CANADIAN SCIENTISTS: THEIR RESEARCH DEPARTMENT
STRUCTURE AND RESEARCH OUTPUT IN FOUR
TYPES OF ORGANIZATIONS

by
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We accept this dissertation as conforming to
the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

July, 1970
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Department of EDUCATION ADMINISTRATION

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ABSTRACT

Previous research has revealed a relationship between research department structure and scientist research output. Investigators have drawn on the findings of this research to make recommendations to research directors and administrators regarding the type of structure necessary to maintain high levels of scientist research output. Since the recommendations were made to research directors and administrators in general, the implication is that one type of research department structure should be utilized in all types of organizations. This, in turn, implies that the relationship between structure and output is constant across organization types.

Consideration of the goals and operating conditions in different types of organizations suggests that some organizations would tend to place greater structural constraints on scientists than others. In other words, differences in goals and conditions of operation make it almost impossible for research departments in different types of organizations to be structured the same way. If this is the case, the hypothesis that follows inevitably is that some types of organizations cannot have the one best structure and must suffer losses in research output.

An examination of some original research, however, reveals that the responding scientists were employed in a
variety of organization types. Moreover, the investigators made no attempt to examine the relationships between structure and research output on an organization type-by-type basis. There remains then, an equally plausible hypothesis, that scientists in different types of organizations accept the existing structure and that no basic incompatibility exists. This implies that the relationship between structure and research output is not constant across organization types, but varies from type to type.

The problem of this study, therefore, was to determine whether or not the relationships between research department structure and research output was constant across organization types. The main hypothesis tested was:

"The relationship between research department structure and research output varies across organization types."

Implicit in this hypothesis were two prior hypotheses.

1. There is a relationship between research department structure and research output.

2. Research departments in different types of parent organizations are structured differently.

Also implicit in the main hypothesis was a type of summary hypothesis, which properly followed the main hypothesis.

3. Relationships between research output and structure found in combined organization samples are different than relationships found in separate organization samples.
These general hypotheses were tested by examining information obtained from testing related specific hypotheses. The data necessary for the testing of the specific hypotheses was obtained from questionnaire responses provided by scientists from four types of organizations—business, government, social development, and university—who were mailed questionnaires in order to obtain measures of reported research output, and perceptions of research department structure. 523 scientists or 45% of the sample, returned a completed questionnaire. Another 15% of the sample provided reasons for not responding.

Examination of the data related to Hypothesis Number One indicated that in a combined organization sample, levels of reported research output were:

1. positively associated with levels of perceived (a) influence to decide own work goals and objectives, (b) decentralized control of research activities, and
2. negatively associated with levels of perceived (a) supervisor influence to decide scientist work goals and objectives, and (b) centralized control of research activities.

On the basis of this information, Hypothesis Number One was accepted.

Examination of the data related to Hypothesis Number Two indicated that scientists in different types of organizations perceived different levels of:
1. emphasis to be placed on particular criteria used in the selection of research projects;
2. time expenditures in basic and applied research;
3. time pressure on their work;
4. influence to decide work goals and objectives;
5. supervisor or department head influence in deciding their work goals and objectives;
6. centralized and decentralized control of research activities;
7. coordination of efforts for common objectives.

On the basis of this information Hypothesis Number Two was accepted.

Examination of the data related to Hypothesis Number Three indicated that high research output scientists, in different types of organizations perceived different levels of:
1. influence in deciding their work goals and objectives (university scientists only);
2. immediate supervisor or department head influence in deciding their work goals and objectives;
3. centralized and decentralized control of research activities; and
4. coordination of efforts for common objectives.

On the basis of this information, Hypothesis Number Three was accepted. Hypothesis Number Four was also accepted because examination of the data indicated that responses from high
research output scientists in combined organization samples—as compared to responses from separate organization samples—differed in the same ways as those listed above.

In summary, this study found relationships between research output and research department structure. Research departments in different types of parent organizations appeared to be structured differently. Finally, relationships between structure and research output varied across organization types, as well as between separate and combined organization samples.

In conclusion, the present study indicated that there is no 'best' type of research department structure for all organizations.
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Implicit in the research work and writings of some investigators is the assumption that there is a relationship between research department decision-making structure and scientist research output. These investigators indicate that scientists require such things as autonomy, an absence of coordination, decentralized decision-making, participative leadership, and so on, in order to achieve high levels of research output.¹ That is, not only does there seem to be a relationship between structure and research output, but a particular kind of relationship. In other words, previous research indicates that there is a particular kind of research department structure related to high research output.

¹Amitai Etzioni, Modern Organizations (Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1964), p. 76. ...Only if immune from ordinary social pressures and free to innovate, to experiment, to take risks without the usual social repercussions of failure, can a professional carry out his work effectively. It is this highly individualized principle which is diametrically opposed to the very essence of the organizational principal of control and coordination by superiors--i.e., the principle of administrative authority. Also, P.R. Lawrence, Organizing for Innovation, an address before the Second Harvard Business School, Pittsburgh Regional Conference, April 4, 1964, pp. 3-4. There is now beginning to be some research evidence to support what many intuitive managers have known for a long time... There is fairly clear evidence that research and development units, if they are to supply the right kind of working environment for innovators, need to follow their own type of organization. Research organizations seem to provide a most stimulating
The identification and study of the structural variables associated with scientist research output has occupied Pelz and Andrews for many years. Their dedication to the search for these variables is indicated in the introduction to their book, *Scientists in Organizations*.

What constitutes a stimulating atmosphere for research and development? That was the guiding question for the six-year exploration described in this book. Each of the following chapters gives results on specific aspects of that question.2

This book is based on the premise that R & D organizations provide more than facilities for their members. They also provide an "environment" which may either stimulate or inhibit the scientists' performance.3

... What we must concern ourselves with are the conditions that are common to all scientists, for the kind of environment which stimulates the creative side of the average scientist is the same environment in which genius flourishes.


3Ibid.
Some of the results and conclusions of the Pelz and Andrews study appeared to support the writings and research of other investigators. That is, they found relationships between research department structural variables and scientist research output.\(^4\)

Pelz and Andrews discussed their results and conclusions at the end of each chapter in their book, and made practical suggestions to research supervisors and administrators.

These results are intriguing as scientific data about research administration and in addition, are also useful. They describe characteristics of organizations, and organizations can be "changed" toward more favorable forms. Individual scientists and engineers, for example, can alter their working relationships with colleagues; often they can steer themselves into (or out of) certain types of commitments. Through such changes the individual researcher can alter his own environment so as to gain more stimulation from it.

The director or supervisor of R & D, using similar techniques and his substantial power as an administrator, can produce changes in his laboratory which increase the likelihood of achievement. Each chapter concludes with a section on implications, usually in the form of a dialogue, which attempts to translate the findings into practical steps for the R & D manager.\(^5\)

\(^4\)Pelz and Andrews, op. cit., pp. 17-32. For example, Pelz and Andrews formed a positive association between levels of reported research output and perceived levels of influence to decide work goals and objectives. They also found that scientists who reported high levels of research output, also perceived particular levels of research coordination ("moderate"), along with particular levels of influence to decide work goals and objectives ("high").

\(^5\)Pelz and Andrews, op. cit., p. 2.
The samples of scientists given questionnaires by Pelz and Andrews, for their study, however, came from several different types of organizations. In their book, they did not consider organization type as one of their units of analysis in studying the relationships between levels of scientist research output and levels of emphasis on various structural variables. They stated that "We did not design the research to test a systematic organization theory."

Ibid. The data on which the study is based come from 1311 scientists and engineers located in eleven different laboratories. Included were 641 professionals in five industrial laboratories specializing in pharmaceuticals, glass and ceramics, electronics, and electrical equipment. Also included were 144 professors from seven departments of a midwestern university (biological, physical, and social sciences) and 526 scientists and engineers from five government laboratories (weapons guidance, animal diseases, commercial uses of agricultural products, and basic research in several physical sciences).

From these three factors, five "primary analysis groups" were defined as follows. These will be used throughout the book.
A. Ph.D.'s in Development-Oriented Laboratories. Half of these were located in industry, half in government.
B. Ph.D.'s in Research-Oriented Laboratories. Two-thirds were in the university (all of our academic scientists were in this category) and one-third in government.
C. Non-Ph.D.'s in Development-Oriented Labs not Dominated by Ph.D.'s. About three-quarters (primarily engineers) were in industrial locations, one-quarter in government.
D. Non-Ph.D.'s in Ph.D.-Dominated Laboratories (either research-or development-oriented). Half of these "assistant" and "subordinate" scientists) were in government, half in industry.
E. Nondoctoral Scientists in Research-Oriented Labs not Dominated by Ph.D.'s. All of these were in government settings.

Pelz and Andrews, op. cit., p. 32.
Since practical suggestions and recommendations were made by Pelz and Andrews to research directors and administrators in general, the implication is that one type of research department structure should be utilized in all types of organizations. This assumption also suggests that scientists are a unique group of people and require special organizational treatment if they are to be made productive. 

The assumption implied in the work of Pelz and Andrews, and the writings of other investigators raises an interesting practical question. If one were trying to maximize research output in a research department, would one tend to do the same things in different types of organizations? Put another way, would the research supervisor in the business organization tend to place the same levels of emphasis as the department head in a university, on particular research department structural variables?

\[\text{Pelz and Andrews, op. cit., p. 2. This set of laboratories was deliberately heterogeneous, but not a representative sample of research organizations. We went where we could gain entree. Some types of labs were missing—the basic research lab in industry, for example, or the independent not-for-profit institute. Although it is possible that findings would have been markedly different in these types of labs, from what was found in those that were studied, this seems unlikely. Reported here are conditions which enhanced performance for a wide variety of research personnel. Thus the idiosyncrasies of particular locations became less important.}\]

\[\text{[*All data were collected in American laboratories and it is not clear how applicable the findings would be in other countries. Although it is possible that the motivational and environmental conditions which enhance intellectual functioning (including research and development) are similar everywhere, the study which demonstrates this has yet to be conducted.]}\]
One would expect scientists in university research departments, and in business organization research departments, to be "organized" in a different way. The business organization, with its "profit" goal, is likely to be more "efficiency" conscious, and exercise more control over decisions about what the scientist does, than the university. Any research carried out in a business organization, that did not make some kind of contribution to the organization's profit-making goal, would likely be considered "inefficient." To ensure that "inefficiency" is kept to a minimum, research supervisors would likely exert a high level of influence over scientists' decisions about work goals and objectives.

The universities' goal of "discovering new knowledge--for its own sake," however, would appear to require a lower level of research supervisor or department head influence in deciding scientist work goals and objectives. No matter what work goals or objectives scientists selected for research, they would theoretically make some contribution to "new knowledge." Hence, because they would be making a contribution to the universities' goal, there would be no need for department heads to exert more than a low level of influence over scientists' decisions about work goals and objectives.

10 Peter M. Blau and R.W. Scott, Formal Organizations (San Francisco: Chandler Publishing Co., 1962), p. 49. ...Business concerns . . . privately owned and operated for a profit. The dominant problem of the business concern is operating efficiency--the achievement of maximum gain at minimum cost in order to further survival and growth in competition with other organizations.

11 University of Waterloo, Brief to the Special Senate Committee on Science Policy, No. 47, May 28, 1969, p. 5972.
Consideration of the goals and operating conditions in different types of organizations suggests that some organizations would have to place greater structural constraints on scientists than others. In other words, differences in goals and conditions of operation make it almost impossible for research departments in different types of organizations to be structured the same way. If this is the case, the hypothesis that follows inevitably is that some types of organizations cannot have "the one best structure," and must suffer losses in research output.

A re-examination of Pelz and Andrews research, however, reveals that the responding scientists were employed in a variety of organization types. Moreover, the investigators made no attempt in their text to examine the relationships between structure and research output on an organization type-by-type basis.\textsuperscript{12}

\textsuperscript{12}F.M. Andrews and D.C. Pelz, Analysis Memos From the Study of Scientific Personnel, #7 and #8, Survey Research Center, Institute for Social Research, The University of Michigan, Ann Arbor, Michigan, March 1961, p. 83. Earlier, in one of their analysis memos, however, Pelz and Andrews appeared to use organization type as a unit of analysis. They stated that: In subsequent analyses, we would not be justified in combining university departments with those in other locations, the differences in departmental atmosphere are too great. . . Government scientists are more diversified in their departmental atmospheres than we find among industrial scientists. . . As one might expect, university scientists perceive the greatest autonomy in departmental operations; industrial scientists report the least; and government scientists stand at an intermediate level.
There remains then an equally plausible hypothesis, that scientists in different types of organizations accept the existing structure and that no basic incompatibility exists. 13

The scientist in the business organization, for example, may perceive a lower level of influence to decide his work goals and objectives than the scientist in the university. The business organization scientist, however, may accept this constraint as one of the norms of the business organization. He may even perceive this constraint as necessary for maximizing the research department's contribution to the organization's goals and objectives. 14 He may also have similar

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13 Robert H. Knapp, Personality Committee Report in 1956 Utah Conference, pp. 229-241. We know, from the analysis of situational factors discussed here two or three times, the effects of different social climates on creativity and upon the type of man who will be creative in different climates. One man will do well in the industrial situation, another will require to be in an academic calling. Also, B.G. Glaser, Organizational Scientists: Their Professional Careers (Indianapolis: The Bobbs-Merrill Co. Inc., 1964), p.3. Glaser indicates that scientists typically work in many different organizations. Perhaps this is a search for a compatible research department structure. ...Scientists standard career pattern is one of moving about the university departments, affiliated research groups, sometimes in government, non-profit or industrial research organizations, always seeking better research conditions, and more interesting, more prestigious, and perhaps more profitable positions.

personal interests and goals to those of the research department and be quite willing to accept any "reasonable" constraints in order to work on his research.15

To maximize the contribution of scientists to organizational goals and objectives, therefore, research supervisors in different types of organizations may exert different levels of emphasis on some research department structural variables. These different levels of emphasis may be accepted by scientists in the different organizations as normal and have no adverse effect on scientist research output. This implies, therefore, that the relationship between structure and research output is not constant across organization types, but varies from type to type.

central theme of most earlier organizational studies, which have tended to focus on the question of what is the one best way to organize, irrespective of the external environmental conditions facing the business.

(ii) . . . the authors have developed a contingency theory of organization which, rather than propounding one best way to organize under all conditions, focuses on the organizational characteristics which lead to effective performance given the specific demands of an organization's environment.


. . . I think you see that the crucial variable is the degree to which the organization's own goals coincide with the goals and intrinsic interests of those members within it who are supposed to create. . . . Now, at some points in industry, you get a happy marriage between individual interests and organizational objectives. . . . The goals of the corporation are identical with the interests of the people who will provide the creativity for it. The advertising agency thrives to the extent that it produces creative, outstanding advertising. Each individual in that firm personally thrives to the extent that he creates outstanding advertising. There is no clash; there is no problem. The reason you get away with regimentation in this case is that people are already preregimented in the same interest that you have.
Now if one were to combine research departments from business organizations and universities into one sample, and examine the relationship between level of research output and another variable such as level of scientist influence to decide work goals and objectives, the relationships found in the combined sample may differ from the relationships found separately in each type of organization. That is, although level of scientist influence to decide work goals and objectives may be positively associated with level of research output, the particular level of influence may vary from one type of organization to another, and be different again when the organization types are combined.\textsuperscript{16} If this is the case, the findings from combined organization samples would be difficult for research directors to utilize, because relationships

\textsuperscript{16}Morris I. Stein, A Transactional Approach to Creativity, 1956 Utah Conference.

If a company is one in which a high value is placed on "basic" or "pure" research, and a man is expected to fulfill scientific-professional roles, then the constellation of factors that would predict creativity in this environment would have greater weights placed on man's theoretical values, capacity to deal in abstractions and independence than would be the case in a company where there is greater emphasis on professional-social roles. Also, by considering both companies as a single unit, significant differences "wash out", and we don't learn the true story.
specific to any one organization type would not be available. That is, if relationships between research department structural variables and research output vary across organization types, the relationships in a combined organization sample would tend to be "washed out" or different than the relationships found in separate organization samples.

Questions

The main question for consideration, therefore, is whether or not the relationships between research department structure and research output vary across organization types. Related to this question, are two prior questions that also need to be answered.

1. Is there a relationship between research department structure and research output?
2. Are research departments in different types of parent organizations structured differently?

Also suggested in the main question is a type of summary question, which properly follows the main question:

4. Are relationships between research output and structure found in combined organization samples, different than relationships found in separate organization samples?

Statement of the Problem

The problem of this study is to determine whether or not the relationship between research department structure and research output are constant across organization types.
In order to study this problem, the following hypothesis is put forward for testing.

**Main Hypothesis**

Relationships between research department structure and research output vary across organization types.

Implicit in this hypothesis are two prior hypotheses.

**Prior Hypothesis (Number One)**

There is a relationship between research structure and research output.

**Prior Hypothesis (Number Two)**

Research departments in different types of parent organizations are structured differently.

Also implicit in the main hypothesis is a type of "summary hypothesis" which was alluded to in the discussion. Since this hypothesis properly follows the main hypothesis, it is called Hypothesis Number Four.

**Summary Hypothesis (Number Four)**

Relationships between research output and structure found in combined organization samples are different than relationships found in separate organization samples.
STUDY PLAN

To study the problem, the following plan will be utilized.

Review of Literature

The review of literature will be concerned, first of all, with the identification or classification of several types of organizations. Literature relevant to each of these different types of organizations will be studied to determine the levels of emphasis particular structural variables receive, in order to maximize scientist research output. Specific hypotheses relevant to the three general hypotheses will be constructed from the information obtained. It is hoped that by testing each of the specific hypotheses enough information will be obtained to test each of the general hypotheses.

Research Methods and Procedures

Questionnaire responses from scientists in research departments in several types of organizations will provide the data for the study. Research output will be measured by the number of project completion reports; articles published in journals; speeches; books and monographs each scientist reports he has completed. Levels of emphasis on research department structural variables will be measured by the
frequency of scientists questionnaire responses regarding the level of emphasis they perceive particular structural variables to receive in their research departments. The questionnaire respondents will be selected from social science departments in several types of organizations in Canada.\(^\text{18}\)

**Analysis of Data**

Four separate analyses of data relevant to each of the four general hypotheses, will be carried out.

The first analysis will be concerned about the relationships between levels of research output and levels of emphasis on research department structural variables. Frequencies of scientist responses regarding levels of emphasis and levels of output perceived will be examined in order to determine whether or not relationships exist.

The second analysis will examine the frequency of scientist responses regarding the level of emphasis they perceive to be placed on particular research department variables.

\(^{17}\) Most studies that include measurements of research output utilize these items as measures of research output. For a more complete analysis of the validity and reliability of these items, see Appendix ix.

\(^{18}\) Most studies of this kind have been carried out in the United States, and involved scientists from the physical, biological, chemical and medical sciences, primarily. The investigator was more interested in the Social Sciences, and in carrying out the study in Canada.
The frequency of scientist responses at each level of emphasis will be compared across organization types. The purpose of this analysis is to determine whether or not scientists in different types of organizations perceive different levels of emphasis to be placed on particular structural variables.

The third analysis will examine the frequency with which scientists who have high levels of research output, perceive particular levels of emphasis on structural variables. The purpose of this investigation is to determine whether or not high output scientists in different types of organizations perceive different levels of emphasis to be placed on structural variables.

The fourth analysis will compare combined organization samples with separate organization samples, to determine whether or not relationships between high output and structure vary from separate to combined samples. Data from the tables used in the third analysis, will be used for the fourth and final analysis.
CHAPTER II

ORGANIZATION TYPES AND RESEARCH DEPARTMENT

STRUCTURAL VARIABLES

Four Types of Organizations

Hills, in his text *Toward a Science of Organization*, identified four different types of organizations. He made distinctions between types according to the societal function or goal around which they were organized. A section from his text provided some of the reasons why one might select (a) business organizations, (b) government organizations, (c) social development organizations, and (d) universities, to represent four different types of organizations in our society.

Basis of Classification

The attainment of a goal by an organization is in the integrated case, the performance of a function on behalf of the society of which it is a part. Hence, the first distinction that can be made among organizations is in terms of the type of social function or goal, around which they are organized. Accordingly, we may distinguish organizations with adaptive, goal-attainment, integrative, and pattern-maintenance goals, depending on the function performed for the society as a system. From this point of view, the principal types of organizations are:

1. Organizations oriented to economic production. The business firm is the most obvious example of organizations with economic primacy.
2. Organizations oriented to the attainment of collective goals. Governmental organizations are the most prominent examples of this type.
3. Organizations oriented to integration. These are organizations which on the societal level contribute to the adjustment of conflicts and the direction of motivation to the fulfillment of
institutionalized expectations. The courts, legal firms, political parties which mobilize support for government, interest groups, and hospitals are included here.

(4) Organizations oriented to the expression and maintenance of cultural patterns and the maintenance of the pattern of the units of the system. Churches and schools are the most clear cut examples.¹⁹

Briefs to the recent Special Senate Committee on Science Policy supported this classification, in that they also identified (a) universities, (b) business and industrial firms, and (c) government organizations as being the organization types carrying out the bulk of research in Canada.²⁰ Although "social development" agencies were not mentioned as frequently, they presented more briefs and were referred to more often than any other organization type, and appeared to meet the criteria in Hills' classification system for the "integrative" organization. Social development agencies, therefore, were the fourth type of organization to be considered in this review of literature.

The goals of each of these organizations, their organizational characteristics, and the implications of these goals and organizational characteristics for their research department organization and scientist research output, will be discussed


²⁰Proceedings of the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, Brief No. 40), p. 4943, Brief No. 50, p. 6282; Brief No. 48, pp. 6098, 6148, 6150; Brief No. 47, p. 5985, 6041 and 5947-48/ Brief No. 61, p. 7372, Brief No. 44, p. 5733. These briefs contain examples of the references made about different organization types carrying out research. The list is by no means complete, but is representative of what is contained in terms of references about research in other briefs.
in succeeding sections of this chapter.

The Business Organization

The goal of the business organization, according to Hills, is economic production—making a profit from the production of goods or services. Blau and Scott also stated that the goal of the business firm is to make a profit and to do this, management must be concerned about operating efficiency.

Business concerns . . . privately owned and operated for a profit. The dominant problem of the business concern is operating efficiency—the achievement of maximum gain at minimum cost in order to further survival and growth in competition with other organizations.

According to this statement, all activities carried out within a business organization should make some contribution to the organization's profit-making goal. Any activities that do not make such a contribution are likely considered "unprofitable" and an "inefficient" expenditure of the organization's resources.

In a business organization, therefore, one would expect a scientist's research activities to make a contribution to the organization's profit-making goal. That is, in this

21Hills, loc. cit.


23See Appendix (xii) for definitions of research activities.
type of organization, the scientist would tend to select projects only if they appeared to make a contribution to the organization's profit-making goal. Stein appeared to support this thinking in the following statement about scientist commitments:

By accepting a position with a company, a researcher both implicitly and explicitly accepts the tasks of working on problems related to the products that the company produces.  

Quinn and Mueller gave further support to the idea that in business firms, research activities should be directed toward the organization's profit-making goal.

The second step in transferring technology efficiently from research into operations is to make sure that the research and development program is specifically designed to support the company's goals and fulfill its technological needs: This "targeting" of research and development involves two essential activities: (1) developing a company-wide long range plan into which R and D are properly integrated and (2) providing adequate commercial information to rank, and balance R and D programs to meet company goals.  

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The research scientist in the business firm, therefore, would appear to utilize as his main criteria in the selection of his research projects, the criteria that his research projects make a contribution to the organization's profit-making goal. To make such a contribution, the scientist would likely restrict his research activities to particular problems of an applied nature, that have commercial value. He would tend to be concerned about the organization's problem of "maximizing marketable outputs at minimum cost," and avoid "inefficient" expenditures of his research efforts on research projects that did not make a contribution to the organization's financial well-being. He would also tend to be concerned about completing his research work as fast as possible—since efficiency would require speed, as well as careful selection of projects.

To ensure that scientists make a contribution to the organization's profit-making goal, research supervisors in business organizations may exert considerable influence on decisions about scientist work goals and objectives.26 These

26 Carl E. Barnes, Industrial Research: Is it Outmoded? in Business Horizons (vol. 7, no. 1; Bloomington, Indiana: Graduate School of Business, Indiana University, Spring, 1964), p. 90. "What kind of new products should management be looking for? ... A complete understanding of corporate objectives by the research staff is perhaps the most essential factor in improving research productivity. No research man wants to waste time on a project he knows will not be accepted by management... With this understanding, the research department can institute sound plans, recruit the right kind of personnel, set up the proper screening tests, and select appropriate ideas for further study."
research supervisors would also tend to be involved in "coordinating" the research efforts of the scientists, toward a common objective—a product, or service of commercial value. To be able to participate effectively in influencing scientists' decisions about work goals and objectives, and in the coordination of scientist efforts, the research supervisor would likely have some delegated authority to make decisions about scientist work goals and objectives. There would likely be a "centralized" control of scientist research activities, therefore, in research departments, in this type of organization. Consequently, the scientist would not likely perceive himself to have high levels of influence to decide his own work goals and objectives.

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27 Quinn, *op. cit.*, p. 124. In selecting individual projects and experiments, there is no question that companies must ultimately rely on the judgement and imagination of individual researchers. But top-level scientific and general managers must plan the framework within which the researcher makes his choice. They must: 1. establish the broad objectives and strategies which the program should be designed to support, 2. see that researchers and research managers are selected on the basis of both their scientific competence and how well their backgrounds and interests fit the defined scope and interests of the company.

28 James C. March and Herbert A. Simon, *Organizations* (New York: Wiley, 1958), pp. 140-141. Once the objectives of the organization are formally established, the hierarchical organization of responsibilities serves as a framework for means-ends chains—specifying for each official the ends of his tasks and thus confining his duties to the selection of the best means for achieving these ends...; also, Amitai Etzioni, *Complex Organizations* (New York: The Free Press of Glencoe Inc., 1961), pp. 80, 141. "There are several reasons why organizations that have economic goals function more
Government Organizations

Government organizations, according to Hills' classification criteria, are "oriented to the attainment of collective goals." The attainment of collective goals would appear to involve the provision of various services, considered necessary by the public-at-large, and too difficult to provide on an individual basis. A government organization would tend to be the type that is concerned about providing many different services to the public.

In Canada, each of the three levels of government (municipal, provincial, and federal) have "departments" created to provide these different services for the public it serves. For example, at the provincial level we have a department of education whose function is to see that educational services are provided to the people of the province. How these services are provided, the nature of the services, who should receive them and so on, is decided primarily by

effectively when they employ remuneration than when they employ coercion or normative power as their predominant means of control. Production is a rational activity, which requires systematic division of labour, power, and communication, as well as a high level of coordination. It therefore requires also a highly systematic and precise control of performance.

Utilitarian organizations emphasize vertical instrumental communication as a condition of effective production. Since this is the most rational type of the three, and since coordination, planning and centralized decision making are emphasized here more than in the other two types (normative and coercive). . ."

29Hills, loc. cit.
the political party in power, through its representative in the department concerned. That is, the Minister of Education is the representative of the political party "in power" who supervises the services provided by the Department of Education.

The public served by each level of government usually knows, to a certain extent anyway, about the kinds of services that will be provided by a political party, if it is elected and "put in power." Most political parties that "run" for election "advertise," prior to election, the goals and objectives of their party, and the services they intend to provide if elected. By receiving votes and being elected to govern, the political party is given authority, by the public concerned, to pursue the goals and provide the services that were advertised.

Through the legitimate use of its authority which defines the rights and obligations of the party in power to do as it has been authorized by the public that elected it, the party makes decisions about the kinds of activities it will engage in, in order to implement its goals and provide the services it advertised at election time. If "good decisions" are made, that is, if the party is able to implement the goals and provide the services advertised, the party is usually re-elected for another term. If "good decisions" are not made, the public may withdraw its authority to make decisions, by voting in another party. In order to continue in power, therefore, the political party will usually extend
some effort toward implementing its stated goals and providing the services it advertised. Hence, each department, supervised by a representative of the political party, will be expected to implement a particular set of goals and provide some services advertised by the political party.

In supervising the activities of a department, the party representative (or Minister, at the provincial and federal level) must make decisions about how best to utilize the resources at his disposal, in order to maximize progress toward the goals, and provision of services, to which his department is committed. In order to make good decisions, he may require information that he does not have on hand. Some of the information may be provided by civil service officials from the various sub-departments within his department. These sub-department officials may have the information on hand, or they may be required to direct members of their sub-department to carry out research, in order to provide the information required by the supervising party representative. In any event, the supervising party representative of a government department may delegate, to those with less authority, the responsibility of providing him with research information that will enable him and the government, to make good decisions. The following statements by government officials appear to support this kind of thinking.
The basic purpose of the Research and Development Program, which consists of five branches with the major research activities concentrated in two of them, it to improve the quality of public and private decision-making on policy formulation and program administration in the labour field through the provision of optimum research and intelligence functions.\(^{30}\)

...[Research] programs are developed to meet the policy needs of the department and of the Federal Government, and are designed to increase understanding of industrial relations problems and issues, and to provide a basis for the intelligent formulation of policy.\(^{31}\)

... The goal of D.B.S., as outlined in the Statistics Act 50 years ago is "generally to organize a scheme of coordinated social and economic statistics pertaining to the whole of Canada and to each of the provinces thereof. ... The Bureau is a major element of the information system upon which public and private individuals and institutions draw in studying social and economic conditions and problems and in making logical decisions.\(^{32}\)

The system of placing decision-making authority, regarding the goals and objectives of an organization, in the hands of one person at the top of a hierarchy, and having subordinates from different levels and departments below him provide

\(^{30}\)Department of Labour, Brief to the Special Senate Committee on Science Policy (Ottawa: Queens Printer, No. 27, February 6, 1969), p. 3817.

\(^{31}\)Canada Dept. of Labour, Brief to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, No. 27, February 6, 1969), p. 3849.

\(^{32}\)Dominion Bureau of Statistics, Brief to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, No. 24, February 5, 1969), pp. 3481-3482, 3498.
him with decision-making information, is typical of the organization with a centralized control of its activities. Each person within the organization is usually responsible for making some decisions that decide the activities of people below him in the hierarchy. Each person, in turn, is usually responsible to someone above him for decisions that decide his activities.

Scientists, in their particular research departments, therefore, would likely have research projects delegated to them from someone in a higher authority position. That is, they would likely be told by someone of higher authority, within their research department, the research projects from which to make a selection. The criteria used by the government research scientist, in the selection of research projects, therefore, would likely be whether or not the research project was "delegated by some higher authority."

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The Centralization and Decentralization of Authority

The authority system provides premises for decision within the hierarchy of the organization. The commands of a superior are taken as "givens," thus decidedly limiting the freedom for decision of the subordinates. When there is centralization within an organization, many decisions are taken at the top of the authority structure, so that decisional latitude is narrower for those in intermediate and lower positions, thereby restricting opportunities for non-conforming, creative decisions.
Close coordination of research activities would likely take place in government research departments. Each scientist would likely be responsible to the research supervisor for providing part of the research information that was required for a research project or projects delegated to the research supervisor from someone of higher authority. In order to maximize the contribution from each scientist, the research supervisor would tend to avoid duplication or overlapping of scientist work goals and objectives. This would require the research supervisor to coordinate the scientists' efforts toward the common research objective—providing information relevant to the delegated research project.\(^{34}\)

In such a department, therefore, the scientist would tend to perceive the research supervisor as having considerable influence in deciding his work goals and objectives. He would likely perceive himself, therefore, as having a low level of influence to decide his work goals and objectives.

One would also expect scientists in government research departments to spend a considerable amount of time

\(^{34}\) Edgar N. Schein, Organizational Psychology (Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1965), pp.7-8. Tied up with the concept of coordination and the rational achievement of mutually agreed upon goals is the idea that such goals can best be achieved if different
on research projects that provide specific information about particular problems, of an applied nature, of interest to the decision-makers. Research time spent on other projects would tend to be viewed as "wasteful" of the resources available to the department. The following statements tend to support this view.

Presumably most of the governmental intramural research is relatively closely mission-oriented, mainly applied and includes a small developmental component.  

Research projects for government departments and even Royal Commissions though limited in scope and quantity are directed to immediate situations and are almost entirely "mission-oriented."  

As already indicated earlier in this Brief, our Department is mission-oriented and the bulk of our research activities is of an applied nature. As the need arises between 8% and 10% of the time of our scientists may be devoted to fundamental research in order to obtain the fundamental information required for the solution of practical problems.  

things in a coordinated fashion. . . . the very idea of coordination implies that each unit submits to some kind of authority for the sake of achieving some common goal. . . . An organization is the rational coordination of the activities of a number of people for the achievement of some common explicit purpose or goal, through division of labour and function, and through hierarchy of authority and responsibility.

35 University of Guelph, Research Advisory Board, Brief submitted to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, No. 47, May 1969), p. 6041.  

36 Social Science Research Council of Canada, Brief to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, No. 57, June 10, 1969), p. 7018.  

Social Development Organizations

Some of the criteria used by Hills to describe the goals of his "integrative" organizations appeared to apply to social development organizations. The "fulfillment of institutionalized expectations" criteria, in particular, seemed to correspond to the "social development" criteria of the social development organization. That is, "developing" or improving the societal living conditions of a particular social group, appeared to be the same as "fulfilling the institutionalized expectations" of people in some groups. Being "disadvantaged" in some way, and not capable of achieving on their own the standard of living expected by the "average Canadian," these people are assisted by social development organizations to move toward a "full development of their potentials." Included in groups assisted by social development organizations are people from socially disadvantaged areas such as the "poverty pockets" in Canada; people from special institutions for the various physical, mental and emotional disorders; people with inadequate education and vocational training; and so on.

38 Hills, loc. cit.

39 Much of this discussion material was obtained from discussions with officials from the Alberta Human Resources Research Council, Alberta Newstart Corp., and Nova Scotia Newstart Corp. as well as from correspondence with social development research department directors.
These social development organizations which are partly financed by voluntary contributions from other members of society, partly by government and partly by the people served; provide services to assist the people concerned to cope with their problems, and raise their standard of living. The services vary from organization to organization, but their goal of "social development" appears to be the same.

The criteria that the research scientist in a social development organization would tend to use in the selection of his research projects, therefore, would be whether or not the project would make a contribution to the well-being of some social group. That is, a particular social group his organization was concerned about assisting. To make this contribution, the research project would have to provide information of practical value to the personnel providing the direct assistance to the socially disadvantaged group. People providing these services would tend to require specific information for the solution of particular problems of an applied nature. The scientist, therefore, would likely spend much of his time on problems of this kind.

An example of some social development organizations are the Canada Newstart Corporations, which direct their efforts to solving the social development problems of people in particularly disadvantaged areas, or "poverty pockets," in Canada. The goal of these newstart organizations is to
"develop, through action research, methods and programs which will prove their effectiveness in helping to motivate and prepare unemployed and under-employed adults for work."\textsuperscript{40} By "action research," Newstart officials were referring to research activities directed toward the identification and solution of practical problems the social group was confronted with.

In order to make a contribution to the organization's social development goal, some coordination of scientist research efforts would likely be required. That is, given a common goal and objective, the scientists' efforts within a social development research department would likely be coordinated, so that a maximum contribution to the groups' social well-being was made. To effectively coordinate scientist research activities one would expect the research supervisor, therefore, to have some delegated authority, and exert considerable influence in deciding scientist work goals and objectives. The scientist, in turn, may perceive himself to have a low level of influence to decide his work goals and objectives--and may even perceive his research department as having a "centralized" control of research activities.

\textsuperscript{40}Department of Regional and Economic Expansion, Brief to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, No. 4, April, 1969), p. 4943.
In order to identify and solve the different social development problems, however, new knowledge about the dynamics of various social groups, their culture, values and possible reactions to social development programs would have to be obtained. This new knowledge—probably obtained from basic research programs—would not be immediately applicable to particular problems, without further research of an applied nature. That is, social development research departments would probably require some basic research, to support their applied research program. 41

Since basic research is, by definition, "discovery of new knowledge, not immediately applicable to particular problems," it could not be coordinated or controlled too much, without changing its nature. There would tend to be, therefore, somewhat less coordination and direction of some social development scientists' research activities. Some of the scientists engaged in some basic research would tend to perceive themselves to have considerably high levels of influence in deciding their work goals and objectives—and likewise would tend to perceive their research supervisors as not having high levels of influence on decisions about their

41 A Newstart research director told the writer that some basic research was required to support their "action research" programs.
work goals and objectives. Feeling less supervisor control over their research activities, some social development scientists may perceive the research department to have a "decentralized" control of scientist activities.42

There would tend to be, therefore, considerable variation in the organizational characteristics and research activities of scientists, in social development research departments.

The University

Hills identified schools and churches as "oriented to the expression and maintenance of cultural patterns."43 Presumably he was referring to the goals these organizations have of both educating and transmitting the culture of the society to those in attendance. The following statement by McDonald appears to support the idea that universities, as "relatives" of schools, also belong to organizations of this type.

42 A decentralized decisional structure provides scope for innovative behavior through its emphasis upon the development of solutions appropriate to the different environments encountered in the various extensions of the organization. When authority is delegated, full advantage can be taken of broad latitude by those able to develop creative responses to an ever-changing environment in which their organization functions. . . Thus one speculates: a dispersed distribution of authority within a firm provides more occasions for innovation, creative decision-making. . ., Guetzkow, loc. cit.

43 Hills, loc. cit.
We see the universities having an important role to conduct basic research where there is no application in sight, research which has cultural value and educational value to our society and without which our society would be destitute from a cultural and educational standpoint.\(^4\)

The university, according to MacDonald and other authoritative sources, differs from the other three types of organizations in that the research activities carried out by the scientists are not of the "means-to-an-end" type. That is, the university appears to have no other goal (such as making a profit, assisting a social group, or providing information for decision-makers) than teaching and research. Research in such an organization would tend to be an end in itself, because in most cases it would not be utilized except for educational purposes. The following statements seem to give further support to these ideas.

Institutions of higher education have two primary functions: teaching and research. These functions are concerned with "knowledge for its own sake," but they are also concerned with the scientific, technological, economic,

\(^4\)Dr. J.B. MacDonald, Executive Vice President, Committee of Presidents of Universities of Ontario, Brief to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, No. 43, May 21, 1969), p. 5670.
social and cultural development of all the communities which they serve, whether local, provincial, regional, national or international.\(^45\)

... much of the university research is indeed of long-term interest and must not be sacrificed to immediate or short-term needs of society. This long term, often disinterested research or "quest for knowledge for its own sake"...\(^46\)

The main points in the research role of the university are:

a) much of the research should be fundamental, aimed at producing new knowledge on a broad front;

b) considerable portion of the fundamental research can be concentrated in selected areas, i.e., broadly mission-oriented;

c) applied research of a mission-oriented nature should be conducted in the university to the mutual advantage of the university and the nation;

d) consulting activities on the part of the faculty should be provided...

e) development research activities should not be carried out in any volume by the university.\(^47\)

Because his projects would be selected with little concern for immediate application, one would expect the university research scientist to engage in more "basic"

\(^{45}\) Association of Universities and Colleges of Canada (AUCC), Brief to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, No. 44, May 27, 1969), p.5733.

\(^{46}\) University of Waterloo, Brief to the Special Senate Committee (Ottawa: Queen's Printer, No. 47, May 28, 1969), p. 5972.

\(^{47}\) University of Guelph Research Advisory Board, Brief to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, No. 47, May 1969), pp. 6041-6042.
research activities than scientists in the other organization types. Scientists in business firms, government organizations, and social development agencies, because of the "means-to-an-end" applicability of their research, would tend to engage in more applied research activities.\textsuperscript{48}

In a university, a scientist would tend to have high levels of influence to decide his work goals and objectives. It wouldn't really matter what his research goals and objectives were, as long as he selected some research projects and engaged in some research activities, he would, theoretically be making a contribution to the university's goal of "discovering new knowledge." This freedom of the university scientist to decide his own work goals and objectives, was considered by Steacie, to be very important.

The chief reason why the university is the ideal place for scientific work (the social sciences included) is that the work is uncommitted. The university man is free to proceed in any direction which he sees fit, and should not in any way be influenced by practical considerations. The university is, in fact, virtually the only place where science can be pursued for its own sake.\textsuperscript{49}

\textsuperscript{48}Amitai Etzioni, Modern Organizations (Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1964), p. 81. In organizations whose goal is non-professional (e.g. profit-making), it is considered desirable for administrators to have the major (line) authority because they direct the major goal activity. Professionals deal only with means, with secondary activities.

Berelson acknowledged that university research scientists have considerable decision-making freedom regarding research.

... the administrator in an academic institution has no real authority and must defer the important decisions about whom to hire, and what the curriculum will be, and whom to promote to tenure, to the cumbersome machinery of faculty voting. Everyone knows that the dean cannot fire him or tell him exactly what to teach or influence his research or his decision to organize a McKinsey Seminar.50

In summary, the university scientist would tend to select projects that were "interesting in themselves" and make some contribution to "new knowledge" because he considered "the search for new knowledge to be intrinsically good." He would not likely be as concerned as his colleagues in other types of organizations about the "discovery of specific knowledge, for the solution to particular problems (applied research)." He would tend to be more concerned about the "discovery of new knowledge, not immediately applicable to particular problems (basic research)." Free of most work goal constraints and the need for supervision or coordination, the university scientist would tend to perceive high levels of influence to decide his work goals and objectives.

The preceding sections described the goals and objectives of scientists in research departments, in four different

types of organizations. Also discussed were the structural constraints on scientists brought about by the need for research supervisors to exert influence on scientist decisions, and coordinate scientist efforts toward some common objectives. Research evidence from the Pelz and Andrews study supported the discussion material regarding the differences—in scientist freedom to decide work goals and objectives, and coordination of efforts toward some common objectives—one might expect to find in research departments in different types of organizations. Their research evidence indicated that university research scientists perceived more influence to decide work goals and objectives and less coordination of their research efforts than either industrial or government research scientists. Industrial research scientists perceived the least amount of influence to decide work goals and objectives, and the most coordination of research activities, while government research scientists stood at an intermediate level on both counts.  

51 Pelz and Andrews, op. cit., pp. 216-217. Pelz and Andrews did not use "organization type" as their unit of analysis. They used possession of Ph.D. etc. as indicated in footnote number 7. The fact that some of these units of analysis contained primarily government scientists, university scientists, and industrial scientists, permitted these deductions. Comparable results were also found in their analysis memos (loc. cit, 1961).
Research Department Structural Variables

The preceding discussion and review of literature identified some of the research department structural variables that might receive different levels of emphasis in different types of organizations, in order to enhance research output. As a result of these different levels of emphasis, scientists in different types of organizations would likely perceive different:

1. levels of influence to decide work goals and objectives;
2. levels of supervisor influence in deciding their work goals and objectives;
3. levels of coordination of efforts for some common objectives;
4. levels of centralized or decentralized control of research activities;
5. levels of importance in utilizing particular criteria in the selection of research projects;
6. levels of time expenditures on basic and applied research activities; and
7. levels of time pressure under which they work.

Specific Hypotheses Related to Hypothesis Number One

Hypothesis Number One states that there is a relationship between research department structure and research output. The first four structural variables are utilized in the construction of specific hypotheses, which then tested, are designed
to provide information with which to test Hypothesis Number One.

**Specific Hypothesis Number 1A**

In a combined organization sample, levels of reported research output will be positively associated with levels of perceived influence to decide work goals and objectives.

**Specific Hypothesis Number 1B**

In a combined organization sample, levels of reported research output will be negatively associated with levels of perceived supervisor or department head influence in deciding scientist work goals and objectives.

**Specific Hypothesis Number 1C**

In a combined organization sample, levels of reported research output will be positively associated with levels of perceived decentralized control, and negatively associated with perceived levels of centralized control of research department activities.

**Specific Hypothesis Number 1D**

In a combined organization sample, levels of reported research output will be negatively associated with levels of coordination of scientist efforts for common objectives.

**Specific Hypotheses Related to Hypothesis Number Two**

Hypothesis Number Two states that research departments in different types of parent organizations are structured differently. The seven structural variables are utilized in
the construction of specific hypotheses, which when tested, are designed to provide information with which to test Hypothesis Number Two.

Specific Hypothesis Number 2A

Scientists in different types of organizations will tend to perceive some project selection criteria to receive different levels of emphasis.

Specifically:

Hypothesis 2A1. More scientists in business organizations, than in the other types of organizations, will respond that it is important to select research projects that contribute to the organization's financial well-being.

Hypothesis 2A2. More scientists in government organizations, than in the other types of organizations, will respond that it is important to select research projects that are delegated by some higher authority.

Hypothesis 2A3. More scientists in social development organizations, than in the other types of organizations, will respond that it is important to select research projects that contribute to the well-being of some social group.

Hypothesis 2A4. More scientists in universities, than in the other types of organizations, will respond that it is important to select research projects that are interesting in themselves.
Hypothesis 2A. More scientists in universities, than in the other types of organizations, will respond that it is important to select research projects that seek new knowledge, because the search for new knowledge is intrinsically good.

Hypothesis Number 2B

Scientists in different types of organizations will perceive different levels of emphasis on time expenditures in basic and applied research activities.

Specifically:

Hypothesis Number 2B1. More scientists in business, government and social development organizations, than in universities, will perceive themselves to emphasize high expenditures of time in applied research activities.

Hypothesis Number 2B2. More scientists in universities, than in the other types of organizations, will perceive themselves to emphasize high expenditures of time on basic research activities.

Hypothesis Number 2C

More scientists in business organizations, than in the other types of organizations, will perceive themselves to work under high levels of time pressure.

Hypothesis Number 2D

More scientists in universities, than in the other types of organizations, will perceive high levels of influence to decide their work goals and objectives.
Hypothesis Number 2E

More scientists in business, government and social development organizations, than in universities, will perceive immediate supervisors or department heads to have high levels of influence to decide their work goals and objectives.

Hypothesis Number 2F

Scientists in each type of organization will tend to perceive different levels of emphasis on centralized or decentralized control of research department activities.

Specifically:

Hypothesis Number 2F₁. More scientists in universities, than in the other types of organizations, will perceive high levels of "decentralized" control of research department activities.

Hypothesis Number 2F₂. More scientists in business, government and social development organizations, than in universities, will perceive high levels of "centralized" control of research department activities.

Hypothesis Number 2G

More scientists in business, government and social development organizations, than in universities, will perceive high levels of coordination toward common objectives.
Specific Hypotheses Related to Hypothesis Number Three

Hypothesis Number Three states that the relationship between research department structure and research output varies across organization types. The first four structural variables are utilized in the construction of specific hypothesis, which then tested, are designed to provide information with which to test Hypothesis Number Three.

Hypothesis 3A

There will be a greater tendency in universities, than in the other types of organizations, for high levels of reported research output to be associated with scientist perceptions of high levels of influence to decide their own work goals and objectives.

Hypothesis 3B

There will be a greater tendency in business, government, and social development organizations, than in universities, for high levels of reported research output to be associated with high levels of perceived supervisor or department head influence in deciding scientist work goals and objectives.

Hypothesis 3C

Relationships between high levels of reported research output and perceived levels of emphasis on centralized and decentralized control of research department activities will vary across organization types.
Specifically:

**Hypothesis 3C₁.** There will be a greater tendency in business, government and social development organization, than in universities, for high levels of reported research output to be associated with perceptions of high levels of emphasis on centralized control of research department activities.

**Hypothesis 3C₂.** There will be a greater tendency in universities, than in the other types of organizations, for high levels of reported research output to be associated with perceptions of high levels of emphasis on decentralized control of research department activities.

**Hypothesis 3D**

There will be a greater tendency in business, government, and social development organizations, than in universities, for high levels of reported research output to be associated with perceptions of high levels of coordination of research efforts for common objectives.

**Specific Hypotheses Related to Hypothesis Number Four**

Hypothesis Number Four states that relationships between research output and structure found in combined organization samples, are different than relationships found in separate organization samples. The first four structural variables are again utilized in the construction of specific hypotheses, which when tested, are designed to provide infor-
Specific Hypothesis Number 4B

Relationships between levels of reported research output and perceived levels of supervisor or department head influence in deciding work goals and objectives found in combined organizational samples, will differ significantly from the relationships found in separate organization samples.

Specific Hypothesis Number 4C

Relationships between levels of reported research output and perceived levels of centralized and decentralized control of research activities found in combined organization samples, will differ significantly from the relationships found in separate organization samples.

Specific Hypothesis Number 4D

Relationships between levels of reported research output and perceived levels of coordination of research efforts for common objectives found in combined organization samples, will differ significantly from the relationships found in separate organization samples.
CHAPTER III

RESEARCH METHODS AND PROCEDURES

In order to study the various research department structural variables and their association with scientist research output, as planned, the populations to be sampled had to be identified, a questionnaire had to be constructed and administered to the samples, and the data obtained had to be analyzed. The questionnaire was designed to obtain some information about the scientists' personal background, their research outputs, as well as perceptions about their research department decision-making structure. This questionnaire was mailed to research scientists in business organizations, government organizations, social development organizations, and universities. Responses to the questionnaire items were coded and punched on computer cards. These "data" were then manipulated by a computer to provide frequency and percentage frequency tables of responses to the questionnaire items.

Details of the methods and procedures utilized will be discussed in succeeding sections of this chapter.

Identification of the Sample

It was decided that scientists from research departments in universities, social development organizations, government organizations and business organizations would be
included in the samples to be studied. These scientists would, according to the review of literature, represent scientists from four different types of organizations.

After an extensive search of the university library and after enquiries directed to librarians in different departments in the library, it was discovered that lists of organizations with research departments did not exist. The most useful sources of information were the university calendars and the McGraw-Hill Directory for Canada.\(^{52}\) By corresponding with people in the various technical and scientific associations listed in the directory—as well as corresponding with people in departments in some of the major universities across Canada and provincial and federal government departments—leads were obtained regarding the identity of some research departments.

These leads provided a tentative list of research departments for the sample. More information about these departments was required, so a short information sheet was sent to the research department directors and department heads of the research departments on the list. The information obtained from this information sheet—and later used in the classification of these research departments—was

simply whether or not the research departments were part of (a) a university, (b) a government organization, (c) a business organization, or (d) a social development organization. Other information such as (a) date the research department started operations, (b) number of scientists, (c) the main purpose and functions of the research unit, and (d) source of financial support, was useful in making decisions about whether or not a research unit had been in operation long enough, whether or not the research unit was really a department of a particular organization type, and how many questionnaires would be needed.

The information provided in response to "Please describe the main purposes and functions of your research unit" helped determine whether or not research departments were concerned, in some way, with social science research. Since it really did not matter whether the scientists were social scientists or not, except as a way of restricting the sample size and providing a more homogeneous sample, no research department was withdrawn from the sample unless it was clearly not of the social sciences. 53

A response rate of eighty percent to all preliminary enquiries was obtained. A response rate of almost one hundred percent was obtained to the information sheet questions.

53 About fifty percent of these research departments were visited and the directors and department heads interviewed. Two large research departments were withdrawn from
Directors and department heads of these research departments were promised the publication of a much-needed directory of social science research departments, in exchange for the information. In the correspondence with these directors and department heads, it was pointed out that this was the first stage of a study of Canadian research scientists.

Since the university calendars provided lists of faculty members in each of the social science research departments and since the main objective of the correspondence was to classify the research departments and obtain research personnel lists, it was not considered necessary to correspond with university social science department heads.

The university social science research department list was much larger than the research department lists from the other organization types. A random sample from small, medium and large size departments was taken to reduce this sample size.  

The names of the research scientists in each of the other research departments on the sample lists were obtained from the research department directors. This was accom-

the sample when it became clear that they were industrial research units, employing only non-social scientists.

54 The random sample procedure is described in Appendix (i). Also see Appendix (ii) for the sample breakdown, according to organization type and research department size.
plished by either visiting them or by corresponding with them. These directors were promised a Directory of Canadian social science research departments as well as a summary of the results of the study, if they would provide a list of their research personnel. They were shown the questionnaire during the interview, or during correspondence. In all cases, these research directors cooperated by providing a research scientist personnel list. The visiting and correspondence was carried out in June, 1969.

The questionnaires were mailed to the research scientists as soon as the personnel lists were obtained. The university sample was the only sample that did not receive questionnaires in June, 1969. They received questionnaires in mid-September in order to avoid the possibility of questionnaires "going astray" during summer session, when personnel are on holiday, teaching in other institutions, or involved in research elsewhere.\(^{55}\)

The questionnaire "package," sent to each Canadian research scientist, contained a self-addressed envelope, a self-addressed post-card, a cover letter and the questionnaire. The cover letter introduced the objectives of the

\(^{55}\)Several faculty members from U.B.C. strongly advised against sending questionnaires to universities during the summer. They stated that staff are either on holiday, teaching, or catching up on their own research.
study to the research scientists, and asked their cooperation in completing and returning the questionnaire. They were promised that a copy of the summary of the results of the study would be forwarded to their research department for their perusal.

The scientists were also informed that the identity of the research department, and their own personal identity, would not be revealed in any written reports. Scientists were not asked to sign the questionnaire. They were asked, however, to sign their name and the name of their research department on the back of the self-addressed post-card. They were asked to send these post-cards in the mail, separate from the questionnaires. This procedure kept their identity secret, provided a record of returns, and permitted follow-up procedures to be used.

The number of post-cards returned corresponded almost exactly with the number of questionnaires received from each research department.  

The Questionnaire

A questionnaire designed by D.C. Pelz and F.M. Andrews --for the study of scientists in research and development

In some cases the handwriting was illegible and names could not be checked off, but credit for a return was given to the particular research department. Since the name of the research department and organization to which it belonged was part of the questionnaire information, a check was made and the tally of post-cards and questionnaires for each research department matched almost perfectly.
laboratories in the United States—was modified and added to for this study. These authors had been studying the performance of scientists in organizations for almost twenty years, had written numerous papers, and finally a book called Scientists in Organizations. Compared to other writers studying scientists in organizations, Pelz and Andrews had written more and been cited more often than any other authors encountered in the course of this study.

Besides evidence that Pelz and Andrews were "pioneers" in the field under study, the questionnaire they had constructed was particularly appropriate. It had items which appeared to measure some of the variables this study was concerned about. With minor alterations, therefore, some of the Pelz and Andrews questions were included in the preliminary questionnaire for this study. The alterations were primarily concerned with:

(a) altering the response system from percentage-type answers to five point rating scales; and

(b) re-wording questions slightly, so that they were more appropriate for Canadian social scientists.

57 It was recognized that questionnaires, at best, measure the "perceptions" of scientists only, and that responses to questionnaires do not necessarily represent reality.
Other questionnaire items suggested by the theoretical discussion and review of literature, were also included with the Pelz-Andrews items and became part of the preliminary questionnaire.

After the preliminary questionnaire was constructed, it was field-tested by administering it to ten scientists. These scientists were from social science departments in the University of British Columbia and from the Alberta Human Resources Research Council (HRRC). These people were asked to complete the questionnaire as if they were respondents. They were also asked to comment, in the margin of the questionnaire, on items they considered to be irrelevant, objectionable, vague, poorly worded, and generally in need of further consideration. The purpose of the field test, in this case, was to "polish up" the questionnaire items.

Suggestions received from these scientists were listed and reviewed with a sociologist employed by the HRRC. This sociologist was considered by staff at HRRC to be an expert in questionnaire design. When final revisions were completed, the questionnaire was printed.  

**Questionnaire administration.** As mentioned earlier, on receiving the scientist personnel lists, questionnaire

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58 See Appendix (iv) for the questionnaire items. Also see Appendix (v) for a discussion of the validity and reliability of the Pelz-Andrews items.
packages were immediately mailed to the research scientists. Returns were received quite steadily for about a month before dropping off to one or two per day. When this occurred, a rather strong follow-up letter, with altruistic overtones, was mailed to each non-respondent. Returns picked up immediately for another two weeks. About ten percent of these scientists responded, and some said they had "mislaid" their original copies of the questionnaire and promised to return one, if another copy was sent to them. This was done, of course.

The second follow-up, after two weeks, included a questionnaire "package" similar to the first, but with a different cover letter. This letter explained the purpose of the study, mentioned that a number of questionnaires had "done astray," and that this package was provided should this be the case. They were promised that a copy of the results would be forwarded to their research department for their perusal and so on, as in the first cover letter. This letter also asked them to respond on the post-card, if there was any reason why they would like to be excluded from the sample. Returns increased again for about two weeks, then dropped off to a "dribble" for another month. About 45 percent of the total sample population (523 scientists) returned a question-

59 See Appendices (vi-viii) for the letters.
Another 15 percent of the sample population gave a reason for not responding. Altogether, therefore, a response rate of 60 percent was obtained.

Preparation of Data for Analysis

The research output items in the questionnaire required numerical coding before responses could be transferred to computer data sheets. A special numbering system recommended by the authors of the computer program used in this study, retained the numerical identity of each respondent, his research department and the organization type of which his research department belonged. After scientists responses to questionnaire items had been transferred to computer data sheets, the data from these sheets were keypunched on computer cards. These cards became the "data decks" for the four types of organizations.

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60 See Appendix (ii) for the distribution of questionnaire returns.

61 See Appendix (iii) for a table of the reasons given for not responding to the questionnaire.

62 Missing data was coded as "0" in all cases, as the computer program used for this study could be sub-programmed to omit "0" responses in statistical calculations.

63 Susan Boyer et al., U.B.C. MVTAB, The U.B.C. Computing Center, Vancouver, B.C., 1966, pp. 8-9. Actual identity of scientists was not known—just the name of the research department in which they worked and the type of organization in which they were classified. Questionnaires were number coded, therefore, to give each respondent a numerical identity containing this information.
Included in the "control deck" for computer programming were provisions to have the response systems for each variable, or question under study, collapsed to "low," "medium," and "high" ratings, or scores. For example, a five point rating scale became

\[
\begin{align*}
\text{L} & \quad \text{M} & \quad \text{H} \\
(1,2) & \quad (3) & \quad (4,5)
\end{align*}
\]

This was done in order to reduce the number of "cells" in the tables of responses, and thus increase the cell frequency for later statistical work.

A special computer program was written for this study in order to combine the five output measures into two measures, and thus increase the frequencies for each measure of output.\(^{64}\) The number of speeches, project completion reports, and articles accepted by journals became "output number one." The number of books or monograph completed, became "output number two."\(^{65}\)

The computer program provided by the U.B.C. Computing Center designed for questionnaire analysis, was included in the "control deck" and submitted with each of the "data decks" for computer "runs."\(^{66}\) Each control deck provided for

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\(^{64}\) Courtesy of John Campbell, U.B.C. Computing Center.

\(^{65}\) See Appendix (ix) for the rationale behind the selection of these items to represent research output. See Appendix (v) for a discussion of the validity of these items.

\(^{66}\) Susan Boyer, \textit{loc. cit.}\)
the construction of univariate and bivariate frequency and percentage frequency tables of responses of scientists to either one question (the univariate case) or two questions (the bivariate case) at a time.

Data from each computer print-out--regarding scientist responses to each question or pair of questions--were transferred to comprehensive frequency and percentage frequency tables so that responses could be compared. Chi-square values and contingency coefficients were then computed for these comprehensive tables on an electric calculator.\(^67\)

The final computer run involved combining the data decks of scientist responses from the four types of organizations into one data deck or sample. Data from the print-out, including the chi-square values for bivariate tables were again transferred to a comprehensive frequency and percentage frequency table.

Analysis of Data: Testing for Significance

In keeping with the principle of parsimony, which states that phenomena should be explained on the basis of the simplest explanation consistent with all the facts of the case, it was assumed that any differences to be noted in the way scientists

\(^{67}\)See Appendices (x) and (xi) for the formulas and rationale for using each of these statistics.
responded was due to chance. Specifically, null hypotheses which deny the existence of any real differences between the "expected" frequency of responses and those "observed"—until the factor of chance has been eliminated as the causative agent in the discrepancy—were assumed for statistical testing. 68

According to the null hypothesis, only when the difference noted is greater than might be accounted for on the basis of chance fluctuations, can it be assumed that the difference is "significant." The null hypothesis was "rejected if the probability of obtaining such a difference on the basis of chance alone, was very small. The null hypothesis was "accepted" of course, when the difference was within the range of differences adequately accounted for by chance. 69

It was decided that the null hypothesis would be rejected if the probability of obtaining the difference in responses observed was less than .05. That is, if the probability of obtaining the observed chi-square value was .05 or less, the difference in scientist responses—from what


69 Ibid.
would be expected by chance—was said to be significant at the .05 level. The .05 probability level, therefore, was descriptive of the degree of confidence one could have that a real difference was observed.  

G.E. Ferguson, Statistical Analysis in Psychology and Education (New York: McGraw-Hill Book Co. Inc., 1959), pp. 132-133. Ferguson stated that it is conventional to accept probabilities of .05 or .01 as standards of significance. Also Mouly, op. cit., pp. 152-154. The level of improbability necessary to lead to the rejection of the null hypothesis is obviously a matter of judgment, based on the nature of the problem and the risk the investigator is willing to take. Two types of errors are involved here. Type 1 or Alpha errors—refer to the acceptance of the null hypothesis when it is actually false. Type 2 or Beta errors, on the other hand, refer to the rejection of the null hypothesis when it is actually true. . . Actually the only two ways in which both types of errors can be reduced simultaneously—and not at the expense of one another—would be by taking larger samples and/or reducing the sampling variability by selecting a more restricted population. It is, therefore, a matter of compromise. One type of error must be balanced against the other, and the level of acceptance and rejection of the null hypothesis must be set at what might be considered the most opportune point, depending on the relative severity of the two types of error. Custom and tradition in the fields of education and psychology favor balancing the two types of errors around the points at which there are either 5 chances out of a 100 or 1 chance out of a 100 of being in error. . . . In the early stages of exploration, it might be advisable to set the level of rejection rather low so that variables are not eliminated before they have had a chance to prove themselves—that is, so that they are not rejected prematurely. In the later stages of the investigation of a given problem, where precision is essential, the level of rejection should be set higher so that relationships that are not significant will be excluded.
CHAPTER IV

RESULTS AND CONCLUSIONS

The results are in the form of an examination of the contents of tables of scientist responses to questions relevant to each specific hypothesis. The conclusions are based on the evidence revealed in the results, and take the form of (1) accepting the null hypothesis, and rejecting the hypothesis, or (2) rejecting the null hypothesis, and accepting the hypothesis. The chi-square values calculated for each table of responses assisted the investigator in making decisions about whether or not to accept or reject the null hypothesis.

The results and conclusions chapter was divided into four separate sections to correspond with each of the four general hypotheses. When examination of the specific hypotheses in each section was completed, the information gained was used to test the general hypothesis relevant to that section.
Results and Conclusions

Section Number One:

Relationships between Research Department Structure and Research Output
Specific Hypothesis Number 1A

In a combined organization sample, levels of reported research output will be positively associated with levels of perceived influence to decide work goals and objectives.

Table I contains the frequency, horizontal percentage frequency and total percentage frequency tables of responses of scientists, from four types of organizations, to two questions. The questions were:

1. How much influence do you feel the following people have in deciding your work goals and objectives?

   | Rating scale |
   |  1  | 2  | 3  | 4  | 5   |
   |---------------------|
   | Yourself             |

2. How many of the following have you completed?
   (a) project completion reports
   (b) speeches
   (c) articles accepted by journals

   An examination of the table indicated that 92 percent (horizontal percentage) of the scientists who responded that they had a "high" number of outputs, also responded that they felt they had "much" or "very much" influence in deciding their work goals and objectives. Although 85 percent of those who had either a "low" or "medium" number of outputs responded that they felt they had "much" or "very much" influence—only 68 percent of the "non-productive" scientists responded this way. Examination of the table, therefore, indicated that most scientists who had high levels of research output also perceived themselves to have a high level of influence in deciding their work goals and objectives.
TABLE I

Levels of Research Output #1 versus Levels of Scientist Influence in Deciding Work Goals and Objectives (Combined Samples)

How much influence do you feel the following people have in deciding your work goals and objectives?

<table>
<thead>
<tr>
<th>Levels of Research Output #1</th>
<th>Low 1,2</th>
<th>Medium 3</th>
<th>High 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>12</td>
<td>22</td>
<td>73</td>
<td>107</td>
</tr>
<tr>
<td>H</td>
<td>11</td>
<td>21</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>2</td>
<td>4</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>24</td>
<td>157</td>
<td>185</td>
</tr>
<tr>
<td>1-4</td>
<td>2</td>
<td>13</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>1</td>
<td>5</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>16</td>
<td>111</td>
<td>131</td>
</tr>
<tr>
<td>5-8</td>
<td>3</td>
<td>12</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>1</td>
<td>3</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>9+</td>
<td>1</td>
<td>7</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>T</td>
<td>0</td>
<td>1</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>69</td>
<td>433</td>
<td>523</td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2 = 29.3 \ (0.001)$

\(f = \text{frequency; } H = \text{horizontal percentage } f; \ T = \text{total percentage } f.\)

C = .23
Appendix (xiii) contains the same elements as Table I, except that research output number one (number of project completion reports etc.) was exchanged for research output number two (number of books and monographs completed). The results were comparable to those in Table I. The chi-square values computed for both tables were significant beyond the .05 level.

On the basis of this information, the null hypothesis that no relationship existed between levels of reported research output and levels of perceived influence to decide work goals and objectives, was rejected. The Specific Hypothesis Number 1A, therefore, was accepted as plausible.

Specific Hypothesis Number 1B

In a combined organization sample, levels of reported research output will be negatively associated with levels of perceived supervisor or department head influence in deciding scientist work goals and objectives.

Table II contains the frequency, horizontal percentage frequency and total percentage frequency tables of responses of scientists, from four types of organizations, to two questions. The questions were:

1. How much influence do you feel the following people have in deciding your work goals and objectives?  
   Rating Scale
   Immediate supervisor or department head 1 2 3 4 5
2. How many of the following have you completed?
   (a) project completion reports
   (b) speeches
   (c) articles accepted by journals

An examination of the table indicated that 52 percent (horizontal percentage) of the scientists who reported a "high" number of outputs also responded that supervisors and department heads had "low" levels of influence in deciding their work goals and objectives. Only 23 percent of the scientists who reported a "high" number of outputs also responded that their supervisors or department heads had "high" levels of influence in deciding their work goals and objectives. These same kinds of relationships were apparent for scientists reporting a "medium" number of outputs.

Only 34 percent of the scientists who reported "0" output also responded that their supervisors or department heads had "low" levels of influence in deciding their work goals and objectives. Forty percent of these "0" output scientists responded that supervisors or department heads had "high" levels of influence in deciding their work goals and objectives. These same kinds of relationships were apparent for scientists reporting a "low" number of outputs.

Examination of the table, therefore, indicated a tendency for scientists who reported high levels of research output to also respond that supervisors or department heads had "low" levels of influence in deciding their work goals and objectives.
**TABLE II**

Levels of Research Output #1 versus Levels of Supervisor Influence in Deciding Scientist Work Goals and Objectives (Combined Samples)

How much influence do you feel the following people have in deciding your work goals and objectives?

Immediate supervisor, or department head  1  2  3  4  5

<table>
<thead>
<tr>
<th>Levels of Research Output #1</th>
<th>Level of Supervisor Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (1,2)</td>
</tr>
<tr>
<td>0</td>
<td>f</td>
</tr>
<tr>
<td></td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>T</td>
</tr>
<tr>
<td>Low 1-4</td>
<td>f</td>
</tr>
<tr>
<td></td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>T</td>
</tr>
<tr>
<td>Medium 5-8</td>
<td>f</td>
</tr>
<tr>
<td></td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>T</td>
</tr>
<tr>
<td>High 9+</td>
<td>f</td>
</tr>
<tr>
<td></td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>T</td>
</tr>
</tbody>
</table>

Total: 228  133  162  523

\( \chi^2 = 22.27 \) (.01)  
\( f = \) frequency;  
\( H = \) horizontal percentage \( f \);  
\( C = .2 \)  
\( T = \) total percentage \( f \).
Appendix (xiv) contains the same elements as Table II, except that research output number one (number of project completion reports etc.) was exchanged for research output number two (number of books and monographs completed). The results were comparable to those in Table II. The chi-square values computed for both tables were significant well beyond the .05 level.

On the basis of this information, the null hypothesis that no relationship existed between levels of reported research output and levels of perceived supervisor or department head influence in deciding scientist work goals and objectives, was rejected. The Specific Hypothesis Number 1B, therefore, was accepted as plausible.

Specific Hypothesis Number 1C

In a combined organization sample, levels of reported research output will be positively associated with levels of perceived decentralized control of research activities, and negatively associated with perceived levels of centralized control.

Table III contains the frequency, horizontal percentage and total percentage frequency tables of responses of scientists, from four types of organizations, to two questions. The questions were:
1. Which of the following best describes your research unit or department?

Highly centralized control of activities 1
Centralized control 2
Neither centralized nor decentralized 3
Decentralized control 4
Highly decentralized control of activities 5

2. How many of the following have you completed?

(a) project completion reports
(b) speeches
(c) articles accepted by journals

An examination of the table indicated that 51 percent (horizontal percentage) of the scientists who reported high levels of research output, also responded that they would describe their research department as either decentralized or highly decentralized. Only 21 percent of the scientists who reported a high number of research outputs also responded that they would describe their research department as either centralized or highly centralized. These same kinds of relationships were apparent for scientists reporting a "medium" number of research outputs.

Only 32 percent of the scientists who reported "0" output also responded that they would describe their research department as either decentralized or highly decentralized. Thirty-seven percent of these "0" output scientists responded that they would describe their research department as either centralized or highly centralized. These same kinds of relationships were apparent for the scientists reporting a low number of outputs.


TABLE III

Levels of Research Output #1 versus Levels of Centralization/Decentralization (Combined Samples)

Which of the following best describes your research unit or department?

- Highly centralized control of activities
- Centralized control
- Neither centralized nor decentralized
- Decentralized control
- Highly decentralized control of activities

<table>
<thead>
<tr>
<th>Level of Research Output #1</th>
<th>Levels of Centralization/Decentralization</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centralized</td>
<td>Neither</td>
</tr>
<tr>
<td></td>
<td>1,2</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>40</td>
<td>33</td>
</tr>
<tr>
<td>H</td>
<td>37</td>
<td>31</td>
</tr>
<tr>
<td>T</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>f</td>
<td>60</td>
<td>53</td>
</tr>
<tr>
<td>Low</td>
<td>1-4</td>
<td>32</td>
</tr>
<tr>
<td>H</td>
<td>32</td>
<td>29</td>
</tr>
<tr>
<td>T</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Medium</td>
<td>5-8</td>
<td>21</td>
</tr>
<tr>
<td>H</td>
<td>21</td>
<td>28</td>
</tr>
<tr>
<td>T</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>High</td>
<td>9+</td>
<td>21</td>
</tr>
<tr>
<td>H</td>
<td>21</td>
<td>28</td>
</tr>
<tr>
<td>T</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>149</td>
<td>151</td>
</tr>
</tbody>
</table>

$\chi^2 = 15.51 (0.02)$  \( f = \) frequency; \( H = \) horizontal percentage \( f; \) \( C = 0.17 \)  \( T = \) total percentage \( f. \)
Examination of Table III, therefore, indicated a tendency for scientists who report high levels of research output to also describe their research department as having a decentralized control of research activities. Table III also indicated a tendency for scientists who report low levels of research output to also describe their research departments as having a centralized control of research activities.

Appendix (xv) contains the same elements as Table III, except that research output number one (number of project completion reports etc.) was exchanged for research output number two (number of books and monographs completed). The results were comparable to those in Table III. The chi-square values computed for both tables were significant beyond the .05 level.

On the basis of this information, the null hypothesis that no relationship existed between levels of reported research output and perceived levels of centralized and decentralized control of research activities, was rejected. The Specific Hypothesis Number 1C, therefore, was accepted as plausible.

Specific Hypothesis Number 1D

In a combined organization sample, levels of reported research output will be negatively associated with levels of coordination of scientists efforts for common objectives.
Table IV contains the frequency, horizontal percentage frequency and total percentage frequency tables of responses of scientists, from four types of organizations, to two questions. The questions were:

1. How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives?

   Rating Scale
   1 2 3 4 5

2. How many of the following have you completed?
   (a) Books
   (b) Monographs

An examination of the table indicated that 69 percent (horizontal percentage) of the scientists who responded that they had completed one or more outputs, also responded that they perceived a low or medium level of coordination. Only 31 percent of the scientists who completed one or more outputs perceived high levels of coordination. There was a tendency, therefore, for scientists reporting one or more outputs to respond that they perceived a low level of coordination. The chi-square value for this table was significant at the .05 level.

Appendix (xvi) contains the same elements as Table IV, except that research output number two (number of books and monographs completed) was exchanged for research output number one (number of project completion reports etc.). The results were comparable to those in Table IV, but the chi-square value for the table was not significant at the .05 level.
TABLE IV

Levels of Research Output #2 versus Levels of Coordination (Combined Sample)

How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives?  

<table>
<thead>
<tr>
<th>Levels of Research Output #2</th>
<th>Low and Medium Coordination 1, 2, 3</th>
<th>High Coordination 4, 5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low &quot;0&quot;</td>
<td>f = 225</td>
<td>161</td>
<td>386</td>
</tr>
<tr>
<td></td>
<td>H = 58</td>
<td></td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>T = 43</td>
<td></td>
<td>31</td>
</tr>
<tr>
<td>High 1+</td>
<td>f = 94</td>
<td>43</td>
<td>137</td>
</tr>
<tr>
<td></td>
<td>H = 69</td>
<td></td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>T = 18</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>319</td>
<td>204</td>
<td>523</td>
</tr>
</tbody>
</table>

$\chi^2 = 4.52 (.05)$  
f = frequency; H = horizontal percentage f;  
C = .029  
T = total percentage f.
On the basis of this information, the null hypothesis that no relationship existed between levels of reported research output and levels of perceived coordination of scientist efforts for common objectives, was accepted. The Specific Hypothesis Number 1D, therefore, was rejected. It was noted, however, that the results were in the predicted direction.

The analysis of specific hypotheses relevant to Hypothesis Number One is completed. Sufficient information appears to be available to test this hypothesis.

**Hypothesis Number One: The Test**

There is a relationship between research department structure and research output. The specific hypotheses related to Hypothesis Number One (number 1A, 1B and 1C) were tested and accepted and Specific Hypothesis Number 1D results were in the predicted direction. The relationships tested in these specific hypotheses were assumed to be indicative of relationships between research output and research department structure.

On the basis of this information, the null hypothesis that no relationship existed between research department structure and research output, was rejected. Hypothesis Number One, therefore, was accepted as plausible.
Results and Conclusions

Section Number Two:

Differences in Structure

Across Organization Types
Specific Hypothesis Number 2A

Scientists in different types of organizations will tend to perceive some project selection criteria to receive different levels of emphasis.

In order to be more specific, specific hypotheses, relevant to the selection criteria used by scientists in each type of organization were constructed. The first of these specific hypotheses was:

Specific Hypothesis 2A. More scientists in business organizations than in other types of organizations will respond that it is important to select projects that contribute to the organization's financial well-being.

Table V contains the frequency and percentage frequency table of responses of scientists from the four types of organizations, to one question. The question was:

How important are the following criteria in your selection of research projects?
Projects that contribute to the organization's financial well-being

Rating Scale
1 2 3 4 5

An examination of the table indicated that 60 percent of the scientists in business organizations—as compared to 21 percent in government, 14 percent in social development, and 5 percent in university organizations—responded that it was "important" or "very important" to select research projects that contribute to the organization's financial well-being. Examination of the table, therefore, indicated that more
TABLE V
Organization Type versus Importance of Selecting Projects That Contribute to the Organization's Financial Well-Being

How important are the following criteria in your selection of research projects?

Please circle the appropriate number.

(a) Projects that contribute to the organization's financial well-being

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Unimportant &quot;0&quot;</th>
<th>Neither 1,2</th>
<th>Neither 3</th>
<th>Important 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f 7</td>
<td>1</td>
<td>11</td>
<td>28</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>T 15</td>
<td>2</td>
<td>23</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Gov.</td>
<td>f 12</td>
<td>65</td>
<td>30</td>
<td>30</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>T 10</td>
<td>47</td>
<td>21</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>f 7</td>
<td>69</td>
<td>17</td>
<td>16</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>T 6</td>
<td>64</td>
<td>16</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td>f 1</td>
<td>185</td>
<td>32</td>
<td>12</td>
<td>229</td>
</tr>
<tr>
<td></td>
<td>T .5</td>
<td>80</td>
<td>14</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = 129.64 \quad f = \text{frequency}; \quad H = \text{horizontal percentage } f; \]
\[ C = .455 \quad T = \text{total percentage } f. \]
scientists in business organizations than in the other types of organizations responded this way.

The chi-square value (129.64), calculated for the table of responses was significant well beyond the .05 level. The assumed null hypothesis that no difference existed across organization types, in scientist responses to the degree of importance involved in selecting research "projects that contribute to the organization's financial well-being," was rejected. The specific hypothesis $2A_1$, therefore, was accepted as plausible.

Specific Hypothesis $2A_2$. More scientists in government organizations than in the other types of organizations will respond that it is important to select research projects that are delegated by some higher authority.

Table VI contains the frequency and percentage frequency table of responses of scientists, from the four types of organizations, to one question. The question was:

How important are the following criteria in your selection of research projects?

<table>
<thead>
<tr>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projects that are delegated by some higher authority</td>
</tr>
</tbody>
</table>

An examination of the table indicated that 65 percent of the scientists in government organizations—as compared to 49 percent in business, 23 percent in social development, and 3 percent in university organizations—responded that it was "important" or "very important" to select research "projects that are delegated by some higher authority." Examination of the table, therefore, indicated that more scientists in
TABLE VI
Organization Type versus Importance of Selecting Projects that are Delegated by Some Higher Authority

How important are the following criteria in your selection of research projects?

Please circle the appropriate number.

(d) Projects that are delegated by some higher authority

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Unimportant &quot;0&quot;</th>
<th>Neither 3</th>
<th>Important 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f 4</td>
<td>11</td>
<td>9</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>T 9</td>
<td>23</td>
<td>19</td>
<td>49</td>
</tr>
<tr>
<td>Gov.</td>
<td>f 6</td>
<td>17</td>
<td>27</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>T 4</td>
<td>12</td>
<td>19</td>
<td>65</td>
</tr>
<tr>
<td>S.D.</td>
<td>f 3</td>
<td>56</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>T 3</td>
<td>51</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Univ.</td>
<td>f 1</td>
<td>191</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>T 5</td>
<td>83</td>
<td>13</td>
<td>3</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 219.25 \]
\[ f = \text{frequency}; \ T = \text{total percentage} \cdot f. \]
\[ C = .548 \]
government organizations than in the other types of organizations, responded this way.

The chi-square value (219.5) calculated for the table of responses, was significant well beyond the .01 level. The assumed null hypothesis that no differences existed across organization types, in scientist responses to the degree of importance involved in selecting research "projects that are delegated by some higher authority," was rejected. The specific hypotheses \( H_2A_2 \), therefore, was accepted as plausible.

**Specific Hypothesis \( H_2A_3 \).** More scientists in social development organizations, than in the other types of organizations will respond that it is important to select research projects that contribute to the well-being of some social group.

Table VII contains the frequency and percentage frequency table of responses of scientists from the four types of organizations to one question. The question was:

How important are the following criteria in your selection of research projects?

<table>
<thead>
<tr>
<th>Rating Scale</th>
<th>Projects that may contribute to the well-being of some social group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

An examination of the table indicated that 76 percent of the scientists in social development organizations--as compared to 43 percent in business, 55 percent in government, and 55 percent in university organizations--responded that it was "important" or "very important" to select research "pro-
TABLE VII

Organization Type versus Importance of Selecting Projects that Contribute to the Well-Being of Some Social Group

How important are the following criteria in your selection of research projects? Please circle the appropriate number.

(c) Projects that may contribute to the well-being of some social group

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Importance</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;0&quot;</td>
<td>1,2</td>
</tr>
<tr>
<td></td>
<td>f</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T</td>
<td></td>
</tr>
<tr>
<td>Bus.</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>Gov.</td>
<td>10</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>S.D.</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Univ.</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2 = 20.32$  
$f = frequency; T = total percentage f.$  
$C = .17$
bjects that contribute to the well-being of some social group." Examination of the table, therefore, indicated that more scientists in social development organizations than in the other types of organizations responded this way.

The chi-square value (20.32) calculated for the table of responses was significant beyond the .05 level. The assumed null hypothesis that no difference existed across organization types, in scientist responses to the degree of importance involved in selecting research "projects that contribute to the well-being of some social group," was rejected. The specific hypothesis $2A_3$, therefore, was accepted as plausible.

**Specific Hypothesis $2A_4$.** More scientists in universities, than in the other types of organizations, will respond that it is important to select research projects that are interesting in themselves.

Table VIII contains the frequency and percentage frequency table of responses of scientists from the four types of organizations to one question. The question was:

> How important are the following criteria in your selection of research projects? [Rating Scale]

| Projects that are interesting in themselves | 1 | 2 | 3 | 4 | 5 |

An examination of the table indicated that 81 percent of the scientists in universities—as compared to 57 percent in business, 38 percent in government and 50 percent in social development organizations—responded that it was "important"
TABLE VIII

Organization Type versus Importance of Selecting Projects that are Interesting in Themselves

How important are the following criteria in your selection of research projects?

Please circle the appropriate number

(a) Projects that are interesting in themselves

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Unimportant &quot;0&quot;</th>
<th>Importance 1,2</th>
<th>Importance Neither 3</th>
<th>Important 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f 8</td>
<td>9</td>
<td>3</td>
<td>27</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>T 17</td>
<td>19</td>
<td>6</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Gov.</td>
<td>f 7</td>
<td>43</td>
<td>34</td>
<td>53</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>T 6</td>
<td>31</td>
<td>25</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>f 7</td>
<td>22</td>
<td>26</td>
<td>54</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>T 6</td>
<td>20</td>
<td>24</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td>f 0</td>
<td>22</td>
<td>21</td>
<td>187</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td>T 10</td>
<td></td>
<td>9</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>96</td>
<td>84</td>
<td>321</td>
<td>501</td>
</tr>
</tbody>
</table>

χ^2 = 81.3
f = frequency; T = total percentage f.
C = .367
or "very important" to select research "projects that are interesting in themselves." Examination of the table, therefore, indicated that more scientists in universities than in the other types of organizations, responded this way.

The chi-square value (81.3) calculated for the table of responses, was significant well beyond the .01 level. The assumed null hypothesis that no difference existed across organization types, in scientist responses to the degree of importance involved in selecting research "projects that are interesting in themselves," was rejected. The specific hypothesis 2A4, therefore was accepted as plausible.

Specific Hypothesis 2A5. More scientists in universities than in the other types of organizations will respond that it is important to select research projects that seek new knowledge--because the search for new knowledge is intrinsically good.

Table IX contains the frequency and percentage frequency table of responses of scientists from the four types of organizations to one question. The question was:

How important are the following criteria in your selection of research projects?

<table>
<thead>
<tr>
<th>Rating Scale</th>
<th>Projects that seek new knowledge--because the search for new knowledge is intrinsically good.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>

An examination of the table indicated that 58 percent of the scientists in universities--as compared to 28 percent in business, 24 percent in government, and 42 percent in social
TABLE IX

Organization Type versus Importance of Selecting Projects that Seek New Knowledge

How important are the following criteria in your selection of research projects?

Please circle the appropriate number

(b) Projects that seek new knowledge—because the search for new knowledge is intrinsically good

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Unimportant &quot;0&quot;</th>
<th>Neither 1,2</th>
<th>Neither 3</th>
<th>Important 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f 7</td>
<td>13</td>
<td>14</td>
<td>13</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>T 15</td>
<td>28</td>
<td>30</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Gov.</td>
<td>f 13</td>
<td>56</td>
<td>35</td>
<td>33</td>
<td>124</td>
</tr>
<tr>
<td></td>
<td>T 9</td>
<td>40</td>
<td>26</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>f 7</td>
<td>31</td>
<td>25</td>
<td>46</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>T 6</td>
<td>28</td>
<td>23</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td>f 1</td>
<td>50</td>
<td>45</td>
<td>134</td>
<td>229</td>
</tr>
<tr>
<td></td>
<td>T .5</td>
<td>22</td>
<td>20</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>150</td>
<td>129</td>
<td>226</td>
<td>495</td>
</tr>
</tbody>
</table>

χ² = 29.29

f = frequency; T = total percentage f.

C = .22
development organizations—responded that it was "important" or "very important" to select research "projects that seek new knowledge. . . ." Examination of the table, therefore, indicated that more scientists in universities than in the other types of organizations, responded this way.

The chi-square value (29.9) calculated for the table of responses was significant beyond the .01 level. The assumed null hypothesis that no differences existed across organization types, in scientist responses to the degree of importance involved in selecting research "projects that seek new knowledge . . . ." was rejected. The specific hypothesis 2A5, therefore, was regarded as tenable.

All of the specific hypotheses for Specific Hypothesis Number 2A were accepted. On the basis of this information, the assumed null hypothesis that no difference existed across organization types, in scientist responses to the level of importance of different criteria in the selection of research projects, was rejected. Specific Hypothesis Number 2A, therefore, was accepted as plausible.

Specific Hypothesis Number 2B

Scientists in different types of organizations will perceive different levels of time expenditures in basic and applied research activities.

In order to be more specific, specific hypotheses relevant to both basic research activities and to applied
research activities, were constructed. The first of these specific hypotheses relevant to applied research activities was:

**Specific Hypothesis 2B₁.** More scientists in business, government and social development organizations than in universities will perceive themselves to emphasize high expenditures of time in applied research activities.

Table X contains the frequency and percentage frequency table of scientist responses to the question:

How much of your working time do you spend in the discovery of specific knowledge for the solution of particular problems (applied research)?

An examination of the table indicated that 60 percent of the scientists in business, 48 percent in government and 36 percent in social development organizations—as compared to 18 percent of the scientists in universities—responded that they spent "much" or "very much" of their time in applied research. Examination of the table, therefore, indicated that more scientists in business, government, and social development organizations than in universities responded this way.

The chi-square value (62.84) calculated for the table of responses was significant well beyond the .05 level. The assumed null hypothesis that no difference existed across organization types, in scientist responses to the amount of time spent in applied research activities, was rejected. The specific hypothesis 2B₁, therefore, was accepted as plausible.
TABLE X
Organization Type versus Levels of Time Expenditure on Applied Research

How much of your working time do you spend on the following activities in your present research unit or department?

Please circle the appropriate number.

(a) Discovery of specific knowledge for the solution of particular problems (applied research)

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Levels of Time Expenditure</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low 1,2 Medium 3 High 4,5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Bus.</td>
<td>f 1 9 9 28 46</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 2 19 19 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov.</td>
<td>f 6 32 33 66 131</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 4 23 24 48</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>f 3 29 38 39 106</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 3 27 34 36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td>f 0 115 72 43 230</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 0 50 31 18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 185 152 176 513</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = 62.84 \quad f = \text{frequency}; \quad T = \text{total percentage f.} \]

C = .33
Specific Hypothesis 2B2. More scientists in universities than in the other types of organizations will perceive themselves to emphasize high expenditures of time in basic research activities.

Table XI contains the frequency and percentage frequency table of scientist responses to the question:

How much of your working time do you spend in the discovery of new knowledge, not immediately applicable to particular problems (basic research)?

An examination of the table indicated that 39 percent of the scientists in universities—as compared to 21 percent in social development, 7 percent in government and 2 percent in business organizations—responded that they spent either "much" or "very much" of their time in basic research. Examination of the table, therefore, indicated that more scientists in universities than in the other types of organizations, responded this way.

The chi-square value (85.2) calculated for the table of responses was significant well beyond the .05 level. The assumed null hypothesis that no differences existed across organization types in scientist responses to how much of their time they spent in basic research activities, was rejected. The specific hypothesis 2B2, therefore, was accepted as plausible.

Both specific hypotheses for Specific Hypothesis Number 2B were accepted. On the basis of this information, the assumed null hypothesis that no differences existed across organization
TABLE XI

Organization Type versus Levels of Time Expenditure on Basic Research

How much of your working time do you spend on the following activities, in your present research unit or department?

Please circle the appropriate number

<table>
<thead>
<tr>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 none</td>
</tr>
<tr>
<td>2 not very much</td>
</tr>
<tr>
<td>3 some</td>
</tr>
<tr>
<td>4 much</td>
</tr>
<tr>
<td>5 very much</td>
</tr>
</tbody>
</table>

(b) Discovery of new knowledge, not immediately applicable to particular problems (basic research).

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Levels of Time Expenditure</th>
<th>Low (0)</th>
<th>1,2</th>
<th>Medium (3)</th>
<th>High (4,5)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f</td>
<td>2</td>
<td>35</td>
<td>9</td>
<td>1</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>4</td>
<td>74</td>
<td>19</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Gov.</td>
<td>f</td>
<td>9</td>
<td>94</td>
<td>25</td>
<td>9</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>7</td>
<td>68</td>
<td>18</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>f</td>
<td>5</td>
<td>51</td>
<td>29</td>
<td>24</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>5</td>
<td>47</td>
<td>27</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td>f</td>
<td>1</td>
<td>73</td>
<td>66</td>
<td>90</td>
<td>229</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>1</td>
<td>32</td>
<td>29</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td>253</td>
<td>129</td>
<td>124</td>
<td>506</td>
</tr>
</tbody>
</table>

$\chi^2 = 85.2$  \( f = \) frequency;  \( T = \) total percentage \( f \).

C = .38
types in scientist responses to the levels of time expenditure in basic and applied research activities, was rejected. Specific Hypothesis Number 2B, therefore, was accepted.

Specific Hypothesis Number 2C

More scientists in business organizations than in the other types of organizations will perceive themselves to work under high levels of time pressure.

Table XII contains the frequency and percentage frequency table of responses to the question:

How much time pressure do you work under (i.e., results needed in a hurry, deadlines to be met, etc.)?

An examination of the table indicated that 91 percent of the scientists in business organizations—as compared to 39 percent in government, 37 percent in social development, and 32 percent in university organizations—responded that they worked under either "much" or "very much" time pressure. Examination of the table, therefore, indicated that more scientists in business organizations than in the other types of organizations responded this way.

The chi-square value (62.87) calculated for the table of responses was significant well beyond the .05 level. The assumed null hypothesis that no differences existed across organization types in scientist responses to the levels of time pressure worked under, was rejected. Specific Hypothesis Number 2C, therefore, was accepted as plausible.
TABLE XII

Organization Type versus Levels of Time Pressure Worked Under

Please circle the appropriate number.

How much time pressure do you work under (i.e., results needed in a hurry, deadlines to be met, etc.)?

<table>
<thead>
<tr>
<th>Rating Scale</th>
<th>1 none</th>
<th>2 not very much</th>
<th>3 some</th>
<th>4 much</th>
<th>5 very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0</td>
<td>1,2</td>
<td>3</td>
<td>43</td>
<td>47</td>
</tr>
<tr>
<td>Medium</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>2</td>
<td>31</td>
<td>51</td>
<td>53</td>
<td>135</td>
</tr>
<tr>
<td>Low</td>
<td>3</td>
<td>40</td>
<td>41</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>4</td>
<td>37</td>
<td>37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>5</td>
<td>80</td>
<td>75</td>
<td>74</td>
<td>229</td>
</tr>
<tr>
<td>Low</td>
<td>6</td>
<td>35</td>
<td>33</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>7</td>
<td>139</td>
<td>169</td>
<td>211</td>
<td>519</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 67.87 \]

\( f = \) frequency; \( T = \) total percentage \( f \).

\( C = .328 \)
Specific Hypothesis Number 2D

More scientists in universities than in the other types of organizations, will perceive high levels of influence to decide their work goals and objectives.

Table XIII contains the frequency and percentage frequency tables of responses to one question. The question was:

How much influence do you feel the following people have in deciding your work goals and objectives?

<table>
<thead>
<tr>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yourself</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

An examination of the table indicated that 93 percent of the scientists in universities—as compared to 81 percent in social development, 69 percent in government, and 79 percent in business organizations—responded that they felt they had either "much" or "very much" influence to decide their work goals and objectives. Examination of the table, therefore, indicated that more scientists in universities than in the other types of organizations, responded this way.

The chi-square value (40.59) calculated for the table of responses was significant well beyond the .05 level. The assumed null hypothesis that no differences existed across organization types in scientist responses to the amount of influence they perceive themselves to have in deciding work goals and objectives, was rejected. Specific Hypothesis Number 2D, therefore, was accepted as plausible.
### TABLE XIII

Organization Type versus Levels of Scientist Influence in Deciding Work Goals and Objectives

How much influence do you feel the following people have in deciding your work goals and objectives?

<table>
<thead>
<tr>
<th>Rating Scale</th>
<th>1 none</th>
<th>2 not very much</th>
<th>3 some</th>
<th>4 much</th>
<th>5 very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>(c) Yourself</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f</td>
<td>0</td>
<td>10</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>0</td>
<td>21</td>
<td>79</td>
</tr>
<tr>
<td>Gov.</td>
<td>f</td>
<td>2</td>
<td>33</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>1</td>
<td>24</td>
<td>69</td>
</tr>
<tr>
<td>S.D.</td>
<td>f</td>
<td>2</td>
<td>15</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>2</td>
<td>14</td>
<td>81</td>
</tr>
<tr>
<td>Univ.</td>
<td>f</td>
<td>3</td>
<td>11</td>
<td>213</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>1</td>
<td>5</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>16</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

χ² = 40.59  f = frequency; T = total frequency f.
C = .268
Specific Hypothesis Number 2E

More scientists in business, government, and social development organizations than in universities will perceive immediate supervisors or department heads to have high levels of influence to decide their work goals and objectives.

Table XIV contains the frequency and percentage frequency table of responses of scientists from the four types of organizations to one question. The question was:

How much influence do you feel the following people have in deciding your work goals and objectives?

<table>
<thead>
<tr>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate supervisor or department head</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

An examination of the table indicated 47 percent of the scientists in business, 60 percent of the scientists in government, and 33 percent of the scientists in social development organizations—as compared to 10 percent of the scientists in universities—responded that they felt their immediate supervisor or department head had "much" or "very much" influence in deciding their work goals and objectives. Examination of the table, therefore, indicated that more scientists in business, government, and social development organizations than in universities, responded this way.

The chi-square value (179.92) calculated for the table of responses was significant well beyond the .05 level. The assumed null hypothesis that no differences existed across
TABLE XIV

Organization Type versus Levels of Supervisor Influence in Deciding Work Goals and Objectives

<table>
<thead>
<tr>
<th>Rating Scale</th>
<th>1 none</th>
<th>2 not very much</th>
<th>3 some</th>
<th>4 much</th>
<th>5 very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>(d) Immediate supervisor or department head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Low 0</th>
<th>Medium 1,2</th>
<th>High 3</th>
<th>High 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f 3</td>
<td>7</td>
<td>15</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>T 6</td>
<td>15</td>
<td>32</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Gov.</td>
<td>f 9</td>
<td>9</td>
<td>37</td>
<td>82</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>T 7</td>
<td>7</td>
<td>27</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>f 8</td>
<td>30</td>
<td>35</td>
<td>36</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>T 7</td>
<td>28</td>
<td>32</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td>f 3</td>
<td>159</td>
<td>46</td>
<td>22</td>
<td>227</td>
</tr>
<tr>
<td></td>
<td>T 1</td>
<td>69</td>
<td>20</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

|                  | 23    | 205        | 133    | 162      | 500|

$\chi^2 = 179.92$  \( f = \) frequency;  \( T = \) total frequency  \( f \).

\[ C = 0.513 \]
organization types, in scientist responses about perceived levels of influence immediate supervisors and department heads have in deciding scientist work goals and objectives, was rejected. Specific Hypothesis Number 2E, therefore, was accepted as plausible.

Hypothesis Number 2F

Scientists in each type of organization will tend to perceive different levels of emphasis on centralized or decentralized control of research department activities.

Specifically:

Hypothesis Number 2F. More scientists in universities, than in the other types of organizations, will perceive a decentralized control of research department activities.

Table XV contains the frequency and percentage frequency table of responses of scientists from the four types of organizations, to one question. The question was:

Which of the following best describes your research unit or department?

<table>
<thead>
<tr>
<th>Control Type</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly centralized control of activities</td>
<td>1</td>
</tr>
<tr>
<td>Centralized control</td>
<td>2</td>
</tr>
<tr>
<td>Neither centralized nor decentralized</td>
<td>3</td>
</tr>
<tr>
<td>Decentralized control</td>
<td>4</td>
</tr>
<tr>
<td>Highly decentralized control of activities</td>
<td>5</td>
</tr>
</tbody>
</table>

An examination of the table of responses indicated that 40 percent of the scientists in business, 23 percent in government, and 29 percent in social development organizations—as compared to 61 percent of the scientists in universities—responded that they would describe their research unit or
TABLE XV

Organization Type versus Levels of Centralized and Decentralized Control of Research Activities

Which of the following best describes your research unit or department?
Please circle the appropriate number

Highly centralized control of activities  1
Centralized control  2
Neither centralized nor decentralized  3
Decentralized control  4
Highly decentralized control of activities  5

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Centralized 0</th>
<th>1,2</th>
<th>Neither 3</th>
<th>Decentralized 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f 0 16</td>
<td>12</td>
<td>19</td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>T</td>
<td>0 34</td>
<td>26</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov.</td>
<td>f 1 61</td>
<td>43</td>
<td>32</td>
<td></td>
<td>136</td>
</tr>
<tr>
<td>T</td>
<td>5 45</td>
<td>31</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>f 1 40</td>
<td>36</td>
<td>32</td>
<td></td>
<td>108</td>
</tr>
<tr>
<td>T</td>
<td>1 37</td>
<td>33</td>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td>f 1 29</td>
<td>60</td>
<td>140</td>
<td></td>
<td>229</td>
</tr>
<tr>
<td>T</td>
<td>5 13</td>
<td>26</td>
<td>61</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 146</td>
<td>151</td>
<td>213</td>
<td>520</td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2 = 72.47$  $f = \text{frequency}; T = \text{total percentage } f.$

C = .348
department as having "decentralized" or "highly decentralized" control of research activities. Examination of the table, therefore, indicated that more scientists in universities than in the other types of organizations, responded this way.

The chi-square value (72.47) calculated for the table of responses was significant well beyond the .05 level. The assumed null hypothesis that no differences existed across organization types, in scientists responses to the amount of "decentralized" control of research department activities, was rejected. Specific Hypothesis Number 2F₁, therefore, was accepted as plausible.

Specific Hypothesis Number 2F₂. More scientists in business, government and social development organizations, than in universities, will perceive a centralized control of research department activities.

A further examination of Table XV indicated that 34 percent of the scientists in business, 45 percent in government, and 37 percent in social development organizations—as compared to 13 percent of the scientists in universities—responded that they would describe their research unit or department as having centralized or highly centralized control of research activities. Examination of the table, therefore, indicated that more scientists in business, government, and social development organizations than in universities responded this way.
The chi-square value (72.47) calculated for the table of responses was significant well beyond the .05 level. The assumed null hypothesis that no differences existed across organization types, in scientists responses to the levels of centralized control of research activities, was rejected. Specific Hypothesis Number 2F2, therefore, was accepted.

Specific Hypotheses Number 2F1 and 2F2 were accepted. On the basis of this information, the assumed null hypothesis that no differences existed across organization types, in scientist responses to the levels of centralized and decentralized control of research activities, was rejected. Specific Hypothesis Number 2F, therefore, was accepted as plausible.

Specific Hypothesis Number 2G

More scientists in business, government and social development organizations than in universities will perceive high levels of coordination toward common objectives.

Table XVI contains the frequency and percentage frequency table of scientist responses to the question:

How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives?

An examination of the table indicated that 70 percent of the scientists in business, 61 percent in government, and 56 percent in social development organizations--as compared to 11 percent of the scientists in universities--responded that they perceived members of their research department to
TABLE XVI

Organization Type versus Levels of Emphasis on Coordination of Effort

<table>
<thead>
<tr>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 none</td>
</tr>
<tr>
<td>2 not very much</td>
</tr>
<tr>
<td>3 some</td>
</tr>
<tr>
<td>4 much</td>
</tr>
<tr>
<td>5 very much</td>
</tr>
</tbody>
</table>

Please circle the appropriate number How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives? 1 2 3 4 5

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Low 0</th>
<th>Medium 1,2</th>
<th>High 3</th>
<th>4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f 0</td>
<td>4</td>
<td>10</td>
<td>33</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>T 0</td>
<td>8</td>
<td>21</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>Gov.</td>
<td>f 4</td>
<td>22</td>
<td>28</td>
<td>83</td>
<td>133</td>
</tr>
<tr>
<td></td>
<td>T 3</td>
<td>16</td>
<td>20</td>
<td></td>
<td>61</td>
</tr>
<tr>
<td>S.D.</td>
<td>f 4</td>
<td>17</td>
<td>27</td>
<td>61</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>T 4</td>
<td>16</td>
<td>24</td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>Univ.</td>
<td>f 0</td>
<td>144</td>
<td>60</td>
<td>26</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td>T 0</td>
<td>62</td>
<td>26</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>187</td>
<td>125</td>
<td>203</td>
</tr>
</tbody>
</table>

$\chi^2 = 165.5$  $f =$ frequency;  $T =$ total percentage $f.$  
$C = .49$
put "much" or "very much" emphasis on coordinating their efforts for some common objectives. Examination of the table, therefore, indicated that more scientists in business, government, and social development organizations, than in universities, responded this way.

The chi-square value (165.5) calculated for the table of responses was significant well beyond the .05 level. The assumed null hypothesis that no differences existed across organization types in levels of coordination of efforts toward common objectives, was rejected. Specific Hypothesis Number 2G, therefore, was accepted as plausible.

The analysis of data related to Hypothesis Number Two is completed. Sufficient information is available, therefore, with which to test this hypothesis.

**Hypothesis Number Two: The Test**

Research departments in different types of parent organizations are structured differently.

The specific hypotheses related to Hypothesis Number Two, in all cases, were accepted. On the basis of this information, the assumed null hypothesis that no differences existed across organization types in research department structures, was rejected. Hypothesis Number Two, therefore, was accepted as plausible.
Results and Conclusions

Section Number Three:

Relationships Between Research Output and Structure Across Organization Types
Specific Hypothesis Number 3A

There will be a greater tendency in universities, than in other types of organizations, for high levels of reported research output to be associated with scientist perceptions of high levels of influence to decide their own work goals and objectives.

Table XVII contains the frequency and percentage frequency tables of responses of high research output scientists, from the four types of organizations, to one question. The question was:

How much influence do you feel the following people have in deciding your work goals and objectives?

<table>
<thead>
<tr>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

An examination of the table indicated that 92 percent of the high output scientists in universities—as compared to 86 percent in social development, 82 percent in government, and 75 percent in business organizations—responded that they perceived a high level of influence in deciding their work goals and objectives. Examination of Table XVII, therefore, indicated that more scientists from universities than from the other types of organizations, responded this way.

71 High research output respondents were those scientists who reported that they had completed 5 or more of output #1 within a five year period. Approximately half of the sample had completed 5 or more outputs.
TABLE XVII

High Levels of Research Output versus Levels of Scientists Decision Making Influence

How much influence do you feel the following people have in deciding your work goals and objectives?

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>High Levels of Research Output (5+)</th>
<th>Low and Medium Influence 1,2,3</th>
<th>High Levels of Influence 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f</td>
<td>T</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus.</td>
<td>5</td>
<td>25</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Gov.</td>
<td>6</td>
<td>18</td>
<td></td>
<td>34</td>
</tr>
<tr>
<td>S.D.</td>
<td>7</td>
<td>14</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Univ.</td>
<td>10</td>
<td>8</td>
<td></td>
<td>127</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>203</td>
<td>92</td>
<td>231</td>
</tr>
</tbody>
</table>

χ² = 6.4 (.10)  High Research Output = 5 or more of: project completion reports; articles accepted by journals; and speeches delivered (completed within the last 5 years, in the scientist's present research department).

C = .164

Chi-Square Values: Separate Sample Compared to One Another

<table>
<thead>
<tr>
<th>Comparison</th>
<th>χ²</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Un. vs. Bus.</td>
<td>5.53</td>
<td>.02</td>
</tr>
<tr>
<td>Un. vs. S.D.</td>
<td>1.55</td>
<td></td>
</tr>
<tr>
<td>Bus. vs. Gov.</td>
<td>2.36</td>
<td>.20</td>
</tr>
<tr>
<td>S.D. vs. Gov.</td>
<td>.419</td>
<td></td>
</tr>
</tbody>
</table>

f = frequency;  T = total percentage f.
Appendix (xvii) contains the same elements as Table XVII, except that output number one (project completion reports etc.) is exchanged for output number two (number of books and monographs completed). The results were comparable to those in Table XVII.

The chi-square values for the two tables of responses were significant at only the .10 level, not the .05 level.

Examination of the chi-square values listed below Table XVII and Appendix (xvii) indicated that the university and business organization scientist responses differed significantly from one another. The values listed below Appendix (xvii) also indicated that university and social development scientist responses differed significantly from one another. The other organization samples, however, did not appear to differ significantly from each other.

On the basis of this information, the null hypothesis that no differences existed across organization types, in the relationship between levels of reported research output and perceived levels of influence to decide work goals and objectives, was accepted. Specific Hypothesis Number 3A, therefore, was rejected. It was noted, however, that the results did not give complete support to rejection of the hypothesis—especially as regards the university sample.
Specific Hypothesis Number 3B

There will be a greater tendency in business, government, and social development organizations, than in universities, for high levels of reported research output to be associated with high levels of perceived supervisor or department head influence in deciding work goals and objectives.

Table XVIII contains the frequency and percentage frequency tables of responses of high research output scientists, from the four types of organizations, to one question. The question was:

How much influence do you feel the following people have in deciding your work goals and objectives?

Rating Scale

Immediate supervisor or department head 1 2 3 4 5

An examination of the table indicated that 30 percent of the high output scientists in business organizations, 56 percent in government, and 22 percent in social development organizations—as compared to 10 percent in universities—responded that they perceived immediate supervisors or department heads to have high levels of influence in deciding their work goals and objectives. Examination of Table XIV, therefore, indicated that fewer scientists from universities than from the other types of organizations, responded this way.

Appendix (xviii) contains the same elements as Table XVIII except that output number one (number of project com-
### TABLE XVIII

High Levels of Research Output versus Levels of Supervisor Decision Making Influence

How much influence do you feel the following people have in deciding your work goals and objectives:

**Immediate Supervisor or department head**

1  2  3  4  5

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>High Levels of Research Output (5+)</th>
<th>Low and Medium Supervisor Inf.1,2,3</th>
<th>High Supervisor Influence 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f 14</td>
<td>6</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov.</td>
<td>f 15</td>
<td>.19</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>f 39</td>
<td>11</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td>f 114</td>
<td>13</td>
<td>127</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 90</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$X^2 = 34.54$ ($0.001$)  
C = .36

High Research Output = 5 or more of: project completion reports; articles accepted by journals; and speeches delivered.

Chi-square Values: Separate Samples vs. Separate Samples

- Un. vs. Bus. $\chi^2 = 5.99$ ($0.02$)  
- Un. vs. S.D. $\chi^2 = 4.23$ ($0.05$)  
- Gov. vs. S.D. $\chi^2 = 10.11$ ($0.01$)  
- Gov. vs. Bus. $\chi^2 = 3.39$ ($0.10$)  
- S.D. vs. Bus. $\chi^2 = .49$

$f = frequency; \ T = total \ percentage \ f$. 
pletion reports etc.) is exchanged for output number two (number of books and monographs completed). The results were comparable to those in Table XVIII. The chi-square values for the two tables of responses were significant well beyond the .05 level.

Examination of the chi-square values listed below Table XVIII and Appendix (xviii) also indicated that the university scientist responses differed significantly from the responses of scientists in most of the other organization samples.

On the basis of this information, the null hypothesis that no differences existed across organization types, in the relationship between high levels of reported research output and perceived levels of immediate supervisor or department head influence to decide scientist work goals and objectives, was rejected. Specific Hypothesis Number 3B, therefore, was accepted as plausible.

Specific Hypothesis 3C

Relationship between high levels of reported research output and perceived levels of emphasis on centralized and decentralized control of research department activities, will vary across organization types.

Specifically:
Specific Hypothesis $3C_1$. There will be a greater tendency in business, government and social development organizations, than in universities, for high levels of reported research output to be associated with perceived levels of emphasis on centralized control of research department activities.

Table XIX contains the frequency and percentage frequency tables of responses of high research output scientists, from the four types of organizations, to one question. The question was:

Which of the following best describes your research unit or department?

<table>
<thead>
<tr>
<th>Control Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly centralized control of activities</td>
<td>1</td>
</tr>
<tr>
<td>Centralized control</td>
<td>2</td>
</tr>
<tr>
<td>Neither centralized nor decentralized control</td>
<td>3</td>
</tr>
<tr>
<td>Decentralized control</td>
<td>4</td>
</tr>
<tr>
<td>Highly decentralized control of activities</td>
<td>5</td>
</tr>
</tbody>
</table>

An examination of the table indicated that 30 percent of the high research output scientists in business organizations, 38 percent in government, and 30 percent in social development organizations—as compared to 12 percent in universities—responded that they perceived a centralized control of activities in their research departments. Examination of Table XV, therefore, indicated that fewer scientists from universities than from the other types of organizations, responded this way.
TABLE XIX

High Levels of Research Output versus Levels of Centralized and Decentralized Control

Which of the following best describes your research unit or department?

| Highly centralized control of activities | 1 |
| Centralized control | 2 |
| Neither centralized nor decentralized | 3 |
| Decentralized control | 4 |
| Highly decentralized control of activities | 5 |

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>High Levels of Research Output (5+)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centralized 1,2</td>
<td>Neither 3</td>
</tr>
<tr>
<td>Bus.</td>
<td>f 6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>T 30</td>
<td>15</td>
</tr>
<tr>
<td>Gov.</td>
<td>f 13</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>T 38</td>
<td>32</td>
</tr>
<tr>
<td>S.D.</td>
<td>f 15</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>T 30</td>
<td>40</td>
</tr>
<tr>
<td>Univ.</td>
<td>f 15</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>T 12</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>49</td>
<td>65</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 28.68(.001) \]

High Research Output = 5 or more of:

Project completion reports; articles accepted by journals; and speeches delivered.

Chi-square Values: Separate Samples vs. Separate Samples

- \[ \chi^2 = 4.87(.10) \] Un. vs. Bus.
- \[ \chi^2 = 17.57(.001) \] Un. vs. S.D.
- \[ \chi^2 = 5.12(.10) \] S.D. vs. Bus.
- \[ \chi^2 = 17.02(.001) \] Un. vs. Gov.
- \[ \chi^2 = .73 \] S.D. vs. Gov.
- \[ \chi^2 = 3.82(.20) \] Gov. vs. Bus.

\( f = \) frequency; \( T = \) total percentage \( f \).
Appendix (xix) contains the same elements as Table XIX except that output number one (number of project completion reports etc.) is exchanged for output number two (number of books and monographs completed). The results were comparable to those in Table XIX. The chi-square values for the two tables of responses were significant well beyond the .05 level.

Examination of the chi-square values listed below Table XIX and Appendix (xix) also indicated that scientist responses in most of the government, social development and business organization samples differed significantly from the responses of the university scientist sample.

On the basis of this information, the null hypothesis that no differences existed across organization types, in the association between high levels of reported research output and perceived level of centralized control of research activities, was rejected. Specific Hypothesis Number 3C₁, therefore, was accepted as plausible.

Specific Hypothesis 3C₂

There will be a greater tendency in universities than in the other types of organizations, for high levels of reported research output to be associated with perceived levels of emphasis on decentralized control of research department activities.
Examination of Table XIX also indicated that 64 percent of the high output scientists in universities—as compared to 30 percent in social development, 30 percent in government, and 55 percent in business organizations—responded that they perceived a decentralized control of activities in their research departments. Further examination of Table XIX, therefore, indicated that more scientists from universities than from the other types of organizations responded this way.

Further examination of Appendix (xix) indicated comparable results to those in Table XIX. The chi-square values for the two tables of responses were significant well beyond the .05 level.

On the basis of this information, the null hypothesis that no difference existed across organization types, in the association between high levels of reported research output and perceived levels of decentralized control of research activities, was rejected. Specific Hypothesis Number 3C₂, therefore, was accepted as plausible.

Specific Hypotheses number 3C₁ and 3C₂ were accepted. On the basis of this information, the null hypothesis that no differences existed across organization types, in the relationships between high levels of reported research output and perceived levels of centralized and decentralized control of research activities, was rejected. Specific Hypothesis Number 3C, therefore, was accepted as plausible.
Hypothesis 3D

There will be a greater tendency in business, government, and social development organizations, than in universities, for high levels of reported research output to be associated with perceptions of high levels of coordination of efforts for common objectives.

Table XX contains the frequency and percentage frequency tables of responses of high research output scientists from the four types of organizations, to one question. The question is:

How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives?

<table>
<thead>
<tr>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

An examination of the table indicated that 70 percent of the high output scientists in business organizations, 74 percent in government, and 56 percent in social development organizations—as compared to 14 percent in universities—responded that they perceived high levels of coordination of research efforts for common objectives. Examination of Table XX, therefore, indicated that fewer scientists from universities than from the other types of organizations, responded this way.

Appendix (xx) contains the same elements as Table XX except that research output number one (number of project
TABLE XX

High Levels of Research Output vs. Levels of Coordination

How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives? 1 2 3 4 5

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>High Levels of Research Output (5+)</th>
<th>Low and Medium Coordination 1,2,3</th>
<th>High Levels of Coordination 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f 6</td>
<td>14</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov.</td>
<td>f 9</td>
<td>25</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>f 22</td>
<td>28</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td>f 109</td>
<td>18</td>
<td>127</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>86</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>146</td>
<td>85</td>
<td>231</td>
<td></td>
</tr>
</tbody>
</table>

χ² = 65.08 (.001)  
High Research Output = 5 or more of:  
Project completion reports; articles accepted by journals; and speeches delivered.

C = .468

Chi-square Values: Separate Samples vs. Separate Samples

Un.vs. Gov.  χ² = 48.27 (.001)  
Un.vs.S.D.  χ² = 32.63 (.001)

Un.vs.Bus.  χ² = 31.62 (.001)  
Gov.vs.S.D.  χ² = 2.67 (.20)

Gov.vs.Bus.  χ² = .07  
S.D.vs.Bus.  χ² = 1.16

f = frequency; T = total percentage f.
completion reports etc.) is exchanged for research output number two (number of books and monographs completed). The results were comparable to those in Table XX. The chi-square values for the two tables were significant well beyond the .05 level.

Examination of the chi-square values listed below Table XX and Appendix (xx) also indicated that scientist responses in each of the government, social development and business organization samples differed significantly from the responses of the university scientist sample.

On the basis of this information, the null hypothesis that no differences existed across organization types, in the association between high levels of reported research output and perceived level of coordination of research efforts for common objectives, was rejected. Specific Hypothesis Number 3D, therefore, was accepted as plausible.

The analyses of the data directly related to Hypothesis Number Three is completed. Sufficient information is available, therefore, with which to test this hypothesis.

**Hypothesis Number Three: The Test**

The relationship between research department structure and research output varies across organization types.

The specific hypotheses related to Hypothesis Number Three (3B, 3C and 3D) were accepted, and results for Specific Hypothesis Number 3A were in the predicted direction. On the
basis of this information, the null hypothesis that no difference existed across organization types, in the relationship between research department structure and research output, was rejected. Hypothesis Number Three, therefore, was accepted as plausible.
Results and Conclusions

Section Number Four:

Differences in Relationships Between
Combined and Separate Organization Samples
Specific Hypothesis Number 4A

Relationships between levels of reported research output and perceived levels of influence to decide work goals and objectives found in combined organization samples, will differ significantly from relationships found in separate organization samples.

Table XXI contains the frequency, horizontal percentage frequency and total percentage frequency tables of responses of high research output scientists, from four types of organizations, to one question. The question was:

How much influence do you feel the following people have in deciding your work goals and objectives?  

<table>
<thead>
<tr>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yourself</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

Examination of the chi-square values listed below Table XXI and Appendix (xvii) indicated that university scientist responses differed significantly from responses of scientists in combined organization samples. The responses of scientists in other separate organization samples, however, did not differ significantly from the responses of scientists in combined organization samples.

On the basis of this information, the assumed null hypothesis that no differences existed between scientist responses in combined and separate organization samples, in the relationships between levels of reported research output and perceived levels of influence to decide work goals and objec-
TABLE XXI

High Levels of Research Output versus Levels of Decision-Making Influence

How much influence do you feel the following people have in deciding your work goals and objectives?

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>High Levels of Research Output</th>
<th>Low and Medium Influence 1,2,3</th>
<th>High Levels of Influence 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus. f</td>
<td>5</td>
<td>15</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>25</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov. f</td>
<td>6</td>
<td>28</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>18</td>
<td>82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.D. f</td>
<td>7</td>
<td>43</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>14</td>
<td>86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Univ. f</td>
<td>10</td>
<td>117</td>
<td>127</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>8</td>
<td>92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chi-square Values: Separate vs. Combined Samples

University vs. Other three $\chi^2 = 4.77$ (.05)
Business vs. Other Three $\chi^2 = 3.4$ (.10)
Government vs. Other Three $\chi^2 = 1.14$
Social Development vs. Other Three $\chi^2 = .21$

$f =$ frequency; $T =$ total percentage $f.$
tives, was accepted. Specific Hypothesis Number 4A, therefore, was rejected. It was noted, however, that the frequency distribution of university scientist responses did not support rejection of the hypothesis.

Specific Hypothesis Number 4B

Relationships between levels of reported research output and perceived levels of supervisor or department head influence in deciding work goals and objectives found in combined organization samples, will differ significantly from relationships found in separate organization samples.

Table XXII contains the frequency, horizontal percentage frequency and total percentage frequency tables of responses of high research output scientists, from four types of organizations, to one question. The question was:

How much influence do you feel the following people have in deciding your work goals and objectives?  

<table>
<thead>
<tr>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate supervisor or department head</td>
</tr>
</tbody>
</table>

Examination of the chi-square values listed below Table XXII and Appendix (xviii) indicated that most separate organization sample responses differed significantly from combined organization sample responses.

On the basis of this information, the assumed null hypothesis that no differences existed between scientist responses in combined and separate organization samples, in the rela-
TABLE XXII

High Levels of Research Output versus Levels of Supervisor Decision-Making Influence

How much influence do you feel the following people have in deciding your work goals and objectives?
Immediate supervisor or department head

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>High Levels of Research Output (5+)</th>
<th>Low and Medium Supervisor Influence 1,2,3</th>
<th>High Supervisor Influence 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f 14</td>
<td>70</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Bus.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f 15</td>
<td>44</td>
<td>19</td>
<td>34</td>
</tr>
<tr>
<td>Gov.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f 39</td>
<td>78</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td>S.D.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f 114</td>
<td>90</td>
<td>13</td>
<td>127</td>
</tr>
<tr>
<td>Univ.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>182</td>
<td>49</td>
<td>231</td>
<td></td>
</tr>
</tbody>
</table>

Chi-square Values: Separate Samples vs. Combined Samples

University vs. Three Others Combined $\chi^2 = 20.33(.001)$
Social Development vs. Three Others Comb. $\chi^2 = .02$
Government vs. Three Others Combined $\chi^2 = 28.67(.001)$
Business vs. Three Others Combined $\chi^2 = 1.01$

f = frequency; T = total percentage f.
tionships between levels of reported research output and perceived levels of supervisor or department head influence to decide work goals and objectives, was rejected. Specific Hypothesis Number 4B, therefore, was accepted as plausible.

Specific Hypothesis Number 4C

Relationships between levels of reported research output and perceived levels of centralized and decentralized control of research department activities found in combined organization samples, will differ significantly from relationships found in separate organization samples.

Table XXIII contains the frequency, horizontal percentage frequency and total percentage frequency tables of responses of high research output scientists, from four types of organizations, to one question. The question was:

Which of the following best describes your research unit or department?

- Highly centralized control of activities 1
- Centralized control 2
- Neither centralized nor decentralized 3
- Decentralized control 4
- Highly decentralized control of activities 5

Examination of the chi-square values listed below Table XXIII and Appendix (xix) indicated that most separate organization sample responses differed significantly from combined organization sample responses.

On the basis of this information, the assumed null hypothesis that no differences existed between scientist
TABLE XXIII

High Levels of Research Output versus Levels of Centralized and Decentralized Control

Which of the following best describes your research unit or department?

- Highly centralized control of activities
- Centralized control
- Neither centralized nor decentralized
- Decentralized control
- Highly decentralized control of activities

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>High Levels of Research Output</th>
<th>Neither</th>
<th>Decentralized</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centralized</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,2</td>
<td>3</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Bus.</td>
<td>f 6</td>
<td>T 30</td>
<td>15</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>15</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Gov.</td>
<td>f 13</td>
<td>T 38</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>11</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>S.D.</td>
<td>f 15</td>
<td>T 30</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>31</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>Univ.</td>
<td>f 15</td>
<td>T 12</td>
<td>24</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>81</td>
<td>117</td>
<td>127</td>
</tr>
</tbody>
</table>

Chi-square Values: Separate Samples vs. Combined Samples

- University vs. Three Others Combined $\chi^2 = 22.74 (.001)$
- Social Development vs. Three Others Comb. $\chi^2 = 10.88 (.01)$
- Government vs. Three Others Combined $\chi^2 = 9.24 (.01)$
- Business vs. Three Others Combined $\chi^2 = 2.22$

f = frequency; T = total percentage f.
responses in combined and separate organization samples, in relationships between levels of reported research output and perceived levels of centralized and decentralized control of research activities, was rejected. Specific Hypothesis Number 4C, therefore, was accepted as plausible.

Specific Hypothesis Number 4D

Relationships between levels of reported research output and perceived levels of coordination of research efforts for common objectives found in combined organization samples, will differ significantly from relationships found in separate organization samples.

Table XXIV contains the frequency, horizontal percentage frequency and total percentage frequency tables of responses of scientists, from four types of organizations, to one question. The question was:

How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives?

<table>
<thead>
<tr>
<th>Rating Scale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

Examination of the chi-square values listed below Table XXIV and Appendix (xx) indicated that all separate organization sample responses differed significantly from the combined organization sample responses.

On the basis of this information, the assumed null hypothesis that no differences existed between scientist res-
### TABLE XXIV

High Levels of Research Output versus Levels of Coordination

How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives? 1 2 3 4 5

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>High Levels of Research Output (5+)</th>
<th>Low and Medium Coordination 1, 2, 3</th>
<th>High Levels of Coordination 4, 5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>f 6</td>
<td>14</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 30</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gov.</td>
<td>f 9</td>
<td>25</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 26</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>f 22</td>
<td>28</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 44</td>
<td>56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td>f 109</td>
<td>18</td>
<td>127</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 86</td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|               | 146                                | 85                                | 231                               |

Chi-square Values: Separate vs. Combined Samples

- University vs. Three Others Combined \( \chi^2 = 62.07 (.001) \)
- Social Development vs. Three Others Combined \( \chi^2 = 10.11 (.01) \)
- Government vs. Three Others Combined \( \chi^2 = 23.13 (.001) \)
- Business vs. Three Others Combined \( \chi^2 = 10.37 (.01) \)

f = frequency; T = total percentage f.
responses in combined and separate organization samples, in the relationships between levels of reported research output and perceived levels of coordination of research efforts for common objectives, was rejected. Specific Hypothesis Number 4D, therefore, was accepted as plausible.

The analysis of specific hypotheses relevant to Hypothesis Number Four is completed. Sufficient information is available, therefore, with which to test this hypothesis.

Hypothesis Number Four: The Test

Relationships between research output and structure found in combined organization samples will be different than relationships found in separate organization samples.

The specific hypotheses related to Hypothesis Number Four (Specific Hypotheses 4B, 4C, and 4D) were tested and accepted. Specific Hypothesis Number 4A was rejected, but results appeared to be in the predicted direction. On the basis of this information, the assumed null hypothesis that no differences existed between combined and separate organization samples, in the relationships between research output and structure, was rejected. Hypothesis Number Four, therefore, was accepted as plausible.
SUMMARY

Previous research reveals a relationship between research department structure and scientist research output. Investigators have drawn on the findings of this research to make recommendations to research directors and administrators regarding the type of structure necessary to maximize scientist research output. Since the recommendations were made to research directors and administrators in general, the implication is that one type of research department structure should be utilized in all types of organizations.

Consideration of the goals and operating conditions in different types of organizations suggests that some organizations would tend to place greater structural constraints on scientists than others. In other words, differences in goals and conditions of operation make it almost impossible for research departments in different types of organizations to be structured the same way. If this is the case, the hypothesis that follows inevitably is that some types of organizations cannot have the one best structure, and must suffer losses in research output.

An examination of the original research, however, reveals that the responding scientists were employed in a variety of organization types. Moreover, the investigators made no attempt to examine the relationships between structure and research output on an organization type-by-type basis.
There remained then an equally plausible hypothesis that scientists in different types of organizations accept the existing structure and that no basic incompatibility exists. This implies that the relationship between structure and research output is not constant across organization types, but varies from type to type.

The problem of this study, therefore, was to determine whether or not the relationship between research department structure and research output was constant across organization types. The main hypothesis tested was:

The relationship between research department structure and research output varies across organization types.

Implicit in this hypothesis were two prior hypotheses.

1. There is a relationship between research department structure and research output.

2. Research departments in different types of parent organizations are structured differently.

Also implicit in the main hypothesis was a type of summary hypothesis, which properly followed the main hypothesis:

4. Relationships between research output and structure found in combined organization samples are different than relationships found in separate organization samples.

These general hypotheses were tested by examining information obtained from testing related specific hypotheses. The data necessary for the testing of the specific hypotheses was obtained from scientist questionnaire responses.
Scientists from four types of organizations—business, government, social development, and university—were mailed questionnaires in order to obtain measures of reported research output, and perceptions of research department structure. 523 scientists, or 45% of the sample, returned a completed questionnaire. Another 15% of the sample provided reasons for not responding.

Examination of the data relevant to Hypothesis Number One indicated that, in a combined organization sample:

1. levels of reported research output was positively associated with levels of perceived influence to decide work goals and objectives;

2. levels of reported research output was negatively associated with levels of perceived supervisor or department head influence in deciding scientist work goals and objectives;

3. levels of reported research output was positively associated with levels of perceived decentralized control of research activities, and negatively associated with perceived levels of centralized control.

On the basis of this information, Hypothesis Number One was accepted.

Examination of the data related to Hypothesis Number Two indicated that scientists in different types of organizations:
1. perceived different levels of emphasis to be placed on particular criteria used in the selection of research projects. Specifically, the project selection criteria were:
   (a) projects that contribute to the organization's financial well-being;
   (b) projects that are delegated by some higher authority;
   (c) projects that may contribute to the well-being of some social group;
   (d) projects that are interesting in themselves; and
   (e) projects that seek new knowledge—because the search for new knowledge is intrinsically good.

2. perceived different levels of time expenditures in basic and applied research activities;

3. perceived different levels of time pressure on their work;

4. perceived different levels of influence to decide work goals and objectives;

5. perceived immediate supervisors and department heads to have different levels of influence in deciding their work goals and objectives;

6. perceived different levels of centralized and decentralized control of research activities; and

7. perceived different levels of coordination of efforts for common objectives.
On the basis of this information, Hypothesis Number Two was accepted.

Examination of the data related to Hypothesis Number Three indicated that high research output scientists, in different types of organizations:

1. perceived different levels of influence in deciding their work goals and objectives (university scientists only);
2. perceived immediate supervisors or department heads to have different levels of influence in deciding their work goals and objectives;
3. perceived different levels of centralized and decentralized control of research activities; and
4. perceived different levels of coordination of efforts for common objectives.

On the basis of this information, Hypothesis Number Three was accepted.

Examination of the data relevant to Hypothesis Number Four indicated that high research output scientists in combined organization samples—as compared to separate organization samples:

1. perceived different levels of influence in deciding their work goals and objectives (university scientists only);
2. perceived immediate supervisors or department heads to have different levels of influence in deciding their work goals and objectives;
3. perceived different levels of centralized and decentralized control of research activities; and
4. perceived different levels of coordination of efforts for common objectives.

On the basis of this information, Hypothesis Number Four was accepted.

In summary, this study found relationships between research output and research department structure. Research departments in different types of parent organizations appeared to be structured differently. Finally, relationships between structure and research output varied across organization types, as well as between separate and combined organization samples.

Limitations of the Study

There were some limitations to the study which should be discussed before the conclusions and implications arising out of the study are considered.

1. Questionnaire Reliability. The questionnaire used in this study, and the reliability and validity of the measurements obtained may tend to limit the strength of the conclusions one can reach. The questions asked were necessarily general so that they would apply to scientists in four types of organizations. It may have been possible, therefore, for scientists in different types of organizations, because of organizational differences, to place different interpretations on these questions. If this was the case, the questionnaire could appear to have validity and reliability and still not present the
true picture for comparisons across organization types.

The questionnaire used was the same as one designed by Pelz and Andrews, except for minor modifications and additions. Pelz and Andrews had checked their questionnaire for reliability by readministering it to 52 scientists after two months. Mean response scores were correlated .97. That is, the mean score of the 52 scientists on each questionnaire item found in the first administration of the questionnaire was compared to the group mean score on the second administration. The correlation between the two sets of mean scores was .97. When individual correlations were computed, 83 per cent were .5 or better.72

A test to determine the reliability of the questionnaire items used in the present study, however, was not carried out. That is, since there were only minor modifications and additions made to the Pelz and Andrews questionnaire items, it was assumed that the instrument would have a similar level of reliability. This was possibly a risky assumption to make, as there were not only modifications and additions to the questionnaire items, but the questionnaire was administered to scientists in another country--Canada instead of the United States.

2. Validity of Research Output Measurements. The measurement of research output has typically been a controversial task. The controversy has revolved around the relative merits of utilizing a quantitative measure of research output,

72 See Appendix (v).
such as the number of research papers that a scientist reports he has completed—and a qualitative measure of research output, such as the quality of a research paper as determined by judges. Both methods were examined by Pelz and Andrews, but they concluded that quantitative measures were highly correlated with qualitative measures and much easier to obtain. The implications of their results were that quantitative measures of research output were valid measures of research quality.

Pelz and Andrews did a further validity check on their research output measures. They examined laboratory records to determine whether or not scientists reported their research output accurately. High correlations between reported research output and lab records indicated that scientists reported research output with high and consistent accuracy.

In utilizing quantitative measures of research output for the present study without checking the validity of these measures, it was again assumed that such measures would also apply for Canadian scientists. Although the NRC did support the use of such measures for research output in a brief to the Special Senate Committee on Science Policy, it is an assumption that should be examined in later research.

3. Questionnaire Return Rate. Forty-five per cent of the sample returned a completed questionnaire. Fifteen per

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74 See Appendix (v).
75 See Appendix (v).
cent of the sample gave reasons for not completing the questionnaires, and these reasons indicated that they should not have been included in the sample in the first place. The remaining forty per cent of the sample did not respond in any way, so there was no way of telling what biases might have been introduced into the data as a result of the absence of their responses.

4. Control of Background Variables. Although there were significant and positive relationships between research output and such variables as age, education, previous research experience, and position, these variables were not controlled in this study. Control of these variables in this study would have reduced the table frequencies to a point where the analysis of data was almost impossible.

Other variables such as the incentive systems used to motivate scientists, and their risk-taking behaviour, were not examined in relationship with research output. Since these and other variables, besides structure, may be related to research output, more studies and more sophisticated measurement and statistical procedures will be required to determine the relationships and inter-relationships of these and other variables with research output.

5. Questionnaire Development. Except for the addition of a few questions, the questionnaire used in this study was

76 See Appendix (iii).
77 A separate analysis of the data revealed these relationships.
made up of the same questions used in the Pelz and Andrews questionnaire. Their questions appeared to be appropriate for this study and were used with only minor modifications.

It is quite possible, however, that other questionnaire items might have been more appropriate for this study. Pelz and Andrews were not concerned about differences across organizational types in the relationships between structure and output. More appropriate questionnaire items might have been discovered if more time had been spent interviewing scientists from each type of organization.

The use of a questionnaire instead of other data gathering techniques can be questioned. An interview guide and scientist observation would likely have provided more valid data than the questionnaire. The questionnaire, however, provided responses from scientists that would not otherwise have been reached—given the resource limitations of the study.

Summary of the Results

The evidence from the present study tends to support previous research evidence in that the data revealed a relationship between research department structure and research output—for a combined organization sample. That is, both previous research evidence and the findings in the present study indicated that when scientists from several different types of organizations were combined into one sample, scientists who reported high levels of research output also perceived themselves to work under lower levels of decision-
making structural constraints than low output scientists. In the present study, for example, there was a tendency for scientists who perceived themselves to have high levels of influence to decide their work goals and objectives to have higher levels of research output than scientists who perceived themselves to have low levels of influence.\textsuperscript{78}

As one might expect from the above results, there was also a tendency for scientists who perceived research supervisors to have high levels of influence to decide their work goals and objectives to have lower levels of research output than scientists who perceived supervisors to have low levels of influence.\textsuperscript{79} Again in the present study, there was a tendency for scientists who perceived themselves to work in a research department with a decentralized control of research activities to have higher levels of research output than scientists who perceived themselves to work under centralized control.\textsuperscript{80}

Previous investigators drew on findings such as these from combined organization samples to make recommendations to research directors in general regarding the type of research department structure to utilize in order to obtain high levels of research output. In other words, previous investigators suggested that all scientists, regardless of the organization type in which they worked, must have such things as autonomy

\textsuperscript{78} See Table I
\textsuperscript{79} See Table III
\textsuperscript{80} See Table III
and decentralized decision-making in their research departments in order for them to attain high levels of research output. Put another way, previous investigators indicated that there was one particular type of research department structure—in which there was a low level of decision-making structural constraints—that was appropriate for scientists in research departments in all types of organizations.

Further analysis of the data in the present study, however, indicated that the relationships between structure and research output found in combined organization samples differed from the relationships found in separate organization samples. For example, a greater proportion of high output university scientists—when compared to a combined sample of high output business, government and social development organization scientists—perceived themselves to have high levels of influence to decide their work goals and objectives.\(^81\) A smaller proportion of high output university students—when

\(^81\) See Table XXI, also Table XXII. A much smaller proportion of high output university scientists—when compared to a combined sample of high output business, government and social development scientists—perceived research supervisors to have high levels of influence to decide their work goals and objectives. Similar results were found when perceptions of centralized control of research activities and co-ordination of research activities were examined.
compared to a combined sample of high output business, government and social development scientists—perceived centralized control of research activities (and vice versa regarding perceptions of decentralized control of research activities).  

Data in the present study also suggested that research departments in different types of organizations have different decision-making structures. For example, a higher proportion of university scientists—when compared to scientists in the other three types of organizations—perceived themselves to have high levels of influence to decide their own work goals and objectives. In the three other types of organizations, more social development organization scientists than business, and more business than government scientists perceived high levels of influence to decide work goals and objectives.  

82 See Table XXIII, also Table XXIV. Likewise, a smaller proportion of high output university scientists—when compared to a combined sample of high output scientists from the other three types of organizations—perceived high levels of co-ordination of research efforts for some common objectives (and vice versa regarding perceptions of low levels of co-ordination).  

83 See Table XIII, also Table XIV. As one might expect from the above results, a lower proportion of university scientists—when compared to scientists in the other three types of organizations—perceived research supervisors or department heads to have high levels of influence to decide their work goals and objectives. In the three other types of organizations, fewer social development organization scientists than business, and fewer business than government scientists perceived research supervisors or department heads to have high levels of influence to decide their work goals and objectives.
As regards perceptions of decentralized and centralized control of research activities, more university scientists and fewer government scientists perceived decentralized control, while the perceptions of scientists in the other two types of organizations fell between. The data were reversed for perceptions of centralized control of research activities.  

The data from the present study also indicated that relationships between structure and research output varied across organization types. That is, scientists in different types of organizations attained high levels of research output under different decision-making structural conditions. For example, a high number of high output government scientists and a low number of high output university scientists perceived research supervisors to have high levels of influence to decide their work goals and objectives. That is, only a few high output scientists in the university research departments perceived supervisors to have high levels of influence to decide their work goals and objectives, whereas the opposite was apparent in government research departments. The perceptions of scientists in research departments in the other two types of organizations fell between these two extreme positions.  

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84 See Table XV, also Table XVI. Still considering examples of structural differences across organization types, the present study also provided data to suggest differences in co-ordination. Fewer university scientists and more business scientists perceived high levels of co-ordination of research efforts for common objectives. The perceptions of the scientists in the other two types of organizations fell between. The data were reversed for perceptions of low co-ordination.
These same relationships were also apparent with regard to the centralized control of research activities. Only a few of the high output university scientists perceived a centralized control of research activities, whereas a high proportion of the high output scientists from government organizations perceived a centralized control of research department activities (vice versa regarding decentralized control). The perceptions of scientists in the other two types of organizations fell between these two extreme positions.  

Conclusions

Analysis of the data in the present study, beyond that carried out in previous research, did not appear to support previous research findings. That is, the present study contradicted evidence that there is one particular type of research department structure—in which there are low decision-making structural constraints—that is associated with high scientist research output in all types of organizations. The present study indicated that high output scientists in research departments in different types of organizations had perceptions of working under different levels of decision-

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85 See Table XVIII, also Table XX. Similar results were apparent with regard to the level of co-ordination of research efforts of high output scientists in different types of organizations. Only a few of the high output university scientists perceived high levels of co-ordination, whereas a high proportion of the high output scientists from the other three types of organizations perceived high levels of co-ordination.

86 See Table XXI.
making structural constraints. For example, scientists in one type of organization appeared to achieve high levels of research output while working under low levels of structural constraints, whereas scientists in another type of organization achieved high levels of research output while working under high levels of structural constraints.

In conclusion, the present study indicated that there is no 'best' type of research department structure for all organizations.

Implications of the Results and Conclusions for Research Directors

There appear to be some obvious implications for research directors that are based on the results and conclusions of this study. The first one is that a research director should be wary of recommendations to utilize a particular type of research department decision-making structure. This would appear to be a necessary precaution, especially if the recommendations are based on data:

(a) obtained from scientists in a different type of organization from the one in which he is director;

or

(b) obtained from scientists from several types of organizations combined into one sample.

In other words, a research director should probably give more weight to recommendations based on data obtained from scientists in organizations which are of the same type as the one
in which he is director. That is, although one cannot infer causal relationships, the data from the present study strongly suggest that research directors in different types of organizations may find that different decision-making structural constraints are associated with high scientist research output. For example, research directors in university and social development organizations are likely to find that when they provide scientists with autonomy, decentralized decision-making and a low level of co-ordination of research efforts, the productivity of their scientists will tend to be high. Conversely, research directors in business and government organizations are likely to find that when they influence their scientists' decision-making, have centralized control over research activities and carefully co-ordinate scientist efforts toward some common organizational objective, their scientists will tend to have high levels of research output.

Research directors, to date, have been reluctant to deviate too far from the structural model of the university research department—probably because of previous research evidence and opinions of vociferous advocates of research scientist autonomy. The results of the present study indicate that scientists can have high levels of research output while working under different levels of decision-making structural constraints. Research directors may find, therefore, that a structure that is best for their organization is different
from what is best for another type of organization. If re-
search directors find that this is the case, they may become
more innovative regarding the type of research department
structures they use, or more willing to alter existing struc-
tures.

The data in the present study indicated that there
were marked structural differences in research departments
in different types of organizations. In spite of these dif-
ferences, most scientists still perceived themselves to have
relatively high levels of autonomy to decide their own work
goals and objectives. For example, a high proportion of
business and government scientists had perceptions of working
in research departments with

(a) centralized control of research activities;
(b) high levels of co-ordination of effort for
common objectives; as well as
(c) research supervisors with high levels of
influence to decide their work goals and objec-
tives. In spite of the high proportion of these
perceptions, a relatively high proportion of
business and government scientists still had
perceptions of autonomy to decide their own
work goals and objectives.\footnote{A significantly lower proportion of business and
government scientists--than the university and social develop-
ment scientists--had perceptions of autonomy to decide their
own work goals and objectives.}
It would appear from this evidence that scientists perceived no marked decision-making structural interference in their decisions about work goals and objectives. This suggests that scientists are either extremely versatile and able to work under almost any structural constraints without loss of perceived autonomy, or that scientists seek out and are recruited by research directors who direct research departments with structures and work goals and objectives compatible to those preferred by the scientist. The latter proposition seems more reasonable since people tend to vary in their preferences and opinions about the best way to do things. If this is the case, research directors may find that a particular type of structure is more appropriate not only because of the needs of the particular organization, but because some scientists self-select a particular organization on the basis that the working conditions are compatible to their preferred conditions of work.

Implications for Further Research

The questionnaire items used in this study were necessarily general so that they would apply to scientists in different types of parent organizations. Refinement of the items could probably be achieved if research departments in only one organization type were studied in depth. In depth studies may also reveal other measures of structure and
research output peculiar to each organization type.

To assist in the development of more specific studies, an organization classification procedure may be helpful. The results and conclusions of this study provided some support for the procedure of classifying organizations and developing a theoretical framework from which to approach the study of departments or other units of analysis, within organizations. That is a classification procedure could also be applied to a particular organization type, to a particular organization, to a particular research department, or to a particular scientist, as a way of developing a theoretical framework from which to launch a study. ⁸⁸

⁸⁸Hills, op. cit., p. 120. "There is considerable number of relatively specific hypotheses that might be advanced concerning differences in values, norms, goals, evaluative standards and standards of successful performance characterizing each of the differentiated subsystems within organizations, but to list them here would be highly repetitious. Perhaps it will be sufficient to point out that, according to the Parsonian model, we should find it possible to differentiate not just an administrative and a technical orientation, but four distinguishable orientations. That is to say, we should find it possible to distinguish, on any given level of analysis, four different ways of seeing things, and the corresponding categories of expectations, and communication."
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MISCELLANEOUS


APPENDICES
Appendix (i)

Random Sampling Procedure for Selection of University Sample

1. Rank order all social science departments according to size, on separate lists for each type of department (psychology, sociology, anthropology, social work, education psychology, education administration, economics and psychiatry).

2. Calculate the number of: (a) social science departments in Canadian universities and (b) social scientists in Canadian universities.

3. From the information in #2, calculate the average size of Canadian university social science departments.

4. Given the limitation of 550 questionnaires for the university sample, divide this by the average size of social science departments, to get the number of departments that can be included in the sample.

5. Calculate the percentage of the total number of social science departments that this sample represents, i.e.

\[
\text{\%} = \frac{\text{no. of departments in sample}}{\text{total no. of social science departments}} \times 100
\]

6. Consider the lists of departments. Note natural breaks in size and divide each list into groups of departments that are of small, medium, and large size.

7. Take the percentage figure from #5 and multiply this by the number of departments in each small, medium and
large group, to get the number of departments allowed for
the sample (nearest whole number in each case, for the
number of departments).

8. Number each group on each list from 01-N.
9. Take a table of random numbers and select a starting
place, with eyes closed.

10. Move down the columns of numbers until a number correspon­
ding to that in the first group, on the first list, is
found. Mark that department. Continue down the random
number rows until the allowed number of departments has
been selected from that group.

11. Repeat #9 and #10 for each group of departments on each
list.

12. This procedure should provide a representative random
sample of university social science departments.

Note:

On completing the procedure, a double check was made
by adding up the total number of departments and the total
number of university social scientists—the figures checked
out very closely with those in #4.
Appendix (ii)

Four Types of Organizations: Their Sample Size and Questionnaire Return Data

<table>
<thead>
<tr>
<th>Type of Organization</th>
<th>Questionnaires returned</th>
<th>Sample size</th>
<th>Questionnaire response rate</th>
<th>Responded but did not return a questionnaire</th>
<th>Total response rate</th>
<th>No. of post cards returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Business (9 departments)</td>
<td>47</td>
<td>76</td>
<td>61.75</td>
<td>0</td>
<td>61.75</td>
<td>47</td>
</tr>
<tr>
<td>2. Government (40 departments)</td>
<td>137</td>
<td>243</td>
<td>56.40</td>
<td>20</td>
<td>64.6</td>
<td>133</td>
</tr>
<tr>
<td>3. Social Development (27 departments)</td>
<td>109</td>
<td>198</td>
<td>54.75</td>
<td>16</td>
<td>62.8</td>
<td>106</td>
</tr>
<tr>
<td>4. University (42 departments)</td>
<td>230</td>
<td>625</td>
<td>36.80</td>
<td>119</td>
<td>55.8</td>
<td>230</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>523</strong></td>
<td><strong>1142</strong></td>
<td><strong>45.75</strong></td>
<td><strong>155</strong></td>
<td><strong>59.3</strong></td>
<td><strong>516</strong></td>
</tr>
</tbody>
</table>

5. Unidentifiable handwriting on post cards | 6 |
6. Post cards returned but no name | 12 |
7. Questionnaires returned after cut-off date and not included in sample | 11 |

| **Totals** | **534** | **1142** | **45.75** | **155** | **60.2** | **534** |
# Appendix (iii)

## Reasons Given for Not Responding to the Questionnaire

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Not involved in research (not enough to justify completing the questionnaire--administration, teaching etc.)</td>
<td>57</td>
<td>36.8</td>
</tr>
<tr>
<td>2. Please exclude--no reason given</td>
<td>49</td>
<td>31.6</td>
</tr>
<tr>
<td>3. No time to respond</td>
<td>9</td>
<td>5.8</td>
</tr>
<tr>
<td>4. On leave--informed by secretary of research department</td>
<td>7</td>
<td>4.5</td>
</tr>
<tr>
<td>5. Questionnaire not applicable to type of research being carried out</td>
<td>10</td>
<td>6.45</td>
</tr>
<tr>
<td>6. Moved to new research department and not active in research yet</td>
<td>8</td>
<td>5.16</td>
</tr>
<tr>
<td>7. Questionnaire criticism--lacks confidentiality, questions not appropriate etc.</td>
<td>9</td>
<td>5.8</td>
</tr>
<tr>
<td>8. Plans to answer questionnaire, but....</td>
<td>1</td>
<td>.645</td>
</tr>
<tr>
<td>9. Objects to questionnaires in general</td>
<td>3</td>
<td>1.93</td>
</tr>
<tr>
<td>10. Prank responses</td>
<td>2</td>
<td>1.29</td>
</tr>
<tr>
<td>11. Questionnaires returned (not completed), address unknown</td>
<td>155</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Total** 155

100.0%
Appendix (iv)

The Questionnaire

THE CANADIAN RESEARCH SCIENTIST
His Research Role and Organizational Environment

Introduction

To All Respondents:

The following questionnaire items attempt to obtain information about the Canadian research scientist, his research activities and the research environment in which he carries out his work. Since Canadian research scientists work in many kinds of organizations, an attempt was made to word questionnaire items in such a way that they would be applicable to most situations. Please respond to all items, but if some items do not apply to your particular situation, please stroke them out.

Please sign your name and the name of your research unit or department, on the back of the post card provided. Please mail the questionnaire and post card separately. This procedure will ensure your anonymity and permit me to maintain a record of returns.

A summary of the findings of this study, keeping the identification of individuals and research units or departments confidential, will be made available to your research unit or department when the analysis is completed. Your cooperation in helping us obtain this information will be greatly appreciated.

Sincerely,

T.R. Pelton, Research Assistant
Center for the Study of Administration in Education
University of British Columbia
Vancouver 8, B.C.
A. BACKGROUND INFORMATION

1. Date of Birth: .................. Place: ..................

2. Degrees: Year University
   (a) Bachelor's ..................
   (b) Master's ..................
   (c) Doctorate ..................
   (d) If no degree, number of years post secondary education.
   (e) If (d) is applicable, where:

   Number of Years
   i. University or College ................. ...........
   ii. Institute of Technology ............... ...........
   iii. Other (please specify) ............... ...........

*3. In describing your scientific disciplines or professional fields, try to break down broad fields such as psychology or sociology into more specific areas such as clinical psychology or sociology of religion, etc.

Part I. In what scientific disciplines or professional fields did you specialize in your graduate or technical studies?
   (a) .................................................
   (b) .................................................
   (c) .................................................
   (d) No formal scientific, technical or professional education .................................................

Part II. List the above scientific disciplines or professional fields in order of their importance to your present work.
   (a) .................................................
   (b) .................................................
   (c) .................................................
   (d) None of special importance: .................

* Items added to Pelz-Andrews Questionnaire items.
4. Previous research experience:

<table>
<thead>
<tr>
<th>Job titles of positions</th>
<th>Employer (Univ., etc.)</th>
<th>No. of years held:</th>
<th>Please specify</th>
<th>held:</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>v.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*5.*

(a) Name of research unit or department in which you are currently employed: ........................................

(b) Name of organization of which the research unit or department is a part: ........................................

(c) Length of your employment in this organization:  
Yrs............. Mths ............

(d) Length of employment in the research unit or department in which you are now working:  Yrs............. Mths.........

(e) Your official job title: ............................

(f) Your immediate supervisor's job title: ............................

*6(a) Your current annual salary:

<table>
<thead>
<tr>
<th>Salary Range</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>under 6,000</td>
<td>1</td>
</tr>
<tr>
<td>6,000 - 7,999</td>
<td>2</td>
</tr>
<tr>
<td>8,000 - 9,999</td>
<td>3</td>
</tr>
<tr>
<td>10,000 - 11,999</td>
<td>4</td>
</tr>
<tr>
<td>12,000 - 13,999</td>
<td>5</td>
</tr>
<tr>
<td>14,000 - 15,999</td>
<td></td>
</tr>
<tr>
<td>16,000 - 17,999</td>
<td></td>
</tr>
<tr>
<td>18,000 or more</td>
<td></td>
</tr>
</tbody>
</table>

B. THE NATURE OF YOUR RESEARCH ACTIVITIES

The following list of statements describes some of the activities of research scientists (supervisors should consider both the research work they supervise, and the work they carry out themselves). Please consider your "average" working month, if possible.

<table>
<thead>
<tr>
<th>Rating Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>not very much</td>
</tr>
<tr>
<td>3</td>
<td>some</td>
</tr>
<tr>
<td>4</td>
<td>much</td>
</tr>
<tr>
<td>5</td>
<td>very much</td>
</tr>
</tbody>
</table>

* Items added to Pelz-Andrews Questionnaire items.
7. How much of your working time do you spend on the following activities in your present research unit or department? Please circle the appropriate number

(a) Discovery of specific knowledge for the solution of particular problems (applied research) 1 2 3 4 5

(b) Discovery of new knowledge, not immediately applicable to particular problems (basic research) 1 2 3 4 5

Rating Scale
1 totally unimportant
2 unimportant
3 neither important nor unimportant
4 important
5 very important

Please circle the appropriate number

8. How important are the following criteria in your selection of research projects?

(a) Projects that are interesting in themselves 1 2 3 4 5

(b) Projects that seek new knowledge--because the search for new knowledge is intrinsically good 1 2 3 4 5

*(c) Projects that may contribute to the well-being of some social group 1 2 3 4 5

*(d) Projects that are delegated by some higher authority 1 2 3 4 5

*(e) Projects that contribute to the organization's financial well-being 1 2 3 4 5

9. How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives? Please circle the appropriate number

1 none
2 not very much
3 some
4 much
5 very much

10. How much time pressure do you work under? (i.e. results needed in a hurry, deadlines to be met, etc.) 1 2 3 4 5

*Items added to Pelz-Andrews Questionnaire items.
11. How much influence do you feel the following people have in deciding your work goals and objectives?

(a) Subordinates
(b) Colleagues
(c) Yourself
(d) Immediate supervisor or department head
(e) Higher level supervisor(s)
(f) Management official(s)
(g) Other people or groups (please specify)

12. Some individuals are completely involved in their research work, absorbed by it night and day. For others, their work is simply one of several interests. To what extent are you involved, or how much involvement do you feel for your present research work?

13. Which of the following best describes your research unit or department?

Please circle the appropriate number.

Highly centralized control of activities
Centralized control
Neither centralized nor decentralized
Decentralized control
Highly decentralized control of activities

14. Over the past five years, about how many of the following have you completed? (1) Approximate number in last 5 years; (2) approximate number while employed in this research unit (if less than 5 years)

i. Speeches

ii. Articles accepted by professional journals

iii. Books completed

iv. Books accepted for publication

v. Patents or patent applications

vi. Monographs completed

vii. Monographs accepted for publication

viii. Project completion reports
Appendix (v)

Questionnaire Validity and Reliability

The reliability of the Pelz-Andrews questionnaire was checked by the authors. They had a group of fifty-two scientists respond to the questionnaire twice, after a two month interval. The second time they responded, they were told to respond as if they were seeing the questions for the first time. Mean response scores were calculated in each case and the two sets of mean scores correlated .97, indicating that the relative standing of the group on these items at the first administration was an almost perfect predictor of the relative standing at the second administration. Since their analysis involved comparisons among groups rather than individuals, as will be the case in the present study, an examination of the stability of group means seemed an appropriate way to assess reliability. When individual scores on the two administrations were compared, the median reliability coefficient was 0.62; 83% of the correlations were 0.5 or higher.\(^1\)

The validity of the questionnaire performance scores was checked against laboratory records. For patents, the Spearman rank-order correlation, between lab records and respondent claims, was 0.91. For published papers the correlation was 0.82.

The reliability, after a two-month period, between the two administrations of performance items was (Pearson product moment correlations) 1.00 for patents and 0.91 for papers. These authors concluded that research scientists reported research outputs with high and consistent accuracy.²

²Pelz and Andrews, op. cit., p. 272. The authors speculated that discrepancies in performance scores could be accounted for by scientists writing papers for journals, and so on, without leaving a record in the organization's files.
Appendix (vi)

Questionnaire Cover Letter

CENTER FOR THE STUDY OF
ADMINISTRATION IN EDUCATION

The University of British Columbia
Vancouver 8, B.C.

To Canadian Research Scientists:

Canadian Research Scientist questionnaires are now being mailed to two thousand research personnel in government departments, university departments, business firms and social development agencies across Canada. This study is sponsored, in part, by the Canada Department of Labour and the Alberta Human Resources Research Council. The primary focus of the study is on the identification of the kinds of organizational environments and conditions which provide the most satisfactory settings for the various types of research.

In order to obtain adequate information for this study, the questionnaire is somewhat longer than usual. May we ask for your patience and co-operation, therefore, in completing the questionnaire and returning it as soon as possible?

To compensate you, in some small way, for your time in completing the questionnaire, we will send a summary of our findings to your research department for your perusal. Individuals and departments will not, of course, be identifiable in any reports.

Yours sincerely,

"T.R. Pelton"

(Dr.) Harold J. Dyck, Project Director
Terrance R. Pelton, Research Assistant
Dear Respondent,

This is an urgent plea for help. In September a Canadian Research Scientist questionnaire was mailed to you as part of a study of Canadian research organizations. The primary focus of the study is on the identification of the kinds of organizational environments which provide the most satisfactory settings for various types of research. A summary of the findings of the study will be made available to research staff in each organizational setting, when the study is completed.

While it would be foolish to assert that the results of the study will have far reaching consequences, it is regarded as sufficiently important to warrant Canada Department of Labour and Alberta Human Resources Research Council support. Perhaps more to the point, it is regarded as extremely important to those of us who have a heavy personal investment in the study.

The plain truth of the matter is that if there is no change in the present rate of return, the study will be a washout. Not only will whatever value the study may have not be realized, but a sizeable investment of funds, time and personal commitment will have been wasted. Hence, the plea for help. Our records indicate that the questionnaire mailed to you has not been returned. If you have not as yet completed the questionnaire, will you please complete and return it at your earliest convenience?

Yours sincerely,

"T.R. Pelton"

(Dr.) Harold J. Dyck, Project Director
Terrance R. Pelton, Research Assistant
Appendix (viii)

Questionnaire Follow-Up Letter Number Two

CENTER FOR THE STUDY OF
ADMINISTRATION IN EDUCATION
The University of British Columbia
Vancouver 8, B.C.

Dear Respondent,

Canadian Research Scientist questionnaires were mailed in June and September, to one thousand research personnel in government, university, business and social development type research organizations as part of a study of Canadian research organizations. During the holiday season some of these questionnaires went astray and a number of research people have requested additional copies in order to participate in the study. In the event that your questionnaire did not reach you, or was lost, I have taken the liberty of sending you an additional copy.

This study is sponsored, in part, by the Canada Department of Labour and the Alberta Human Resources Research council. The primary focus of the study is on the identification of the kinds of organizational environments which provide the most satisfactory settings for various types of research. A summary of the results will be made available to the personnel of research organizations participating in the study.

A rough preliminary analysis of the data collected so far would indicate some interesting differences in the research environments provided by different organizational settings. In order that generalizations can be made, however, a high return rate from the sample population is essential. We appeal to you to help us obtain this high return rate. If you have not as yet completed the questionnaire, will you please complete and return it as soon as possible?

Yours sincerely,

(Dr.) Harold J. Dyck, Project Director
Terrance R. Pelton, Research Assistant

P.S.
If for some reason you wish to be excluded from the sample population of this study, would you kindly indicate this desire on the enclosed self-addressed postcard? Thank you.
Appendix (ix)

Scientist Output: Rationale for Its Use

The "output" items used in this study were the same as those used by Pelz and Andrews. They defined "output" as any "unpublished, written, or oral presentation." They had concluded that these items were a good representation of "research output." Among the items they used in their questionnaire were the items referred to as "output number 1," and "output number 2" used in this study. Items included in output number 1 were number of:

1. articles published in journals;
2. formal reports (Project Completion Reports); and
3. unpublished oral presentations (speeches).

Items included in output number 2 were number of:

1. books completed; and
2. monographs completed.

The National Research Council (NRC) seemed to support the items selected to obtain some measure of scientist output.

An important criterion in assessing excellence in the scientist is the number and quality of his scientific papers, patents, products and processes. Scientific achievement can be evaluated on the basis of articles published in competently refereed journals and such papers available for further scrutiny by grant selection committees.2

---

1 D.C. Pelz and F.M. Andrews, Scientists in Organizations (John Wiley and Sons, 1966), p. 272. Appendix (v) discussed the reliability and validity of these items.

2 NRC Brief to the Special Senate Committee on Science Policy, no. 3 (October 23, 1968), p. 92.
Appendix (x)

Rationale for Using the Chi-Square Statistic

According to Siegel, nonparametric statistics have certain advantages over parametric statistics.

A parametric statistical test is a test whose model specifies certain conditions (given on page 19) about the parameters of the population from which the research sample was drawn. Since these conditions are not ordinarily tested, they are assumed to hold. The meaningfulness of the results of a parametric test depends on the validity of these assumptions. Parametric tests also require that the scores under analysis result from measurement in the strength of at least an interval scale.

A nonparametric statistical test is a test whose model does not specify conditions about the parameters of the population from which the sample was drawn. Certain assumptions are associated with most nonparametric statistical tests, i.e., that the observations are independent and that the variable under study has underlying continuity, but these assumptions are fewer and much weaker than those associated with parametric tests. Moreover, nonparametric tests do not require measurement so strong as that required for the parametric tests; most nonparametric tests apply to data in an ordinal scale, and some apply to data in a nominal scale.¹

Siegel strongly advised against using parametric statistics when "ordinal" measurement is used.

At the risk of being excessively repetitious, the writer wishes to emphasize here that parametric statistical tests, which use means and standard deviations (i.e., which require the operations of arithmetic on the original scores), ought not to be used with data in an ordinal scale. The properties of an ordinal scale are not isomorphic to the numerical system known as arithmetic. When only the rank order of scores is known, means and standard deviations found on the

scores themselves are "in error" to the extent that the successive intervals (distances between classes) on the scale are not equal.\(^2\)

Since most of the questionnaire data in this study were in the form of "ordinal" measurements of scientists' perceptions (rating scale responses) and since only one of the samples was selected using random sample procedures, it was decided to use nonparametric statistics. The most appropriate statistical test appeared to be the chi-square test for "\(k\) independent samples," which was described by Siegel in his text, *Nonparametric Statistics*.

In the analysis of research data, the investigator often needs to decide whether several independent samples should be regarded as having come from the same population. Sample values almost always differ somewhat, and the problem is to determine whether the observed sample differences signify differences among populations or whether they are merely the chance variations that are to be expected among random samples from the same population.\(^3\)

According to Siegel, when the data of research consist of frequencies in discrete categories, the chi-square test may be used to determine the significance of differences between two or more groups. The measurement involved may be as weak as nominal scaling. Siegel stated that:

The hypothesis under test is usually that the two (or more) groups differ with respect to some characteristic and therefore with respect to the


\(^3\) *Ibid.*., p. 104.
relative frequency with which group members fall in several categories. To test this hypothesis, we count the number of cases from each group which fall in the various categories, and compare the proportion of cases from one group in the various categories with the proportion of cases from the other group(s). For example, we might test whether two political groups differ in their agreement or disagreement with some opinion. . .4

The following method of computing chi-square for "k independent samples" was described by Siegel.

To apply the chi-square test, one first arranges the frequencies in a k x r table. The null hypothesis is that the k samples of frequencies, or proportions, have come from the same population or from identical populations. This hypothesis, that the k samples do not differ among themselves, may be tested by applying formula (6.3):

\[
\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}
\]

(6.3)

where \(O_{ij}\) = observed number of cases categories in the \(i^{th}\) row of the \(j^{th}\) column.

\(E_{ij}\) = number of cases expected under \(H_0\) to be categorized in \(i^{th}\) row of \(j^{th}\) column, as determined by method presented on page 105.

\[
\sum_{i=1}^{r} \sum_{j=1}^{k} \text{ direct one to sum over all cells.}
\]

Under \(H_0\), the sampling distribution of chi-square as computed from formula (6.3) can be shown to be approximated by a chi-square distribution with \(df = (k-1)(r-1)\), where \(k\) = the number of columns and \(r\) = the number of rows. Thus the probability associated with the occurrence of values as large as an observed chi-square is given in Table C of the Appendix. If an observed value of chi-square is equal to or larger than that given in Table C for a particular level of significance and for \(df = (k-1)(r-1)\), then \(H_0\) may be rejected at that level of significance.5

---

4 Ibid., p. 104.  
5 Ibid., p. 175.
Appendix (xi)

The Contingency Coefficient: C

According to Siegel, the contingency coefficient C is a measure of the extent of association or relation between two sets of attributes.

To be able to use the contingency coefficient, it is not necessary that we be able to assume underlying continuity for the various categories used to measure either or both sets of attributes. In fact we do not even need to be able to order the categories in any particular way. The contingency coefficient as computed from a contingency table, will have the same value regardless of how the categories are arranged in the rows and columns.¹

To compute C, Siegel stated that data from chi-square computations could be incorporated into the formula.

The degree of association between two sets of attributes, whether orderable or not and irrespective of the nature of the variable (it may be either continuous or discrete) or of the underlying distribution of the attribute (the population distribution may be normal or any other shape), may be found from a contingency table of the frequencies by

\[ C = \sqrt{\frac{\chi^2}{N + \chi^2}} \quad (9.1) \]

where \( \chi^2 \) = formula (6.3).

In other words, in order to compute C, one first computes the value of chi-square by formula (6.3) and then inserts that value into formula (9.1) to get C.²


²Ibid., p. 197. Also on p. 199, Siegel points out that "we may test whether an observed C differs significantly from chance simply by determining whether the chi-square value for the data is significant."
Limitations of C

The upper limit for the contingency coefficient is a function of the number of categories. When $k = r$, the upper limit for $C$, that is, the $C$ which would occur for two perfectly correlated variables, is

$$\frac{k-1}{k}$$

For instance, the upper limit of $C$ for a $2 \times 2$ table is

$$\frac{1}{2} = .707$$

For a $3 \times 3$ table, the maximum value which $C$ can attain is

$$\frac{2}{3} = .816.3$$

The limitations of $C$, therefore are:

(a) it does not attain unity when there is a perfect association,

(b) comparisons cannot be made unless the tables compared are the same size,

(c) $C$ is not directly comparable to any other measure of correlation.

---

$^{3}$Siegel, op. cit., p. 201.
Appendix (xii)
Definitions of Research Activities

As stated by the N.R.C., the classification of the research activities of scientists is usually into either basic applied, or developmental research activities. These terms, according to the N.R.C., are commonly used in a general way by both scientists and others as broad loose categories. ¹ They stated further that:

In practice, however, when one gets down to specifics, it is almost impossible to get agreement on any specific project as to which category is correct. In fact, like beauty, the nature of the categorization depends a great deal on the eye of the beholder, and every beholder sees differently.²

General agreement from several sources, however, permitted the following general classification of research activities.

Basic research. Discovery of new knowledge, not immediately applicable to particular problems.

Applied research. Discovery of specific knowledge for the solution of particular problems.

Developmental research. The development or improvement of products and/or processes using research information.³

¹National Research Council of Canada (N.R.C.), Brief to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, no. 21, Jan. 29, 1969), p. 3113.

²Ibid.

³Science Council of Canada, Towards a National Science Policy, Brief to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, Report No. 4, Sec. 2, 1969), p. 7; also, University of Alberta, Brief to the Special Senate Committee on Science Policy (Ottawa: Queen's Printer, no. 48, May 29, 1969), p. 6150; also, University of Guelph, Brief to
The Science Council, like the N.R.C., implied that these research activities have no distinct boundaries, but merge into each other and are part of what could be considered a "spectrum of scientific activities." 4

4 Science Council of Canada, loc. cit.
Appendix (xiii)

Levels of Research Output #2 versus Levels of Scientist Influence in Deciding Work Goals and Objectives
(Combined Samples)

How much influence do you feel the following people have in deciding your work goals and objectives?

<table>
<thead>
<tr>
<th>Yourself</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Levels of Research Output #2</th>
<th>Levels of Influence</th>
<th>Low 1,2</th>
<th>Medium 3</th>
<th>High 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>f = frequency; H = horizontal percentage f; T = total percentage f.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>16</td>
<td>63</td>
<td>307</td>
<td>386</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>12</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>16</td>
<td>112</td>
<td>121</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>93</td>
<td></td>
<td></td>
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<tr>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>14</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>12</td>
<td>88</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>.5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>69</td>
<td>433</td>
<td>523</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2 = 14.43$
Appendix (xiv)

Levels of Research Output #2 versus Levels of Supervisor Influence in Deciding Scientist Work Goals and Objectives (Combined Sample)

How much influence do you feel the following people have in deciding your work goals and objectives?

Immediate supervisor or department head 1 2 3 4 5

<table>
<thead>
<tr>
<th>Levels of Research Output #2</th>
<th>Levels of Supervisor Influence</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low 1,2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medium 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High 4,5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>386</td>
</tr>
<tr>
<td>f</td>
<td>144</td>
<td>112</td>
</tr>
<tr>
<td>H</td>
<td>37</td>
<td>29</td>
</tr>
<tr>
<td>T</td>
<td>28</td>
<td>21</td>
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<tr>
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<td></td>
<td>25</td>
</tr>
<tr>
<td>f</td>
<td>76</td>
<td>17</td>
</tr>
<tr>
<td>H</td>
<td>63</td>
<td>14</td>
</tr>
<tr>
<td>T</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Low 1-4</td>
<td></td>
<td>121</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>H</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>T</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Medium 5-8</td>
<td></td>
<td>523</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = 25.51 (.01) \quad f = \text{frequency}; \quad H = \text{horizontal percentage f}; \]

\[ C = .215 \quad T = \text{total percentage f.} \]
Appendix (xv)

Levels of Research Output #2 versus Levels of Centralization/Decentralization (Combined Samples)

Which of the following best describes your research unit or department?

Please circle the appropriate number.

- Highly centralized control of activities: 1
- Centralized control: 2
- Neither centralized nor decentralized: 3
- Decentralized control: 4
- Highly decentralized control of activities: 5

<table>
<thead>
<tr>
<th>Levels of Research Output #2</th>
<th>Levels of Centralization/Decentralization N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centralized 1,2</td>
</tr>
<tr>
<td>f</td>
<td>116</td>
</tr>
<tr>
<td>H</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>22</td>
</tr>
<tr>
<td>Low</td>
<td>1-4</td>
</tr>
<tr>
<td>H</td>
<td>22</td>
</tr>
<tr>
<td>T</td>
<td>5</td>
</tr>
<tr>
<td>Medium</td>
<td>5-8</td>
</tr>
<tr>
<td>H</td>
<td>38</td>
</tr>
<tr>
<td>T</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>149</td>
</tr>
</tbody>
</table>

\[ X^2 = 10.33 \ (0.05) \]

f = frequency; H = horizontal percentage f;
C = .139                   T = total percentage f.
Appendix (xvi)

Levels of Research Output #1 Versus Levels of Coordination
(Combined Samples)

How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives? 1 2 3 4 5

<table>
<thead>
<tr>
<th>Levels of Research Output #1</th>
<th>Low and Medium Coordination</th>
<th>High Coordination</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,2,3</td>
<td>4,5</td>
<td></td>
</tr>
<tr>
<td>Low 0-4</td>
<td>f 173</td>
<td>119</td>
<td>292</td>
</tr>
<tr>
<td></td>
<td>H 59</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 33</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>High 5+</td>
<td>f 146</td>
<td>85</td>
<td>231</td>
</tr>
<tr>
<td></td>
<td>H 63</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T 28</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>319</td>
<td>204</td>
<td>523</td>
</tr>
</tbody>
</table>

$\chi^2 = .84$
Appendix (xvii)

Research Output versus Levels of Scientist
Decision-Making Influence

How much influence do you feel the following people have in deciding your work goals and objectives?

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Low and Medium Influence 1,2,3</th>
<th>High Levels of Influence 4,5</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus.</td>
<td>0</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Gov.</td>
<td>4</td>
<td>22</td>
<td>85</td>
</tr>
<tr>
<td>S.D.</td>
<td>4</td>
<td>23</td>
<td>83</td>
</tr>
<tr>
<td>Univ.</td>
<td>3</td>
<td>80</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>125</td>
<td>92</td>
</tr>
</tbody>
</table>

$X^2 = 5.7$ (.10)

C =

*Research Output = 1 or more books or monographs completed

Chi-square Values

<table>
<thead>
<tr>
<th>Separate Samples vs. Combined Samples</th>
<th>Separate Samples vs. Separate Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. vs. Gov + S.D. $X^2 = 5.73 (.02)$</td>
<td>Gov. vs S.D. $X^2 = 0$</td>
</tr>
<tr>
<td>S.D. vs. Univ. + Gov. $X^2 = 2.05 (.20)$</td>
<td>Gov. vs. Univ. $X^2 = 4.56 (.05)$</td>
</tr>
<tr>
<td>Gov. vs. Univ. + S.D. $X^2 = 2.30 (.20)$</td>
<td>Univ. vs. S.D. $X^2 = 4.28 (.05)$</td>
</tr>
</tbody>
</table>
Appendix (xviii)

Research Output versus Levels of Supervisor Decision Making Influence

How much influence do you feel the following people have in deciding your work goals and objectives?

Immediate supervisor or department head

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Research Output (1+)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low and Medium Supervisor Infl. 1,2,3</td>
<td>High Supervisor Influence 4,5</td>
</tr>
<tr>
<td>Bus.</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Gov.</td>
<td>27</td>
<td>19</td>
</tr>
<tr>
<td>S.D.</td>
<td>70</td>
<td>8</td>
</tr>
<tr>
<td>Univ.</td>
<td>94</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>104</td>
<td>32</td>
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</tbody>
</table>

\( \chi^2 = 49.42 \ (0.001) \) Research output = 1 or more books or monographs completed.
C = .515

Chi-square Values

Separate vs. Combined Samples
Un. vs. S.D. + Gov. \( \chi^2 = 36.27 \ (0.001) \) Un. vs. Gov \( \chi^2 = 51.18 \ (0.001) \)
S. D. vs. Un. + Gov. \( \chi^2 = .69 \)
Un. vs. S. D. \( \chi^2 = 10.89 \ (0.001) \)
Gov. vs. Un. + S. D. \( \chi^2 = 43.85 \ (0.001) \) Gov. vs. S. D. \( \chi^2 = 10.00 \ (0.01) \)
Appendix (xix)

Research Output versus Levels of Centralized and Decentralized Control

Which of the following best described your research unit or department?

Highly centralized control of activities  1
Centralized control  2
Neither centralized nor decentralized  3
Decentralized control  4
Highly decentralized control of activities  5

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Research Output (1+)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Centralized 1,2</td>
</tr>
<tr>
<td></td>
<td>Neither 3</td>
</tr>
<tr>
<td></td>
<td>Decentralized 4,5</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Bus.</td>
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</tr>
<tr>
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<td>1</td>
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<tr>
<td></td>
<td>0</td>
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<tr>
<td></td>
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<tr>
<td>Gov.</td>
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<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>0</td>
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<tr>
<td></td>
<td>5</td>
</tr>
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<td></td>
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<tr>
<td>S.D.</td>
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<td>7</td>
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<td>10</td>
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<tr>
<td></td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>27</td>
</tr>
<tr>
<td>Univ.</td>
<td>9</td>
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<td>58</td>
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<tr>
<td></td>
<td>70</td>
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<tr>
<td></td>
<td>33</td>
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<tr>
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<tr>
<td></td>
<td>23</td>
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<tr>
<td></td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>136</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 29.30 \ (0.001) \]

Research output = 1 or more books or monographs completed.

Chi-square values

Separate vs. Combined Samples

Un. vs. Gov. + S.D. \( \chi^2 = 26.97 \ (0.001) \)
S. D. vs. Gov. + Un. \( \chi^2 = 4.23 \ (0.20) \)
Gov. vs. Un. + S.D. \( \chi^2 = 19.04 \ (0.001) \)

Separate vs. Separate Samples

Un. vs. Gov. \( \chi^2 = 26.68 \ (0.001) \)
Un. vs. S. D. \( \chi^2 = 12.07 \ (0.001) \)
S. D. vs. Gov. \( \chi^2 = 2.31 \)
Appendix (xx)

Research Output \#2 versus Levels of Coordination

How much emphasis do members of your research unit or department place on the coordination of their efforts for some common objectives? 1 2 3 4 5

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Research Output (1+)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low and Medium Coordination 1,2,3</td>
<td>High Levels of Coordination 4,5</td>
</tr>
<tr>
<td>Bus.</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Gov.</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>S.D.</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>Univ.</td>
<td>73</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>94</td>
<td>69</td>
</tr>
</tbody>
</table>

$\chi^2 = 35.56 \ (0.001)$  
Research Output = 1 or more books or monographs completed  
$C = .455$

Chi-square values

<table>
<thead>
<tr>
<th>Separate vs. Combined Samples</th>
<th>Separate vs. Separate Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Un.vs. S.D.+Gov. $\chi^2 = 35.39\ (0.001)$</td>
<td>Un.vs.Gov. $\chi^2 = 21.71\ (0.001)$</td>
</tr>
<tr>
<td>S.D.vs.Un.+Gov. $\chi^2 = 16.24\ (0.01)$</td>
<td>Un.vs.S.D. $\chi^2 = 28.51\ (0.001)$</td>
</tr>
<tr>
<td>Gov.vs.Un.+S.D. $\chi^2 = 10.82\ (0.01)$</td>
<td>S.D.vs.Gov. $\chi^2 = .15$</td>
</tr>
</tbody>
</table>