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Technical Report—Phase I

**A PRELIMINARY INVESTIGATION AND ANALYSIS OF
THE ROLE OF SCIENTISTS IN RESEARCH ORGANIZATIONS**

Prepared for:

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
WASHINGTON, D.C.

CONTRACT NO. AF 49(638)-1028
TASK NO. 37707
PROJECT NO. 9778

STANFORD RESEARCH INSTITUTE

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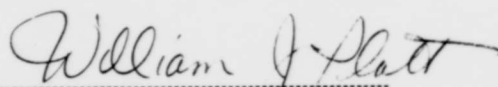
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ABSTRACT

The general objective of this research is to analyze systematically interrelationships among (1) organizational requirements for participation of scientists at different organizational levels and in different types of organizations; (2) orientations toward work and careers among scientists employed in various organizational contexts; and (3) incentive mechanisms available for relating individual orientations to organizational requirements. This report describes the findings of exploratory studies constituting Phase I of this research.

A review of past studies has provided the basis for a conceptual representation of elements commonly included in the role of a scientist in a research organization. These elements include varying responsibilities for participation in certain research development processes, research production processes, research transmission processes, and administrative processes. Influences shaping the specific nature of these responsibilities may emanate both from the social and technological context of a research organization and from the characteristics and expectations of individual research scientists. This conceptual representation, in turn, provides a framework for further research on variations in elements in the research role in different organizational settings.

Analysis of survey data has indicated differences and similarities in specific role expectations of research scientists in an industrial research laboratory versus other types of employees in a variety of organizations. Comparison of findings from this survey with findings from two other studies suggests that situational variations in the context of employment may have considerable effect upon scientists' expectations regarding relations with supervision, career advancement opportunities, and salary considerations; whereas the importance that scientists attach to intellectual challenge in their work and to professional status among colleagues appear to be more constant, regardless of variations in organizational environment.

A case study has provided further illustrative evidence of the relative importance of certain requirements imposed upon scientists in a specific research context and scientists' reactions to these requirements. Responsibilities as "research entrepreneurs" appeared to create some role conflict on the part of some research scientists in this setting. This case study indicates that scientists may attempt to work out their own mechanisms for adjustment in situations where discrepancies occur between organizational requirements and individual professional interests.

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I INTRODUCTION

The general objective of this research is to analyze systematically interrelationships among (1) organizational requirements for participation of scientists at different organizational levels and in different types of organizations; (2) orientations toward work and careers among scientists employed in various organizational contexts; and (3) incentive mechanisms available for relating individual orientations to organizational requirements. This report describes the findings of exploratory studies constituting Phase I of this research, extending from March 1, 1961, to February 28, 1962. Phase I has included an examination of influences on the role of a scientist in a research organization, based upon an analysis of findings from past studies; an investigation of survey data on the role expectations of research scientists as compared with the expectations of employees in other occupational categories; and a case study of the research role in a specific research organization.

It is anticipated that Phase II of this research, to commence on March 1, 1962, will include further analysis of variations in incentives required of scientific personnel in different immediate organizational contexts within one larger organizational context; of variations in incentives appropriate to different types of research personnel; and of variations in incentives arising from the adaptations made by research personnel after different lengths of employment in research organizations.

The author wishes to express appreciation to the U.S. Air Force Office of Scientific Research for sponsorship of the study, and to Albert Shapero, K. H. Schaeffer, Donald L. Mills (now at the University of Alberta), Charles J. Erickson, David Bushnell, and other colleagues at Stanford Research Institute for their useful suggestions and helpful criticisms from time to time during the course of this research. Gerrie Carpenter provided valuable assistance in processing research data and in interviewing research scientists. Prof. William Kornhauser of Princeton University made some initial suggestions based upon his studies of industrial research which were useful in the design of this exploratory study, and Prof. Philip Selznick of the University of California provided helpful criticism of a draft of this Phase I report. Finally, the author is especially indebted to the research scientists in several organizations who were so generous of their time and suggestions in connection with this study.

The author claims full responsibility for any errors of interpretation or any oversights which may have occurred in this report. If any such errors exist, it is hoped that they will be corrected in future phases of the research.

Since this is a Phase I report of a continuing study, the author will greatly appreciate any suggestions or criticisms which any reader may wish to make.

II SUMMARY AND GENERAL DISCUSSION

From 1945 to 1962, expenditures on research and development in American industry have increased from about \$2 billion to \$16.5 billion per year.* As of 1960, 66,700 scientists, exclusive of engineers, were employed in R&D activities in American industry.** Two general problems are suggested by this impressive increase in R&D activities: (1) To what degree, and under what conditions, are industrial and governmental agencies able to utilize scientific personnel effectively in solving organizational problems caused by accelerated technological and social change--that is, for the conduct of effective applied research and development activities? (2) To what degree and under what conditions is the ethic of science supported in industrial and government R&D programs--that is, for the conduct of effective basic research activities which contribute significantly to the accumulation of general scientific knowledge?

The assumption underlying this study is that basic research and applied research are equally important to the total welfare of a society. A science which is out of touch with practical day-to-day problems eventually starves from a lack of motivational impetus, and a science with inadequate opportunity to reflect upon logically consistent general principles becomes impotent from a lack of intellectual exercise. The fundamental question to which this study addresses itself is: How, and under what conditions, can management in industry and government organize research activities in a way that will contribute both to the solution of organizational problems and to the accumulation of scientific knowledge?

In Phase I of this project, tentative answers to this question have been sought by an exploratory investigation of (1) influences and conditions which appear to determine what characteristics management requires and expects of research scientists in modern complex organizations, (2) influences and conditions which appear to determine what characteristics these individual research scientists expect of their employers,

* Industrial Research (1962), p. 19. Complete references for all citations in the text of this report are given in the Bibliography, presented as Appendix G.

** National Science Foundation (1961), Table A-6, p. 24.

and (3) adaptive mechanisms which can be used to bridge any discrepancies between managerial requirements and scientists' expectations in different organizational contexts. Because of the pressures caused by technological and social changes and the consequent need for rapid organizational adaptation to these changes, managers in government and industry often require research scientists to focus their attention upon practical problems of significance to the organization employing them.* Many research scientists, on the other hand, are more interested in basic research than in applied research and are more oriented toward accomplishment within the scientific community than within the employer organization. This study seeks to explore the functional basis for organizational requirements and individual scientist's orientations where they may diverge, and also where they may be congruent.

Influences on the Role of the Research Scientist

Section III of this report presents an exploratory analysis of some findings from previous studies, as they relate to an initial conceptual representation of the role of a scientist employed in a research function within a larger organizational context.** To develop this conceptual representation, the expectations of scientists themselves regarding their roles are examined and compared with the expectations of others occupying significant counterroles.

Managers in research organizations obviously occupy a very significant counterrole to the role of the research scientists they employ--research scientists must adapt, in some way, to the performance requirements managers impose upon them. These requirements, in turn, appear to be influenced by the goals and structure of the immediate organizational context, by the character of the larger industrial context in which the organization operates, and by the political structure of the total society.

It appears that all societies attempt to integrate research goals with societal goals. Although different societies have this objective in common, they may differ in the means employed to accomplish it--some

* Only about 3% of R&D funds in American industry are spent on basic research (National Science Foundation, 1960a, Table V, p. 12).

** This conceptual representation is illustrated in Figure 5 in Section III.

attempt to control research activities directly through administrative mechanisms, while others influence research activities indirectly through financial grants and contracts. Either mechanism may limit significantly the scope of basic research endeavors, although most Americans would probably agree that control by financial manipulation allows more freedom for basic research than control by a central bureaucratic administration.

It also appears that there are variations within societies--at least within American society--in the degree to which basic research or applied research and development may be stressed in different industries. Data from past studies suggest that R&D activities receive more emphasis in industrial contexts where greater adaptability to technological change is required than in industrial contexts wherein products and processes are more stable. Industrial contexts in which technological change creates pressures for adaptation over a long period seem to be more conducive to basic research activities than industrial contexts in which technological development causes pressure for immediate adaptations. The latter are more likely to place primary emphasis upon applied research and development.

The nature of the organization itself may also influence the requirements for research and development. For example, larger organizations are more likely to place greater emphasis upon research and development and to separate research functions from other organizational functions. This separation or departmentalization of research functions in larger organizations may, on one hand, protect the autonomy of basic research functions from pressures exerted by other departments, but, on the other hand, may create a need for a proportionately greater number of development personnel (e.g., engineers) who can translate research findings into applications which are relevant to the problems of the many specialized departments in these large and complex organizations.

Research functions within complex organizations require certain inputs to sustain necessary outputs. Essential classes of inputs from the larger system context include physical resources (facilities and money), ideational resources (problems for research studies, and findings from past studies), and human resources (scientists and other research personnel). Outputs from a research function into a larger system context may include progress reports, technical reports, prototypes and models, technical assistance, and educational materials. The specific character and relative importance of these inputs and outputs may vary according to the formal goal of the research function. For example, basic research functions may require relatively more emphasis upon such

ideational resources as findings from past and current studies and upon human resources that include proportionately more research scientists in comparison with engineers to produce as an output technical reports of general scientific significance. Applied research functions, on the other hand, may depend more upon information about organizational problems and the specific technological constraints surrounding these problems and upon engineers and development personnel to provide an output of effective technical assistance to other functions within the organization.

The role of a research scientist is not only influenced by different organizational requirements, but also by the past experiences and the present relationships and affiliations of the individual who occupies this role. Some studies have indicated that, even in early childhood, research scientists are likely to have developed an especially strong interest in exploring the world around them, particularly when the family atmosphere has been one of relative independence from authoritative direction. A love of independent investigation is likely to be enhanced and strengthened by educational experience in scientific fields, especially by experience in university graduate schools. These experiences and later employment in an academic context are likely to predispose research scientists to be more interested in basic research--research oriented toward the free pursuit of general scientific knowledge--than in applied research--research oriented toward the solution of specific problems.

The orientations of research scientists are likely to be influenced also by immediate relationships, both within and outside the context of their work. It appears that research scientists working under "participatory" supervision are more likely to consider themselves to be doing worthwhile research. It also appears that research scientists with stimulating colleagues (i.e., some with similar backgrounds and supporting interests and others with different backgrounds and a critical outlook) are more likely to produce research of scientific significance. Scientists who frequently participate in professional associations with colleagues outside work are more likely to retain an interest in professionally significant research, as might be expected. There is some indication that increased family responsibilities may be a factor that mitigates against a strong professional orientation on the part of some research scientists.

The role of a research scientist may include responsibilities for certain research development processes (e.g., acquisition of funds, information, or personnel), certain research production processes (e.g.,

research design, data collection, data manipulation and interpretation, and project resource management), and certain transmission processes (e.g., writing progress and technical reports, building models and prototypes, implementing findings, and teaching), and participation in certain administrative processes (e.g., relating to supervision, to other research personnel, and to personnel in other functions). However, the specific nature of these responsibilities and their relative importance depend upon organizational requirements and individual orientations in a given situation; the variety of combinations of these elements within the role of a research scientist can only be determined by further research.

Role Expectations of Scientists and Other Employees

Section III of this report includes a description of what appear to be fundamental components of the research role in a research function and points out some major sources of variations in managerial and employee expectations regarding the research role. Section IV further specifies the role expectations of scientists and, on the basis of recently collected survey data, compares them with the role expectations of employees in other occupational categories. Special attention is focused upon the expectations and experiences of a small sample of scientists in one company and on those of a large number of employees in other categories in seven other companies regarding (1) relations with their companies, (2) relations with their immediate supervisors, (3) relations with other employees, (4) the nature of their work, and (5) extrinsic work benefits.

This exploratory survey indicated that the research scientists surveyed were less likely to be oriented toward a career in their present company and less likely to express any great concern for the reputation of the company in which they were employed than were personnel in other occupational categories. This finding supports those of previous studies which revealed that research scientists are more likely to be professionally than organizationally oriented.

The research scientists in this survey, along with employees in other occupations, emphasized the need for supervisors who know their own jobs well, who treat employees fairly, and who show respect for employees. The research scientists put more stress on being treated as professionals by their supervisors and on participation in work-related decisions than did other employees, especially manual workers. The scientists also were less likely to state that their supervisors should know subordinates' jobs well or that supervisors should give precise instructions to their subordinates. The scientists were more

likely than employees in most other categories to emphasize the importance of gaining the respect of fellow employees, but were less likely to emphasize sociability or close friendships with other employees.

The research scientists in this survey were more likely than most other employees, especially manual workers, to stress the importance of doing intellectually challenging work, and of seeing their ideas put to use in their work. On the other hand, they were much less likely to indicate a need for variety in their work assignments.

Finally, salaries or wages, job security, and opportunities for promotion into supervisory positions were of less importance to the research scientists in this survey. However, in common with most other salaried employees, these scientists tended to be interested in opportunities for promotion within their line of work.

A comparison of these survey findings with the findings from two other studies suggests that situational variations in the context of employment may have a considerable effect upon scientists' expectations regarding relations with supervision, career advancement, and salary. The importance that scientists attach to the nature of the work itself (in terms of intellectual challenge) and to relations with professional colleagues (in terms of mutual respect and professional status) appears to be more constant, regardless of situational variations in the organizational environment.

The findings of this survey, insofar as they may be substantiated by further research, suggest that management's ability to provide a working environment in which research scientists can engage in research activities which they consider to be intellectually challenging and in which they have a high degree of freedom to determine the course of their research represents the most potent area of incentive for sustaining and increasing scientific research endeavors. Such an environment may be easier to achieve in a research activity oriented toward basic research. However, there may also be ways to provide many research scientists with greater intellectual challenge and freedom in applied research situations.

The findings of this research suggest that incentives which attempt to stimulate the activities of research scientists through company-oriented fringe benefits and social-recreational activities are likely to be relatively ineffective. Likewise, it appears that high salaries, job security provisions, or opportunities for promotion into management positions are likely to have only a limited appeal to many scientists.

More effective incentives--and more satisfactory to all concerned--may be found in the kind of supervision and colleague relationships which appear to stimulate and sustain research efforts.

The Research Role in a Research Organization

Section V presents a case study of the research role in a particular organizational setting. The organization studied is referred to under the pseudonym "TAROS" (The Applied Research Organization Studied) and is one of several hundred independent research corporations in the United States which are oriented toward the application of scientific knowledge and methods to the solution of technical problems of governmental agencies and private commercial and industrial enterprises. Perhaps the characteristic of TAROS that is most relevant to this study is that, essentially, it has no endowment or other source of financial support aside from its research contracts with governmental or industrial organizations.

Data for this case study were drawn primarily from interviews with twenty-six physical scientists in two laboratories at TAROS. One laboratory is interdisciplinary in character, and includes scientists with backgrounds in several fields of physical science. The other laboratory comprises entirely scientists specializing in a single field within a broader academic area of the physical sciences.

Although the majority of TAROS scientists studied did not indicate any major difficulty in obtaining funds to do the kind of research they preferred, a large minority indicated that fund raising was a major problem for them. This finding suggests the hypothesis that the personality characteristics which are more often associated with a successful sales ability may be less often associated with scientific research capabilities, and vice versa. Yet a research organization like TAROS is greatly dependent upon the entrepreneurial and sales ability of its research scientists.

Two conditions appeared to differentiate the scientists who were apparently more successful research entrepreneurs from those who were less successful in fund raising activities at TAROS. Scientists employed in the interdisciplinary laboratory, which is essentially oriented toward problem-solving, and scientists who had previously been employed in academic institutions, where they were likely to have had experience in seeking financial support for their own research, were more likely to be satisfied with the financial support they obtained at TAROS. These findings suggest that interdisciplinary research groups may be more effective in acquiring and maintaining financial support within an essentially applied research context, and that individual scientists may learn

how to obtain financial support for research activities by experience. However, an interdisciplinary research environment may not be as satisfactory for scientists who are oriented toward a single academic discipline.

Although the majority of TAROS scientists did not express any dissatisfaction with the amount of technical assistance available for the conduct of their research, a considerable minority did indicate that a lack of technical assistance at TAROS was a factor that inhibited their research productivity and caused them to be generally dissatisfied with their working conditions. Again, it appeared to be the interdisciplinary research laboratory within TAROS that was most capable of providing the technical assistance expected by its personnel. However, there was some indication that the variety of activities in the interdisciplinary research context might detract somewhat from the interest of many individual research scientists in a relatively narrow scientific specialty. Thus TAROS scientists, like research scientists in most other contexts, appear to be primarily professionally oriented and to be interested in doing basic research of significance in their scientific disciplines, even though they are employed in a research organization with an applied research orientation.

To satisfy basic research interests within an applied research contract, some TAROS scientists engage in a practice known as "bootlegging"--that is, trying out basic research ideas within the constraints of more or less loosely defined applied research contracts. "Bootlegging" represents a form of adjustment between professional interests of scientists and organizational-contractual requirements. This practice may be recognized in many scientific circles, and it is reported to be informally condoned by management and research clients on the grounds that it is generally of some benefit to all concerned. Its importance to this study is that it suggests that where discrepancies exist between formal managerial or contractual requirements, on one hand, and scientists' interests, on the other, scientists themselves will attempt to develop mechanisms to resolve them.

Most TAROS scientists emphasized that they expected management to perform primarily a service function as research entrepreneurs--that is, to provide access to potential clients and supply the technical assistance and facilities needed to conduct research. This concept of management as a provider of services rather than as a director of work activities represents a reversal of the staff-line functions actually performed by administrators and professional personnel in typical bureaucratic organizations.

The TAROS case study shows that some scientists can be challenged and satisfied by opportunities to do both basic research and applied research in an independent research organization. As research and development in modern industrial and governmental organizations becomes more expensive, stricter cost accounting practices might be initiated which could cause many R&D functions within larger organizational contexts to develop a financial structure more like self-supporting independent research organizations. If this development takes place, there may be a greater need for individual initiative and research entrepreneurship in R&D organizations.

In preparation for such a development, there should be further research to discover what facilitates and sustains individual initiative in research scientists to do both applied research and basic research. Certainly the requirement that research activities be integrated with the goals of the organization cannot be imposed by coercion--incentives must be offered that induce the voluntary cooperation of creative people. There is a special need for further research that will answer the following questions:

1. What kinds of individual scientists (e.g., in terms of personal background) are most willing and most able to assume responsibility for the conduct of both basic and applied research within the general requirements of modern large-scale organizations?
2. What types of organizational structure (e.g., interdisciplinary or discipline oriented) are most adaptable to the requirements of applied and basic research activities combined?
3. What happens over time to the individual orientation of scientists and the requirements of an organization as a result of their interaction with each other?

Some Implications for Organizational Theory

The structure of modern large-scale enterprises is changing and the proportion of scientific and other professional personnel in these enterprises is increasing rapidly. Department of Labor surveys have shown, for example, that the proportion of "white collar" employees in the total U.S. labor force has increased from 28 percent in 1900 to 47 percent in 1960, while the proportion of "blue collar" workers has decreased from 57 percent to 40 percent in the same time period (Barry, 1961). In addition, the average (median) educational level of the labor

force has increased from 8.8 median school years completed in 1940 to 11.3 median school years completed in 1957 for males.* Scientists and engineers alone constituted 2.7 percent of employment in all industrial companies and over 4 percent of employment in larger companies (of over 5,000 employees) in 1960.** These scientists and engineers, along with other highly educated "white collar" employees in professional categories, may be expected to exert an increasing influence on managerial practices in directions consonant with the expectations of these employees, especially in larger enterprises.

Max Weber, in his model of rational bureaucratic organization, emphasized increasing centralization of authority in large-scale organizations and separation of official job requirements from personal qualifications. Concerning "collegial bodies"--in which the basis of authority and decision-making responsibilities are more diffuse--Weber wrote in 1913:

At the present time [collegial bodies] are rapidly decreasing in importance in favour of types of organization which are in fact, and for the most part formally as well, subject to the authority of a single head. For instance, the collegial "governments" in Prussia have long since given way to the monocratic "district president." The decisive factor in this development has been the need for rapid, clear decisions, free of the necessity of compromise between different opinions and also free of shifting majorities.***

In Weber's analysis, money was the fundamental incentive for obtaining and sustaining individual participation in accord with prespecified job requirements:

[In bureaucratic enterprises there is] a clearly defined hierarchy of offices. Each office has a clearly defined sphere of competence in the legal sense. The office is filled by a free contractual relationship . . . [Office holders] are remunerated by fixed salaries in money, for the most part with a right to pensions . . . The salary scale is primarily graded according to rank in the hierarchy . . . ****

* U.S. Dept. of Commerce, Bureau of the Census, 1957.

** National Science Foundation, 1961, Table A-3, p. 21.

*** Weber, 1947, p. 336. See also Weber, 1946.

**** Weber, 1947, pp. 333-34.

It appears that in modern industrial organizations, the need for personnel with professional skills (scientific and otherwise) has caused these organizations to move in directions away from Weber's strictly bureaucratic model. Modern industrial organizations appear to be developing a character somewhat more like that of hospitals, universities, and similar professionally oriented institutions, and somewhat less like that of bureaucratic government agencies. In such contexts, scientific and professional personnel exert strong pressures for the freedom to make their own decisions about matters relating to their professional specialities and rely less upon prespecified administrative direction--that is, scientific and other professional personnel tend to define the context of their jobs themselves, rather than simply to fulfill formalized job requirements. Administrators tend to perform service functions for professional personnel, rather than vice versa. Professional groups also significantly influence the over-all goals of an organization through their power to veto management decisions on technical grounds, and through promotional patterns which draw top executives from professional scientific ranks. Thus, organizations may become dependent upon professional initiative and originality, and professional incentives may become more important than formal administrative arrangements and job specifications. Scientific personnel participate in organizational activities for monetary rewards, but money is not ordinarily enough incentive. Modern enterprises may ultimately have to modify bureaucratic patterns of organization so as to provide a working environment that is intellectually challenging and that provides a greater opportunity for professionals to participate in work-related decisions.

Weber's model of bureaucratic structures was based largely upon analysis of government agencies in a more static context, and it did not emphasize the importance of innovation in modern industrial enterprises. Such enterprises do exhibit many facets of bureaucratization in the Weberian sense--for example, a formal hierarchy of authority, specialization of functions in departmental entities, and formalization of rules and procedures. However, under the competitive pressures of a dynamic capitalism, industrial organizations must also provide for a high degree of innovation to meet the forces of competition and rapidly changing technology. The same can be said of governmental agencies in this second half of the twentieth century.

The theory of Joseph Schumpeter deals with the problem of innovation in more detail. In contrast to Karl Marx, Joseph Schumpeter maintained that capitalism is dying, not as a result of its failures, but rather because of its "successes." Schumpeter wrote that capitalism has built into its structure a trend toward bureaucracy and big business monopoly which tends to automate progress and replace entrepreneurs with bureaucratic management dedicated to preservation of the status quo. As

innovation becomes a matter of routine and industrial progress becomes separated from individual initiative in large-scale enterprises, the entrepreneurial function itself becomes obsolescent, according to Schumpeter. The development of capitalism in this direction, he claimed, prepares the way for a socialist revolution led by intellectuals who have no opportunity within a bureaucratic context to satisfy their quest for social and technical innovation.*

It appears to be true that complex organizations attempt to constrain innovative activities insofar as they run contrary to organizational objectives. This tendency is stated formally in the following structural-functional proposition:**

Proposition 1: The adaptability of complex organizations (e.g., larger national entities or smaller industrial or governmental enterprises) to social and technological change requires that research activities within these organizations be integrated, as much as possible, with organizational objectives.

Mechanisms to integrate research activities with organizational objectives include:

1. Direct control of research activities through a bureaucratic authority structure.
2. Indirect control of research activities through financial grants or research contracts.

Aligning innovative activities with larger organizational goals appears to be especially important as organizations increase in size and complexity, as Schumpeter maintained. This tendency may be expressed as follows:

* Schumpeter, 1952.

** I consider it important to state the principal findings of a study in formal terms so that research findings may be more readily amenable to testing for purposes of verification or modification in future research. The formal propositions presented in this report are not intended to be final conclusions, but rather to guide further research toward precisely formulated conclusions.

Proposition 2: As organizations increase in size and complexity, more emphasis must be placed upon research and development in comparison with other functions so as to maintain and/or enhance adaptability to technological change.

Mechanisms for achieving organizational adaptability under conditions of increasing size and complexity include:

- 1. Allocating funds to R&D activities.**
- 2. Employing scientists and engineers for R&D functions.**
- 3. Separating R&D functions from other functions within the organizational structure.**

Moreover, innovative activities which conform to organizational objectives appear to be more prevalent in organizations that must adapt immediately to social and technological changes. This tendency may be described formally as follows:

Proposition 3: For a complex organization to achieve short-run and immediate adaptability to social and technological change, relatively more emphasis must be placed upon development and applied research compared with basic research in R&D activities.

Mechanisms for achieving short-run adaptability within a complex organization include:

- 1. Allocating more funds to development and applied research compared with basic research activities.**
- 2. Employing relatively more engineers compared with scientists.**

However, the long-run adaptability of complex organizations would appear to require relatively more emphasis upon basic research, which, by definition, is not constrained by considerations of immediate application within some organizational contexts. This consideration may be summarized as follows:

Proposition 4: For a complex organization to achieve long-run adaptability to social and technological change, relatively more emphasis must be placed upon basic research compared with applied research and development in R&D activities.

Mechanisms for achieving long-run adaptability within a complex organization include:

1. Allocating relatively more funds to basic research compared with applied R&D activities.
2. Employing relatively more scientists compared with engineers.

Effective basic research functions oriented toward long-run social and technological changes within large organizations require a particular kind of personnel--creative scientists who are innovators of the kind Schumpeter predicted would disappear within large-scale capitalistic enterprises. To attract and sustain the participation of such creative talent requires special incentive mechanisms, many of which are not ordinarily found in the pure type of bureaucratic organization corresponding to the Weberian model. Some of these mechanisms are indicated in the following formal statement.

Proposition 5: To produce contributions to general knowledge (basic research outputs), research organizations require the participation of professionally oriented research personnel.

Mechanisms for acquiring and sustaining the participation of professionally oriented research personnel include:

1. Recruiting and selecting personnel with professional interests and training (e.g., scientists rather than engineers).
2. Providing financial support for research activities with objectives that are loosely defined (e.g., broad grants rather than narrow contracts).

3. Providing opportunities to keep up to date on new scientific knowledge and techniques (e.g., through information retrieval systems, attendance at professional meetings, etc.).
4. Providing colleague relationships which stimulate and sustain a professional orientation (e.g., colleagues of similar background and discipline).
5. Providing a professional type of administration (e.g., supervisors who encourage participation in work-related decisions, and who provide supporting "staff" services to research personnel in "line" functions).
6. Providing adequate technical assistance to research personnel.
7. Providing monetary and nonmonetary rewards or incentives for professional accomplishment.

It is perhaps instructive to note that, to the extent that many of these mechanisms (such as the recruitment of professionally oriented scientists, the provision of loosely defined financial support rather than narrowly defined research contracts, etc.) are utilized in applied research organizations, these mechanisms tend to undermine (are dysfunctional to) the practical, problem-solving objectives of these applied research organizations. The requirements of organizational contexts which emphasize applied research appear to be more in accord with the following formal statement.

Proposition 6: To produce solutions to practical problems (applied research outputs), research organizations require the participation of organizationally oriented research and development personnel.

Mechanisms for acquiring and sustaining the participation of organizationally oriented R&D personnel include:

1. Recruiting and selecting personnel with practical organizational interests and training (e.g., engineers rather than scientists).

2. Providing financial support for R&D activities with objectives that are strictly defined initially (e.g., detailed research contracts and performance requirements).
3. Providing opportunities to keep up to date on current organizational problems (e.g., through frequent contact with personnel in other organizational functions).
4. Providing colleague relationships which stimulate and sustain a problem-solving orientation (e.g., multidisciplinary research groups).
5. Providing a bureaucratic type of administration for which R&D functions perform a "staff" service function.
6. Providing adequate technical assistance to R&D personnel.
7. Providing monetary and nonmonetary rewards or incentives for accomplishment within the larger organizational context.

Research administrators frequently hire research scientists of professional stature and orientation to enhance the prestige of an applied research function. The orientation of such individuals and the organizational mechanisms necessary to sustain their participation often provide a dynamic which changes the goals of the research function from an applied research to a basic research emphasis.

Schumpeter's theory did not account for the fact that innovative activities may be sustained and even enhanced in complex organizations by the degree to which these organizations are not under immediate pressures to adapt to social or technological changes, nor the fact that innovative activities may be enhanced by the participation of creative, professionally oriented research scientists even in applied research situations. As is pointed out in Section V of this report, research scientists tend to develop their own forms of adaptation to applied research constraints--such as "bootlegging" basic research on applied research contract funds--in order to make their own contributions to scientific knowledge.

Furthermore, the general trend in modern capitalistic society is not necessarily toward integrating more and more formally independent operations into large-scale bureaucratic enterprises. Human organizations, like systems of any type, reach limits beyond which an efficient span of control cannot operate. Decentralization of administration, rather than bureaucratic centralization, now characterizes many of the largest American industrial enterprises. In addition, increased technological specialization stimulates an increasing amount of subcontracting to specialized independent enterprises--a process that has perhaps reached its most advanced stage in the missiles and electronics industries. Subcontracting for research has also resulted in the establishment and growth of hundreds of independent research organizations. Even within large industrial organizations and government agencies, the increased expenditures and costs connected with R&D functions may eventually require more accountability in the budgets of these research functions and cause them to adopt a financial structure more similar to that of self-supporting independent research organizations.

Independent research organizations, in turn, require entrepreneurship on the part of research personnel. This is stated formally in the following proposition.

Proposition 7: To support themselves, independent research organizations (or self-supporting research functions within larger organizational contexts) require research personnel who are essentially research entrepreneurs who originate research ideas and who assume considerable responsibility to "sell" or gain financial support to pursue these ideas.

Mechanisms for maintaining and supporting research entrepreneurs include:

1. Recruiting and selecting personnel with previous experience and interest in initiating and supporting their own research projects (e.g., scientists with prior employment experience in large academic centers).
2. Providing a professional type of administration under which supervisors encourage participation in work-related decisions and provide supporting "staff" services--especially "broker" services to provide contacts between individual research scientists and potential research clients.

3. Providing colleague relationships which enhance a capability to originate research ideas and to gain financial support for these ideas (e.g., interdisciplinary research groups).

Thus the "success" of the capitalistic system does not necessarily include the decline of creative innovation in the large-scale organizations of modern society. Even to the degree to which larger organizational contexts tend to inhibit basic research--e.g., because of pressures for immediate adaptation to social or technological changes--the professional orientation of individual scientists imposes pressures upon organizational systems to conduct research of general scientific significance. Research functions within larger organizational contexts may become major collective sources of innovation in the future.

III INFLUENCES ON THE ROLE OF THE RESEARCH SCIENTIST: FINDINGS FROM PAST STUDIES

The complexity of the role of the research scientist is often minimized in studies which investigate the relationship of such scientists to the organizations in which they are employed. The purpose of the discussion presented in this section is to analyze some findings from past studies and to develop a broad understanding of the most important influences upon the research role as a preliminary basis for further study.

By "role," we mean the rights and duties exercised by persons of a given social status or position.* In this case we are primarily concerned with the rights and duties of scientists employed in organized research activities. The rights and duties of an individual occupying a given status or position are always exercised in relation to other persons performing counterroles.** Thus, one cannot perform the role of an actor without an audience, the role of a physician without a patient, or the role of an employee without an employer. A counterrole that is very important to most employees in large-scale organizations today is that of the supervisor, who is himself an employee. The employee role must also relate to a greater or lesser degree to many other counterroles, such as that of the wife or husband in the case of married employees, or that of professional colleagues in the case of professional employees. The components (rights and duties) of an employee's role are determined by the role expectations held by people who occupy this role, and those held by people who occupy significant counterroles.

All employees, by virtue of their common status as employees, share certain role expectations. For example, they expect to receive treatment that is consistent and in accord with company policies and rules, and they expect their employment to be terminated involuntarily only for "just cause"--i.e., for reasons that are clearly inconsistent with the goals of

* Ralph Linton is generally recognized as the first having described the concept of "role" in these terms in The Study of Man, 1936.

** For a discussion of the concept of "counterroles," see Lindesmith and Strauss, 1956, Chapter 12.

the employer.* Research scientists, however, have role expectations that are not shared by other employees.

The research role is set in a social and institutional context. The characteristics of the research organization shape managerial expectations with regard to the research role. These characteristics are determined in large part by the functional position of the research organization within the larger organizational context, e.g., company, government agency, or academic institution. Research organizations are also influenced by surrounding industrial and societal systems.

When we consider the research role, a minimum of two major systems referents must be taken into account: (1) the social system of the organization in which the research role is embedded, and (2) the personality system of individuals who occupy these roles. Industrial companies, government agencies, and academic institutions exert pressure through their organizational integrative mechanisms upon research functions and roles so that they will develop and operate in ways that contribute to organizational goals. In turn, individual research scientists attempt through their personality integrative mechanisms to reconcile their obligations as a research employee with their obligations and values in other roles (e.g., as a husband or as a member of a professional association). Obviously, the relative emphasis assigned various components of the research role by those performing it or significant counterroles will vary considerably, depending upon past and present variations in the context in which the research function exists.

In the discussion which follows, certain selected findings of previous studies are examined in terms of (1) contextual influences on research functions, (2) research function inputs and outputs, (3) processes within a research function, and (4) influences on individual researcher's expectations. These elements are then combined in a total schematic representation of the research role in a research function. The findings of previous studies have necessarily been re-interpreted in many cases, and in many cases are used to draw conclusions that go beyond the interpretations made by the authors of the studies. This has been done in keeping with the objective of this part of the present study--i.e., developing ideas for further research from clues provided by past studies, rather than simply presenting a chronicle of findings from other studies or evaluating their methodology.

* For a more detailed study of employee expectations regarding fair treatment, see H. M. Vollmer, 1960a.

Influences on Managerial Expectations

Figure 1 presents a simple schematic diagram of the research function within the societal, industrial, and organizational contexts. As used here, a research "function" is a research organization or enterprise viewed in terms of its relationship to a larger organizational context. Although the most immediate influence upon the character of a research function may be its position within a company, government agency, or academic institution, the larger industrial and societal setting may also greatly influence managerial expectations regarding the research function.

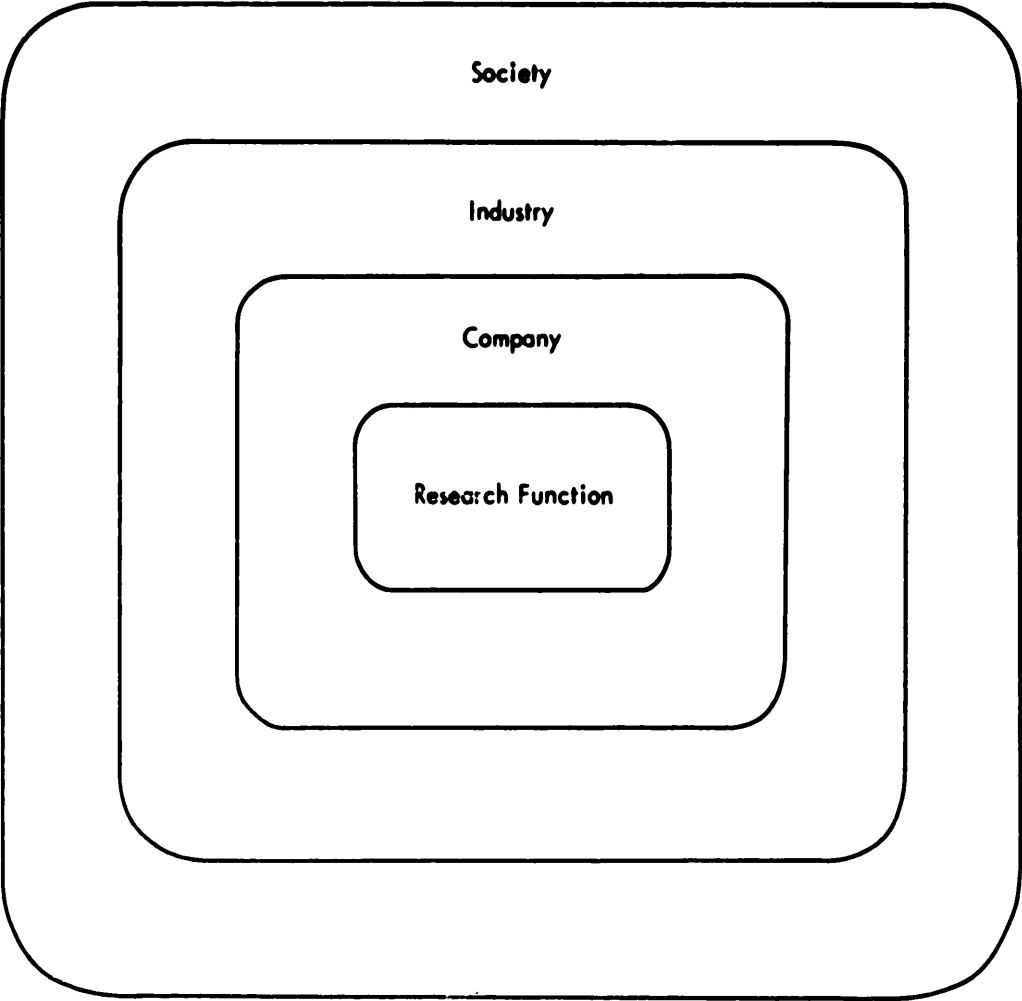
Societal Influences

Certain relationships which exist between research functions and societal contexts have been suggested by previous studies. It appears that all societal systems attempt to control research functions in accord with broad societal goals or objectives. However, the predominant mechanisms whereby research functions are controlled seem to vary according to the political and economic structure of each societal system. For example, in the Soviet Union, scientific activities are centralized under governmental controls exercised by the Soviet Academy of Sciences or the Ministries of Agriculture, Health, or Education to assure that research coincides with national needs (Oster, 1949, Turkevich, 1960).^{*} Similarly, a high degree of centralized scientific leadership is exercised in Communist China by the Chinese Academy of Sciences. Until recently, the only adequate general laboratory facilities in China have been those in major research centers in Peking and Shanghai (Orleans, 1961).

In the United States also there is a tendency to influence research activities in terms of national interests. However, under a capitalistic economy and pluralistic political system, research activities are likely to be controlled not so much by a centralized administration as by economic manipulation of research resources. Today, scientific research is expensive, requiring large-scale government financing through grants and contracts. Private industrial companies are induced to seek government-sponsored R&D contracts for a number of reasons: first of all, production contracts often follow upon R&D contracts; second, under such contracts commercial patent rights can often be retained; third, government contracts

* However, this high degree of centralized control of scientific activities in the U.S.S.R. has apparently decreased since 1957 (Graham, 1962).

FIGURE 1
SCHEMATIC REPRESENTATION OF
CONTEXTUAL INFLUENCES ON RESEARCH FUNCTIONS



and grants provide special opportunities for recruiting scientists and building more complete laboratories; and, finally, they provide an entrée to "invitation only" technical conferences (Mandell, 1961). These advantages account, in part at least, for the fact that over 50 percent of the funds spent on research and development in the United States come from the federal treasury (National Science Foundation, 1960a, Table I, p. ix).

Government grants and contracts are not assigned at random, but rather to sponsor scientific activities which have some probability of making an immediate or ultimate contribution to national goals and purposes (Rankin, 1956). Thus, the objectives of the National Science Foundation are:

To develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences

To initiate and support basic scientific research, and at the request of the Secretary of Defense, initiate and support defense-related scientific research activities

To appraise the impact of research upon industrial development and the general welfare

To evaluate scientific research programs undertaken by the agencies of the federal government, and correlate the Foundation's scientific research programs with those undertaken by others.*

Some authorities feel there is a need for further coordination of government sponsorship of research activities, perhaps through a proposed U.S. "Department of Science" (Humphrey in Sellin, 1960, especially pp. 27-35). The contention that government research contracting mechanisms influence research endeavors to some degree, if only in regard to the general direction they take, is substantiated by the criticism of such mechanisms by some scientists (see for example: Bray, 1952; Brown and Shepherd, 1956; Condon, 1952; Darley, 1952; Lanier, 1952; Reid, 1953; J. Wilson, 1952).

* U.S. Federal Register Division, 1953, pp. 441-2. Underlining has been added for emphasis.

Although national societies attempt to control research activities by whatever means are available, research scientists tend to value autonomy which will permit them to direct research toward their own theoretical interests rather than toward societal or organizational problems. Many scientists in the United States tend to resist government influence over research even though they appreciate the financial support. Even in more authoritarian societies, scientists tend to resist centralized control of research activities. For example, during a brief period in 1957 when criticism in intellectual circles in China was encouraged by the government (Orleans, 1961), Chinese scientists expressed dissatisfaction with the amount of time allocated to administrative and nonprofessional duties, the greater encouragement given by the Chinese Academy of Sciences to physical sciences at the expense of social sciences, and the centralization of laboratory facilities.

Authoritarian nations with highly centralized administrations which tend to control scientific research activities directly sometimes provide special mechanisms to protect the autonomy of research scientists. In the Soviet Union, for example, research activities are coordinated almost entirely by government agencies; however, there is a strict distinction between the status and role of researchers and administrators. Norman Kaplan (1961) reports that the Soviet research administrator's function is restricted to "pure execution of policy." He is paid less and accorded less prestige than scientists, and is trained in "bookkeeping" rather than in science. Kaplan claims that this procedure allows the Soviets less formal administration in scientific organizations, and avoids role conflicts by clearly distinguishing between the status and responsibilities of scientists and administrators.

Thus, it appears that every nation attempts to resolve the dilemma of assuring that research activities contribute efficiently to the technological growth of the society and yet, at the same time, provide at least the minimum degree of autonomy needed by scientists to conduct research effectively.

Industrial Influences

The emphasis placed on research and development activities by different types of industries within a modern industrial society varies considerably. These variations appear to be related to the degree to which industrial organizations in a highly competitive economy are subject to product or process obsolescence. It is not surprising then that the aircraft, electrical equipment, chemical, and petroleum extraction

and refining industries in the United States allocate the largest amount of total funds to research and development expenditures. The aircraft, electrical equipment, and chemical industries, especially, spend more on research and development in proportion to net sales and are likely to hire relatively large numbers of scientific and engineering personnel. The proportion of total personnel who are scientists or engineers varies from about 8 to 12 percent in the aircraft, electrical equipment, chemical, and petroleum industries. Data on the emphasis on research and development in certain selected industries are presented in Table 1.

Industries also vary in the degree to which technological change may require long-run or short-run changes in products or processes. Where short-run changes in products or processes are required, we would expect industrial organizations to place relatively more emphasis upon development in their R&D programs and to require that research findings be immediately translated into product or process changes. We would also expect industrial organizations under short-run pressures to employ proportionately more engineers in comparison with scientists, since engineers are usually the ones who translate research findings into answers to the problems of production managers (Given, 1955; Shepard, 1957).^{*} Conversely, where long-run adaptations to technological change are required, we would expect industrial organizations to place relatively more emphasis upon research in proportion to development activities, and upon the employment of scientists in proportion to engineers.

Moreover, we would expect this perception of the time dimension (long run or short run) with respect to the industrial impact of technological change to be relatively independent of the perceived magnitude of the impact of technological change upon different industries. This expectation is generally supported by data presented in Table 2, which shows that the emphasis on research (especially basic research) in comparison with development activities is generally higher in some industries (e.g., primary metals and food products) which Table 1 showed as having a lower emphasis on all R&D activities. Conversely, Table 2 shows that the emphasis on research in comparison with development activities is lower in other industries (e.g., electrical equipment and aircraft) which Table 1 showed as having a higher emphasis on all R&D activities.

* Engineers tend to be as concerned about training in human relations skills as training in technical matters (Professional Engineers Conference Board for Industry, 1957, pp. 30-2).

Table 1

EMPHASIS ON R&D ACTIVITIES IN SELECTED U.S. INDUSTRIES

Selected U.S. Industries	Indicators of Emphasis on R&D		
	(1) Millions of dollars	(2) Percent	(3) Percent
Aircraft and parts	\$2,544	17.9%	12.2%
Electrical equipment	1,170	7.6	7.7
Chemicals and allied products	596	3.0	9.6
Petroleum refining and extraction	230	0.8 ^a	7.7
Primary metals	113	0.6	2.5
Fabricated metal products	110	1.6	3.3
Food and allied products	68	0.3	0.7
Paper and allied products	50	0.8	1.6

Code for Indicators of Emphasis:

- (1) Total funds for research and development allocated in 1957, shown in millions of dollars (Source: National Science Foundation (NSF), 1960a, Table V, p. 12)
- (2) Total funds for research and development, shown as percent of net sales, 1957 (Source: NSF, 1960a, Table A-17, p. 89)
- (3) Number of scientists and engineers employed, shown as percent of total employment, 1960 (Source: NSF, 1961, Table 2, p. 6)

- a. This proportion is lower than might be expected because of the fact that exploration activities are not classified strictly as research and development activities within the petroleum industry.

Table 2

**EMPHASIS ON RESEARCH ACTIVITIES
COMPARED WITH DEVELOPMENT ACTIVITIES
IN SELECTED U.S. INDUSTRIES
(Percent)**

Selected U.S. Industries	Indicators of Emphasis on Research Activities		
	(1)	(2)	(3)
Petroleum refining and extraction	13%	49%	47%
Chemicals and allied products	8	51	72
Primary metals	5	^a	50
Food and allied products	5	43	67
Electrical equipment	3	15	13
Aircraft and parts	2	15	18
Fabricated metal products	1	33	11
Paper and allied products	1	^a	45 ^b

Code for Indicators of Emphasis:

- (1) Funds for basic research, shown as percent of total R&D funds, 1957 (Source: NSF, 1960a, Table V, p. 12)
- (2) Funds for basic and applied research combined, shown as percent of total R&D funds, 1957 (Source: NSF, 1960a, Table V, p. 12)
- (3) Number of scientists employed in R&D activities, shown as percent of all scientists and engineers employed in R&D activities, 1960 (Source: NSF, 1961, Table A-10, p. 28)

- a. No data were available for these categories.
- b. It is possible that the proportion of scientists to scientists and engineers is higher than might be expected for the paper products industry because engineering training may be less applicable to development activities in this industrial context, except possibly for chemical engineers. The vast majority of scientists employed in the paper products industry are chemists.

On the basis of the data presented in Tables 1 and 2, it is possible to classify certain industries according to the degree of emphasis they place on research and development and according to relative emphasis placed on research compared with development.

	Greater Emphasis on Development	Greater Emphasis on Research
High Emphasis on R&D	Aircraft & parts Electrical equipment	Chemicals and allied products Petroleum refining and extraction
Low Emphasis on R&D	Fabricated metals Paper and allied products	Primary metals Food and allied products

Such a classification might contribute to a better understanding of how certain managerial expectations may influence the research role and may affect the development of research functions in different industrial contexts. For example, in industries where technological changes have an immediate effect on product development or production processes, we might expect scientists to be under pressure to work more closely with engineers and with production managers in day-to-day operations. On the other hand, in industries where the consequences of technological change are felt over the long run, we might expect to find scientists more at liberty to work in laboratory situations isolated from production activities and to exchange information on research activities with professional colleagues in other organizations.

Wider variations in the relative emphasis placed on research compared with development activities become apparent when the employment conditions for industrial, governmental, and academic scientists are contrasted. Several surveys have indicated that most scientists consider academic institutions or academic-affiliated institutions to be more suitable for long-range basic research activities and more oriented toward allowing scientists to freely pursue their own interests. Industrial laboratories are considered to be more suitable for shorter-range applied research, and government laboratories are rated as falling somewhere in between the academic and industrial situations (Ahlberg and Henry, 1950; Meltzer, 1956; U.S. President's Scientific Research Board, 1947).

Academic institutions, by virtue of their responsibility for the education of future generations, tend to be oriented primarily toward

long-run social and technical changes than are manufacturing firms. However, the variation between manufacturing firms in their orientation toward longer-run or toward more immediate changes in products or processes may be considerable, depending on the goals and the technology of the industrial context in which they operate.

Organizational Influences

Certain characteristics of company, government, and academic organizations, which provide the immediate context of research functions, have a more direct influence upon managerial expectations with regard to the research role. One of the more important of these characteristics appears to be size in terms of total number of employees. Size is important because it is indicative of the degree to which an organization is bureaucratized--that is, the degree to which a hierarchy of authority, a division of labor or functions, the rules governing personnel actions, and other aspects of organizational behavior have become formalized (Weber, 1947, p. 338; Blau, 1956, p. 19). The larger an organization is, the more likely it is that R&D activities will be recognized as a functional activity formally distinguished from other organizational functions such as production or marketing.

This generalization is supported, at least for very large firms, by the data shown in Table 3. The vast majority (about 85 percent) of R&D funds in American industry are spent by firms of 5,000 or more employees. Other indicators show that firms of 5,000 or more employees are likely to devote a higher proportion of funds to research and development in relation to net sales, to employ more scientists and engineers in proportion to their total employment, and to employ more scientists and engineers in R&D activities in relation to other activities. Three National Science Foundation surveys conducted in 1953, 1956, and 1959 and published prior to the surveys drawn upon for the data shown in Table 3 also indicate that larger firms are more likely to conduct R&D activities and to sponsor research contracts in outside commercial and independent laboratories (NSF, 1956b, 1959b, 1960b). A positive association between company size and the level of research activities was also a finding of two studies in England (Carter and Williams, 1959; Manchester Joint Research Council, 1954). It was concluded in an analysis of corporate staff research activities in 85 manufacturing companies in the United States and Canada (Janger, 1960) that research activities are less likely to be emphasized in smaller firms because smaller firms are less likely to expand into new fields of activity.

Table 3

**EMPHASIS ON R&D ACTIVITIES
ACCORDING TO SIZE OF U.S. INDUSTRIAL FIRM**

Size of Firm	Indicators of Emphasis on R&D				
	(1) Millions of Dollars	(2) Percent	(3) Percent	(4) Percent	(5) Percent
5,000 or more employees	\$6,060	3.7%	89.5%	4.1%	46.8%
2,500 to 4,999	318	1.8	67.9 ^a	2.5 ^a	31.6 ^a
1,000 to 2,499	328	2.3	b	b	b
500 to 999	143	--	53.8	2.2	31.3
100 to 499	213	2.1 ^c	33.0	1.5	28.7
Less than 100	93	--	16.4	2.2	19.5

Code for Indicators of Emphasis:

- (1) Total funds for research and development allocated in 1957, shown in millions of dollars (Source: NSF, 1960a, Table I, p. ix)
- (2) Total funds for research and development, shown as percent of net sales, 1957 (Source: NSF, 1960a, Table A-17, p. 89)
- (3) Number of firms employing any scientists or engineers, shown as percent of all firms, 1959 (Source: NSF, 1960b, Table A-2, p. 27)
- (4) Number of scientists and engineers employed, shown as percent of total employment, 1960 (Source: NSF, 1961, Table A-3, p. 21).
- (5) Scientists and engineers employed in research and development activities, shown as percent of all scientists and engineers employed, 1960 (Source: NSF, 1961, Table A-11, p. 29)

- a. These data apply to all firms of from 1,000 to 4,999 employees.
- b. No data were available for these categories separately.
- c. This datum applies to all firms of less than 500 employees.

Since certain differences in research activities seem to be associated with variations in the type of industrial context, one might question whether R&D activity is more directly associated with variations in the type of industry than with size of firm or vice versa. Table 4 presents some data indicating degree of emphasis on research and development for large and small firms within the industrial categories discussed previously. These data show that, except perhaps for petroleum firms, there is a marked variation in emphasis on R&D activities according to size of firm within each industrial category. It may also be seen in Table 4 that the differences in emphasis between industrial categories (see Table 1) do not disappear when one looks at either large or small firms within the industrial categories. It appears that both the size of a firm and the character of its industrial context tend to influence the amount of emphasis placed on R&D activities.

As a firm grows larger and more bureaucratized, more formal distinctions may be drawn between pure research activities, on the one hand, and development activities, on the other (Hickey, 1958). Over half of a panel of 105 experts in research management indicated that it is at least "of some importance" to separate research activities completely from production, sales, and other departments of a company (Deutsch and Shea, 1959, p. 56). In this regard, Albert Rubenstein has described the experiences of larger firms as follows:

It is widely recognized among the larger and more research oriented companies that routine improvement and service work are not compatible with the kind of activity needed to produce radically new ideas and products. Some companies have found that a budgetary separation, with perhaps a nominal organizational separation within the industry, can provide the necessary isolation. Others have found that nothing less than complete geographic, organizational, budgetary, and personnel separation are necessary for each of these disparate research and development functions to be performed satisfactorily (Hickey, 1958, p. 120).

One survey of 337 large companies (Randle, 1959) has indicated that fewer companies have established written policies and rules for research functions than for other major functions. Many scientists prefer the relative autonomy of research functions in larger firms since it allows them to conduct research in fields of their own choosing with minimal direction from management, a situation which emphasizes "colleague authority" rather than "executive authority" (Marcson, 1960b). However, the autonomy permitted in larger organizations sometimes strains the

Table 4

EMPHASIS ON R&D ACTIVITIES
FOR LARGE AND SMALL U.S. FIRMS, BY INDUSTRY
(Percent)

Selected U.S. Industries	Indicators of Emphasis on R&D in:			
	Large Firms ^a		Small Firms ^a	
	(1) Percent	(2) Percent	(1) Percent	(2) Percent
Aircraft and parts	18.2%	12.8%	5.8%	9.0%
Electrical equipment	8.6	8.8	5.1	8.5
Chemicals and allied products	3.2	11.0	1.9	10.0
Petroleum refining and extraction	0.8	8.5	b	8.6
Primary metals	0.5	3.0	b	1.2
Fabricated metal products	1.8	5.7	1.5	1.7
Food and allied products	0.3	1.1	b	0.7
Paper and allied products	0.8	3.2	b	0.8

Code for Indicators of Emphasis:

- (1) Total funds for research and development, shown as percent of net sales, 1957 (Source: NSF, 1960a, Table A-17, p. 89)
- (2) Number of scientists and engineers employed, shown as percent of total employment, 1960 (Source: NSF, 1961, Table A-3, p. 21)

- a. Large firms are classified as those with 5,000 or more employees.
Small firms are classified as those with less than 1,000 employees.
- b. No data were available for these categories.

relationship between research scientists and manufacturing or sales personnel--those who are most likely to be immediately affected by research outputs (Randle, 1959). It is perhaps for this reason that very large firms (5,000 or more employees) are especially likely to allocate proportionately more funds and personnel to development than to research (see Table 5). Very large bureaucracies must devote a greater portion of their resources to coordinating functionally differentiated units, because, over time, these units tend to develop goals and an institutionalized "life of their own" which may differ considerably from the technical goals or missions originally assigned to them.

The type of estrangement that can develop between company goals and objectives and the emergent objectives of research functions within a company is illustrated by statements made by paper and pulp industry executives and research directors at a meeting in 1959 (Chemical and Engineering News, 1959a). At this meeting it was reported that research officials requested that management: (1) define research policy clearly, (2) keep research officers fully informed, and (3) not confine research salaries to the levels dictated by requirements in effect elsewhere in the company. In turn, management officials requested that researchers: (1) return a profit to the company within a reasonable time, (2) acquaint themselves with over-all company problems, and (3) consider themselves a part of the company rather than as people apart. Another survey of 3500 researchers (Business Week, 1958) found that researchers have little contact with management or knowledge of company goals. Several studies have shown that research scientists tend to exert pressure to become independent of overly directive management (Baumgartel, 1957; Weschler, Kahane, and Tannebaum, 1952; Marcson, 1960). Despite such pressure, the coordination of research activities with organizational objectives remains an important managerial requirement. William Kornhauser's recently published study (1962) has discussed this theme in considerable detail.

Research Functions

The character of research activities can be described in terms of their functional relationship to larger organizational, industrial, and societal contexts, and may be viewed as "research functions" within these larger contexts. The operation of a research function can be described in terms of characteristic inputs from the larger system to the research function and characteristic outputs from the research function to the larger system.

Table 5

**EMPHASIS ON RESEARCH ACTIVITIES
COMPARED WITH DEVELOPMENT ACTIVITIES
ACCORDING TO SIZE OF U.S. INDUSTRIAL FIRM**

<u>Size of Firm</u>	<u>Indicators of Emphasis on Research</u>		
	<u>(1)</u> <u>Percent</u>	<u>(2)</u> <u>Percent</u>	<u>(3)</u> <u>Percent</u>
5,000 or more employees	3%	23%	22%
2,500 to 4,999	5	35	23 ^a
1,000 to 2,499	5	36	b
500 to 999	3 ^c	31 ^c	22
100 to 499	b	b	16
Less than 100	b	b	12

Code for Indicators of Emphasis:

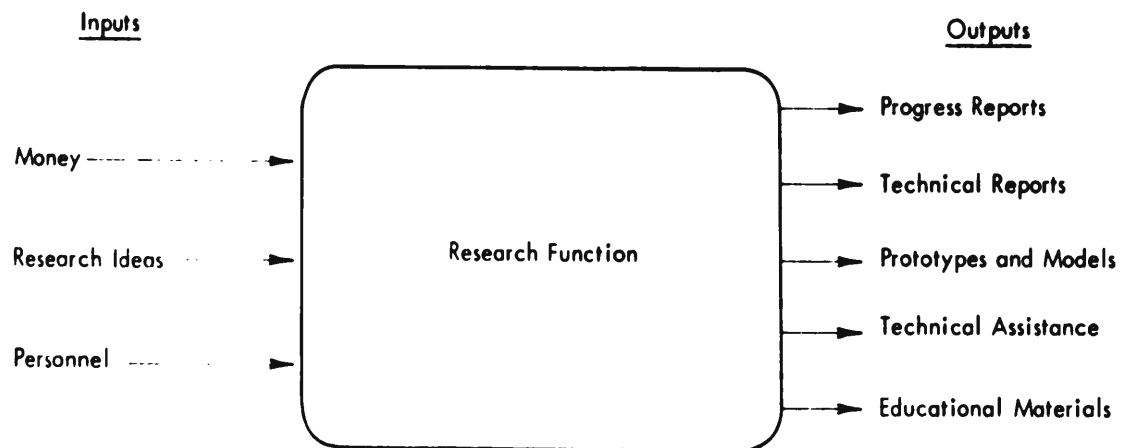
- (1) Funds for basic research, shown as percent of total R&D funds, 1957 (Source: NSF, 1960a, Table V, p. 12)
- (2) Funds for basic and applied research combined, shown as percent of total R&D funds, 1957 (Source: NSF, 1960a, Table V, p. 12)
- (3) Number of scientists employed in R&D activities, shown as percent of scientists and engineers employed in R&D activities, 1959 (Source: NSF, 1960b, Table A-7, p. 31)

- a. This datum applies to all firms of from 1,000 to 4,999 employees.
- b. No data were available for these categories separately.
- c. These data apply to all firms of less than 500 employees.

Figure 2 presents a schematic representation of inputs and outputs which relate a research function to a larger system context. There are at least three classes of inputs: (1) physical resources--facilities and money; (2) ideational resources--problems for research and findings from past research studies; and (3) human resources--scientists and other research personnel. An effective research organization cannot exist without obtaining funds to maintain adequate physical facilities, information on current scientific knowledge in relevant fields, and personnel capable of effectively utilizing scientific knowledge and physical facilities.

Also shown in Figure 2 are several classes of possible outputs from a research function. These include: (1) progress reports to inform those who may utilize research outputs of the status of a research project, (2) technical reports to present research findings, (3) prototypes and models to demonstrate research results, (4) technical assistance in applying research findings, and (5) educational materials to guide future participants in similar research activities.

FIGURE 2
SCHEMATIC REPRESENTATION OF
RESEARCH FUNCTION INPUTS AND OUTPUTS



Organizations and individual scientists may vary as to the degree of emphasis they place upon certain research function inputs and outputs. For example, industrial organizations are likely to provide more funds per capita for research personnel than do governmental or academic organizations, in that order (Meltzer, 1956). Regarding outputs, another study (U.S. Committee on Engineers and Scientists for Federal Government Programs, 1957) found that government scientists in nondefense agencies felt they have greater opportunities to publish the results of their research than do industrial scientists, but not as much opportunity to publish as do university scientists. Similarly, the Meltzer study (1956) found that 86 percent of academic scientists, 83 percent of government scientists, and only 39 percent of industrial scientists reported that published papers have at least some effect on promotions in their situations.

The effectiveness of a research function within a larger systems context can be evaluated on the basis of input-output relationships. Meltzer's study throws some light on the relationship of two research inputs, funds and research ideas, to research productivity in terms of publications. Table 6 shows that physiologists who had more funds available for research and who reportedly were freer to select research problems on the basis of their own information on current scientific developments were more likely to be rated "high" in research productivity. Table 6 also shows that increasing degrees of freedom resulted in relatively small increments in the proportion of scientists with high productivity when less funds were available. Similarly, increasing amounts of research funds resulted in relatively small increments in the proportion of scientists with high productivity where there was less freedom to select research problems on the basis of information on current scientific developments. These data suggest that it is the interaction of inputs of funds and ideas together which contribute most to research productivity outputs.

Few studies have attempted to specify in detail the typical job requirements of research personnel in a research organization, an exception being the research conducted by Flanagan (1949). It is possible to develop a tentative schematic representation of the typical development, transmission, and administrative processes related to characteristic inputs and outputs in a research function. These processes are shown in Figure 3. Elements within these processes are ordinarily allocated in the form of job requirements for research personnel. Developmental processes in a research function include funds and facilities acquisition, information acquisition, and personnel acquisition. Administrative processes include supervision (e.g., relating superiors to subordinates within the research

organization) and coordination (e.g., relating research colleagues to each other). Research production processes include research design, data collection, data manipulation, data interpretation, and management of project resources (e.g., personnel, materials, funds, and time). Transmission processes include progress report writing, technical report writing, model building, implementation, and teaching.

Table 6

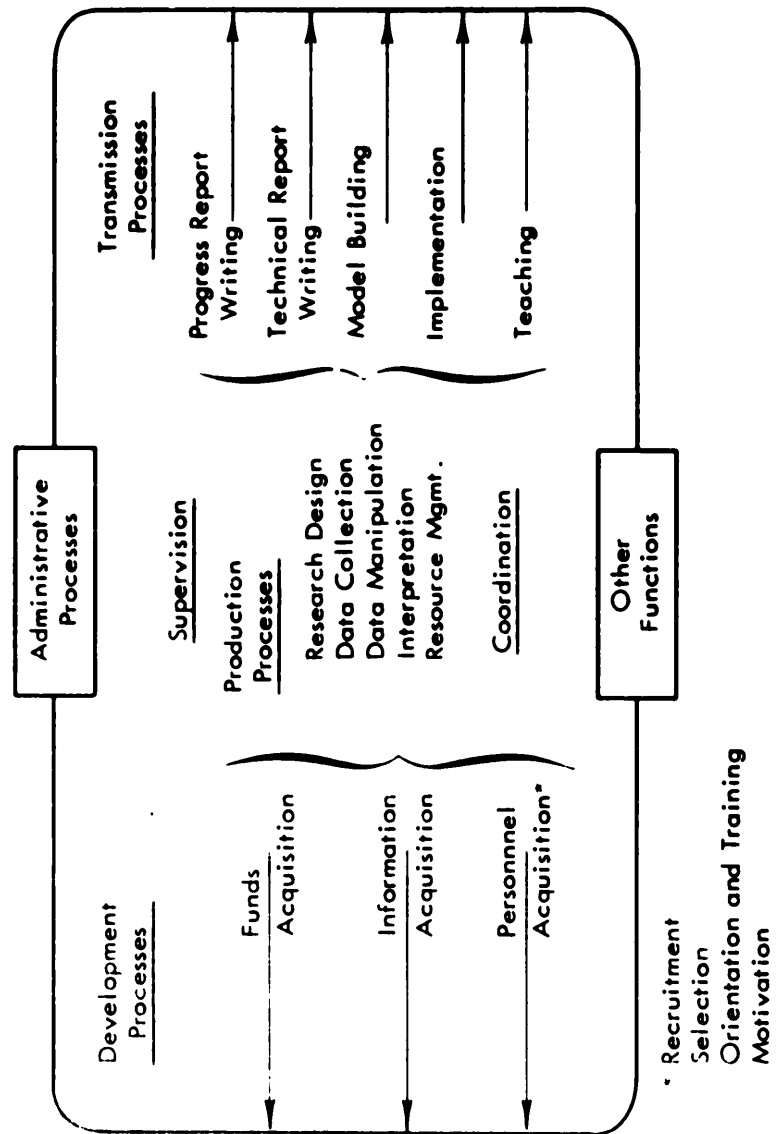
PERCENT OF PHYSIOLOGISTS RATED AS "HIGH PRODUCERS,"
BY AMOUNT OF RESEARCH FUNDS AVAILABLE
AND FREEDOM TO SELECT RESEARCH PROBLEMS

Reported Freedom to Select Own Research Problem	Funds Available for Current Research		
	\$1-4,999 (percent)	\$5,000-19,999 (percent)	\$20,000 or more (percent)
Complete freedom	33%	69%	80%
Considerable freedom	39	56	62
Less freedom	24	36	40

Source: Meltzer, 1956, Table 2, p. 36. Each cell of the table shows that percentage of physiologists with the combination of freedom and funds who are rated as "high producers"--those exceeding a median rate of 4.5 technical papers in three years. 3,084 physiologists participated in this study; however, the report does not indicate the numerical base for percentages shown in this table.

These processes may differ considerably in importance in different types of research situations--for example, in basic research activities as compared with organizations emphasizing applied research and development. Table 7 shows the extent to which responsibilities placed on industrial research personnel doing basic research activities may differ from those placed on personnel in applied research and development. These data suggest that in activities which emphasize basic research, management tends to emphasize technical reports contributing to general scientific knowledge and not the implementation of research in terms of specific

FIGURE 3
SCHEMATIC REPRESENTATION OF PROCESSES WITHIN
A RESEARCH FUNCTION



product applications; and researchers' work with minimal direction and supervision and in relatively close cooperation with competent professional colleagues. In contrast, managers of applied R&D activities tend to expect personnel to work in relatively close cooperation with competent nonprofessional colleagues, and to be concerned primarily with the quality of company products.

Table 7

EXPERIENCE SCORES ON SELECTED WORK FACTORS OF PERSONNEL
DOING BASIC OR APPLIED RESEARCH IN TEN U.S. INDUSTRIAL FIRMS

<u>Work Factors</u>	<u>"Experience Scores"^a of Personnel in:</u>	
	<u>Basic Research</u>	<u>Applied Research and Development</u>
Opportunity to contribute to scientific knowledge	69	38
Freedom to manage own work	89	78
Association with able professionals	78	70
Association with able nonprofessionals	52	60
Member of company producing reputable goods	78	84

- a. "Experience scores" are indexes, varying from 0 to 100, of the degree to which employees in each category reported experiencing a given work factor.

Source: Riegel, 1958, Part II; Table V, p. 27; Table VI, p. 31.

The primary responsibilities of personnel for various processes within a research function may vary considerably. In turn, the nature of these responsibilities may impose role strains upon some scientists, who may be as ill suited to "selling research ideas" or dealing with implementation activities as they are well suited to conducting research in the laboratory. For example, one study in an international and foreign

policy research organization at an academic institution (Bennis, 1955 and 1956) found that research scientists spent considerable time raising funds (e.g., writing proposals, visiting potential clients, keeping up with information relevant to research activities in competing organizations, etc.) rather than actually conducting research; such fund-raising activities require social as well as intellectual skill. The author of this study pointed out that the traditional role conflict of the academic man arises from having to balance his time between research, teaching, and administrative duties--he is forced to teach in order to do research. In contrast, scientists in this research organization found it necessary to raise funds as "research entrepreneurs" in order to do research, and many were unsure of themselves in this fund-raising role.*

A nationwide survey (U.S. Committee on Engineers and Scientists for Federal Government Programs, 1957) has reported that 40 percent of the scientists and engineers in governmental agencies and 44 percent of those in industrial organizations said they were required to spend more than one-fourth of their time on duties which were not directly related to their areas of professional training and competence.

Some additional indications of role strains that may be associated with different combinations of role requirements (managerial expectations) may be found in Table 8. In this table, data are presented for a small number of personnel in a federal agency sponsoring and coordinating research activities. The personnel in this agency whose jobs require them to make policy decisions regarding the conduct of research and also to implement research activities are more likely to be satisfied with their jobs than those who only implement research and collect information. Perhaps of most interest is the fact that personnel in this agency who have responsibility in all three areas are least likely to be "highly satisfied" with their jobs.

In summary, job requirements (managerial expectations) of scientists in research functions are likely to include responsibilities for development of research activities, research production, transmission of research products or outputs, and research administration. These research processes are emphasized to varying degrees in different research functions. Such variations or differences in emphasis arise from differences in the objectives and structure of larger organizational, industrial, and

* For a further discussion of scientists as research entrepreneurs, see Section V of this report.

societal system contexts. Differences in emphasis within research functions and differences in the allocation of responsibilities for various processes may affect, in turn, the relationship of research personnel to their employing organization, depending upon the employee's role expectations.

Table 8

**JOB SATISFACTION AMONG PERSONNEL IN A FEDERAL RESEARCH AGENCY,
BY JOB ACTIVITY
(Percent)**

Job Activity	Degree of Job Satisfaction		
	Highly Satisfied	Satisfied	Not Satisfied
Information collection and implementation (N = 25)	60%	20%	16%
Information collection, policy decisions, and implementation (N = 10)	50	30	10
Policy decisions and implementation (N = 9)	78	11	0

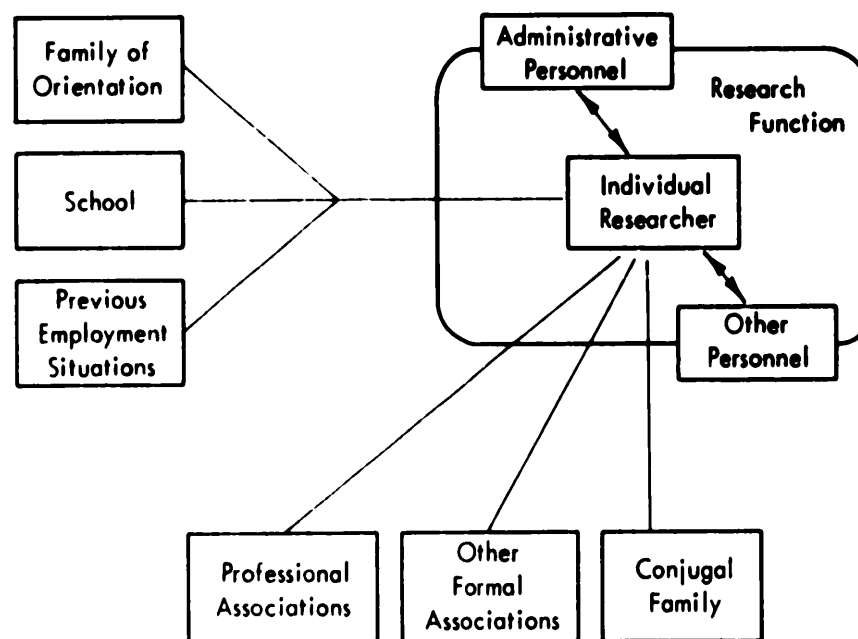
Source: Weiss, 1956, Table 14, p. 45. The percentages shown in this table do not equal 100 percent because of nonresponses.

Influences on the Expectations and Behavior of Individual Scientists

At the same time that larger societal, industrial, and organizational factors influence the character of research functions, individual researchers with their differences in past experience, present relationships, and past and present affiliations also affect the character of research. The major influences on the expectations of individual research scientists are presented schematically in Figure 4.

FIGURE 4
SCHEMATIC REPRESENTATION OF
INFLUENCES ON EXPECTATIONS OF INDIVIDUAL RESEARCH SCIENTISTS

Major Sources of
Past Influence



Major Sources of Present External Influence

Past Influences

Previous studies have indicated that early family experiences inculcate values or expectations into children which are characteristic of either life career patterns of scientists or those of nonscientists in other professional and intellectual occupations. Several investigations have shown that eminent scientists, especially, are more likely than nonscientists to have had fathers who were in professional occupations (Terman, 1954; Roe, 1953) or who were prominent in public life (Galton, 1895). Research has also indicated that parents of children who become eminent scientists are less likely than parents of nonscientists to take dogmatic positions on religious questions (Terman, 1954; Galton, 1895) and more likely to place a high value on learning (Roe, 1953), to have several "interest areas" (Terman, 1954), and to encourage scientific interests in their children (Terman, 1954; Galton, 1895). The over-all picture of the early family life of the outstanding scientists included in these studies is one composed of influences that have encouraged intellectual activity in an atmosphere of relative independence from control by others in positions of authority, i.e., an environment in which the child is encouraged to explore the mysteries of the world for himself.

It is not surprising, then, that scientists differ from nonscientists, even nonscientists who are equally "gifted" in general intellectual ability. Scientists are more likely to be work oriented and to have chosen a type of work early in life. They are less likely to be concerned with adjusting to other people or with conforming to authority than lawyers, for example (see Table 9).

By virtue of their predominantly middle-class professional family backgrounds, scientists in the United States often share middle-class values emphasizing scholastic achievement (Rosen, 1956 and 1961), interest and accomplishment in work activity as an end in itself rather than as a means to obtain economic rewards (Morse and Weiss, 1955; Lyman, 1955; Orzack, 1959), and orderly careers which are predictive of more stable participation in community activities (Wilensky, 1961). Nevertheless, there is some evidence which suggests that scientists tend to differ from other professional personnel (e.g., lawyers) in the degree to which their motivation toward high achievement in work activity expresses itself in terms of conformity to authority and social adjustment, as is suggested by findings from the Terman study (1954).

Academic institutions, especially graduate schools, are important social agencies for instilling the values and expectations that characteristically differentiate research scientists from nonscientists. For

example, Becker and Carper (1956) have described how graduate school experiences tend to change the orientation of physiologists from the service values of the "art" of medicine to the research values of a career in the "science" of physiology. Contacts with informal groups of fellow physiology graduate students and with professors in laboratory situations, along with the mechanism of "sponsorship"--whereby benefits accrue both to professors and to graduate students by placing these students in high prestige laboratory positions after acquiring the Ph.D. degree--all operate to instill and strengthen an attachment to an ideology of "science."

Table 9

SELF-DESCRIPTIONS OF PHYSICAL SCIENTISTS
AND LAWYERS IN A GROUP OF "GIFTED" MEN

Characteristics	Percent of "Gifted" Men Applying Characteristic to Themselves among:	
	Physical Scientists (N = 51)	Lawyers (N = 95)
Average conformity to authority and conventions	48%	74%
Good social adjustment is a factor in life accomplishment	27	48
Fulfilled first serious choice of life work	91	77
Work itself is one aspect of life giving greatest satisfaction	92	75

Source: Terman, 1954

On the other hand, according to Becker and Carper (1956), mechanical engineers often choose their occupation before becoming subject to the influences of graduate school, and in graduate school tend to be less

involved in research situations with other graduate students or with professors. A labor market characterized by a high demand for engineers assures engineering students of placement in industrial positions, so there is little opportunity or need to depend upon the process of "sponsorship" by professors. Many engineers do not even attend graduate schools, and if they do, are more likely to be oriented toward completing courses in specific subjects rather than toward obtaining advanced academic degrees. In accord with these experiences, engineers are more likely than physiologists to value high salaries and advancement into managerial positions in industrial employment.

The effects of graduate school experience on work expectations may also be illustrated by comparing the job conditions considered most important by engineers with advanced degrees—those who have participated in graduate school activities—with those considered most important by engineers who have only bachelor's degrees. Although some of the percentage differences are small, the data in Table 10 indicate that engineers with only bachelor's degrees tend to place relatively more emphasis on what might be characterized as "financial" or "organizational" values (e.g., salaries, employee benefits, competent supervision, clear definition of authority and responsibility, and opportunity for advancement within the organization), whereas engineers with more advanced degrees tend to place relatively more emphasis on what might be characterized as "professional" or "scientific" values (e.g., opportunity to do creative or challenging work, opportunity to keep up with new developments in an occupational field, recognition of individual achievement, and minimal supervision).

Moreover, a study of the faculty members of a small liberal arts college (Gouldner, 1957 and 1958) has indicated that faculty members who possessed, or were working toward, the Ph.D. degree were more likely to rate low on loyalty toward their employing organization and high on commitment to specialized skills and a professional reference group. Faculty members with less graduate education tended to rate high on loyalty to the employing organization and low on commitment to specialized skills and a professional reference group, and were more likely to favor administration of college affairs in terms of rules and regulations.

The career patterns of scientists in different scientific fields vary from one field to another in ways that might affect the work expectations of scientists. For example, a study by the U.S. Department of Labor in 1948 showed that physicists were more likely than biologists, who in turn were more likely than chemists, to be employed in an academic institution immediately after having received the Ph.D. degree (see Table 11).

Table 10

**JOB CONDITIONS CONSIDERED MOST IMPORTANT BY U.S. ENGINEERS
WITH BACHELOR'S DEGREES**

Job Conditions	Percent Considering Factor among "Five or Six Most Important Factors"	
	Engineers with Bachelor's Degrees Only (N = 187)	Engineers with Advanced Degrees (N = 78)
Good salary	71%	55%
Liberal employee benefits	15	8
Supervisor who knows his job	50	38
Clear definition of authority and responsibility	34	28
Opportunity for advancement	80	73
Chance to do creative, challenging work	78	83
Chance to keep up with new developments in engineering	42	53
Recognition of individual achievement	52	63
Minimum of direct supervision	18	28

Source: Professional Engineers Conference Board for Industry, 1957,
pp. 58-59.

Table 11

**FIRST EMPLOYMENT, SECOND EMPLOYMENT, AND CHANGES FROM
FIRST TO SECOND EMPLOYMENT OF U.S. PHYSICISTS, BIOLOGISTS,
AND CHEMISTS WITH Ph.D. DEGREES
(Percent)**

<u>Context of Employment</u>	<u>Physicists (N = 125)</u>	<u>Biologists (N = 269)</u>	<u>Chemists (N = 252)</u>
First employment			
Academic institution	84.8%	74.4%	64.0%
Government agency	--a	21.9	6.2
Private industry	15.2	3.7	29.9
Second employment			
Academic institution	74.4	66.5	55.3
Government agency	8.8	26.1	10.1
Private industry	16.8	7.4	34.7
Changes from first to second employment			
Academic to academic	67.2	55.4	41.6
Academic to government	8.0	16.4	4.6
Academic to industry	9.6	2.6	17.8
Government to academic	--a	8.9	3.2
Government to government	--a	9.3	2.1
Government to industry	--a	3.7	0.9
Industry to academic	7.2	2.2	10.5
Industry to government	0.8	0.4	3.4
Industry to industry	7.2	1.1	16.0

a. The numbers of persons in these categories were too small to warrant computing percentages.

Source: U.S. Dept. of Labor, 1953, Table 22, p. 43.

The study also showed that biologists were the most likely to have been employed initially in a government agency, and chemists the most likely to have been employed initially in an industrial situation. The relative proportion of scientists in these three occupations employed in these three contexts remained about the same for second jobs. The data in Table 11 indicate that the biologists were more likely to change from academic to government positions and the chemists more likely to change from academic to industrial positions between their first and second jobs.

On the basis of these career patterns, we would expect physicists to be oriented more toward academic "scientific" values, and chemists to be oriented more toward industrial "financial and organizational" values.*

Another study (Marvick, 1954) has shown that personnel in a federal research coordinating and subsidizing agency who have more advanced educational backgrounds and more varied work experience in both public and private employment are more likely to be oriented toward "specialist" values than toward "institutional" or "hybrid" values (see Table 12).

Present Influences

Personal relationships both at work and outside work influence the expectations and behavior of research scientists. Within the work situation, the relationship between scientist and supervisor is extremely important to research scientists. Unfortunately, as has been shown in a survey of scientists in 19 research organizations, there is likely to be a considerable degree of dissatisfaction among scientists concerning their relations with supervisors. Scientists are likely to be especially dissatisfied with the technical competence of their supervision and the effectiveness of research administration (Moore and Renck, 1955).

At least some of the difficulties between research scientists and supervisors may derive from problems built into the research supervisor role. On the basis of long-term studies of research management, Norman Kaplan (1959) has described these problems in the following terms:

* The proportion of physicists to chemists in American industrial organizations has about doubled from 1948 to 1959 (NSF, 1960b, p. 28; U.S. Dept. of Labor, 1953, p. 40), due, in part, to the utilization of nuclear technology in industry. However, there are still about 5 industrial chemists to 1 industrial physicist.

Table 12

ORIENTATION OF EMPLOYEES IN A FEDERAL RESEARCH AGENCY,
BY EDUCATIONAL BACKGROUND AND WORK EXPERIENCE
(Percent)

	Orientation ^a		
	<u>Institutionalist</u>	<u>Hybrid</u>	<u>Specialist</u>
Education			
No more than a B.A. degree (N = 59)	80%	8%	12%
Postgraduate work short of an M.A. degree (N = 74)	22	40	38
M.A. or Ph.D. degree (N = 71)	7	41	52
Work experience			
Public employment only (N = 92)	58	29	13
Both private and public employment (N = 112)	13	33	54

a. "Institutionalists" are described as persons who think of themselves primarily as civil or military service career persons; "hybrids" are described as those who think of themselves as both "government service and specialty group persons"; and "specialists" are described as persons who think of themselves primarily as scientists, lawyers, engineers, or accountants.

Source: Marvick, 1954, Tables VI and VII, pp. 38-39.

(1) the research administrator is a "man in the middle" who is frequently caught between the demands of the research scientist and those of the organization; (2) his job may be economically unrewarding because his salary is held down by that of the relatively low pay scale of scientists; (3) he may not have the technical skill to make decisions on scientific matters but is often involved in such decisions; (4) his status within the organization from the point of view of most of the persons with whom he deals may be very low; (5) he can seldom be promoted to the top of his organization, but must remain an auxiliary near the top; (6) his education is often inferior to that of a large percentage of those below him in the formal hierarchy; and (7) his primary reference groups tend to be outside both science and research. Compounding these problems is the fact that most research scientists expect their supervisors to refrain from supervising them closely and to allow them a maximum degree of freedom in conducting research activities (Arensberg and McGregor, 1942; Brinker, 1957; Brown and Shepherd, 1956; U.S. President's Scientific Research Board, 1947). Many industrial managers recognize the desirability of minimal direction in scientific research activities (Arnold, Blake, and Jones, 1960; Deutsch and Shea, 1959).

However, it is not necessarily true that the "best" supervision of research scientists is automatically the "least" supervision. In a study of about 250 scientists in 20 laboratories of the National Institutes of Health (1957), Howard Baumgartel found that scientists tend to be more satisfied with the quality of their supervision in laboratories operating under "participatory" supervision than in those under "laissez-faire" supervision, and also tend to be more satisfied in laboratories under "laissez-faire" supervision than in those under "directive" supervision, as is shown in Table 13. It was reported that under "participatory" supervision: (1) directors' decisions have a moderate influence; (2) some subordinates feel they are on their own; (3) there is more joint discussion and decision; (4) there is more frequent contact with the director; (5) subordinates feel they influence the director; and (6) the director rarely decides things by himself. In contrast, "directive" laboratories are administered unilaterally by the director, and "laissez-faire" laboratories have the least supervisory control.

It is significant that "participatory" rather than "laissez-faire" supervision appears to be most in accord with the expectations of research scientists. It was found that "participatory" supervision is much more likely to permit scientists to utilize their abilities and is somewhat more likely than "laissez-faire" supervision to provide "freedom for originality" and "opportunity for contributing to basic science." Laboratories with "directive" supervision tend to rank much lower on all three factors (see Table 13).

Table 13

MEAN RANKING OF TWENTY LABORATORIES UNDER "DIRECTIVE,"
 "LAISSEZ-FAIRE," AND "PARTICIPATORY" SUPERVISION IN A FEDERAL RESEARCH AGENCY,
 BY SATISFACTION WITH SUPERVISION AND BY JOB CONDITIONS

Satisfaction and Job Conditions	Mean Rank ^a of Laboratories under Different Forms of Supervision	
	<u>Directive</u>	<u>Participatory</u>
Satisfaction with quality of supervision	15.9	5.6
Use of present abilities	15.3	6.6
Freedom for originality	17.7	8.6
Opportunity to contribute to basic science	17.0	7.7

a. Rankings of laboratories from 1 to 20 were based on questionnaire responses of scientists within the laboratories. Higher rankings are indicated by lower mean ranking scores.

Source: Baumgartel, 1957, Table 1, p. 354; Table 2, p. 357.

Another important influence on the values and activities of scientists within research organizations is their relationships with colleagues at work. Simon Marcson (1960b) has pointed out that scientists who have high status in a laboratory because of their scientific accomplishments exert a considerable influence on other scientists in the form of "colleague authority," which, in a sense, supplements "executive authority" in a research organization.

There is some discussion in the literature on past studies regarding the relative merit, in terms of scientific productivity, of interdisciplinary and discipline-oriented research teams. Hertz and Rubenstein (1953) claim that interdisciplinary teams are the most advantageous and are often the only feasible way to organize industrial research activities. Herbert Shepard has concluded from his studies (1956b, 1956c) that groups which are permanently discipline oriented favor communication and solidarity among members of a discipline, which sometimes encourages narrow interests, discourages creativity, and makes it difficult to cross traditional boundaries of disciplinary interests. Shepard claims that interdisciplinary groups are likely to be more efficient and enthusiastic, but may also be more difficult to control; also the paths of promotion within such groups are less clear.*

Studies by Donald Pelz (1956, 1957, 1958, 1959, 1960) throw more light upon the effects of scientists' relations with colleagues. Studies of medical research scientists at the National Institutes of Health (Pelz, 1956) indicate that senior scientists having several colleagues of differing disciplines, prior employment experience, and general value orientation tend to perform somewhat better, and that this tendency is more marked with frequent contact. At the same time, Pelz found that higher scientific performance is associated with daily contact with one major colleague with similar values--"someone who 'talks the same language' with whom the scientist can air his problems and get a sympathetic hearing." Pelz concluded that an environment conducive to high performance includes at least one supportive colleague and frequent contacts with other scientists who provide dissimilar viewpoints. Thus, the findings from these studies suggest that the previous experience and general orientation of organizational colleagues performing important counterroles for research scientists may significantly influence the productivity of such scientists.

* For a further discussion of interdisciplinary and discipline-oriented research groups, see Section V of this report.

Individual research scientists may adjust quite differently to interdisciplinary research situations. Warren Bennis (1956) has found from a study of an academic research organization that social scientists developed five different role patterns in adapting to interdisciplinary influences. These may be described as follows: (1) the articulator, who accepts the goal of interdisciplinary teamwork and is able to maintain liaison between two or more disciplines; (2) the innovator, who accepts the interdisciplinary goal but attempts to develop new means of interdisciplinary communication; (3) the ritualist, who goes along with interdisciplinary activities but doesn't really believe in them; (4) the isolate, who accepts neither the goals nor the day-to-day interdisciplinary activities; and (5) the rebel, who attempts to develop new goals and procedures. These findings suggest the need for further research which will determine the conditions under which individual scientists select one mode of adaptation to relationships with colleagues rather than another mode.

Apart from their immediate work relationships, the professional society or association greatly influences the values of scientists who are professionally oriented. For example, one study (Barnes, 1960) has shown that engineers who are professionally oriented tend to place more emphasis on "theoretical" or "aesthetic" values than do engineers who are organizationally oriented; the latter tend to place more emphasis on "economic" values (see Table 14). Another study (Marvick, 1954) indicates that professional or specialist-oriented personnel in a federal research agency tend to be more concerned about opportunities to learn, originality, and respect for workers in their jobs; whereas organizationally or institutionally oriented personnel tend to be more concerned with influence, salary, organizational prestige, and security (see Table 15). Both of these studies included a third category of personnel, classified as "hybrids" or "socials," whose value patterns tended to fall between those of professionally and organizationally oriented persons. The Marvick study (1954, p. 95) reported that a larger number of "specialists" were of the opinion that their agency should conduct basic research primarily; a larger number of "institutionalists" thought their agency should be more concerned with research administration.

These differences in work expectations apparently result from differences among "reference groups," which serve as normative sources of values and attitudes (Merton and Kitt, 1950; Kelley, 1952; Hyman, 1960). The pertinent reference groups for the two types of value orientations discussed previously are: (1) the employing organization, or (2) the profession or specialized occupational group. Persons for whom the

Table 14

VALUES ON THE ALLPORT-VERNON SCALE SCORED AS FIRST OR SECOND MOST
IMPORTANT BY ENGINEERS IN AN INDUSTRIAL SERVICE DEPARTMENT,
BY PRIMARY REFERENCE GROUP ORIENTATION
(Number of Cases)

<u>Allport-Vernon Value Category</u>	<u>Primary Reference Group Orientation*</u>	
	<u>Profes- sional (N = 10)</u>	<u>Organi- zational (N = 9)</u>
Theoretical	8	6
Economic	1	5
Aesthetic	2	0
Social	2	2
Political	3	2
Religious	4	3

* The individuals were classified into these categories on the basis of their responses to an interview question prior to completing the Allport-Vernon Value Test.

Source: Barnes, 1960, Exhibit III-D, p. 51.

scientific professional category or association is the primary reference group are apparently more likely to stress what are loosely categorized as "scientific" values and rewards, that is, to emphasize more creative and theoretically oriented activities and the reputation which derives from successful accomplishment in these activities. Persons for whom the employing organization is the primary reference group are apparently more likely to stress "organizational and financial" values and rewards, to emphasize organizational prestige and influence, job security within the organization, and outstanding performance records.

Scientific professional associations or societies tend to confer special status within the association upon members who distinguish themselves in terms of professional goals. A study of professors in social

Table 15

**JOB CONDITIONS CONSIDERED VERY IMPORTANT BY PERSONNEL
IN A FEDERAL RESEARCH AGENCY, BY PRIMARY
REFERENCE GROUP ORIENTATION
(Percent)**

<u>Job Condition</u>	<u>Primary Reference Group Orientation *</u>	
	<u>Specialist (N = 72)</u>	<u>Institu- tionalist (N = 68)</u>
Opportunity to learn	97%	80%
Originality	92	78
Respect for workers	85	76
Influence	46	66
Salary	41	70
Organizational prestige	37	54
Security	30	66

* The "specialist" orientation is roughly equivalent to the "professional" orientation shown in Table 14, and the "institutionalist" orientation is roughly equivalent to the "organizational" orientation shown in Table 14. The individuals were classified into these categories on the basis of their responses to a question on their primary career orientation.

Source: Marvick, 1954, Tables XV and XVI, pp. 53-54.

science fields (Lazarsfeld and Thielens, 1958, p. 9) has indicated that professors with higher research productivity (in terms of publications) are more likely to hold offices in their professional associations.

The values and expectations of individuals identifying with the employing organization are apparently sustained by interaction with other individuals in appropriate counterroles. At least three studies have indicated that organizationally oriented persons are more likely to associate with other members of the employing organization than are

professionally oriented persons. The Marvick study (1954, Table 30, p. 102) reported that "institutionalists" are more likely to work with others on day-to-day matters in their federal agency than are "specialists." The Barnes study (1960, Exhibit III-L, p. 64) showed that organizationally oriented engineers are more likely to participate with fellow employees in informal lunch groups or special groups outside work and to have a mutual friendship with at least one other employee than are professionally oriented engineers. The Gouldner study (1957, Table 11, p. 302) showed that faculty members who are organizationally oriented are more likely to have a higher rate of sociability with other faculty members than are those who are professionally oriented.

Thus, it appears that the work expectations of organizationally oriented persons tend to be sustained more by persons performing significant counterroles within their organizations, whereas the values of professionally oriented persons tend to be sustained more by counterroles elsewhere--most likely within their professional societies or associations. A professional orientation is probably maintained not so much by face-to-face contact as by recognition through publications and reviews of publications. Nevertheless, professionally oriented persons seek opportunities for face-to-face contact with fellow professionals whenever possible and principally by attending meetings of professional associations. We might hypothesize that professionally oriented scientists employed by organizations wherein they have little day-to-day contact with professionally oriented colleagues in their field (e.g., industrial organizations where developmental or applied research activities are emphasized) would be especially desirous of participating in professional meetings.

The distinction in work expectations which apparently exists between professionally and organizationally oriented persons in scientific fields may not be as true of engineering fields, however. Several studies have indicated that engineering societies and associations tend to be dominated by engineers who are in managerial positions in industrial organizations, rather than by nonmanagerial personnel in research or technical positions (Mills, 1946; Professional Engineers Conference Board for Industry, 1957, p. 45). Thus persons in significant counterroles may be prominent in both the employing organization and in the professional association with which the research engineer is affiliated. We would therefore expect professional and organizational values of engineers to be more congruent than is the case for scientists. Professional engineering associations might be expected to exert less of an influence toward independence on the part of engineers than would a professional scientific association on scientists. It has also been hypothesized (Brown, 1954) that professional groups with higher prestige are more able to influence the values

of members in bureaucratic organizational contexts than are professional groups with lower prestige.*

Affiliations other than professional associations outside the employing organization are at least a potential influence on role expectations. Trade unions are organizations of this type (Walton, 1961). However, most scientists, insofar as they have a professional orientation, tend to resist unionization because of: (1) their general resistance to being treated as members of a common category (e.g., a bargaining unit) and to being directed by formal rules and regulations (e.g., provisions of collective contracts); (2) their general emphasis on such rewards as colleague recognition of technical achievement rather than financial emoluments and seniority status; and (3) their general identification with the upper middle rather than proletarian class (Goldstein, 1955).

Engineers are not as likely as scientists to resist unionization, however. A survey of 1,400 engineers employed in industrial companies (Professional Engineers Conference Board for Industry, 1954) reported that 34 percent of the respondents believed that "engineers' interests are strengthened economically or otherwise by membership in a collective bargaining organization." Another survey of 17,000 civil engineers (Civil Engineering, 1953, p. 75) showed that 37 percent of those surveyed were "not opposed to collective bargaining." Only a small proportion of engineers are now unionized, however. Most of these are found in the aircraft, electrical, oil, and public utility industries, in which firms hire engineers by the hundreds and thousands and a personal relationship does not exist between an individual engineer and management (National Industrial Conference Board, 1956; National Society of Professional Engineers, 1955). In such cases, management officials do not perform the counterroles which sustain the organizational values of engineers. This is probably why unionized engineers seem to be more professionally oriented than nonunion engineers. This orientation is illustrated by the fact that the collective bargaining demands of engineering unions tend to reflect professional values, such as (1) employer payment of professional society dues, (2) paid time off to attend meetings of professional engineering societies, (3) tuition refunds, (4) educational and professional leaves of absence, and (5) professional standards (Bambrick and Zagat, 1955).

* Further discussion of relations between professional associations and industrial organizations is contained in Kornhauser, 1962.

The favorable attitude of a sizable minority of engineers toward union organization may reflect their recognition of the fact that professional engineering societies are often management dominated and therefore not always completely responsive to the interests of engineers who, by individual choice or force of circumstance, are professionally rather than organizationally oriented.*

Family relationships are another potential influence on the work expectations of scientists in research contexts. The Marvick study (1954) has indicated that federal research agency personnel with the most dependents were more likely to be "hybrid" in their work orientation--that is, more likely to see themselves as equally dependent on their occupation and their place of employment for career satisfaction (see Table 16). These same "hybrids" were also more likely to feel deprived if their present work situation did not offer them adequate opportunities for professional or organizational advancement and adequate salary compensation. These findings suggest that greater family obligations may cause individuals, who otherwise might identify themselves more closely with either professional or organizational career patterns, to seek job satisfaction in terms of pay or promotion.

Another factor which might influence the work orientation of research scientists is the degree to which their marital relationships reflect an older patriarchal institutionalized pattern or a newer equalitarian companionship pattern (Burgess and Locke, 1945). It might be hypothesized that in the newer equalitarian patterns of marital relationships characteristic of upper middle class persons in American society (which includes most research scientists), family welfare considerations (e.g., husband's salary, employment opportunities for the wife in a particular geographic area, or recreational and cultural facilities available) might be more important to research scientists in making employment decisions than might be true in more patriarchal family patterns.

* Here, of course, we must distinguish between a "professional orientation" as used in this discussion and a "professional attitude" as described by many writers who maintain that a "professional" attitude is incompatible with unionization. What these writers refer to as a "professional" attitude might be better described in terms of this discussion as an "organizational" or "managerial" orientation.

Table 16

**FAMILY DEPENDENT RESPONSIBILITIES AND
PERCEIVED JOB DEPRIVATIONS AMONG PERSONNEL IN A
FEDERAL RESEARCH AGENCY, BY PRIMARY REFERENCE GROUP ORIENTATION
(Percent)**

	<u>Primary Reference Group Orientation</u>		
	<u>Specialist</u> <u>(N = 68)</u>	<u>Hybrid</u> <u>(N = 64)</u>	<u>Institutionalist</u> <u>(N = 72)</u>
Number of dependents			
None or only one dependent	43	27	30
Two or three dependents	31	26	44
At least four dependents	25	47	26
Perceived job deprivations			
Professional advancement	32	44	26
Organizational advancement	46	53	39
Salary	17	32	18

Source: Marvick, 1954, Table III, p. 34; Figure 7, p. 90.

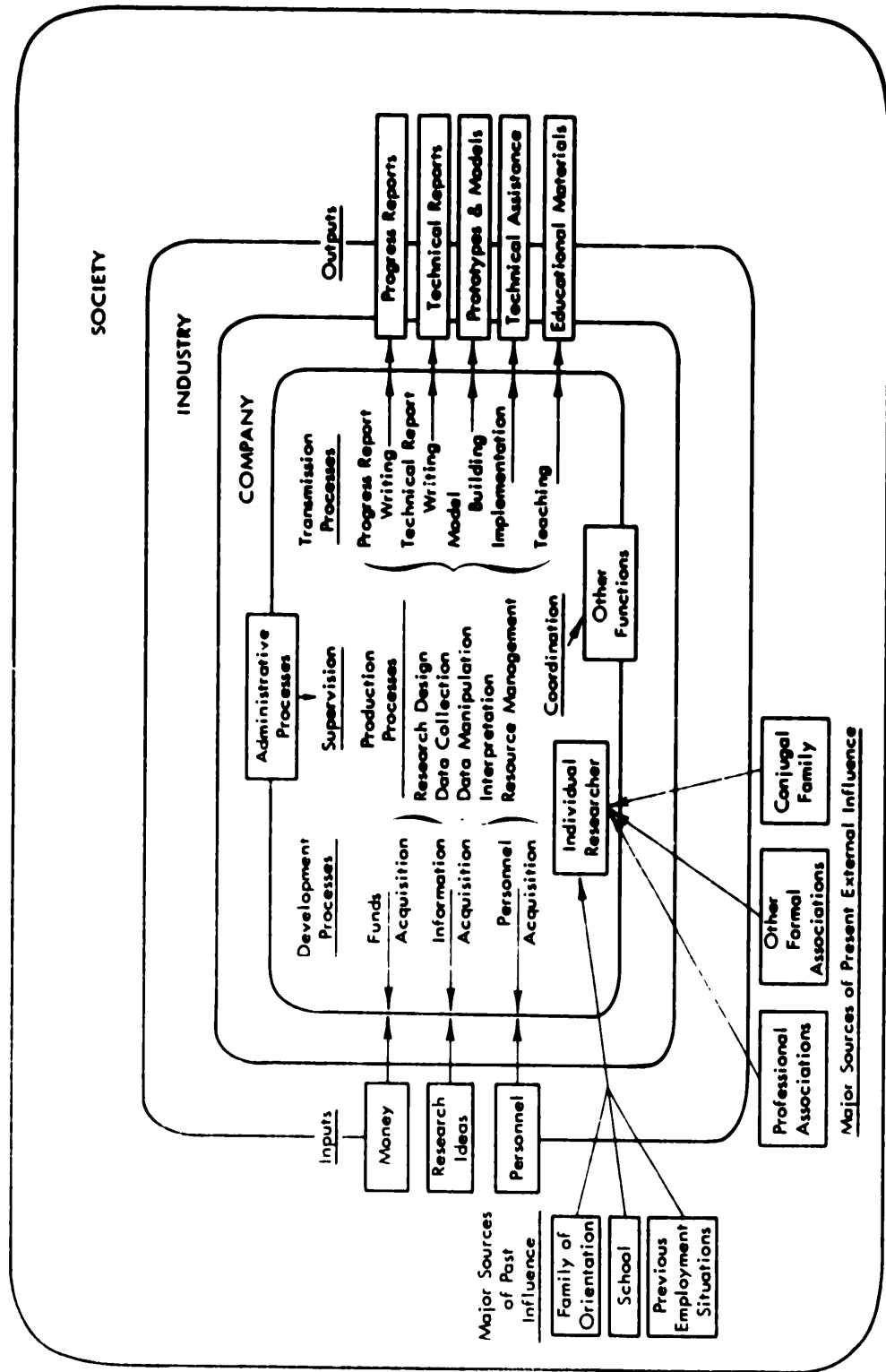
Although systematic analysis of most of the foregoing factors is lacking in previous studies, there is at least some evidence to suggest that certain background factors and present relationships both inside and outside the work situation may influence the role expectations of scientists.

Summary of the Research Role

Figure 5 draws upon findings from past studies and presents a schematic representation of the various sources of managerial and employee expectations which interact to define research roles within research functions.

As suggested in Figure 5, managerial expectations or requirements may be influenced by the following:

FIGURE 5
SCHEMATIC REPRESENTATION OF JOB REQUIREMENTS AND DETERMINANTS
FOR A RESEARCHER IN A RESEARCH FUNCTION



1. **Societal contexts.** These contexts may vary politically and economically in structure, and consequently in the mechanisms used to integrate research activities with societal objectives.
2. **Industrial contexts.** Technology varies from one industry to another and consequently there are differences in the emphasis placed on research and development as compared with other functions (e.g., production and sales activities).
3. **Organizational contexts.** These may vary in objectives and in complexity (e.g., size and associated degree of bureaucratization), and consequently in the emphasis placed on research and development as compared with other functions and in the emphasis on research as compared with development.
4. **Research function contexts.** The objectives prescribed for research functions (e.g., basic research, applied research, development) by larger systems contexts vary, as does the relative emphasis placed on specific requirements for research development, research production, research products transmission, and research administration. Thus a basic research function may place relatively more emphasis on acquiring relevant scientific information prior to actually conducting research, whereas an applied research function may place relatively more emphasis on implementation activities following the research.

The work expectations of individual scientists employed in research functions may be influenced by the following:

1. **Family orientation.** A family may either support or repress independent intellectual activity in a child and consequently influence the occupational aspirations of the individual and his attitudes toward authority and intellectual inquiry.
2. **Educational experience.** The relationships between faculty and students and among students themselves, especially in graduate schools, may determine whether an individual develops a professional or institutional orientation toward his role as a research scientist.
3. **Previous employment experience.** These may strengthen prior work expectations to a greater or lesser degree or instill new expectations in the research scientist.

4. Present employment experience. The characteristic relationships between scientists and supervisors and among scientists themselves may cause differences in the work expectations of scientists.
5. Professional associations. The objectives of such associations and their membership base may vary (e.g., research oriented or managerial oriented) and consequently strengthen or weaken certain work expectations of research scientists.
6. Other organizational affiliations. These vary in the degree to which they strengthen certain work orientations, such as toward common employee status in the case of most trade unions, or toward special status in the case of most professional associations.

The specific nature of various components of the research role and, in turn, the allocation of these to individual scientists depend on the expectations of management and of individual research scientists in a particular situation. However, we can generally describe these role elements in terms presented schematically in Figure 5 and listed as follows:

1. Development processes
 - a. Funds acquisition
 - b. Information acquisition
 - c. Personnel acquisition (recruitment, selection, training, motivation)
2. Production processes
 - a. Research design
 - b. Data collection
 - c. Data manipulation (analysis)
 - d. Interpretation
 - e. Resource management (of funds, facilities personnel, and time)

3. Transmission processes

- a. Progress report writing
- b. Technical report writing
- c. Model building
- d. Implementation
- e. Teaching

4. Administrative processes

- a. Supervision
- b. Coordination (between activities at the same organizational level)

Although previous research has indicated several possible variations in managerial and employee expectations regarding research roles, there is a special need for further research on (1) the interactions of various managerial expectations with each other, (2) the interactions of various expectations of research scientists with each other, and (3) the interactions of management expectations with the expectations of scientists—especially in situations where contradictions or discrepancies exist.

A situation which illustrates a contradiction in managerial expectations is that in which management recruits scientists with considerable advanced academic training (e.g., Ph.D.'s) and professional prestige to engage in essentially applied research and/or development activities. Many managers in research organizations try to hire what they believe to be "better qualified" research scientists, who presumably can do better research and who will also enhance the prestige of a research organization. Yet these very individuals might be relatively unqualified to engage in the kind of research activities required in an applied research laboratory.

On the other hand, a research scientist who seeks to publish technical reports which will gain him a reputation with his professional colleagues and at the same time seeks employment which will offer a high income in an area in which it is especially desirable to live may also find these expectations to be incompatible. In many cases, industrial organizations locate laboratories in suburban "industrial parks" and provide attractive salary inducements. This sometimes puts the scientist

in the position of choosing between employment that is especially favorable in terms of family welfare and employment that offers the opportunity to do the kind of research the scientist would prefer.

Management characteristically requires that research activities be channeled toward organizational goals. Research scientists, on the other hand, tend to be motivated toward research on topics of their own choosing and of general scientific interest rather than toward research on specific organizational problems. The discrepancy between the general expectations of managers and those of scientists is a constant theme throughout all previous studies of problems of research management (especially in Marcson, 1960b, and Kornhauser, 1962). What seems to be needed is further understanding of mechanisms and modes by which the expectations of management and the research scientist might be better adapted to one another.

IV ROLE EXPECTATIONS OF SCIENTISTS AND OTHER EMPLOYEES: SURVEY FINDINGS

The foregoing section of this report describes what appear to be basic components of the research role in a research function, and points out some major sources of variations in managerial and employee expectations regarding the research role. This section presents further specification which compares the role expectations of scientists with those of employees in other occupational categories. Scientists hold many values in common with other employees but, in many other respects, the employment of scientists introduces new pressures, tensions, and problems into modern organizations. In certain areas of the work situation, scientists express dissatisfactions which are peculiar to scientific personnel and which are not commonly experienced by other employees in modern industrial and governmental organizations. The identification of such areas might point out special incentives or general incentives which might be used to align scientists' needs with managerial requirements, or vice versa.

The analysis presented in this section is based on a survey of (1) the items specified by scientific personnel and other employees as important or unimportant to them in their work, (2) the perceived degree to which these employees obtain these important and unimportant things in their present jobs, and (3) the degree of discrepancy between their expectations and their current working conditions as derived from a comparison of items (1) and (2) above. This approach follows the method used by John W. Riegel (1958, Part II) in a comparative study of work satisfaction and dissatisfaction among research personnel, engineers engaged in development and application, and engineers engaged in operating functions in ten industrial companies. In fact, many of the topics included in the present survey were suggested by the Riegel study--thus this analysis is a partial replication of the Riegel study.*

As part of another project, 3,026 employees in seven organizations located in the western United States were given a self-administered

* A similar approach was also taken by Robert S. Weiss (1956) in a study of research administrators in a federal government agency.

questionnaire which included questions on a wide range of work experiences and attitudes.* Representative samples of employees from each organization were assembled in groups during regular working hours to complete the questionnaire. The organizations included one federal government installation concerned with the maintenance and storage of military equipment, three manufacturing companies with union contracts covering hourly employees, three manufacturing companies which had no union contracts, and a large nonunionized insurance firm. For the purposes of the analysis reported herein, the employees surveyed were categorized under the following occupational classifications:

1. Research scientists (21 persons) identified as professional, college-graduate, nonsupervisory male employees of a research department at the corporate headquarters level of a manufacturing firm.
2. Managerial personnel (246 persons) employed in office supervisory capacities in seven organizations.
3. Professional personnel (201 persons) who were college graduates employed in staff specialist capacities in the seven organizations.
4. Technical personnel (309 persons) also employed in staff specialist capacities, but who were not college graduates.
5. Clerical personnel (752 persons) employed in clerical functions.
6. Foremen (166 persons) employed in shop supervisory positions.
7. Skilled manual workers (527 persons) employed in manual work normally requiring at least four years of apprentice training.
8. Unskilled manual workers (608 persons) employed in manual work normally requiring less than four years of training.

Because this survey included only a small number of research scientists in only one research establishment, the findings reported herein for the research scientists must be considered to be tentative, except

* A survey made under the general direction of Professor Philip Selznick and sponsored primarily by the Fund for the Republic. The questionnaire used is included as Appendix A.

insofar as they are substantiated by other studies, and subject to confirmation by further research on other groups of scientific personnel.

The employees surveyed were asked to indicate how important certain things were to them in their work and whether or not they had obtained these things in their present work situation. The specific items used for this analysis are included as pages 12 through 14 of Appendix A. These items might be categorized as follows:

1. Relations with the company
2. Relations with immediate supervisor
3. Relations with other employees
4. Nature of the work
5. Extrinsic work benefits

Relations with the Company

Respondents were asked how important it was to them to be "employed by a company with a good reputation in the community," and were later asked whether or not they thought their company had a "good reputation in the community." In Table 17, the percentage of employees in each occupational category who indicated that being employed by a company with a good reputation was "extremely important" or "quite important" is shown in the "Importance" column. The percentage of employees who were of the opinion that their company did have a good reputation is shown in the "Experience" column. The positive (+) discrepancies between the "Importance" and "Experience" columns of Table 17, shown in the "Difference" column, indicate that a higher proportion of employees in all categories believed their company had a good reputation than believed that company reputation was of any great importance to them.

Although the company's reputation met the expectations of employees in all occupational categories, the data show that company reputation is claimed to be of importance by fewer research scientists and fewer professional personnel than by other employees.

Research scientists may be more oriented toward a career in their line of work and have more job mobility between companies than employees in other categories. This possibility is supported by the answers to the following question included in the survey questionnaire:

"Which of the following is most important to you? (1) Keeping a job at this company even if I had to take a temporary cut in pay; (2) Keeping any good job I could get at my present rate of pay."

Table 17

**IMPORTANCE AND EXPERIENCE OF BEING EMPLOYED BY A COMPANY WITH
A GOOD REPUTATION IN THE COMMUNITY, BY OCCUPATIONAL CATEGORY
(Percent)**

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	62%	86%	+24%
Professional personnel	70	92	+22
Technical personnel	76	94	+18
Unskilled manual workers	79	92	+13
Clerical personnel	80	93	+13
Skilled manual workers	85	93	+8
Managerial personnel	85	96	+11
Foremen	87	91	+4

The percentage of employees in the different occupational categories who indicated that they were "company oriented," or "security oriented" in response to this question are shown in Table 18. The lack of company

Table 18

**COMPANY, OCCUPATION, OR JOB SECURITY ORIENTATION, BY
OCCUPATIONAL CATEGORY^a
(Percent)**

<u>Occupational Category</u>	<u>Company Oriented</u>	<u>Occupation Oriented</u>	<u>Security Oriented</u>
Research scientists	5%	71%	19%
Professional personnel	19	49	32
Technical personnel	28	34	37
Foremen	36	24	37
Managerial personnel	43	23	33
Skilled manual workers	24	22	47
Clerical personnel	26	17	55
Unskilled manual workers	29	16	51

a. Percentages shown in this table do not total 100% because of occasional nonresponses.

orientation among scientists shown in Table 18 may be the result of excess of demand over supply of scientific personnel in the post-World War II American labor market. One study of the occupational mobility of scientists has concluded the following:

. . . despite the employment stability of Ph.D. scientists, they must be characterized as a relatively mobile group in certain respects. By the time they reach middle age, a large proportion have had experience in at least three of the functions normally performed by scientists. Most of them--whether educators, government employees, or employees in private industry--have worked for at least one other type of employer. The majority have held positions in two or more states. (U.S. Dept. of Labor, 1953, p. 5)

These conditions apparently create a situation in which scientists, typically, are not "organization men." This finding is corroborated by Marvick's study (1954) showing that over half of scientific administrators with advanced academic degrees were oriented toward their occupational specialty rather than the government agency for which they were employed. In addition, a study by Shepherd (1961) found that scientists tend to be oriented toward their profession, while engineers are more likely to be oriented toward the organization. Another study has shown that scientists and engineers in six companies surveyed "show more enthusiasm for the job than the company" (Opinion Research Corporation, 1959, p. 2) and tend to seek recognition for personal achievements rather than for company reputation (*ibid.*, p. 26).

In his best-selling book The Organization Man, William H. Whyte, Jr. (1956, p. 1), described organization men as neither workers nor

. . . white collar people in the usual, clerk sense of the word. These people only work for The Organization. The ones I am talking about belong to it as well. They are the ones of our middle class who have left home, spiritually as well as physically, to take the vows of organization life, and it is they who are the mind and soul of our great self-perpetuating institutions.

Whyte's comments might be expected to apply most appropriately to supervisory personnel (managers and foremen). However, less than half the supervisory personnel in this sample indicated a clear company orientation (see Table 18). The greatest unanimity in orientation was shown among research scientists, most of whom were occupation oriented. It may be, therefore, that Whyte's concern with the extent of organizational

involvement in modern business and industry has been somewhat overdrawn, perhaps for the understandable purpose of focusing attention upon a considerable problem among what may be a minority of employees in large corporations.

Relations with the Immediate Supervisor

Several questions included in this survey dealt with employees' expectations and experiences relative to their immediate supervisors. These questions referred specifically to employee perceptions of job knowledge among supervisors and treatment of employees by supervisors.

A previous study (Vollmer and Kinney, 1957a, p. 436) found that "knowledge of own job" was the most frequently expressed attribute of an "ideal" supervisor among Army Ordnance employees. In the present study, employees were also asked how important it was to them to have a supervisor "who knows his own job well." Table 19 shows the proportion of employees in each occupational category who indicated that this characteristic in supervisors was "extremely important" or "quite important" and the proportion of employees who believed their supervisors possessed this characteristic.

Table 19

IMPORTANCE AND EXPERIENCE OF HAVING A SUPERVISOR WHO KNOWS HIS
OWN JOB WELL, BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	95%	90%	-5%
Skilled manual workers	95	77	-18
Technical personnel	97	84	-13
Foremen	97	75	-22
Unskilled manual workers	98	76	-22
Clerical personnel	98	81	-17
Professional personnel	98	85	-13
Managerial personnel	98	84	-14

The data in Table 19 show that knowledge of supervisory responsibilities among supervisors is commonly important to almost all employees in all occupational categories. The higher negative discrepancies shown in the "Difference" column of Table 19 indicate that foremen, manual workers, and clerical personnel were least likely to believe their supervisors had sufficient job knowledge, whereas research scientists appeared to be most satisfied with their supervisors' knowledge of supervisory responsibilities. This finding is in accord with answers to other questions included in the survey questionnaire which indicate that the research scientists in the organization studied were very well satisfied with their supervision in most respects.

Another question was asked regarding the importance of having a supervisor who knows his subordinates' jobs well. Data on responses to this question are shown in Table 20.

Table 20 shows that research scientists, especially, and professional personnel, to a lesser extent, are less likely to emphasize the need for extensive knowledge of subordinates' jobs, and are also less likely to report that their supervisors have this knowledge. This finding supports findings from many previous studies that stress the desire among research

Table 20

IMPORTANCE AND EXPERIENCE OF HAVING A SUPERVISOR WHO
KNOWS HIS SUBORDINATES' JOBS WELL
BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	66%	67%	+1%
Professional personnel	74	72	-2
Managerial personnel	79	65	-14
Foremen	80	64	-16
Technical personnel	84	72	-12
Skilled manual workers	85	68	-17
Clerical personnel	87	68	-19
Unskilled manual workers	89	72	-17

personnel for freedom from close supervision. As the Baumgartel study (1957) indicated, research scientists tend to prefer "participatory" supervision, which includes joint decision-making between supervisors and research personnel. Relevant to this matter, the present study included a question on the importance and experience of "helping to decide how the work should be done." Responses on this item are shown in Table 21.

Table 21

IMPORTANCE AND EXPERIENCE OF HELPING TO DECIDE
HOW THE WORK SHOULD BE DONE
BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Unskilled manual workers	69%	51%	-18%
Clerical personnel	70	52	-18
Skilled manual workers	76	65	-11
Technical personnel	85	77	- 8
Research scientists	86	95	+ 9
Professional personnel	89	80	+ 9
Foremen	90	93	+ 3
Managerial personnel	97	96	- 1

Table 21 shows that research scientists, along with professional and technical personnel, are more likely than manual workers and clerical personnel and almost as likely as foremen and managerial personnel to desire to participate in supervisory decision-making. Moreover, Table 21 suggests that, at least as regards respondents in this study, the expectation of research scientists that they participate in work-related decisions are most likely to be met, whereas those of manual workers and clerical personnel are least likely to be met.

A possible corollary of participating in work-related decisions might be the degree to which an employee expects and experiences being treated "as a professional" by his supervisor. A question on this matter was included in the study (see Table 22). Everett C. Hughes (1960) has pointed out that persons in practically all occupations aspire to

Table 22

IMPORTANCE AND EXPERIENCE OF BEING TREATED AS
A PROFESSIONAL BY SUPERVISORY PERSONNEL
BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Clerical personnel	63%	47%	-16%
Unskilled manual workers	64	44	-20
Foremen	76	70	-6
Skilled manual workers	78	60	-18
Technical personnel	79	66	-13
Managerial personnel	84	81	-3
Professional personnel	86	74	-12
Research scientists	86	95	+9

"professional" status. Some studies (Foote, 1953; Vollmer and Mills, 1962) have shown that skilled crafts tend to become more professionalized under the impact of new technologies. However, data in Table 22 show that among the employees in this study research scientists and professional and managerial personnel are most likely to indicate professional aspirations and research scientists are the most likely to have their aspirations met in terms of being treated "as a professional."

Since research scientists tend to be relatively more concerned with participating in work-related decisions and in being accorded "professional" status, one might expect them to be relatively less concerned with obtaining precise instructions on what to do from their supervisors. This assumption was examined by reviewing employee responses to a question regarding the importance and experience of "having a supervisor who gives clear-cut instructions." Table 23 shows that responses on this item formed the anticipated pattern--research scientists were least likely to stress the importance of obtaining "clear-cut instructions" from supervisors. The proportion of employees in all other occupational categories who stressed the importance of this factor was larger than the proportion of employees reporting that their supervisors actually did give them precise instructions. Thus, communication with supervisors appeared not to be a problem among most research scientists, at least in this study.

Table 23

**IMPORTANCE AND EXPERIENCE OF HAVING A SUPERVISOR
WHO GIVES CLEAR-CUT INSTRUCTIONS
BY OCCUPATIONAL CATEGORY
(Percent)**

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	71%	86%	+15%
Professional personnel	81	64	-17
Managerial personnel	87	74	-13
Foremen	87	70	-17
Technical personnel	87	70	-17
Skilled manual workers	88	71	-17
Unskilled manual workers	89	71	-18
Clerical personnel	93	73	-20

A measure of the degree to which supervisors are expected, and actually do, treat employees impartially according to work rules and standards was provided by questions on the importance and experience of "having a supervisor who treats employees fairly." Almost all employees in all occupational categories stressed the importance of fair treatment from their supervisors. Research scientists in this study were most likely to say their expectations in this regard had been met, whereas manual workers and clerical personnel were somewhat less likely to feel their supervisors treated them fairly (see Table 24). Moreover, the research scientists were slightly less likely to stress the importance of fair treatment, possibly because some may interpret "treating employees fairly" to mean uniform treatment without regard for individual circumstances. "Being treated as a professional" actually may imply leniency and flexibility in the application of rules and regulations among professional personnel and scientists.

A final measure of the importance research scientists and other kinds of employees attach to respect from their immediate supervisors was provided by questions on the importance and experience of "being well thought of by my supervisor because of my work." Table 25 shows that most research scientists tend to be as desirous as other employees of respect from supervisors. This finding corresponds to Riegel's (1958, Part II, Chapter III) finding that research personnel tend to stress the importance of "favorable regard of management." In accord with previous

Table 24

**IMPORTANCE AND EXPERIENCE OF HAVING A SUPERVISOR
WHO TREATS EMPLOYEES FAIRLY
BY OCCUPATIONAL CATEGORY
(Percent)**

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	86%	95%	+9%
Professional personnel	94	87	-7
Technical personnel	95	85	-10
Managerial personnel	95	86	-9
Skilled manual workers	95	77	-18
Unskilled manual workers	95	76	-19
Foremen	97	84	-13
Clerical personnel	98	81	-17

findings, Table 25 shows that the research scientists included in this study were more likely to feel assured of the respect of their supervisors than were employees in other categories. However, a sizable proportion of employees in every category indicated they were not sure of their supervisors' attitudes toward their work.

Table 25

**IMPORTANCE AND EXPERIENCE OF BEING WELL THOUGHT OF
BY IMMEDIATE SUPERVISOR BECAUSE OF WORK ACCOMPLISHMENT
BY OCCUPATIONAL CATEGORY
(Percent)**

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	90%	81%	-9%
Skilled manual workers	90	74	-16
Foremen	90	76	-14
Unskilled manual workers	91	64	-27
Technical personnel	92	75	-17
Professional personnel	92	78	-14
Clerical personnel	95	68	-27
Managerial personnel	96	76	-20

Relations with Other Employees

Ever since the publication of the Hawthorn studies (Roethlisberger and Dickson, 1949) management theory has tended to place considerable emphasis on the importance of interpersonal relations among groups of employees. Relatively little attention, however, has been given to possible occupational variations in the importance of interpersonal relations among employees. Therefore, this study has included consideration of possible occupational differences in the importance and experience of "being well thought of by other employees," "working with employees who are pleasant and friendly," and "having close friendships with fellow employees."

The importance and experience of "being well thought of by other employees because of my work" is shown in Table 26. It may be seen that

Table 26

IMPORTANCE AND EXPERIENCE OF BEING WELL THOUGHT OF BY
OTHER EMPLOYEES BECAUSE OF WORK ACCOMPLISHMENT
BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Clerical personnel	77%	62%	-15%
Skilled manual workers	78	71	-7
Technical personnel	79	75	-4
Unskilled manual workers	80	62	-18
Professional personnel	80	80	0
Foremen	82	84	+2
Research scientists	86	90	+4
Managerial personnel	87	87	0

research scientists tend to share with most other employees a desire for the respect of their colleagues. Moreover, the research scientists in this study, along with professional, technical, and supervisory personnel, tend to feel they have the respect of their colleagues, whereas sizable proportions of unskilled manual workers and clerical workers are unsure of the degree to which their work accomplishments have gained them the

respect of their co-workers. This may reflect the fact that the work activities of less-skilled manual workers and clerical personnel may be accorded relatively little prestige by their fellow workers.

Another question was included to measure the importance of sociability to different types of employees. Respondents were asked about the importance and experience of "working with employees who are pleasant and friendly on the job." Table 27 shows that almost all employees in all occupational categories indicated they work with other employees who are pleasant and friendly but that research scientists and professional personnel, especially, are not as likely to emphasize the importance of this factor.

Table 27

IMPORTANCE AND EXPERIENCE OF WORKING WITH
EMPLOYEES WHO ARE PLEASANT AND FRIENDLY ON THE JOB
BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	71%	95%	+24%
Professional personnel	75	97	+22
Technical personnel	81	99	+18
Managerial personnel	83	94	+11
Foremen	87	98	+11
Skilled manual workers	89	92	+3
Clerical personnel	90	93	+3
Unskilled manual workers	91	93	+2

A desire to work with employees who are pleasant and friendly does not necessarily indicate a desire for close friendships with fellow employees outside working hours. Table 28 shows that less than 40 percent of the respondents in this study indicated a special desire for close friendships with fellow employees, although from 38 to 65 percent of these employees indicated they actually had close friendships outside work with one or more fellow employees. Moreover, Table 28 shows that having close friendships with fellow employees was more often considered important (and more often experienced) among manual workers than among

Table 28

**IMPORTANCE AND EXPERIENCE OF HAVING CLOSE FRIENDSHIPS WITH
ONE OR MORE FELLOW EMPLOYEES OUTSIDE WORK
BY OCCUPATIONAL CATEGORY
(Percent)**

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Professional personnel	10%	48%	+38%
Research scientists	14	38	+24
Managerial personnel	14	51	+37
Foremen	14	60	+46
Clerical personnel	15	51	+36
Technical personnel	20	55	+35
Skilled manual workers	30	65	+35
Unskilled manual workers	39	60	+21

"white collar" employees. This finding corresponds to findings of an earlier study (Vollmer, 1960a, pp. 74-78) indicating that manual workers are more likely than "white collar" employees to emphasize the importance of close friendships with co-workers.

Although research scientists seem to be likely to share the common emphasis most employees place upon the respect of co-workers for work accomplishment, they appear to be less likely than many other employees to emphasize the importance of sociability at work and the development of close friendships with fellow employees outside work situations. These findings may reflect the high importance research scientists attach to the nature of their work itself as opposed to extrinsic or derived benefits.

Nature of the Work

It was pointed out earlier that research scientists tend to share with professional and managerial personnel a desire to participate in supervisory decisions regarding the conduct of their work. Three questions were included in the survey which might indicate the importance and experience of intellectually challenging work, variety in work tasks, and seeing one's ideas put to use in work activities.

Table 29 shows that research scientists and professional personnel are especially likely to emphasize the importance of intellectual challenge in their work. This finding is in accord with the finding of the Riegel study (1958, Part II, Table V, p. 27) that "challenge by projects assigned me" was the most important intangible reward among research personnel.

Table 29

IMPORTANCE AND EXPERIENCE OF DOING WORK THAT
REQUIRES A LOT OF THOUGHT
BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Unskilled manual workers	77%	62%	-15%
Skilled manual workers	80	80	0
Clerical personnel	81	73	-8
Managerial personnel	83	91	+8
Foremen	85	90	+5
Technical personnel	88	91	+3
Research scientists	90	95	+5
Professional personnel	92	86	-6

In response to questions posed regarding the importance and experience of variety in work tasks, a lower proportion of research scientists than of employees in other occupations in this sample indicated that variety in work was especially important to them. However, most of the research scientists reported that their work did involve considerable variety, as may be seen in Table 30. These research scientists appear to think of themselves primarily as specialists. This finding contrasted with the Riegel study (1958, *loc. cit.*) whose subjects tended to rate the importance of variety fairly high. The relative lack of interest in variety among research scientists in the present study may reflect an impatience with work assignments not directly related to their scientific activities, a fact which has been noted by previous studies of scientific personnel (e.g., U.S. Committee on Engineers and Scientists for Federal Government Programs, 1957).

Table 30

**IMPORTANCE AND EXPERIENCE OF DOING MANY DIFFERENT
KINDS OF THINGS IN ONE'S JOB
BY OCCUPATIONAL CATEGORY
(Percent)**

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	48%	86%	+38%
Unskilled manual workers	74	82	+8
Clerical personnel	76	83	+7
Professional personnel	77	86	+9
Technical personnel	81	92	+11
Skilled manual workers	82	85	+3
Managerial personnel	83	97	+14
Foremen	85	95	+10

Being able to see the application of one's ideas to work operations appears more likely to be important to scientists and to professional and managerial personnel than to manual workers or clerical personnel in this study. Moreover, as may be seen in Table 31, the research scientists were among those who most often felt their ideas were actually used in their work. The Riegel study (1958, loc. cit.) indicated that influencing work processes was one of the factors most important to research scientists, but not all the scientists in that study felt they influenced work processes in their work situations.

Thus it appears that research scientists prefer work that they perceive as intellectually challenging and of some consequence within their organizations, but are not oriented toward work which takes them far afield from their specialized scientific interests.

Extrinsic Work Benefits

Several questions in this study were concerned with extrinsic work benefits--that is, employment benefits which are not intrinsic in the work performed. These included questions on the importance and experience of an adequate salary (or wage), job security, promotion into managerial positions, and promotion within one's line of work.

Table 31

IMPORTANCE AND EXPERIENCE OF SEEING ONE'S IDEAS
PUT TO USE IN THE WORK
BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Unskilled manual workers	64%	61%	-3%
Clerical personnel	65	61	-4
Skilled manual workers	74	74	0
Technical personnel	80	87	+7
Research scientists	81	95	+14
Foremen	82	93	+11
Professional personnel	85	90	+5
Managerial personnel	87	96	+9

Table 32 shows that research scientists in this study are almost as likely to be concerned about an adequate wage or salary as employees in other

Table 32

IMPORTANCE AND EXPERIENCE OF HAVING AN ADEQUATE WAGE OR SALARY
BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	86%	90%	+4%
Foremen	92	60	-32
Skilled manual workers	95	53	-42
Unskilled manual workers	95	50	-45
Clerical personnel	95	49	-46
Technical personnel	96	51	-45
Professional personnel	97	48	-49
Managerial personnel	97	61	-36

occupational categories, although they are also much more likely to feel that their present salary is adequate to their expectations. In this latter respect, the research scientists differed more from professional employees than from any other occupational group in this study. For most employees, inadequate wage or salary was the most frequently expressed dissatisfaction with working conditions, as might be expected.

In regard to job security, scientists and professional personnel were less likely than other employees to stress the importance of this factor (see Table 33), perhaps because of greater potential job mobility among scientists and professional employees.

Table 33

IMPORTANCE AND EXPERIENCE OF HAVING JOB SECURITY
BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	52%	71%	+19%
Professional personnel	54	83	+29
Managerial personnel	72	87	+15
Technical personnel	74	75	+1
Foremen	82	72	-10
Skilled manual workers	82	63	-19
Clerical personnel	85	72	-13
Unskilled manual workers	89	56	-33

Previous research (e.g., Marvick, 1954) has indicated that research personnel are often oriented toward career advancement in their occupations rather than toward promotion into managerial positions. This finding is substantiated by data presented in Table 34. This table shows that research scientists, like unskilled manual workers and clerical personnel, do not tend to place much importance on promotion into managerial positions. Unlike unskilled manual workers and clerical personnel, however, most research scientists perceive an opportunity for advancement into managerial ranks. These findings further substantiate the occupationally oriented career perspective of most scientific personnel.

Table 34

**IMPORTANCE AND EXPERIENCE OF HAVING CHANCES FOR PROMOTION INTO
HIGHER-LEVEL SUPERVISORY OR MANAGERIAL POSITIONS
BY OCCUPATIONAL CATEGORY
(Percent)**

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Research scientists	48%	62%	+14%
Unskilled manual workers	49	16	-33
Clerical personnel	49	18	-31
Skilled manual workers	56	26	-30
Technical personnel	69	41	-28
Foremen	78	61	-17
Professional personnel	79	52	-27
Managerial personnel	87	51	-36

Data presented in Table 34 also support the findings of an earlier study (Vollmer, 1960a, Table 19, p. 90) that "staff specialists" (professional personnel) tend to be highly oriented toward advancement into management positions. A lack of interest in promotion into supervisory positions may be the factor that distinguishes most sharply between the expectations of research scientists and other professional personnel in modern industrial and governmental organizations.

In contrast to Table 34, data presented in Table 35 show that research scientists are likely to express much the same interest in advancement in their line of work as other "white collar" employees. (Many respondents probably interpreted "line of work" to include supervisory as well as nonsupervisory positions connected with their present work activities; therefore, responses to this question do not provide a clear alternative to the previous question concerning promotion into managerial or supervisory positions). As in the case of Table 34, research scientists were more likely than personnel in other categories to believe that they have opportunities for advancement.

Table 35

IMPORTANCE AND EXPERIENCE OF HAVING CHANCES FOR
PROMOTION INTO HIGHER-LEVEL JOBS IN ONE'S LINE OF WORK
BY OCCUPATIONAL CATEGORY
(Percent)

<u>Occupational Category</u>	<u>Importance</u>	<u>Experience</u>	<u>Difference</u>
Skilled manual workers	73%	38%	-35%
Unskilled manual workers	77	32	-45
Clerical personnel	81	41	-40
Foremen	86	61	-25
Research scientists	85	81	-4
Technical personnel	87	53	-34
Professional personnel	89	64	-25
Managerial personnel	91	64	-27

Comparison of Findings from Three Studies

As has been pointed out previously, the findings discussed in this section are based upon the responses of only a small number of scientists in one research organization and the responses of a much larger number of employees in other occupational categories employed in seven organizations. The degree to which these findings can be applied to research scientists in other situations can only be determined by comparing the findings of this survey with findings from other studies. Table 36 presents data on the importance attached to different work factors by the 21 scientists in the present survey and compares it with the importance attached to these same work factors in two other studies--the Riegel survey (1958, Part II) of an unspecified number of research personnel from among a sample of 276 nonsupervisory scientists and engineers in ten industrial companies, and a study of 26 research scientists in an independent research organization. The latter study is described more completely in Section V, following.

The data in Table 36 indicate the relative percentage of research personnel in each survey who checked each work factor as being important to them, thus providing a means of ranking the "contingent" importance of each factor to the personnel surveyed in the three studies. This

Table 36
IMPORTANCE ASSIGNED TO VARIOUS WORK FACTORS BY
RESEARCH PERSONNEL IN THREE STUDIES

Present Survey ^a	Percent	TAROS Study ^b	Percent	Riegel Study ^c	Score
Supervisor competent in own job	95%	Intellectually challenging work	88%	Intellectually challenging work	88
Intellectually challenging work	90	Fair treatment by supervisors	88	Participation in work decisions	86
Respect of supervisors	90	Participation in work decisions	81	Seeing ideas put to use	81
Participation in work decisions	86	Treatment as a professional	81	Respect of supervisors	79
Respect of fellow employees	86	Supervisor competent in own job	73	Respect of fellow employees	78
Treatment as a professional	86	Respect of fellow employees	69	Variety in work	76
Fair treatment by supervisors	86	Adequate salary	54	Treatment as a professional	72
Adequate salary	86	Advancement in line of work	50	Job security	71
Advancement in line of work	86	Respect of supervisors	46	Company reputation high	62
Seeing ideas put to use	81	Job security	35		
Precise instructions from supervisor	71	Supervisor knows subordinates' jobs	31		
Pleasant and friendly co-workers	71	Company reputation high	27		
Supervisor knows subordinates' jobs	66	Advancement into management jobs	4		
Company reputation high	62				
Job security	52				
Advancement into management jobs	48				
Variety in work	48				
Close friendships with co-workers	14				

- a. Responses of 21 research scientists in a research department at the corporate headquarters of a manufacturing company, shown as percentage of all respondents indicating that the factor was "extremely important" or "quite important" to them.
- b. Responses of 26 research scientists in two research laboratories in an independent research organization. For a description of this organization, see Section V. Responses are shown here as percent of all respondents indicating that the factor was "extremely important" to them. (Other response categories were "moderately important" or "not very important"; it was thought that inclusion of these responses would not permit as close comparability with the responses tabulated here for the scientists in the manufacturing company.) Also, since the TAROS study did not investigate some of the factors investigated in the present study, data for respondents in the TAROS study were not available for these factors.
- c. Responses of an unspecified number of research personnel from among 276 nonsupervisory scientists and engineers in ten companies shown in terms of an "importance score," varying from 0 to 100, providing an index of the degree to which these research personnel stressed the importance of each work factor (Source: Riegel, 1958, Part II, Table V, p. 27). Again, some of the factors included in the other studies shown here were not included in the Riegel study.

ranking must be considered to be contingent in the sense that it is dependent upon the degree to which the respondents' expectations regarding these various factors are presently being met in their work situations. Thus, for example, the emphasis that research personnel place upon salary factors compared with other factors might increase considerably if it were not for the fact that most research personnel are presently satisfied by their salary status (see Table 32). Data presented in Table 36, therefore, do not show the relative importance of various work factors in any absolute sense, but they do show the relative importance of these factors to these three groups of research personnel within their present contexts of employment.

In addition, it might be pointed out that the three studies drawn upon for the data shown in Table 36 were not strictly comparable, in that there were differences between the studies in the wording of questions. These differences in wording might account for some variations between the survey groups in the importance assigned to various work factors.

Table 36 shows that a consistently high proportion of research personnel in all three studies considered it important to have intellectually challenging work, to participate in decisions affecting their work, to be respected by fellow employees, and to be treated as professionals, whereas a lower proportion of research personnel in all three studies emphasized the importance of job security and of being employed by a company with a good reputation. However, there appears to be some inconsistency in the importance attached to such factors as supervisory competence, respect from supervisors, supervisors' knowledge of subordinates' jobs, opportunities for advancement into both managerial and higher professional job categories, variety in work, and salary considerations. These findings suggest that situational variations in the context of employment may have more effect upon the expectations of scientists regarding relations with supervision, career advancement opportunities, and salary considerations; whereas expectations regarding the nature of the work itself (in terms of intellectual challenge) and relations with other professionals (in terms of mutual respect and professional status) appear to be more constant, regardless of variations in the organizational environment.

Implications

In summary, the findings of this survey suggest that research scientists tend to share with other employees a common expectation that they have a supervisor whom they can respect for his competence and who respects them for their work accomplishments and treats them fairly, that they be

respected by fellow employees, and that they have an adequate salary (or wage). Research scientists also tend to share with other professional employees a special interest in work that is intellectually challenging, participation in work-related decisions, treatment "as a professional," opportunity for advancement within the profession, and seeing their ideas put to use in their work.

In contrast, research scientists and other professional personnel are apparently not as likely to express special interest in the reputation of their company, in having a supervisor who knows well the jobs of his subordinates or who gives them especially precise instructions, in having close friendships with other employees or even especially friendly co-workers, or in having job security (although interest in this latter factor was expressed more frequently among research personnel in the Riegel study). Finally, the research scientists included in the present study differed markedly from all other categories of employees in their relative lack of interest in variety in work tasks and in opportunities for promotion into managerial ranks.

Not all the research scientists participating in this study were sure that their supervisors respected them, nor, in turn, were they all sure of the competence of their supervisors in performing their supervisory responsibilities. In addition, not all these respondents were confident about their opportunities for professional advancement in their line of work. The apparent inadequacies or uncertainties in the present work situations of these research scientists along with the importance they ordinarily attach to various work factors provide important clues regarding the relative effectiveness of different kinds of work incentives.

For example, research scientists would not ordinarily be expected to be as susceptible as other employees to incentives which stress status or career advancement within an organization. Fringe benefits attached to seniority, for example, may have relatively little appeal to many scientists. Use of such incentive mechanisms to change the research scientist's orientation from a professional or occupational orientation to a company orientation might even have the undesirable effect of reducing the scientist's commitment to scientific skills. At least one study has suggested that scientists who seek to identify themselves with groups outside their places of employment tend to have a higher commitment to scientific skills than those who identify themselves with their organizations (Gouldner, 1957, Table 3, p. 294). Similarly, programs to enhance a "company family" atmosphere through company parties and social events may be relatively ineffective because of the primarily technical and work orientation rather than a social orientation that exists among research scientists.

To research scientists, work is generally an end in itself--of intrinsic importance and interest--rather than a means to other ends, such as high salary and promotion into management. (Not that salaries are unimportant. They are probably just taken for granted by many scientists--unless family pressures make salary an important factor or salary status becomes symbolic of management's respect or lack of respect for the research accomplishments of an individual scientist.) Therefore, whatever management can do to establish a working environment in which research scientists can engage in what they consider to be intellectually challenging research activities with a high degree of freedom to determine the course of their research represents perhaps the most potent single category of incentives for sustaining and increasing scientific research endeavor. Such an environment may be more easily provided within a research activity oriented toward basic research; however, there may also be ways to provide the same incentives for many scientists in applied research contexts.

The relationship between a research scientist and his immediate supervisor appears to be important to most scientists in all organizational contexts. The need for mutual respect between scientist and supervisor results in a corollary need for special management attention to the selection and training of research supervisors who thoroughly understand their own responsibilities, who know how to provide the assistance that research scientists require, and who can foster conditions of mutual respect and fair dealing. Furthermore, it is perhaps quite significant that the research scientist is more likely to be satisfied with a supervisor who is a general administrator rather than a fellow scientist--one who provides appropriate administrative support without interfering in technical-scientific matters.

Like other employees, scientists require the respect of co-workers. In some cases, this may mean that scientists with specialized interests are better suited to research groups relatively isolated from industrial employees who are unable to understand and appreciate scientific problems and methods. Other scientists, however, may be especially stimulated by new ideas from individuals of other disciplinary backgrounds or interests, and may be better suited to interdisciplinary research contexts. Relevant to these considerations are Donald Pelz's (1956, 1958) findings that scientific productivity appears to be enhanced in work situations where there is daily contact with at least one supportive colleague and frequent contacts with scientists with dissimilar viewpoints.

The relationships of employee expectations to managerial practices which have been discussed in this section have dealt mostly with what were called earlier the administrative and production processes in the

research role--that is, the research scientist's expectations regarding the conduct of his work, his employing organization, his supervisor, and his fellow employees. The following section of this report investigates these administrative and production processes in more detail among another group of research scientists and draws attention to the importance of professional initiative in the development and transmission aspects of the research role. It will be shown that in modern organizations which are professionally rather than bureaucratically oriented, management may become more dependent upon the initiative of professional employees to secure the inputs and outputs which are essential to the survival of the organizational system.

V THE RESEARCH ROLE IN A RESEARCH ORGANIZATION: A CASE STUDY

To examine further the effects of organizational requirements and employee expectations on the research role, adjustments made by scientists to the requirements of a particular organizational setting were investigated. The organization in which this investigation took place shall be referred to herein under the pseudonym "TAROS." Many of the problems of adaptation of scientists at TAROS are much the same as those of scientists employed in similar contexts elsewhere. However, certain of these problems may be specific to the TAROS organizational context, especially insofar as both interdisciplinary "problem solving" and single-discipline-oriented research groups exist within this context. It is hoped that this analysis will suggest additional topics for further research on the role of scientists in different types of organizational settings.

TAROS is one of several hundred independent research corporations in the United States. Its formal purpose, briefly stated, is to apply scientific knowledge and methods to research which is oriented toward solving technical problems of governmental agencies and private commercial and industrial enterprises. The legal instrument for accomplishing this purpose is ordinarily a research contract. Inquiries leading to a research contract are generally initiated by appropriate representatives of a client organization, although sometimes representatives of the research organization initiate contact with a potential client in an attempt to gain sponsorship for research activities which they believe to be in accord with present or anticipated future needs of the potential client.

Although the primary purpose of TAROS is commonly recognized to be the conduct of research that applies to specific problems of government or industry, individual research scientists on the TAROS staff occasionally seek and obtain grants or contracts for basic or fundamental research studies which are not oriented toward the solution of specific practical problems. Scientists are encouraged by TAROS management to conduct this type of research for several reasons, including the following: it may lead to discoveries of new knowledge or new techniques that might be useful to clients in applied research programs; it may contribute to the general prestige of TAROS in the scientific community; and it may contribute to job satisfaction among scientists on the staff.

TAROS has no endowment. The organization is supported essentially by revenue from its research contracts. Therefore, in the long run at least, the research activities of its staff scientists must be salable. Although a very small amount of the revenue from all research contracts is made available to support internally sponsored research, practically all research activities--whether they are "applied" or "basic" in nature--depend upon gaining external support through individual contracts or, occasionally, through research grants. For this reason, TAROS, like many similar independent research organizations, is a hybrid. It is both a business and a professional organization.

Twenty-six professional staff members from two laboratories conducting research studies in the physical sciences were interviewed in connection with this study in December 1961 and January 1962.* Sixteen of these scientists were employed in one laboratory, designated as "Laboratory A," and ten were employed in the other, designated as "Laboratory B." The staff of Laboratory A was composed entirely of scientists specializing in a single field within a single academic area; the staff of Laboratory B included scientists with various backgrounds in several fields of physical science who were currently engaged in interdisciplinary research. These twenty-six physical scientists constituted the entire professional staff of these laboratories who were available for interview at the time of the study. In addition, several management officials who were engaged in activities connected with these two laboratories were interviewed as part of the study.

The research scientists interviewed ranged in age from 26 to 54 years, with a median age of 34 years. Sixteen had Ph.D's, five had master's degrees, and five had bachelor's degrees. Nineteen had had previous employment experience in industrial or governmental laboratories, and nine had been employed previously in research and/or teaching capacities at academic institutions. The average (median) length of employment of these scientists at TAROS was four years.

In addition to the twenty-six male scientists, one female research scientist was interviewed. However, her responses have been omitted from this analysis to eliminate the possibility of variations in response due to sex differences.

* Types of information collected in connection with these interviews are indicated in Appendixes B, C, D, E, and F.

The following discussion focuses attention upon four aspects of the research role (i.e., research development processes, research production processes, research transmission processes, and administrative processes) in the specific context of TAROS.

Research Development Processes

A research activity depends upon certain inputs. Among these are personnel, who do the research; ideas, which stimulate and suggest research activities; and financial support, which sustains the research effort. Research organizations differ, however, in the degree to which they place the responsibility for these inputs into the hands of individual research scientists. Industrial corporations and some government agencies, for example, tend more to relieve the individual research scientist of responsibility for obtaining research funds. In large industrial firms, R&D programs are often supported by relatively large and long-term government contracts. In leading academic institutions, on the other hand, faculty members are under more pressure to develop research ideas and to seek individual research grants, and individual research accomplishments may be measured in terms of tenure appointments and other rewards.* Moreover, organizations differ somewhat in the degree to which management or administration takes the responsibility for recruiting new personnel and for providing assistance through library facilities and various information retrieval devices, in acquiring research ideas.

At TAROS, the assistance of research scientists in recruiting new personnel is often solicited by management under the principle that "our best people are often obtained through the personal recommendations of present staff members." Although referrals for job openings are usually sought from present staff members, TAROS management assumes full responsibility for the actual hiring--unlike some academic institutions where faculty committees have a strong voice in hiring actions.** This method of acquiring new personnel did not seem to be a source of serious complaint among the TAROS personnel interviewed.

Opportunity to keep up to date on new scientific developments in their fields of study was described as "extremely important" by

* See for example Caplow and McGee, 1958, Chapter IV.

** Ibid., p. 183.

twenty-three of the twenty-six scientists interviewed. Actually acquiring such information appeared to be a specific problem to at least a minority (four out of twenty-six) of the research scientists surveyed. This problem, where it was expressed, was generally linked to the need for additional technical assistance in TAROS, as the following specific comments show:

[I need more time for] looking through the literature. There's so much literature involved that it's hard to keep track of it all, but it would be valuable if one could. Having a trained technician for this would help a lot.

Literature research should be continued all through a project, not just at the beginning. If I had adequate technical help, I wouldn't have to do so much actual lab work, and I'd have more time for literature research.

The need for technical assistance in the actual conduct of experimentation is discussed later in the analysis of research production problems at TAROS.

Over half of the scientists interviewed at TAROS apparently felt they had sufficient funds to conduct the kind of research which they preferred. However, the acquisition of funds to support research activities seems to constitute a considerable problem among some of the TAROS personnel interviewed. In response to a check list which they were asked to fill out during the interview,* sixteen of the scientists indicated that having "funds available to conduct the kind of research I want to do" was "extremely important," and nine more indicated that this was "moderately important." Only one scientist indicated that it was "not very important." Of the twenty-five who said this factor was at least moderately important, eleven expressed the opinion that they did not have sufficient funds available at TAROS to do the kind of research which they preferred.

Research scientists who complained of insufficient funds to support their research expressed their complaints in the following terms:

There is not enough freedom here, although the potential amount of freedom is good--you don't get to work on projects you are interested in unless you can sell them. So I haven't had opportunity to develop professionally.

* See Appendix E.

The work is too much dependent here upon getting client contracts--this is perhaps my biggest single disappointment. You are constantly fighting for support. This is a painful, frustrating experience, and a very time-consuming one, also. The feeling is that, after you publish a fair number of papers--in fact, no matter how many papers you publish--you still have to fight every inch of the way to sell your work and get support.

One can do almost anything he wants here if he can get the money for it. The main disadvantage is that we are dependent upon other people for our research money. We have only a moderate degree of control over the availability of this money and also over the areas for which the money will be spent. Whereas in principle we can do anything we want, we often have to do that work for which there is money available.

We have the same disadvantages that are associated with independent research organizations in general--insecurity, frequent change in type of work, a lot of small projects to do, and a concern to raise money. It's no worse at TAROS than at similar places.

One important environmental factor that concerns financial support of research at TAROS is its financial structure. TAROS is almost totally dependent upon income from research contracts, rather than from endowments or revenue from manufacturing activities, as is true in many academic or industrial research centers. However, research men often do not make effective salesmen. One scientist expressed this idea succinctly in response to a question about what job activities he enjoyed least by saying, "Traveling and meeting clients, especially when it's not related to a specific proposal or project. I'm not a salesman and I don't enjoy selling."

It is quite possible that the personality characteristics which are most often associated with interests in the physical sciences--a low interest in sociability and social adjustment and a high interest in natural science activities*--are more or less incompatible with the personality characteristics associated with successful sales activities, even in more technical fields of salesmanship. Thus scientists may often resist sales responsibilities themselves, maintaining that management should assume them. As one TAROS scientist put it:

* See Terman, 1954.

. . . one thing we always have to fight for is to get money for our work. We get very little help from management on this--I mean management above [immediate supervisor]; he has given us an awful lot of help.

Research management officials today, even though they may have been distinguished scientists in the past, cannot ordinarily keep up to date in increasingly complex scientific specialties and, at the same time, pay attention to complex managerial responsibilities. They are often unable to do more than bring together a staff scientist and a potential client who has funds to sponsor research. It then becomes the responsibility of the scientist to sell the potential client on the desirability of sponsoring his research in a mutually agreeable direction. Research management officials in such organizations can often do little more than perform a "broker's" function; the scientist himself must be the "research entrepreneur."*

Some individual scientists apparently become successful research entrepreneurs. This is suggested by the fact that fourteen of the twenty-five scientists who indicated the importance of having funds available to do the kind of research they preferred also indicated that they did have such funds at TAROS. An investigation was undertaken to determine which situational or individual characteristics, if any, might differentiate between individuals at TAROS who said they had enough funds available to do the research they preferred and those who said they did not. This investigation revealed a marked situational difference in opinions on the availability of research funds between scientists in the two laboratories studied.

As is shown in Table 37, over two-thirds of the scientists located in Laboratory A said they did not have sufficient funds, whereas all of the scientists located in Laboratory B said they did have sufficient funds.

* For a discussion of research entrepreneurship among social scientists, see Bennis, 1955 and 1956.

Table 37

OPINIONS OF TAROS SCIENTISTS IN TWO LABORATORIES
ON SUFFICIENCY OF FUNDS FOR PREFERRED RESEARCH

	<u>Laboratory A</u> <u>(N = 16)</u>	<u>Laboratory B</u> <u>(N = 10)</u>
Have sufficient funds for preferred research	5	10
Do not have sufficient funds for preferred research	11	0

It may be that the interdisciplinary atmosphere of Laboratory B contributed to the expectation among its scientists that they would have to engage in a variety of tasks, including fund-raising activities; whereas the narrower area of specialization among scientists in Laboratory A may contribute to their expectation that they should stay within their field of scientific specialization and leave "extraneous" activities to others--i.e., to management officials or special research salesmen.* This interpretation is supported by further analysis, which indicates that at least eight scientists in Laboratory B were attracted to TAROS by the "variety" of activities it offered them, whereas only three scientists in Laboratory A mentioned "variety" as a desirable feature of their work at TAROS. In this regard, scientists in Laboratory B commented:

[I like best] the lab work, proposal writing, and writing up the results. It's really the mixture of these that I like.

Where I worked formerly, the work tended to be more restricted in subject matter. About three years ago [here at TAROS] I worked on a [project in another scientific field] that I got very interested in, and I am still interested in the subject. My present job can and does encompass a wide variety of things.

* For a further discussion of the advantages and disadvantages of interdisciplinary research groups, see Hertz and Rubenstein, 1957; Shepard, 1956a, 1956b; and Bennis, 1956.

I came from a government laboratory, and the initial attraction was the nongovernment, or industrial, aspect of TAROS. I was attracted by the variety of research possibilities available.

The selectivity involved in attracting scientific personnel who are especially interested in "variety" of work experiences has also apparently provided a staff in Laboratory B who are more reconciled to being "research entrepreneurs"--participants in research proposal writing and client contract activities--as the following comments would indicate:

I like proposal writing; it is very challenging. The interesting part of research is thinking up ways to solve problems and taking part in the formulation of a solution.

I like writing proposals--it represents an attempt to find a solution to a problem. And I like discussions with clients--they represent situations where you synthesize in a short time all that you know on a subject. Things have been better here than I expected. There is more variety than I expected. I am quite satisfied.

However, although many scientists in Laboratory B were attracted to TAROS by the variety in work opportunities, most TAROS scientists did not stress the particular importance of interdisciplinary work. Only five of the TAROS scientists indicated that opportunity to do interdisciplinary research with scientists of different backgrounds is "extremely important" to them; eighteen said that it is "moderately important." Three of the scientists interviewed, all in Laboratory A, said that doing interdisciplinary research is "not very important" to them. Therefore, it appears that a problem is created in an organization like TAROS by the fact that interdisciplinary research situations may not be strongly favored by some scientists and yet may be more effective in developing and sustaining support for research in an applied research context.

Prior work experience also may influence scientists' expectations with regard to the entrepreneurial aspects of the research role. For example, it may be that scientists who have been employed in academic contexts where they have been under pressure to obtain grants for support of their research activities may be more adaptable to entrepreneurial responsibilities in an organization like TAROS than scientists who have not previously been employed in such a context. This expectation is supported somewhat by findings presented in Table 38, which shows that scientists who said they had adequate research funds were almost evenly divided between persons with and persons without prior academic employment

experience, whereas those who said they did not have adequate research funds were preponderantly without prior academic employment experience.

Table 38

**OPINIONS OF TAROS SCIENTISTS ON SUFFICIENCY OF
FUNDS FOR PREFERRED RESEARCH
BY PRIOR ACADEMIC EMPLOYMENT EXPERIENCE**

	Have Been Em- ployed in an Academic Institution (N = 11)	Have Not Been Employed in an Academic Institution (N = 15)
Have sufficient funds for preferred research	8	7
Do not have sufficient funds for preferred research	3	8

Scientists with previous academic employment experience, especially those with experiences in large universities, are familiar with research entrepreneurial activities. Such individuals are apparently not as likely as persons less familiar with entrepreneurial activities to be dissatisfied with work requirements in an organization such as TAROS, as is revealed in the following comments of a scientist in Laboratory B who had prior employment experience in both academic and industrial contexts, and who indicated that he had sufficient funds for research at TAROS:

I couldn't be happier in the type of work I do--exploring fields that are new to me in the physical world. This job couldn't be better suited to my needs. I've been able to work on enough projects in different areas to advance my background and education in fields I might not have been able to work on elsewhere. Then, too, I enjoy contacts with people at [nearby universities].

Research Production Processes

Planning and conducting research studies and interpreting research findings are the core of the research production process. These activities require considerable skill and ability, not only in laboratory techniques (among physical scientists, especially), but also in the management of resources available for research production. These resources may include technical assistance personnel, laboratory equipment, and funds allocated to particular projects.

At TAROS research scientists tend to expect a large degree of freedom to manage their own research activities. Twenty-five of the twenty-six scientists interviewed indicated that "having a large degree of freedom to manage my own work" was "moderately" or "extremely" important to them. Furthermore, most scientists at TAROS (twenty of the twenty-six interviewed) reported that they do have a large degree of freedom to manage their own research activities in this organizational context--most of these respondents made the essential provision that they obtain enough funds to support research in areas of their particular interest. The scientists who said they did not have much opportunity to manage their own research activities were more likely to be individuals without higher professional accomplishments such as Ph.D. status and/or professional recognition in terms of papers accepted for publication in professional journals, etc.

A frequently stressed complaint which seemed to indicate a considerable problem among research scientists at TAROS was the absence of what they considered to be adequate technical support. Twenty-five of the twenty-six scientists interviewed emphasized the importance of having adequate technical assistance in their research activities. Nine of the twenty-five, however, also claimed they did not have adequate technical assistance at TAROS. Most of these nine scientists indicated that this shortage of technical assistance was a special problem at TAROS; this was stated explicitly in the following comment:

We need more nontechnical help. Industry, at least, does supply you with lab technicians--several if you want them--and so do academic institutions, with graduate students. But here it's a problem, and it causes too much time to be wasted.

One scientist, however, maintained that the lack of technical assistance is a general problem in the United States:

There is this problem of not having a lab assistant. I feel my productivity could be enhanced by a factor of 2 with a technician to help me. This is a constant gripe everywhere here. But it's really a criticism of science in America compared with science abroad--in Europe all research people have assistants. We do not perform research here efficiently without them. After all, the scientist's greatest contribution is in the interpretation of results, not in handling routine matters.

It is interesting to note, however, that all of the TAROS scientists who claimed to have inadequate technical assistance in the conduct of research were located in Laboratory A, whereas none of the scientists in Laboratory B placed any special emphasis upon lack of technical assistance, as is shown in Table 39.

Table 39

OPINIONS OF TAROS SCIENTISTS IN TWO LABORATORIES
ON ADEQUACY OF TECHNICAL ASSISTANCE

	Laboratory A (N = 16)	Laboratory B (N = 10)
Have adequate technical assistance	7	10
Do not have adequate technical assistance	9	0

One possible interpretation of the findings shown in Table 39 is that, within the TAROS context, the diversified, interdisciplinary research program of Laboratory B is better able to support what the scientists consider to be adequate technical assistance than is the more specialized, discipline-oriented research program in Laboratory A. The reported lack of such assistance in Laboratory A is perceived, by some scientists at least, as detracting from their more specialized professional interests, as is indicated by the following comments of two Laboratory A scientists:

We have adequate clerical assistance, but not technical assistance. Our workload doesn't warrant more employees, but perhaps we don't make the best use of the employees we have at the technical level . . . Technicians are underpaid, so it's hard to keep them here because of the competition . . . [I like] planning research and carrying it out [and] I like to have my hand in at least part of the lab work . . . [but] in my experience here there has not been opportunity to grow in a particular field--no opportunity to restrict one's interests in order to become top notch in a specific area. The demand for projects has meant that you work first on one thing and then another . . . [And I have not been able to keep up with] current literature in my field. I've been drawn away from my field in the past few years.

[I enjoy most] experimental work and reading scientific literature. [I enjoy least] cleaning up the lab and running to the stock room for supplies. To the extent that I'm doing clean-up work, this time is not well spent. I should be doing research. The answer, of course, is [partly] that we need more technical help . . . Recently, I've had to do work not at all related to my field of interest.

Thus it appears that research production at TAROS is characterized by a diversification-specialization dilemma. Diversified, interdisciplinary research programs, because of their flexibility, may be more likely to generate the financial support required to maintain what scientists consider to be adequate personnel and facilities to do their research. However, research efforts that become too diversified may detract from the professional goals of scientists who wish to enhance their capabilities in a specialized scientific area. Even in Laboratory B, where scientists do not tend to be as specialized in their interests, a respondent expressed this dilemma as follows:

The best and the worst feature [of research activities at TAROS] is the same thing--diversification. It's an advantage to talk to so many different people--this has been very satisfying for me. But diversification does spread things out too much and creates some lack of direction. It allows people to loaf along if they're so inclined, and to set themselves up as experts when they're not at all.

Research Transmission Processes

What is done with research findings after a study has been conducted is, of course, a function of the nature of the research itself. The findings from more basic or fundamental research are ordinarily reported in professional publications directed primarily toward an audience of professional colleagues; applied research findings are ordinarily presented in written reports, occasionally supplemented by oral reports, to a client in business or government.

In spite of the fact that the fundamental raison d'etre of TAROS is to conduct applied research for business or governmental agencies, the research scientists in the TAROS groups studied tended to prefer basic to applied research, as is shown in Table 40. This tendency to place more emphasis upon the desirability of basic rather than applied research may be more characteristic of scientists with a "professional reference group" orientation.

Table 40

OPINIONS OF TAROS SCIENTISTS ON THE IMPORTANCE OF BASIC RESEARCH AND APPLIED RESEARCH ACTIVITIES

	<u>Extremely Important</u>	<u>Moderately Important</u>	<u>Not Very Important</u>
Opportunity to do research that contributes to scientific knowledge	19	6	1
Opportunity to do research that helps solve problems in industry or government	9	11	6

Thus another dilemma is created at TAROS by the fact that it must hire scientists of high professional capability (sixteen of the twenty-six interviewed had Ph.D.'s, and fourteen had published two or more technical papers in journals in their professional fields) to do research that is primarily oriented toward the solution of practical problems outside their professional fields. Yet eighteen of the TAROS scientists

indicated that "respect among other scientists because of my work" was "extremely important" to them, and seventeen said that "opportunity to write up and publish research findings in addition to TAROS (client) reports" was also "extremely important." In accord with their professional interests, the TAROS scientists emphasized their preference for basic research leading to opportunities for publication in such comments as the following:

TAROS does most of its work for clients who have something specific in mind. Usually the research is applied research--it would be nice if it weren't The one nice thing here is that you are able to do a fairly close approximation to pure research now and then. More frequently it is apt to be applied research, but once in awhile you get hold of a real "plum" if you are lucky.

I'd like to attain a situation similar to Dr. _____
[TAROS scientist who conducts considerable basic research].
I'm not at all interested in applied research--only in fundamental research.

I'd like to have more time to spend developing ideas of my own. Also more time in generating publications. I've written nothing since I came here that resulted from TAROS work. The work I do here isn't publishable, and I don't have time to delve into work of my own that would be.

The difficulty of satisfying basic research interests among scientists in the TAROS context was expressed in the following comments of management officials:

A major problem in this organization is that you have to be a good scientist, but you have no time to remain one. You have to translate the results of scientific studies in terms of client interests.

We have no defined product, so we have no clearly defined research program lines. This is an advantage for someone who likes to be a "problem solver." Fundamental researchers are not happy here unless they are also successful salesmen to get longer-run support for research in a particular area.

Despite these difficulties, it is instructive to note that twenty-four of the twenty-six individuals interviewed reported having at least some opportunity to do basic research at TAROS. Many research scientists

in applied research contexts at TAROS and elsewhere have utilized a mechanism which has been referred to as "bootlegging." This concept is generally used among scientists in applied research organizations when referring to trying out basic research ideas (oriented toward making a contribution to scientific knowledge) within an applied research contract. Two TAROS scientists described the necessity for bootlegging as follows:

It's vital if we're going to stay in business. You can't write a research proposal without trying out some things. I don't like the term, but one shouldn't feel guilty about doing it. It's part of our job, and quite easy to manage.

I've not done any bootlegging because I've been able to obtain support for research activities in my field of interest. But if I didn't have this support, I'd probably be doing some bootlegging. In a way, I think it's a gyp to projects to use their time for other things, but the way things are set up here, there doesn't seem to be any other way to do things.

Another scientist pointed out that many applied research contracts have enough flexibility to permit trying out basic research ideas:

I tend to interpret the client's needs in terms of my own inclinations--that is, I tend to influence the client in the directions I think will be most effective. I enjoy most the projects where I am given the most leeway, and where I can interpret the client's needs in my own way. I take all the reins the client will give me. But I wouldn't do anything that I couldn't easily justify to the client.

Several scientists pointed out that clients may actually encourage some experimentation that is not directly related to contract objectives:

We have done a little bootlegging, partly on our own. We have good relations with our present client because we have done a lot of work for them and they like our work . . . They often call us and ask us informally to do something that isn't specifically in the contract . . . The latest contract renewal was written somewhat loosely just to allow for this sort of thing.

Bootlegging occurs quite often. It's a question as to what extent it's done with the client's knowledge. Sometimes the technical people in the client's office want us to do

additional work that isn't in the contract. However, I think you can't accomplish much unless the client, or some part of his organization, knows about it and is willing to pay for it.

"Bootlegging" appears to be a fairly commonly accepted mechanism for professionally oriented scientists to test basic research ideas while performing an entrepreneurial role in applied research contexts. It is one means for reconciling management's requirements for developing and conducting applied research with the interest of scientists in basic research of significance to their profession.

Administrative Processes

Supervision and coordination of research activities involve relations between superiors and subordinates, between colleagues, and between individuals and the total research organization. Table 41 presents data on some of the expectations of TAROS scientists with regard to such relations, and on the fulfillment of these expectation at TAROS.

Research scientists at TAROS appear more likely to be professionally oriented (e.g., to emphasize the importance of being employed by an organization which is highly regarded by other scientists, of having the opportunity for promotion within their scientific fields, of achieving respect for their work from other scientists, and of having the opportunity to associate with other scientists of recognized ability) and less likely to be organizationally oriented (e.g., to emphasize the importance of being employed by an organization which is highly regarded in the general community and of having the opportunity for promotion into management positions at TAROS). These expectations were in general accord with the lower frequency of organizational orientation and higher frequency of occupational orientation among scientists in the industrial laboratory reported on in Section IV. It appears that scientists in general are likely to be less oriented toward accomplishment strictly within the framework of the organization that employs them, and more oriented toward accomplishment within the framework of their scientific professions, than are persons in many other professional categories.

Table 41 also shows that the professionally oriented expectations of most TAROS scientists were met by the conditions and opportunities that actually existed at TAROS. Moreover, while the large majority of TAROS scientists emphasized the importance of having supervisors who treat them fairly and in accord with their professional status and aspirations and who were proficient in their supervisory responsibilities, fewer TAROS scientists were concerned with having supervisors who know their

Table 41

**OPINIONS OF TAROS SCIENTISTS ON THE IMPORTANCE OF VARIOUS WORK FACTORS
AND ON WHETHER THESE FACTORS EXIST AT TAROS**

	<u>Extremely Important</u>	<u>Moderately Important</u>	<u>Not Very Important</u>	<u>Condition Exists at TAROS</u>
Employment by an organization with a good reputation in the community	7	18	1	26
Employment by an organization which is highly regarded by scientists in my field	12	13	1	25
Opportunity for promotion within my scientific field at TAROS	13	10	3	22
Opportunity for promotion into management positions at TAROS	1	9	16	16
A supervisor who treats employees fairly	23	3	0	22
Treatment as a professional by management	21	5	0	25
A supervisor who knows his own job well	19	7	0	26
A supervisor who knows my job well	8	11	7	17
Respect of TAROS management because of my work	12	14	0	25
Respect among other scientists because of my work	18	8	0	23
Association with other scientists of recognized ability in scientific fields	18	7	1	25
Opportunity to do interdisciplinary research with scientists of different backgrounds	5	18	3	19

subordinates' jobs well. In addition, TAROS scientists were not as often concerned with management's respect for their work as they were with the respect of other scientists. These findings were also in accord with the findings of previous studies.

The ideal type of supervision for scientists who are professionally oriented research entrepreneurs appears to be a helpful, "participatory" type of supervision in which the typical functions of administrators and scientists in industrial and governmental organizations are reversed-- i.e., administrators performing "staff" functions to provide support and assistance to the "line" functions of the research scientists.*

In accordance with this reversal of staff-line functions, interview comments indicated that the minority of TAROS scientists who complained about their management were particularly concerned with what they considered to be failure to provide the services the scientists felt their management should provide:

I have a general criticism of TAROS. Research activities are the sole source of support for TAROS, but there doesn't seem to be as great a value placed on them as there should be by management and the policy-makers here, in terms of providing facilities and technical help. Central administration is large and unwieldy from the standpoint of getting proposals through, and expensive from the standpoint of overhead. It doesn't do as much as it should to facilitate the acquisition of new funds or facilities, or in providing services. Management is not imbued with the idea that research is our most important activity.

Among scientists here there is a great deal of dissatisfaction and frustration with TAROS management--dissatisfaction concerning the overhead rate, the general planning for new buildings, and the overstaffing of central administration . . . When a new building was planned, the physical scientists were horrified at the lack of laboratory space planned. We expressed the opinion that all management wanted was a glorified

* See Baumgartel, 1957, for a discussion of "participatory supervision" among scientists; see Etzioni, 1959, on the reversal of staff-line functions in professionally oriented organizations.

office building. Now we're starved for laboratory space, and there are empty offices in the new building . . . I feel rather strongly that management has built a wonderful building mainly for central administration and the service groups, and has neglected the physical scientists, who I feel are the most important people at TAROS.

Finally, Table 41 shows that most TAROS scientists indicated they had opportunity to do research with scientists of different backgrounds. As might be expected, the seven scientists who said they had no opportunity to do interdisciplinary research were all in Laboratory A--the more discipline-oriented laboratory.

Adaptation of Scientists at TAROS

Key facets of the role of research scientists as research entrepreneurs in an independent research organization such as TAROS, which must support itself primarily through applied research contracts, may be highlighted by an examination of the differences in working conditions and rewards experienced by scientists who are essentially "satisfied" and those who are "dissatisfied" by the general employment relationship at TAROS. For the purpose of classifying the research scientists as being generally satisfied or dissatisfied at TAROS, the respondents were asked to discuss the degree to which employment conditions at TAROS met their initial expectations at the time of hire, and the extent of their intentions to remain at TAROS in the future in the light of present conditions. Analysis of the response to these questions indicated that eighteen of the scientists interviewed could be classified as essentially satisfied; whereas eight could be classified as dissatisfied. Table 42 shows the findings regarding certain factors which might be expected to discriminate between the satisfied and dissatisfied groups, thereby suggesting basic causes of dissatisfaction or lack of adjustment between managerial requirements and employee expectations.

The data presented in Table 42 reveal that inadequate salary, job insecurity, lack of promotional opportunity, unsatisfactory relations with supervisors or colleagues, or even dissatisfaction with the nature of the work itself did not sharply discriminate between satisfied and dissatisfied scientists at TAROS, even though these are commonly accepted as primary sources of job dissatisfaction. The two items that appeared to discriminate most sharply between satisfied and dissatisfied scientists at TAROS were "having adequate technical assistance" and "having funds available to conduct the kind of research I want to do." In other words, those scientists who expressed dissatisfaction with

Table 42

**REPORTED EXPERIENCES OF SATISFIED AND DISSATISFIED SCIENTISTS
AT TAROS**

		Satisfied Scientists (N = 18)	Dissatisfied Scientists (N = 8)
Have an adequate salary	Yes	17	8
	No	1	0
Have job security because of attainments	Yes	14	7
	No	4	1
Have opportunity for promotion into management at TAROS	Yes	12	4
	No	6	4
Have opportunity for promotion in my scientific field at TAROS	Yes	15	7
	No	3	1
Have a supervisor who is fair	Yes	17	5
	No	1	3
Have the respect of TAROS manage- ment	Yes	17	8
	No	1	0
Am employed by an organization with a good reputation in the community	Yes	18	8
	No	0	0
Am employed by an organization which is highly regarded by other scientists	Yes	17	8
	No	1	0
Associate with other scientists of recognized ability	Yes	17	8
	No	1	0
Have the respect of other scientists	Yes	15	8
	No	3	0
Have opportunity to do inter- disciplinary research with scientists of different back- grounds	Yes	13	6
	No	5	2
Have opportunity to keep up to date on new scientific develop- ments in my field	Yes	15	7
	No	3	1
Have opportunity to do research that is challenging	Yes	18	5
	No	0	3
Have a large degree of freedom to manage my own work	Yes	15	6
	No	3	2
Have opportunity to do research that contributes to scientific knowledge	Yes	18	6
	No	0	2
Have opportunity to write up and publish research findings in ad- dition to TAROS reports	Yes	18	17
	No	0	1
Have adequate technical assistance	Yes	14	3
	No	4	5
Have funds available to conduct the kind of research I want to do	Yes	12	3
	No	6	5

organizational requirements and opportunities at TAROS frequently tended to be less adaptable to the entrepreneurial aspects of their role--obtaining financial support for research projects--and less adaptable to the minimal staffing pattern required of an organization which is totally dependent upon fluctuations in the market for research.

Scientists whose professional productivity was relatively high at TAROS (in terms of having published two or more papers in scientific journals based upon research they had conducted at TAROS) were much more likely to feel that they had adequate funds to do the research they preferred; whereas scientists whose professional productivity was not as high were slightly more likely to feel that they did not have sufficient funds, as is shown in Table 43. These findings are in accord with Leo Meltzer's findings (1956) to the effect that scientists who actually do have more research funds available and freedom to select their research topics are more likely to be professionally productive. Thus success as a research entrepreneur at TAROS was related not only to subjective feelings of satisfaction, but also to an objective indicator of scientific accomplishment based upon work at TAROS.

Table 43

OPINIONS OF TAROS SCIENTISTS ON
THE SUFFICIENCY OF FUNDS FOR RESEARCH
BY PROFESSIONAL PRODUCTIVITY

	Professional Productivity ^a	
	High (N = 9)	Low (N = 17)
Have sufficient funds for preferred research	7	8
Do not have sufficient funds for preferred research	2	9

-
- a. Professional productivity was arbitrarily rated as "high" if the respondent had published two or more papers in scientific journals based upon research he had conducted at TAROS.

Further analysis of the level of satisfaction of TAROS scientists indicated that seven of the eight scientists who were basically dissatisfied were employed in Laboratory A; only one dissatisfied scientist was in Laboratory B. It may be that the interdisciplinary (Laboratory B) form of research is more flexible and more adaptable to the conduct of applied research in an independent research organization like TAROS than is the more discipline-oriented (Laboratory A) program. In contrast, it may be that discipline-oriented programs are more compatible with the essentially basic research goals of academic research organizations.

To the extent that research organizations are staffed by professionally oriented scientists, however, individual scientists may be expected to exert pressure upon such organizations to provide them with at least some opportunities to do basic research oriented toward a professional audience. Even in industrial or government laboratories organized primarily for the conduct of research in certain product lines or service areas closely connected with the objectives of the larger organizational entity, scientists may work out mechanisms--such as "bootlegging"--to meet their professional interests. The provision of better facilities (funds, technical assistance, etc.) to conduct research compatible with the professional interests of individual scientists would seem to constitute a powerful incentive to attract, retain, and generally motivate scientists in such situations. The problem, of course, is the degree to which an organization like TAROS is capable of providing such incentives, in view of its objectives and financial structure.

Implications

This case study shows clearly that many scientists can feel challenged and satisfied by opportunities to do both basic and applied research in an independent research organization such as TAROS. The same thing is likely to be true of many scientists in industrial and governmental laboratories that provide some opportunity, at least, to do research of scientific as well as practical significance. Problems for research on this topic remain largely unexplored--for example:

1. What kinds of individual scientists (e.g., in terms of personal background) are most willing and able to conduct both basic and applied research within the general requirements of modern large-scale organizations?
2. What kind of organizational structure (e.g., interdisciplinary or discipline-oriented research groups) is most adaptable to applied and basic research requirements in combination?

3. What happens over time to individual orientations and organizational requirements in interaction with each other?

It has often been pointed out that academic scientists are more likely to be professionally oriented, whereas industrial scientists are more likely to be organizationally oriented. A question left unanswered is: Do scientists who are organizationally oriented tend to be attracted into industrial or governmental organizations because they are organizationally oriented at the time of initial hire? Or do they tend to become organizationally oriented after a period of industrial or government employment?

Although this case study has been exploratory in nature and is to be followed by more extensive and intensive research, and although it has involved only a small number of research scientists in an independent applied research organization, its findings do indicate directions for further research which might be of potential value to industrial and governmental organizations that employ scientists for R&D functions. From 1945 to 1962, expenditures for research have increased from 2 billion to 16.5 billion dollars in the United States.* The increased number and proportions of scientists, engineers, and other professional personnel in American business and industry may be expected to have an increasing impact upon organizational structure and incentive systems that will eventually modify the applicability of the Weberian bureaucratic model. Research activities in many industrial and government research organizations are partially subsidized by funds from corporate revenues or taxes not directly related to the research activity itself (but certainly indirectly related). However, increasingly higher research expenditures may have the effect of inducing a closer cost accounting over research activities than has typically been the case in industry and government in the past. Stricter cost accounting, in turn, could make many future R&D functions within the context of larger industrial and governmental organizations much more like independent research organizations, which are highly dependent upon the individual initiative of research scientists.

To the extent that research functions within larger organizational contexts become more independent and self-supporting, they may be expected to exert more pressure upon individual research scientists to

* Industrial Research, January 1962, p. 19.

assume a greater responsibility for raising funds for research within limited staffing constraints--that is, to become research entrepreneurs like the scientists at TAROS. The management of research entrepreneurs, in turn, requires certain adjustments and emphasis upon certain incentives. To the degree that an organizational environment inadequately provides for the fulfillment of research scientists' professional needs and interests, the scientists tend to work out their own mechanisms of adaptation, such as "bootlegging." The answers to the problem which sometimes results in "bootlegging" are not easily identified and must hopefully wait upon further research.

A P P E N D I X E S

Appendix A

EMPLOYEE ATTITUDE INVENTORY

(A questionnaire administered to 21 research scientists
and 3,005 other employees in seven organizations in
the western United States in 1961.)



STANFORD RESEARCH INSTITUTE
EMPLOYEE ATTITUDE INVENTORY

Stanford Research Institute is making a survey of employee attitudes in western industrial organizations. This survey includes a large number of employees in many different lines of work. Your company is one of many companies taking part in the survey. The purpose of the study is to add to general knowledge about what work means to employees in modern business and industry.

Do not sign your name to this questionnaire. Your answers will be anonymous and strictly confidential. No one will know who says what in this survey. No one in the management of your company will see any of the questionnaires after they are filled out. They will be taken directly to Stanford Research Institute, where your answers will be put together with the answers of thousands of other employees in other companies. Therefore, you can feel free to give honest and straightforward answers to the questions in this survey.

Please be sure to check one and only one answer to each question.
Do not spend too long on any one question.

Please pay no attention to the numbers alongside the spaces to be checked. They are for use in tabulating the answers.

Your cooperation in this survey will be appreciated very much.

The Meaning of Work

Work may mean different things to different people. Please check your answer to each of the following questions about what work means to you.

1. Which one of these statements is closer to the way you feel about your work? (check one)
 - 5-1 ☐ I put in my hours and do my work. In return I get a paycheck to spend for the things I need.
 - 2 ☐ Having this job makes me feel I am doing something important. There's more to it than getting paid.
2. Do you think of the work you are doing now as part of a career or trade you would like to follow for the rest of your working life? (check one)
 - 6-1 ☐ Yes, definitely
 - 2 ☐ Yes, probably
 - 3 ☐ No, probably not
 - 4 ☐ No, definitely not
 - 5 ☐ I don't know
3. Do you ever worry about the chance that you might lose your job at this company? (check one)
 - 7-1 ☐ Very often
 - 2 ☐ Sometimes
 - 3 ☐ Hardly ever
 - 4 ☐ Never
4. From your own point of view, which is more important to you: trying to get ahead in a job, or having a steady job you can depend on? (check one)
 - 8-1 ☐ Trying to get ahead in a job
 - 2 ☐ Having a steady job I can depend on

5. As you see it now, what do you hope you will be doing about ten years from now? (Read all the answers carefully, then check the one answer that applies best to you.)
 - 9-1 ☐ Working at the same company in the same line of work as I am now
 - 2 ☐ Working at the same company in a different line of work than I am now
 - 3 ☐ Working at the same company but promoted to a supervisory or management job
 - 4 ☐ Working at a different company in the same line of work as I am now
 - 5 ☐ Working at a different company in a different line of work than I am now
 - 6 ☐ Working at a different company, but promoted to a supervisory or management job
 - 7 ☐ Working in business for myself
 - 8 ☐ Retired, housewife, or not working for pay
6. Which of the following is most important to you? (check one)
 - 10-1 ☐ Keeping a job at this company even if I had to take a temporary cut in pay
 - 2 ☐ Keeping a job in my line of work even if I had to take a temporary cut in pay
 - 3 ☐ Keeping any good job I could get at my present rate of pay
7. Suppose you quit your job at this company. How easy do you think it would be for you to get a job in your line of work at another company? (check one)
 - 11-1 ☐ Very easy
 - 2 ☐ Fairly easy
 - 3 ☐ Not very easy

Work Relations

Please check your answer to each of the following questions about your relations to other people at your place of work.

1. Which of the following is more important to you? (check one)

12-1 ☐ That management in my company thinks I do good work

2 ☐ That other people in my line of work think I do good work

2. Think of the three people who are your closest friends. How many of them work for your company? (check)

13-0 ☐ None of them

1 ☐ One

2 ☐ Two

3 ☐ Three

3. Outside of working hours, about how often do you get together and talk about your work with other people in your line of work? (check one)

14-1 ☐ Never, or hardly ever

2 ☐ Once every month or so

3 ☐ Once every week or so

4 ☐ More often than once a week

4. Do you enjoy talking about your work off the job when you get a chance? (check one)

15-1 ☐ Yes, very much

2 ☐ Yes, somewhat

3 ☐ No, not very much

Supervision

Following are some questions about supervision. When a question is asked about your "supervisor," it means the person over you who usually tells you what to do in your work.

1. Taking everything into account, how satisfied are you with your supervisor? (check one)

16-1 ☐ Very satisfied

2 ☐ Satisfied

3 ☐ Somewhat satisfied and somewhat dissatisfied

4 ☐ Dissatisfied

5 ☐ Very dissatisfied

2. Suppose you felt your supervisor was unfair to you. In your company, would you be able to talk to a higher level supervisor about it? (check one)

17-1 ☐ Yes; there is a general rule in our company that complaints can be taken to higher level supervisors

2 ☐ Yes; there is no rule about it, but some of our higher level supervisors would listen to our complaints

3 ☐ No, I don't think I would be able to talk to a higher level supervisor without getting into trouble

3. Suppose you had a complaint about the way your supervisor treated you. Do you think it would do any good in your company to discuss your complaint with someone in the personnel office? (check one)

18-1 ☐ Yes, I think it probably would do some good

2 ☐ Yes, I think it might do some good

3 ☐ No, I don't think it would do any good

4. Suppose you had a complaint about the way your supervisor treated you. Suppose you talked it over with your supervisor, but you were not satisfied with his answers. Then where would you take your complaint? (check one)

19-1 ☐ To a higher level supervisor or member of management
 2 ☐ To someone in the personnel office
 3 ☐ To a union representative
 4 ☐ Other (write in here) _____
 5 ☐ There is no place I could take it
 6 ☐ I don't know

5. Then, if your complaint still wasn't taken care of to your satisfaction, where would you take it next? (check one)

20-1 ☐ To a higher level supervisor or member of management
 2 ☐ To someone in the personnel office
 3 ☐ To a union representative
 4 ☐ Other (write in here) _____
 5 ☐ There is no place I could take it
 6 ☐ I don't know

6. In your line of work, do you think it is important for supervisors to ask for employees' opinions before they plan the work to be done? (check one)

21-1 ☐ Yes, they should always ask for employees' opinions
 2 ☐ Yes, they should sometimes ask for employees' opinions
 3 ☐ No, it is not important

If yes, why do you think it is important for supervisors to ask for employees' opinions? (check one)

22-1 ☐ Because employees should take part in deciding how to do the work
 2 ☐ Because it makes employees feel their opinions are important to the company
 3 ☐ Some other reason

7. How often does your supervisor ask for your opinions before he makes plans regarding your work? (check one)

23-1 ☐ Always
 2 ☐ Very often
 3 ☐ Sometimes
 4 ☐ Not very often
 5 ☐ Hardly ever or never

8. Has your supervisor ever been to your home on a social visit or get-together? (check one)

24-1 ☐ Yes
 2 ☐ No

9. Which is closest to the way you feel? I think the best supervisors usually keep their closest friendships with: (check one)

25-1 ☐ Their employees
 2 ☐ Other supervisors
 3 ☐ It doesn't make much difference

Work Discipline

Sometimes companies "discipline" employees who do not follow company rules. For instance, an employee could be "disciplined" by being given several days off without pay, by not being given a promotion or a pay raise, or by being fired. Following are some questions on your opinions about discipline.

1. Suppose a supervisor says he saw an employee taking valuable supplies from the company. The employee said he didn't do it, but other employees say he has done this before. Should he be fired right away, or should he be given a hearing where evidence for and against him can be discussed? (check one)

- 26-1 ☐ He definitely should be fired right away
 2 ☐ He probably should be fired right away
 3 ☐ He probably should be given a hearing
 4 ☐ He definitely should be given a hearing

In your company, what do you think would happen in a case like this? (check one)

- 27-1 ☐ He would be fired right away
 2 ☐ He would be given a hearing
 3 ☐ I don't know

2. Should an employee who is being disciplined be given a hearing in all cases, only in case of firing, or not at all? (check one)

- 28-1 ☐ In all cases
 2 ☐ Only in cases of firing
 3 ☐ Not at all

3. Suppose an employee in your line of work gets drunk in a bar on Saturday night, gets into a fight, and gets his picture in the paper. Suppose when he comes to work on Monday morning his supervisor tells him he is fired, because what he did might give the company a bad name. Do you think the supervisor is treating the employee fairly? (check one)

- 29-1 ☐ Yes, it certainly is fair
 2 ☐ Yes, it probably is fair
 3 ☐ No, it probably is not fair
 4 ☐ No, it certainly is not fair

In your company, what do you think would happen in a case like this? (check one)

- 30-1 ☐ The man would be fired right away
 2 ☐ He would be warned not to let it happen again
 3 ☐ Probably nothing would be done about it
 4 ☐ I don't know

4. Suppose there is not much work available in some kind of highly skilled work, but there is a need for persons to do unskilled work. Suppose management asked a highly skilled employee to do this unskilled work for a few weeks at his regular rate of pay, but the employee refused, saying he would rather take a lay-off without pay for awhile. What do you think management should do about it? (check one)

- 31-1 ☐ Fire him for not doing what he was told to do
 2 ☐ Give him a temporary lay-off without pay

In your company, what do you think would happen in a case like this? (check one)

- 32-1 ☐ He would be fired for not doing what he was told to do
 2 ☐ He would be laid off without pay
 3 ☐ I don't know

Seniority

In some companies, employees with high seniority (who have worked longer for the company) are given certain special privileges connected with their work. Following are some questions about seniority.

1. Suppose there were less work available in your line of work, and your company had to lay off some people for a month or two without pay. Whom should they let go first? (check one)

- 33-1 ☐ Those who have been with the company or department for the shortest time
 2 ☐ Those who, in management's opinion, are the poorest workers

In your company, whom do you think would be laid off first? (check one)

- 34-1 ☐ Those who have been employed for the shortest time
 2 ☐ Those who, in management's opinion, are the poorest workers
 3 ☐ I don't know

2. Suppose your company has a job opening at a higher rate of pay. Who should be promoted into the job? (check one)

- 35-1 ☐ The employee at the next lower rate of pay who has been employed at the company longest
 2 ☐ The employee at the next lower rate of pay who has the best training and experience for the job

In your company, which employee do you think would be promoted? (check one)

- 36-1 ☐ The employee at the next lower rate of pay who has been employed at the company longest
 2 ☐ The employee at the next lower rate of pay who has the best training and experience for the job
 3 ☐ I don't know

3. Suppose an employee who had a good record at one company for 20 years was found guilty of stealing company supplies. Should he be fired for stealing supplies, just like a new employee might be, or should he be given some lighter form of discipline because of his 20 years of good service? (check one)

- 37-1 ☐ He definitely should be given a lighter form of discipline
 2 ☐ He probably should be given a lighter form of discipline
 3 ☐ He probably should be fired
 4 ☐ He definitely should be fired

In your company, what do you think would happen in this case? (check one)

- 38-1 ☐ The employee would be given a lighter form of discipline
 2 ☐ He would be fired
 3 ☐ I don't know

4. In your line of work, do you think an employee with high seniority should be given any special privileges? (check one)

- 39-1 ☐ Yes
 2 ☐ No

If yes, after how many years of employment in your line of work do you think an employee should be given special privileges because of seniority? (check one)

- 40-1 ☐ After 1 year of employment
 2 ☐ After 2 or 3 years of employment
 3 ☐ After about 5 years of employment
 4 ☐ After about 10 years of employment
 5 ☐ After about 15 years of employment
 6 ☐ After about 20 years of employment

Fair Treatment

Employees may have different ideas about what "fair treatment" by management means. Following are some questions about fair treatment.

1. To me, "fair treatment" means mostly:
(check one)

- 41-1 ☐ Getting the same treatment that other employees get--no favoritism
2 ☐ Having one's abilities recognized by management
3 ☐ Having management live up to its promises
4 ☐ Some other meaning

2. Have you ever felt you were treated unfairly by your present company?
(check one)

- 42-1 ☐ Yes, once
2 ☐ Yes, several times
3 ☐ Yes, many times
4 ☐ No, never

If yes, please tell about one time you think was important. Please write a few words about how you were treated unfairly.

3. In your company, do you think employees are generally treated fairly by management? (check one)

- 43-1 ☐ Yes, always treated fairly
2 ☐ Yes, treated fairly most of the time
3 ☐ Treated fairly about half the time
4 ☐ No, not treated fairly very often
5 ☐ No, never treated fairly

4. Are there any specific rules in your company to protect employees against unfair treatment by a supervisor?
(check one)

- 44-1 ☐ No, I don't know of any rules to protect employees
2 ☐ Yes, I know there are some rules to protect employees, but they are not followed very closely
3 ☐ Yes, I know there are some rules to protect employees that are followed pretty closely

5. Do you think there was more unfair treatment by management in companies 25 years ago than there is today?
(check one)

- 45-1 ☐ Yes, definitely
2 ☐ Yes, probably
3 ☐ No, I don't think so
4 ☐ I don't know

Personnel Practices

Following are some questions on your opinions about lay-offs, promotions, and overtime work.

1. Suppose there is not enough work to go around, and some people have to be laid off without pay. In your opinion, what is the better way for management to decide who should be laid off first? (check one)

- 46-1 ☐ By following a set of rules about lay-offs
2 ☐ By using their own judgment without using rules

Which way do you think your company would use? (check one)

- 47-1 ☐ Follow a set of rules about lay-offs
2 ☐ Use their own judgment without using rules
3 ☐ I don't know

2. When there is a supervisory job open, what do you think is the better way for management to decide who should be promoted into it? (check one)

- 48-1 ☐ By following a set of rules about promotions
2 ☐ By using their own judgment without using rules

Which way do you think your company would use? (check one)

- 49-1 ☐ Follow a set of rules about promotions
2 ☐ Use their own judgment without using rules
3 ☐ I don't know

3. Suppose there is some overtime work to be done for extra pay. In your opinion, what is the better way for management to decide who should do it? (check one)

- 50-1 ☐ By following a set of rules about overtime work
2 ☐ By using their own judgment without using rules

Which way do you think your company would use? (check one)

- 51-1 ☐ Follow a set of rules about overtime work
2 ☐ Use their own judgment without using rules
3 ☐ I don't know

Opinions about Work

Following are some statements of opinion. Please check how much you agree or disagree with each statement.

1. Where he has a choice, an employee ought to buy a product made by his own company rather than a product made by another company. (check one)

- 52-1 ☐ Strongly agree
2 ☐ Agree
3 ☐ Undecided
4 ☐ Disagree
5 ☐ Strongly disagree

2. When talking to people outside the company, it is all right for an employee to say a product made by his company is no good, if he thinks the product is no good. (check one)

- 53-1 ☐ Strongly agree
2 ☐ Agree
3 ☐ Undecided
4 ☐ Disagree
5 ☐ Strongly disagree

3. It would be all right for a supervisor to fire an employee for something he did outside working hours and away from the company. (check one)

54-1 ☐ Strongly agree
2 ☐ Agree
3 ☐ Undecided
4 ☐ Disagree
5 ☐ Strongly disagree

4. It is all right to fire a new employee during his probationary or trial work period if his boss doesn't like his personality. (check one)

55-1 ☐ Strongly agree
2 ☐ Agree
3 ☐ Undecided
4 ☐ Disagree
5 ☐ Strongly disagree

5. It is all right to fire an employee after he has been accepted as a regular employee if his boss doesn't like his personality. (check one)

56-1 ☐ Strongly agree
2 ☐ Agree
3 ☐ Undecided
4 ☐ Disagree
5 ☐ Strongly disagree

6. There should be definite rules to keep supervisors and other management officials from treating workers unfairly. (check one)

57-1 ☐ Strongly agree
2 ☐ Agree
3 ☐ Undecided
4 ☐ Disagree
5 ☐ Strongly disagree

7. Which do you think is most true about the job you have now? (check one)

58-1 ☐ The job duties would be the same, regardless of who filled the job
2 ☐ The job duties would change, depending on the person who filled the job

8. Looking ahead ten years from now, about how many people would you guess your company will employ in your line of work? (check one)

59-1 ☐ Fewer people than now
2 ☐ More people than now
3 ☐ About the same number of people
4 ☐ I have no idea

Wages and Salaries

1. Compared with wages or salaries in your line of work at other companies, how satisfied are you with your wage or salary? (check one)

60-1 ☐ Very satisfied
2 ☐ Satisfied
3 ☐ Somewhat satisfied and somewhat dissatisfied
4 ☐ Dissatisfied
5 ☐ Very dissatisfied

2. Compared with wages or salaries for other jobs in this company, how satisfied are you with your wage or salary? (check one)

61-1 ☐ Very satisfied
2 ☐ Satisfied
3 ☐ Somewhat satisfied and somewhat dissatisfied
4 ☐ Dissatisfied
5 ☐ Very dissatisfied

Communications

1. Do you feel you know all you need to know about policies and programs in your company? (check one)
- 62-1 ☐ Yes, I feel I know all I need to know about company policies and programs
- 2 ☐ No, I feel I need to know more about company policies and programs

Training Needs

1. Do you think there is any kind of special training you could take that would help you do your job better? (check one)
- 63-1 ☐ Yes, definitely
- 2 ☐ Yes, maybe
- 3 ☐ No

If yes, what subjects would this training cover?

General Job Satisfaction

1. Taking everything into account, how satisfied are you with the job you have now? (check one)
- 64-1 ☐ Very satisfied
- 2 ☐ Satisfied
- 3 ☐ Somewhat satisfied and somewhat dissatisfied
- 4 ☐ Dissatisfied
- 5 ☐ Very dissatisfied

Background Questions

It is necessary to find out a few things about the backgrounds of people who are answering this questionnaire, so the answers can be related to their background characteristics.

1. Are you: (check one)

65-1 ☐ Male

2 ☐ Female

2. What is your age? (check one)

66-1 ☐ Under 30 years

2 ☐ 30 - 39 years

3 ☐ 40 - 49 years

4 ☐ 50 years or over

3. Not counting adult education courses, how many years of school have you completed? (check one)

67-1 ☐ Some grammar school, but did not finish 8th grade

2 ☐ Finished 8th grade, but did not graduate from high school

3 ☐ High school graduate

4 ☐ Some college

5 ☐ Jr. college graduate (2-year course)

6 ☐ College graduate (4-year course or more)

4. What is the name of the company you are now working for?

5. How many years have you worked for this company? (check one)

68-1 ☐ Less than 1 year

2 ☐ 1 or 2 years

3 ☐ 3 or 4 years

4 ☐ 5 to 9 years

5 ☐ 10 to 14 years

6 ☐ 15 to 19 years

7 ☐ 20 years or more

6. Which describes best the kind of work you do? (check the one answer closest to your kind of work)

- 69-1 ☐ Skilled manual work in a journeyman trade, like a machinist or electrician, that requires four years or more to learn
 2 ☐ Manual work that requires less than four years to learn
 3 ☐ Retail sales work
 4 ☐ Clerical or secretarial work
 5 ☐ Semiprofessional, professional or scientific work
 6 ☐ Foreman or supervisor of manual workers
 7 ☐ Supervisor or manager of "white collar" personnel

7. What did your father do for most of his working life? (check the one answer that best describes the work your father did longest)

- 70-1 ☐ Worked on a farm he owned himself
 2 ☐ Worked on a farm owned by someone else
 3 ☐ Was a professional man
 4 ☐ Was in business for himself
 5 ☐ Worked as a supervisor or manager in a company or organization
 6 ☐ Worked as a nonsupervisory employee in a company or organization
 7 ☐ Was in military service
 8 ☐ Did not work at all
 9 ☐ I don't know

8. If the average person in your city were told your job title, do you think he would know what kind of work you do? (check one)

- 71-1 ☐ He probably would know what I do
 2 ☐ He might know what I do
 3 ☐ He probably wouldn't know what I do

9. How many persons besides yourself do you mainly support with your paycheck--that is, how many persons mainly depend on you for a living? (check one)

- 72-0 ☐ None, besides myself
 1 ☐ One, besides myself
 2 ☐ Two or more, besides myself

10. Are you a member of a trade union? (check one)

- 73-1 ☐ Yes, I now belong to a trade union
 2 ☐ No, not now, but I have been a member of a trade union in the past
 3 ☐ No, I have never been a member of a trade union

Do not write here

74-
 75-
 76-
 77-
 78-
 79-
 80-1

Incentives

How important are these things to you in your work?

1. Being employed by a company with a good reputation in the community (check one)

6-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

2. Having a friendly and considerate supervisor (check one)

7-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

3. Having a supervisor who treats employees fairly (check one)

8-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

4. Having a supervisor who knows his own job well (check one)

9-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

5. Having a supervisor who knows my job well (check one)

10-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

6. Having a supervisor who gives clear-cut instructions (check one)

11-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

7. Being well thought of by my supervisor because of my work (check one)

12-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

8. Being treated as a professional by my supervisor (check one)

13-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

9. Having close friendships with fellow employees outside work (check one)

14-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

10. Working with employees who are pleasant and friendly on the job (check one)

15-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

11. Being well thought of by other employees because of my work (check one)

16-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

12. Doing work that requires a lot of thought (check one)

- 17-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

13. Helping decide how the work should be done (check one)

- 18-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

14. Doing many different kinds of things in my job (check one)

- 19-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

15. Seeing my ideas put to use in the work (check one)

- 20-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

16. Having job security, so I am not worried about losing my job (check one)

- 21-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

17. Having chances for promotion into higher level jobs in my line of work (check one)

- 22-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

18. Having chances for promotion into higher level supervisory or managerial jobs (check one)

- 23-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

19. Having an adequate wage or salary (check one)

- 24-1 ☐ Extremely important
 2 ☐ Quite important
 3 ☐ Somewhat important
 4 ☐ Not very important

Please check whether or not the following things apply to your own work situation.

1. My company has a good reputation in the community. (check one)

- 25-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

2. My supervisor is usually friendly and considerate. (check one)

- 26-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

3. My supervisor usually treats employees fairly. (check one)

- 27-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

4. My supervisor knows his own job well. (check one)

- 28-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

5. My supervisor knows my job well. (check one)

- 29-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

6. My supervisor usually gives clear-cut instructions. (check one)

- 30-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

7. My supervisor thinks well of me because of my work. (check one)

- 31-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

8. My supervisor treats me as a professional. (check one)

- 32-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

9. I have close friendships with one or two of my fellow employees outside work. (check one)

- 33-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

10. Most of the employees I work with are pleasant and friendly on the job. (check one)

- 34-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

11. Other employees think well of me because of my work. (check one)

- 35-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

12. The work I do requires a lot of thought. (check one)

- 36-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

13. In my job I help to decide how the work should be done. (check one)

- 37-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

14. In my job I do many different kinds of things. (check one)

- 38-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

15. My ideas are sometimes put to use in the work. (check one)

- 39-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

16. I feel secure in my job, and I am not worried about losing it. (check one)

- 40-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

17. There are chances for me to be promoted into higher level jobs in my line of work. (check one)

- 41-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

18. There are chances for me to be promoted into higher level supervisory or managerial jobs. (check one)

- 42-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

19. I have an adequate wage or salary. (check one)

- 43-1 ☐ I think so
 2 ☐ I don't think so
 3 ☐ I don't know

PLEASE CHECK BACK AND MAKE SURE YOU HAVE CHECKED AN ANSWER TO EACH QUESTION.
 THANK YOU FOR YOUR COOPERATION.

Appendix B

ANNOUNCEMENT PRECEDING TAROS INTERVIEWS

Appendix B

ANNOUNCEMENT PRECEDING TAROS INTERVIEWS

To: (Scientist to be interviewed)

Date: November 21, 1961

From: (TAROS management official)

Subject: Request for Your Cooperation
in Study of Scientists

Dr. Howard Vollmer of Stanford Research Institute is conducting Phase I of a study of scientists employed in different organizational contexts. This study is sponsored by the U.S. Air Force Office of Scientific Research. The purpose of the study is to contribute to general knowledge about (1) what management expects of scientists working in different kinds of organizations (e.g., academic, government, or industrial laboratories), (2) what different kinds of scientists expect of their job; and careers in these different organizational contexts, and (3) work incentives (both monetary and nonmonetary) which can be used to bridge gaps between management expectations and employee expectations.

In order to explore methods and ideas to be used in future phases of this study, Dr. Vollmer or his assistant, Gerrie Carpenter, will be conducting interviews with approximately 26 physical scientists at TAROS in the near future. Each interview will not exceed one hour's duration, and can be arranged at a time and place to suit the convenience of the person being interviewed. In addition, each person interviewed will be asked to fill out a short questionnaire on certain background items.

Professional personnel in ("Laboratory A") and ("Laboratory B") at TAROS have been asked to participate in these interviews. Personnel from these two groups were selected in order to represent some variety in physical sciences research activities at TAROS.

Of course, the information collected in these interviews will be anonymous and will be detached from any personal references for reporting purposes.

Appendix C

INFORMATION COLLECTED FROM TAROS PERSONNEL RECORDS

Appendix C

INFORMATION COLLECTED FROM TAROS PERSONNEL RECORDS

1. Name :
2. Year of birth :
3. Date of initial employment at TAROS :
4. Education (list degrees) :
5. Marital status :

Appendix D

GUIDE FOR TAROS INTERVIEWS

Appendix D

GUIDE FOR TAROS INTERVIEWS

1. Do you have any questions about the purpose of the interview?
2. First, I would like to ask a few questions about your work activities--that is, about how much time you spend doing various things connected with your work.

On the average, about how many hours do you spend each week:

- a. Reading scientific books, articles, papers, or reports connected with your field? (Include time spent at home as well as at TAROS.)
- b. Writing research proposals?
- c. Planning research experiments or studies (aside from proposal writing)?
- d. Planning research costs and budgets?
- e. Working in the laboratory, or actually conducting experiments and research activities?
- f. Meeting with lab technicians or assistants and giving them instructions on experiments or studies?
- g. Meeting with project leaders or supervisors on project-related matters?
- h. Meeting with supervisors on more general administrative matters?
- i. Meeting with research colleagues?
- j. Meeting with TAROS clients?
- k. Interpreting and writing up the results of lab experiments and studies?

16. What do you feel are the best features of being employed by TAROS?
(Major source of satisfaction)
17. What are the disadvantages? (Major source of dissatisfaction)
18. How do you feel about your present salary compared with what scientists in your field make elsewhere?
19. How does your family feel about your present job at TAROS and in this area?
20. If you had your choice, what would you be doing and where would you be working ten years from now? Why?
21. Are there any other comments you would like to add?

Appendix E

CHECK LIST ADMINISTERED DURING TAROS INTERVIEWS

Appendix E

CHECK LIST ADMINISTERED DURING TAROS INTERVIEWS

The following items have been used in other studies of scientists. They refer to possible sources of job satisfaction in research activities. Please read over the list and indicate how important each item is to you in your work. (Each item is followed by the categories: "Extremely important," "Moderately important," "Not very important.")

1. Employment by an organization with a good reputation in the community
2. Employment by an organization which is highly regarded by scientists in my field
3. Opportunity to do research that helps solve problems in industry or government
4. Opportunity to do research that contributes to scientific knowledge
5. Opportunity to influence the work done on technical and scientific matters
6. Opportunity to do research that is challenging
7. Opportunity to keep up-to-date on new scientific developments in my field
8. Opportunity to do interdisciplinary research with scientists of different backgrounds
9. Opportunity to teach other people new things
10. Opportunity to write up and publish research findings in addition to TAROS reports
11. Opportunity for close contact with research clients
12. Respect among other scientists because of my work

13. Respect of TAROS management because of my work
14. Respect in the local community because of my work
15. Association with other scientists of recognized ability in scientific fields
16. A large degree of freedom to manage my own work
17. Funds available to conduct the kind of research I want to do
18. Opportunity for promotion within my scientific field at TAROS
19. Opportunity for promotion into management positions at TAROS
20. Treatment as a professional by TAROS management
21. A supervisor who treats employees fairly
22. A supervisor who knows his own job well
23. A supervisor who knows my job well
24. Adequate technical and clerical assistance
25. An adequate salary
26. Job security because of my attainments

The following are the same items that were used on the previous check list. Please look them over again and indicate the degree to which each item applies to your own present work situation. (Each item is followed by the categories: "Yes, definitely," "Yes, I think so," "No, I don't think so," "No, definitely not.")

1. I am employed by an organization with a good reputation in the community
2. I am employed by an organization which is highly regarded by scientists in my field
3. I have opportunity to do research that helps solve problems in industry or government
4. I have opportunity to do research that contributes to scientific knowledge
5. I have opportunity to influence the work done on technical and scientific matters
6. I have opportunity to do research that is challenging
7. I have opportunity to keep up-to-date on new scientific developments in my field
8. I have opportunity to do interdisciplinary research with scientists of different backgrounds
9. I have opportunity to teach other people new things
10. I have opportunity to write up and publish research findings in addition to TAROS reports
11. I have opportunity for close contact with research clients
12. I have the respect of other scientists because of my work
13. I have the respect of TAROS management because of my work
14. I have respect in the local community because of my work
15. I have opportunity to associate with other scientists of recognized ability in scientific fields

16. I have a large degree of freedom to manage my own work
17. I have funds available to conduct the kind of research I want to do
18. I have opportunity for promotion within my scientific field at TAROS
19. I have opportunity for promotion into management positions at TAROS
20. I am treated as a professional by TAROS management
21. I have a supervisor who treats employees fairly
22. I have a supervisor who knows his own job well
23. I have a supervisor who knows my job well
24. I have adequate technical and clerical assistance
25. I have an adequate salary
26. I have job security because of my attainments

Appendix F

SUPPLEMENTARY INFORMATION COLLECTED AFTER TAROS INTERVIEWS

Appendix F

SUPPLEMENTARY INFORMATION COLLECTED AFTER TAROS INTERVIEWS

1. Please indicate the approximate total number of years of employment you have had in (1) research and (2) nonresearch activities in each of the following types of organizations prior to employment at TAROS.

<u>Type of Organization</u>	<u>Number of Years</u>	
	<u>Employed Primarily in:</u>	
	<u>Research</u>	<u>Nonresearch</u>
	<u>Activities</u>	<u>Activities</u>
Military service	_____	_____
Government agency	_____	_____
Private industrial organization .	_____	_____
Academic institution	_____	_____
Independent research organization	_____	_____
Other: _____	_____	_____

2. Please list any professional societies or associations to which you now belong. Please indicate also the year you joined each.
3. In the past, have you ever been a member of any other professional societies or associations? If so, please list them here and indicate the year you dropped your membership in each.
4. How many meetings of professional societies or associations in your field have you attended in the past 24 months, if any?
5. How many research papers have you authored or coauthored for presentation at professional meetings during the past 24 months, if any?
6. Since becoming an employee of TAROS, have you attended more, fewer, or about the same number of professional meetings per year as you did before becoming an employee of TAROS?

7. Please list below all research publications you have written, if any, including (1) title, (2) coauthor(s), (3) name of publishing company or journal in which article was published, and (4) date of publication. Then with a check mark (✓) before the title, please indicate those publications which were based primarily upon research conducted at TAROS.

Appendix G

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Appendix G

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