting the external contract work accordingly, and channeling the talents of the professional staff into the most effective use."

When asked about his views on ways to improve the lot of the S&E officer, Major E mentioned:

"1. Housing. This is tough to find around some bases, and it's likely to be expensive. It is discouraging to me to see the housing conditions in which some of our commanding officers have to live and entertain.

2. Pay. We should have the same supplements as medics.

3. Disintegration of fringe benefits. As in the case of the base exchanges, for example, discount stores can now beat the base exchange prices. Also there is often poor medical care for dependents and no dental care is provided for dependents.

4. Image of a second class citizen. When they say there are gold flow problems, they send back military dependents overseas--but not the civilians. If they close a base, the FHA offers civilian homeowners relief on their house payments--but not to the military. In some cases they have raised civil service pay 100%, but military pay only 10%."

A Technical Manager

There are other S&E officers who, because of their basic attitudes and orientations toward their careers, have not become technology management generalists in the sense of the preceding examples. Regardless of their present assignments, they think and act more like technical managers. These officers are more likely to feel that their future career advancement opportunities in the military service are distinctly limited, and are therefore more likely to be thinking seriously about returning to civilian life at their next opportunity. Lt. Colonel F is perhaps a typical example.

Lt. Colonel F has a master's degree and a doctor's degree in a physical science field. His work on the master's degree was Air Force sponsored; the doctor's degree was achieved on his own sponsorship, because of his strong scientific interests. In looking back over his career, Lt. Colonel F reported that he did "some basic soldiering" for the first few years, but that even then, about 50 percent of his work was in his technical field of interest. Since then he has been assigned to a series of technical positions when not attending university courses. He has volunteered for technical assignments throughout his military career and frankly reports that "I feel a primary loyalty to my science, not to the Air Force. I'll transfer to wherever I can work in my technical field. I'll soon have twenty years of service, and I'm tired of fighting the system. I think I'll get out."

Lt. Colonel F has a high reputation in his technical field, achieved through his own publications. He is currently director of an R&D program, in which he says that he makes "both technical and personnel" decisions. When asked what he thought could be done to increase the retention rate of S&E officers, Lt. Col. F replied "(1) pay them decently and (2) give them some choice in their scientific pursuits."

Another Technical Manager

Major G is also more of a "technical manager," rather than a "technology management generalist," in his orientation. Major G entered the Air Force through Officers Training School during the Korean action. Previously, he had served as an enlisted electronics technician in another branch of the service. In the Air Force, he has had a series of assignments in operations, training, and R&D activities, but all have been technical assignments. Also, during his Air Force career, he was able to attend two civilian universities under Air Force sponsorship and to receive bachelor's and master's degrees, both in an engineering field.

In regard to his present assignment--as the director of an R&D program--Major G says, "This was a bag of worms that was not being managed. They needed a slave driver and so they chose me. But I am not suited to this work." In regard to the work for which he feels he is not suited, Major G says that his main responsibilities involve "(1) logistics and procurement decisions in order to provide technical equipment when needed and (2) the coordination of efforts of various organizations in order to obtain the cooperation needed on a project." He reports that "about 80 percent" of his present work requires day-to-day technical decisions by him. He regrets, however, that most of the technical work in his program is done by outside contractors not directly under his control.

In sum, Major G says that "there is no satisfaction for me in this kind of work. I want a job with (1) a clear goal, (2) direct control over technical people, but (3) where I am not told how to meet the goal. I recognize that the Air Force system for doing this kind of work is right, but I just don't fit this system. I would rather be an electronics communications officer, a teacher at the Academy or in AFROTC, or in some other technical assignment. I used to think of myself as a 30-year man, but I now think I will be getting out soon."

Conclusions

At this point, some tentative conclusions suggested by these examples may be stated as follows.

1. S&E officers whose Air Force career experiences or education combines significant tours of duty in operations assignments with tours of duty in R&D assignments are more likely to be better adapted to performing the technology management generalist role.

2. S&E officers who are now performing a technology management generalist role, or who are oriented toward performing this role in the future, are more likely to desire to remain in an Air Force military career than are those S&E officers who are now performing, or oriented toward performing, a technical manager role.

3. There are three main career routes into a technology management generalist role: (1) from a technical manager role, (2) from an administrative manager role, or (3) from a military generalist role; however, each of these three routes should involve at least basic familiarization experiences in all three roles--technical manager (following bench-level experience), administrative manager, and military manager--before assuming technology management generalist responsibilities.

4. Since S&E officers are not likely to be able to remain in technical manager roles throughout a military career, and since there is no apparent advantage to the Air Force in having them so remain, staying in the technical manager role could be viewed primarily as an occupation for civilian scientists or engineers.

Chapter V

REVIEW OF POLICY RECOMMENDATIONS

This chapter reviews the recommendations of several recent studies of the motivation and retention of S&E officers in the Air Force, thus providing a basis for the overall conclusions of this report, as stated in Chapter I. This review concludes with a summarizing discussion of the professionalization of the technology management generalist role--the particular managerial role that has been identified as being most crucial to integrating Air Force military capabilities with its scientific and technical capabilities. First, however, we shall turn to a brief description of the background and content of the recent studies to be reviewed.

Description of Recent Studies

In recent years, studies by Air Force officers and by civilian consultants have resulted either in direct recommendations or indirect suggestions relating to ways to improve the motivation and retention of S&E officers. In reviewing these studies, one is struck by the large areas of common agreement between them; almost never do they disagree on any specific recommendations. In many cases, however, these recommendations have not been implemented because they require fundamental policy changes or modifications at the highest levels in the federal government, although steps are now beginning to be taken in the direction of implementing some of these recommendations, such as the 1965 Military Pay Act.

In this chapter, we shall review the major recommendations that have been made in recent studies. For the sake of conciseness, this review will focus attention on the most recent studies that have made a systematic analysis of this problem area and have provided a broad range of policy recommendations.

The first study reviewed here was completed in October of 1960 by a committee of 22 lieutenants who had been commissioned through the ROTC program and who were working in scientific and development engineering activities. Gen. Bernard A. Schriever, then Commander of the Air Research and Development Command (ARDC, the predecessor of AFSC and OAR) requested these lieutenants to recommend "reasonable and feasible proposals which, when implemented, would induce a large number of qualified scientific and engineering officers to choose the Air Force as a career." The lieutenants' committee met continuously for ten days and, drawing on their own experiences and all other information available at that time, and then making revisions after receiving comments on a draft report, published what has come to be known as the "Lieutenants' Ad Hoc Committee Report."*

In February 1963, a study was initiated by the Ohio State University Research Foundation, under contract to the Air Force. The primary objective of the study was to "devise a comprehensive program of laboratory/experimental work spanning a 20-30 year career in the Air Force of such a character as will invite and attract scientists and engineers to seek out such a career and remain in the same." The study reviewed existing career patterns, pay scales, etc., and included original questionnaires filled out by a sample of AFROTC students and interviews with a sample of lieutenants in S&E categories at seven Air Force bases. This study is referred to herein as the "Ohio State Study."†

On February 15, 1964, a committee consisting of Col. Richard C. Gibson, Chairman; Dr. William J. Price; Col. Andrew Boreske, Jr.; Col. Leo A. Kiley; Maj. Jack E. Montgomery, and Lt. William R. Alford completed a study of the role of military scientists and engineers in the Air Force, as requested by Maj. Gen. Don R. Ostrander, Commander of the Office of Aerospace Research. This study particularly considered the contributions of OAR to the career development of S&E officers, and also included a comprehensive list of recommendations on ways to improve S&E career development. The report giving the conclusions of this study has come to be known as the "Gibson Report."‡

The fourth comprehensive study to be considered resulted in a thesis completed this year by George M. Williams in connection with obtaining the degree of Master of Engineering Administration at George Washington University. This study reviewed all prior studies and data on career patterns, turnover, salaries, etc., obtained from Air Force personnel sources in order to derive its recommendations. It also drew on the author's own experiences as a chemist and a nuclear research officer in the Air Force over a 15-year period, as well as four years in an operational unit. This study is referred to herein as the "Williams Thesis."§

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* Lieutenants' Ad Hoc Committee Report on the Retention of Junior Officers (Washington, D.C.; Headquarters, ARDC, 5 November 1960).

† W. A. Beckdahl, B. J. May, W. M. Morgenroth, and H. M. Pryor, Utilization and Progression Patterns for Air Force Scientists and Engineers (Columbus, Ohio: Ohio State University Research Foundation, 1 November 1963).

‡ Richard C. Gibson, et al., Report to the Commander, OAR, on the Role of the Military Scientist and Engineer (Washington, D.C.: Headquarters, OAR, 15 February 1964).

§ George M. Williams, An Analysis of the Problems Encountered by the United States Air Force in the Motivation and Retention of Military Scientists and Engineers (Washington, D.C.: a thesis for the degree of Master of Engineering Administration in the library of the George Washington University, February 1965).

2. Motivate outstanding S&E officers by individual career planning. All four studies emphasize this recommendation. Several of the studies also indicate the importance of giving an S&E officer more opportunity to express his own desires and opinions with regard to his assignments within the limits of Air Force personnel requirements. Other studies indicate the importance of laboratory directors having the opportunity to make requests by name for S&E officers after interviewing them and others who know them personally regarding their individual qualifications and interests. This recommendation is in accord with one of the principal characteristics of the technology management form of organization in contrast to the conventional bureaucratic form of organization, as was pointed out in Chapter III. In the technology management form of organization, job content is determined by, or at least markedly affected by, the characteristics, abilities, and interests of the individual job occupant.

In effect, all of the following are recommendations that are intended to implement this fundamental recommendation to motivate outstanding S&E officers by individual career planning.

3. Establish career counseling boards to match outstanding S&E officers with vacancies. The Ohio State Study and the Gibson Report both emphasized particularly the importance of career counselling of S&E officers, rather than allowing them to fend for themselves in a vast, impersonal, and seemingly mechanical placement system. The Ohio State Study particularly stressed the importance of career counselling for ROTC students during college, and then continuing into their military careers.* The Gibson Report recommended more specifically:

> OAR and AFSC should establish a career counselling board for senior S&E officers who annually match outstanding individuals to programmed vacancies and advise on educational opportunities according to individual desires, AF needs, and good career planning. These boards should act in an advisory capacity to established personnel organizations and augment their efforts. A far less desirable alternative would be to assign senior S&E officers to personnel staffs.†

4. Accelerate "below zone" promotions for outstanding S&E officers. All four studies have emphasized this recommendation to provide for more flexibility in promoting technically qualified officers. An overemphasis upon seniority or time-in-grade as a prerequisite for promotions is not appropriate for more technically oriented organizations or occupations, and is very strongly resented by technically trained people who are

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* Ohio State Study, p. 187.
† Gibson Report, pp. 9-10.

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subjected to such an overemphasis.* The Bolte legislation proposes more flexibility for promotions based on technical qualifications and accomplishments.

5. Award promotion list service credit for time spent in obtaining advanced degrees in fields relevant to S&E assignments. This could be applied to "Category C" reserve officers under the provisions of U.S. Code 10, Section 8287, paragraph a(4). This recommendation would seem especially appropriate in view of the fact that reserve officers taking advanced degrees in civilian institutions before entry into active duty are preparing themselves for their later duty assignments, and therefore should not be penalized for the loss of promotion list credit during that time. In regard to this recommendation, the Gibson Report states:

> This is considered by the committee to be a most urgent and long overdue action. Added promotion list service should be commensurate with time necessary to obtain the academic degree. A reserve officer should not be credited with longer service than he would have accrued had he been on active duty since commissioning.†

6. Award incentive pay to officers with relevant advanced degrees. All studies point out gross inequities in the salaries of S&E officers compared to civilian salaries for comparable management responsibilities. However, several studies point out, and many officers also agree when queried, that a strict parity between military and civilian salaries is not necessary;‡ professional military personnel often express the view that "they did not decide on the service as a career for the money, but rather for the opportunity to serve their country and to do this in challenging work situations."§ This is similar to the attitude of other highly professionalized personnel who take lower paying jobs in universities for reasons of public service and intrinsic job satisfaction, rather than to take higher paying jobs in industry.**

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* For a report of a study of the declining emphasis on seniority and the increasing emphasis on technical qualifications as a basis for promotion among technically trained personnel in industry, see Philip Selznick and Howard M. Vollmer, "Rule of Law in Industry: Seniority Rights," Industrial Relations, Vol. I (May 1962), pp. 97-116.

† Gibson Report, p. 8. See also the Williams Thesis, p. 102.

‡ See, for example, the Lieutenants' Ad Hoc Committee Report, p. 13.

§ This attitude regarding the perceived appeals of a military career is generally confirmed by the findings of Charles H. Coates in "The Influence of Sociological Factors on the Acceptance or Rejection of Military Careers," a paper presented before the annual meeting of the American Sociological Association, 1965.

** See William Kornhauser, Scientists in Industry: Conflict and Accomodation (Berkeley and Los Angeles: University of California Press, 196[illegible]), pp. 131-134.

On one hand, incentive pay for S&E officers beyond the normal grade salary structure is often justified by reference to the precedent of ing medical officers an increment over their normal grade salaries. On the other hand, objections are sometimes raised as to the way an incentive pay system for S&E officers with advanced degrees would be administered. In this regard, the Gibson Report stated:

> Many questions may be raised about the administration of this controversial proposal, but none seems overwhelming. (a) It should be restricted to those holding degrees from institutions accredited by recognized and specified professional accrediting agencies. (b) The officer should meet acceptable effectiveness standards. (c) The degree should be in a field related to his primary duty AFSC and should be continued during "broadening" assignments outside principal career area. (d) "Pay for degree" should probably not exceed flight pay for same rank if S&E officers are to retain line status, and no officer should draw both simultaneously.*

7. Provide appropriate medals, awards, commendations, etc., for technical and managerial accomplishments. These would further implement recommendation 1 above, that the Air Force should appropriately recognize managerial and technical competence. This symbolic aspect of recognition could include the use of joint military and technical professional titles in formal address and introductions, such as "Colonel Doctor Jones" or "Lieutenant Doctor Smith." In addition, the Williams Thesis stated:

> The prestige of scientific and engineering officers in the Air Force is an important factor in their career motivation. There is a strong need for professional recognition among this group. The Air Force is aware of this fact and has taken some steps to recognize this group. Some additional recommendations which would improve the prestige of this group include the use of a special badge to identify the scientific and engineering officer and encouragement to join professional societies related to their career fields. . . .†

The Gibson report suggested also that the Commendation Ribbon should be awarded more frequently for such actions as the preparation and publication of a high quality technical paper.*

8. Provide a more effective relationship between advanced degree programs under AFIT sponsorship and S&E career development needs. Three of the four studies commented on the need to examine the relationship between the AFIT program and career development requirements. For example, the Gibson Report pointed out that "time restrictions should be

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* Gibson Report, p. 9.

† Williams Thesis, pp. 103-104.

removed for highly qualified candidates."* The Williams Thesis also recommends "more judicious selection" of those taking part in AFIT advanced degree programs,† and the Ohio State Study proposes a phased education program for selected S&E officers as follows:

(a) One year of graduate study in a technical field leading to a master's degree during the fifth year of commissioned service.

(b) Ninety-four percent of all career officers pursue one year of graduate study leading to a master's degree in R&D Management during their tenth year of service.

(c) Six percent of all career officers pursue a Ph.D. in a technical field during their ninth and tenth year of service.

(d) All colonels, except those with Ph.D.'s, attend the Air War College during their first year in rank.‡

9. Maintain a rotation plan for tours of duty in R&D and operations assignments. This recommendation again relates to the primary characteristic of the technology management generalist role in the Air Force--the integration of technical capabilities with military requirements. In this regard, the Gibson Report states:

> . . . included in the S&E officer career should be operational experience. "Blue-suit" test and evaluation of new weapons is one method. If rated, he may occupy a key position in the test and evaluation of new aircraft weapon systems. If non-rated, he may do the same for missile systems. Operations analysis with a combat unit is another duty which would provide operational experience. . . .
>
> The effective (Air Force) leader must speak several "languages"--the language of the operations people as well as the language of the scientific, engineering, and development people. It makes no difference which language is learned first--the scientific or the operational; however, in the final analysis, the officer must become and remain proficient in both. . . .
>
> OAR and AFSC should insist that outstanding S&E officers serve a tour or more in an operational command. Present restrictive assignment policies for S&E officers, while well meaning, are not completely consistent with long-term Air Force requirements. Rotation must be made to work even though past experience has been less than encouraging.§

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* Ibid.
† Williams Thesis, p. 102.
‡ Ohio State Study, p. 186.
§ Gibson Report, pp. 5, 6, and 9.

10. Provide continuous career opportunities for S&E officers, especially in middle management positions. At present, there are only limited opportunities for S&E officers in middle management positions (e.g., at about the major and lieutenant colonel levels) in AFSC and OAR because many of these positions are held by civilians. In 1960, the Lieutenants' Ad Hoc Committee noted:

> Civilian-military relationship--this is a critical problem area in ARDC primarily because of inequities which exist between military and civilian scientists. Advancement of civilians into the lower supervisory positions has blocked the advancement of competent officers. Recommendation: Positive steps must be taken to create an equitable civilian-military relationship. Provision must be made for equal advancement opportunities for both civilian and military scientists, with the selection criteria based upon capability and performance.*

In 1964, the Gibson Report still recognized difficulties in this regard within OAR (OAR being the organization on which the Gibson Committee was focusing its attention):

> Branch and division level management positions within OAR laboratories should be placed on a rotating basis, with the most qualified scientist, officer or civilian, being appointed periodically. The board is convinced that sufficient middle level management opportunities for outstanding officers are not being provided by OAR at this time. The situation will become worse if we succeed in motivating more good people toward an Air Force career.†

This "middle management squeeze," or the problem of "getting up through the hour glass," as it has been described by some S&E officers, might be somewhat alleviated if a clearer distinction were made between technical management roles and technology management generalist roles. Chapter III pointed out that technical managers are most often first level supervisors who are primarily concerned with the technical qualify of activities under their direction, while technology management generalists are most often at second level or higher supervisory positions where they perform the function of integrating technical capabilities with military requirements. It was also pointed out that military S&E officers, although they should first be qualified by bench-level technical experience and then by experience as a technical manager, administrative manager, or both, are mostly destined to become technology management generalists, rather than to remain as technical specialists. Most civilian scientists or engineers, on the other hand, because of their lack of a continuing military experience and commitment, and because of the longer periods they are able to

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* Lieutenants' Ad Hoc Committee Report, p. 15.

† Gibson Report, p. 10.

remain in their technical or administrative specialties, can more appropriately remain in technical management, administrative management, or nonmanagerial scientific and engineering specialty careers, and can make extremely vital contributions to the Air Force in these careers.

As indicated in Chapter III, these role distinctions can then form the basis for effective dual career ladders for both civilians and for military officers; ordinarily, civilians can have opportunity to advance to more important responsibilities (with appropriate advances in salaries) within technical management or administrative management fields, while military officers can start their careers alongside civilian scientists or engineers in bench-level technical assignments, advance to technical or administrative management positions (perhaps serving as "dual deputies" to civilian technical or administrative managers), and then finally advance to technology management generalist positions where the officers may be expected to make their most significant contributions to the modern Air Force.*

11. Improve recruitment of Category C ROTC officers. S&E officers from Category C ROTC sources currently have the lowest retention rates in comparison to those from Academy and Officer Training School programs. The present modified two-year ROTC program is open to students majoring in any field; there is no systematic attempt to attract those in major fields of study that are most appropriate to S&E requirements. More especially, there is no assessment and selection program for those who have technology management generalist abilities and interests in contrast to those who have a narrower technical specialist interest, which, in turn, generally predisposes these individuals against a military career. Three of the four studies reviewed here give some attention to the recruitment problem, but there is some confusion as to the type of individual (in terms of his attitudes and interests) who should be recruited for the military technology management generalist role. As indicated at several points previously in the present report, this would have to be an individual with what has been described as a "mixed" or dual orientation, with interests both in military affairs and in technical matters.

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* A corollary of this "dual career" approach to military and civilian career development would be to deemphasize attempts to retain S&E officers in the military service who wish to remain in strictly technical assignments, like "Lt. Colonel F" and "Major G" in Chapter IV. As was indicated in that chapter, these individuals might well be happier and better able to continue to make significant technical contributions to the Air Force if they did transfer to civil service status or to a civilian contractor organization. Generally, it has been recognized by AFSC and OAR management that these individuals are therefore not necessarily "lost" to the Air Force when they transfer to civilian status.

12. Follow academic S&E training with bench-level assignments in in-house laboratory programs. All four studies have indicated that a technical training is not enough for a well-qualified S&E officer; it is also important for him to have had bench-level experience in a technical field, especially before he is placed in charge of an in-house project or assumes the responsibility for managing or monitoring an extramural technical contract. Thus, the Lieutenants' Ad Hoc Committee stated in 1960:

> ARDC is misusing its junior scientific and engineering talent. It has not provided the foundation of appropriate, first-hand, technical jobs at entry necessary for sound technical and professional development. The junior scientific or engineering officer entering ARDC often finds himself thrust prematurely into project management without adequate technical training. . . . There should be provisions for adequate technical as well as managerial development and advancement.*

Indeed, one of the principal justifications for maintaining high quality in-house laboratories in AFSC and OAR is to provide a ready context in which S&E officers can gain this necessary bench-level technical experience, followed by later experience in technical or administrative management in R&D activities.

The next section of this chapter examines more closely the function of in-house laboratories in providing this kind of experience. At this point, however, the recommendations derived from the four studies reviewed are presented in Figure 5, showing whether each recommendation was emphasized in each study under consideration.

In-house Laboratories and S&E Career Development

In Chapter II it was pointed out that the Air Force contains in-house laboratories both in the Office of Aerospace Research and in the Air Force Systems Command. The OAR laboratories are oriented more toward basic or fundamental research in areas of interest to the Air Force, while the laboratories of the Research and Technology Division and of other divisions within AFSC are oriented more toward applied research and development activities. Both kinds of laboratories, therefore, offer opportunities for different experiences during the career development of S&E officers. Many studies have shown that basic research requires forms of organization and of management practices that differ from those required by applied research and development, and vice versa. Thus one important function of in-house laboratories within a larger technology-dependent organization is to provide an organizational context in which technology management personnel can obtain a first-hand knowledge of the management of research and of development activities. This management education function of in-house laboratories has been described by industrial research executives in such

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* Lieutenants' Ad Hoc Committee Report, p. 14.

Figure 5

RECOMMENDATIONS OF STUDIES ON THE MOTIVATION AND RETENTION OF AIR FORCE S&E OFFICERS

	Lieutenants' Ad Hoc Committee Report (1960)	Ohio State Study Report (1963)	Gibson Study Report (1964)	Williams Thesis (1965)
1. Recognize need for managerial & technical competence in AF leadership, rather than over-emphasis on aeronautical rating	X		X	X
2. Motivate outstanding S&E officers by individual career planning, voice in assignments, etc.	X	X	X	X
3. Establish career counseling boards to match outstanding S&E officers with vacancies		X	X	
4. Accelerate below zone promotions for outstanding S&E officers	X	X	X	X
5. Award promotion list service credit for time spent in obtaining advanced degrees			X	X

Figure 5 (continued)

RECOMMENDATIONS OF STUDIES ON THE MOTIVATION AND RETENTION OF AIR FORCE S&E OFFICERS

	Lieutenants' Ad Hoc Committee Report (1960)	Ohio State Study Report (1963)	Gibson Study Report (1964)	Williams Thesis (1965)
6. Award incentive pay to officers with relevant advanced degrees	X	X	X	X
7. Provide appropriate medals, awards, and commendations for technical & managerial accomplishments			X	X
8. Provide more effective advanced degree programs under AFIT sponsorship in relation to career development, select candidates more carefully, phase advanced degree programs to follow tours of duty, etc.		X	X	X
9. Maintain a rotation plan for tours of duty in R&D and operations assignments, assure that officers be qualified when placed in either assignment		X	X	

Figure 5 (concluded)

RECOMMENDATIONS OF STUDIES ON THE MOTIVATION AND RETENTION OF AIR FORCE S&E OFFICERS

	Lieutenants' Ad Hoc Committee Report (1960)	Ohio State Study Report (1963)	Gibson Study Report (1964)	Williams Thesis (1965)
10. Provide continuous career opportunities for S&E officers, especially in middle management; carefully evaluate where officers and where civilians are needed	X	X	X	
11. Improve recruitment of "Category C" ROTC officers, selectively recruit those with S&E abilities		X	X	X
12. Follow academic S&E training with bench-level assignments in in-house labs, reserve project manager and contract manager assignments until later	X	X	X	X

Note: An "X" in the above figure indicates that the study indicated place substantial emphasis upon the item indicated in the recommendations resulting from the study.

diverse organizations as North American Aviation, Inc., and the Ford Motor Company as possibly the most important function of in-house laboratories.*

For example, the Aerospace Research Laboratories and the F. J. Seiler Laboratory of OAR provide facilities and programs that are especially convenient as a context for thesis studies connected with obtaining advanced scientific or engineering degrees at the Air Force Institute of Technology (Wright Field) or the Air Force Academy, respectively. The OAR Air Force Cambridge Research Laboratories benefit by close working relations with scientific programs and individual scientists at Harvard University, the Massachusetts Institute of Technology, and other outstanding institutions in the Boston scientific and technical complex. Similar advantages are enjoyed by the AFSC Research and Technology Division Laboratories in the Wright Field area. The Air Force Weapons Laboratory (Albuquerque, N.M.) of the Research and Technology Division is predominantly staffed by S&E officers, and therefore is an especially appropriate context for these officers to gain career experience in technical fields.

However, the role of in-house laboratories in the career development of S&E officers has been severely limited in the past by the lack of adequate numbers of available middle management positions, either for direct officer assignment or for assignment in "dual deputy" positions. In this regard, the Gibson report has pointed out (with special reference to OAR):

> Opportunities to direct, manage, and lead are rare in OAR except at the colonel level. Middle management scientific positions in OAR units are almost devoid of officers. If, indeed, the USAF desires to improve the image of the "blue suit" R&D leader in the eyes of the technological community, the "blue suit" scientific leader must be allowed and encouraged to develop himself along both managerial and scientific lines.†

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* For a further description and analysis of the management education function and other functions of in-house basic research laboratories in industry and government, see H. M. Vollmer, editor, The Fundamental Research Activity in a Technology-Dependent Organization (Washington, D.C.: AFOSR, forthcoming); see also Jacob E. Goldman, "Basic Research in Industry," International Science and Technology (December 1964), pp. 38-46; Jack A. Morton, "From Research to Technology," International Science and Technology (May 1964), pp. 82-92; William J. Price, "The R&D Organization's Fundamental Research Activity as a Window between Science and Technology" (Washington, D.C.: a paper presented before the American University Ninth Conference on Research Administration, 1964, available from AFOSR); and H. M. Vollmer, Applications of the Behavioral Sciences to Research Management: an Initial Study in the Office of Aerospace Research.

† Gibson Report, p. 6.

The authors of the Gibson report view OAR in-house laboratories as making significant contributions to the following phases of S&E career development:

> The early years of the S&E officer's career should be spent on obtaining professional competence just as the pilot obtains flying competence. If he is qualified, he should write professional papers so as to become nationally known in his field. If not qualified to do original research, he should be allowed to assist more experienced scientists on projects already in being and then at some time point should go on to school to get the advanced degree that will qualify him to do research on his own. . . .
>
> During his early tours in research and development, the S&E officer should broaden himself and be given positions of increasing responsibility. An assignment such as branch chief in an OAR laboratory would allow him to learn, as well as demonstrate, leadership. There should also be opportunities to participate in research under the Training with Industry program. AFOSR contractors might welcome such an arrangement. Whether "training with industry" should be as bench scientist or manager or both would have to be resolved. . . .
>
> As he progresses further toward his career goals, he should direct technical activities, manage research programs, plan and execute science and engineering endeavors, and provide a link between the Air Force and world science. He must eventually furnish the scientific leadership which is necessary to establish priorities and obtain DOD resources for programs which will lead to high payoff in combat potential for the Air Force.*

To accomplish these career objectives for S&E officers, it is suggested that officers in OAR and AFSC could be more often assigned to middle management positions to serve as dual deputies to civilian technical managers and administrative managers.† This procedure would simultaneously provide for the career development needs of officers (as military technology management generalists) and of civilian employees (as technical or administrative managers).

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* Ibid., pp. 5-6.

† To provide opportunities for dual deputy assignments, a departure from normal manpower allocation concepts may be required by establishing a mechanism for "career progression slots" whereby the S&E officer would always be covered by a "space." He would carry this "space" with him when he moved, thereby making possible his assignment if the organization involved does not have a space for him.

Professionalization of Military Technology Management Generalists

The process of professionalization has affected a variety of occupations, to a greater or lesser degree, especially as these occupations have been confronted by changing technology in recent centuries. Among the key elements of professionalization, as it affects any occupation, are the concurrent development of (1) specialized techniques supported by a body of fundamental theory, (2) a fairly predictable career (or sequence of job assignments) supported by an organized body of colleagues, and (3) professional status recognized by the wider community or society.* The military constitutes one of the most highly professionalized groups in modern societies.† Whereas military organizations were once led largely by an aristocratic class with personal pledges of loyalty and service to a monarch or a feudal lord and were staffed largely by amateurs--peasants, draftees, and "civilian soldiers"--the core of modern military organizations is a group of dedicated and highly trained career officers (both commissioned and noncommissioned) who have been recruited from all social strata. This group exhibits a high degree of professionalization by virtue of the fact that (1) the military techniques they practice are based on a complex body of fundamental military theory, especially since the time of von Clausewitz, (2) their career patterns have become clearly formulated and maintained by the policies and practices of the officers' corps of the different branches of the military service, and (3) their status is clearly differentiated from all other civilian statuses and recognized by civilians; and this recognition is constantly reinforced through symbolic means such as the wearing of uniforms and insignia of grade and the use of military titles, etc.

Modern urban-industrial society, in general, has been characterized as a "professionalizing society"; it requires many different professions to carry on its vital functions. These professions must interact in institutional matrixes for a society to survive. Thus, the health maintaining functions of modern society are focused in hospitals, where members of a variety of health professions and segments of the medical professions collaborate to save lives; educational functions are performed by a variety

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* Examples of how these elements effect a wide variety of occupations and an analysis of their ramifications is presented in H. M. Vollmer and D. L. Mills, editors, Professionalization: Readings in Occupational Change (Englewood Cliffs, N.J.: Prentice-Hall, publication forthcoming in 1966).

† For a further discussion and analysis of the military profession, see Morris M. Janowitz, The Professional Soldier (Glencoe, Ill.: Free Press, 1960).

of educational groups in schools and universities (or "multiversities," to use Clark Kerr's term); and science is advanced not only by the efforts of outstanding individual scientists working within their narrow fields of specialty, but also by multidisciplinary teams of members from several scientific professions working in new frontier fields of biochemistry, physical chemistry, psychosomatic medicine, etc., in research institutes. Likewise the modern defense establishment requires a variety of professional groups, including professional military personnel, scientists, engineers, management and administrative specialists, and others in both military and civilian categories to carry out its functions.

It is the fundamental thesis of this report that the coordination and integration of these diverse professional groups, all with their own particular group interests, require individuals who perform a technology management generalist role to achieve the primary objectives of the defense establishment. To perform this role effectively, technology management generalists must combine in their education and experience a fundamental understanding of science and technology with a fundamental understanding of military affairs. This is the logical objective of the career development of the S&E officer.

Such a career objective cannot be obtained if military officers are restricted to "strictly military" (i.e., traditional military operations) functions; they must also have a fundamental understanding of key activities in the R&D spectrum, which in turn provides the changes in technology that are having such a profound effect on modern military strategy and tactics. Allowing Air Force officers to have significant assignments in AFSC or OAR, or preferably in both, as well as in operational commands, is most desirable for this purpose.

The end result of the approach to career development suggested in this report would be the professionalization of the military technology management generalist. All the recommendations listed earlier in this chapter would contribute to this end. Highly professionalized military technology management generalists would achieve high status and recognition, not only among other segments of the military profession, but also in civilian scientific, technical, and management professions. To accomplish this objective, military technology management generalists must be trained in service schools or civilian schools in a body of theory that underlies technology management practices, as well as in a body of theory that underlies military operations. Furthermore, military technology management generalists must be able to foresee a reasonably predictable career of meaningful assignments where their abilities are fully recognized and used.

Appendix

INTERVIEW SCHEDULE

INTERVIEW SCHEDULE

AF S&E Officers Career Study

1. Introduce self; from SRI. Have been conducting studies of R&D management in all kinds of labs, not just government.

2. At this particular time, we are taking a deeper look at the military manager of science - the S&E officer - what he does, how he gets where he is now (his career), and his problems and satisfactions. We want to look at the kind of world he lives in and how the Air Force can attract, retain, and develop young men for this kind of career.

3. Therefore, we would like to ask you some questions about these matters from the standpoint of your own work experiences, past and present. We will also be interviewing other experienced S&E officers in other commands and at other Air Force locations.

4. I have a series of questions to ask about your own background, work experiences, and opinions on this subject. As we go through these questions, if you have any comments to add that you feel will be useful, please do so.

5. Do you have any questions before we begin?

Name: ______________________________

Address: ______________________________

____

____

Date: ____________________ Time: ____________________

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Background

1. Date of entry into service:

2. Source of commission (OTS, RCTC, AFA, other) and date:

3. Date of birth:

4. Where did you grow up (rural vs. urban, etc.):

5. Any civilian employment (nature and duration)?

6. Current AFSC specialties:

7. Service schools and colleges:

Name of school	Dates attended	Degree	Date of degree	Field of degree

8. Civilian schools and colleges:

Name of school	Dates attended	Degree	Date of degree	Field of degree	Financial sponsor

9. Ever rated status? When?

10. Title of present position:

11. Summary of past military positions: (Any non-R&D experience, operating experience, etc.)

Job Title	Dates	General nature of duties

Present Activities

1. How many professional-level S&E type personnel are there under your supervision?

   a. Military:

   b. Civilian:

2. What is the approximate degree mix of the professionals under your supervision?

	Doctors	Masters	Bachelors	Non-degreed
a. Military:				
b. Civilian:				

3. How would you generally describe the nature of the work under your supervision? (e.g., basic research, exploratory development, advanced development, engineering development.)

4. Thinking back on the work in your present job, what would you say are the most important decisions you have to make? (For example, decisions about the technical conduct of the work, about personnel assignments, about other administrative matters, etc.)

5. In your group or lab, how are decisions made about starting a new project? Who usually initiates the project idea? Who has the final approval?

6. In your group or lab, who usually makes decisions on the day-by-day technical conduct of the work? How much do you personally participate in this?

7. If you had to make an estimate, about how much of your time would you say you normally spend on the following three types of activities:

   a. Actually working on research projects, or making decisions on their day-by-day conduct?

   b. Planning future projects and activities, including proposal writing?

   c. Administrative matters? Which of these takes the most time?

8. To what extent is publication in technical journals an important facet of the activity under your supervision? During the last year, say, have you had an opportunity to participate as an author or coauthor of any of these publications? (If so, get citation.)

9. Which of the following would you say best describes the kind of supervision you practice in your activities:

   a. Close direction of the work of scientists or engineers?

   b. Occasional consultation with scientists and engineers on their work?

   c. A hands off approach - we rarely discuss their work?

   Could you expand on your answer here a little bit and point out what you mean?

10. What would you say are the principal satisfactions that you get from your present work? (Include here present assignment as well as other likely AF assignments.)

11. What are the main problems that you have in connection with your work? Please describe:

Funding
Physical facilities
Personnel
Support services
Management practices
Administrative requirements
Other

12. When you first came into the service, did you think you would be staying in for_____years, like you have? When did you make this decision? Can you identify any (other) major career decisions that you have made, or perhaps are going to have to make in the near future? What do you now see as the pros and cons on deciding one way or the other?

13. As you see it now, do you feel that in the future, you will more likely:

a. Stay in the Air Force or become a civilian?

b. Stay in R&D work or get into something else?

c. Why - pros and cons?

Opinions on S&E Career Development

1. From the standpoint of your experience, what do you think could be done to improve the retention and career development of S&E officers in the AF?

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13. ABSTRACT

This is a revision of a special report based in part on data obtained during a two-year study (1963-1964) of the Applications of the Behavioral Sciences to Research Management, for the Office of Aerospace Research, USAF. It was published in 1966 and is being released in this form to make it available to a wide audience of management and social science personnel. Chapter II draws on studies of the US defense establishment to show how it is becoming a military technology management organization. Chapter III reviews findings of studies of various technology management organizations, and emphasizing the key importance of technology management generalists in an integrating role in them. The remaining chapters concern themselves with the Air Force situation when the data were collected. Results have become somewhat dated, and do not reflect the policies or opinions of the management of agency that sponsored the research.

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