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INFORMATION PROCESSING IN BASIC AND APPLIED SCIENCE: AN EXPLORATORY STUDY AT THE INTERFACE OF THE SOCIOLOGY OF SCIENCE AND INFORMATION SCIENCE

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INFORMATION PROCESSING IN BASIC AND APPLIED SCIENCE:
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SOCIOLOGY OF SCIENCE AND INFORMATION SCIENCE

Daniel James Amick, Ph.D.

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The study is a first attempt at developing a theoretical model of the means by which individuals process information in connection with their occupational roles. The sociology of science provides a context in which the role of the scientist is investigated; i.e., science as an information processing activity, the scientist as an information processing agent, and the general functions of the information environment of science are studied. The interface between information science and the sociology of science derives from the joining of an information theoretic stance vis-a-vis the complex social phenomenon known as science with behavioral methodology and a sociological theory of the middle range.

The scientist's role is conceptualized in terms of his basic (fundamental) or applied orientations to his work. Instead of relying on an <u>a priori</u> two-type dichotomy (i.e., basic vs. applied), scaling techniques were used to rank scientists on a continuum from basic to applied according to their reading habits of professional periodic literature. The scaling techniques employed were modifications of the basic Thurstone variety. The scientist's scale score or rank was conceived as his scientific mission and the variance about that score was taken to reflect the diffuseness of his interests. It was found that subjects did not cluster at the ends of the continuum (thus refuting the two-type dichotomy) and that there was a distinct tendency toward

the middle. The scale scores approached a normal distribution on the continuum. Using factor analysis, a seven item scale of professional involvement was developed. Scientists with more basic research interests (higher scale scores) exhibited significantly higher professional involvement. Scientists with less diffuse, more narrowly defined interests also tended to be more professionally involved. It therefore follows, and the analysis bears out the fact that, scientists with more basic research interests define their interests more narrowly. Multiple discriminant function analysis was used to discriminate three distinct groups according to their degree of professional involvement: BASIC, MIXED, and APPLIED.

As correlaries to these findings, an analysis of scientific elitism was included in this study. A ten item scale of scientific elitism was constructed using factor analysis. Elites were identified using a reputational sociometric technique. There was a distinct tendency for elites to cluster at the basic sector of the continuum. Elites have more narrowly defined, less diffuse interests and significantly greater professional involvement and visibility than non-elites.

The theroetical model of information processing is then investigated relative to the scientist's mission vis-a-vis his basic and applied interests. The model is viewed as a vehicle by which we might approach a middle range theory. The elements of the model of the information processor (Ego) are: 1. information needs (internally and externally generated); 2. information use (primarily cognitive processes); and 3. information flow (information procurement when information flows to Ego and communication when information flows away from Ego.) Needs act as a catalyst to procurement except for the case of accidental acquisition of information. Two processes are described: 1. Pure - B processes involve only Ego and stem from internally generated needs; 2. A + B processes involve Ego and Alter (others) and have externally generated needs. Information processing encompasses either or both processes.

Correlation and partial correlation techniques were used to analyze subject's ratings of scientific communication media. Media which were thought to be easiest to use were also perceived as best qualitatively. When controlling on "ease of use," the correlation between "quantity of information" and "quality of information" is significantly reduced. Scientists get the largest amount of their information from sources which are easiest to use and most accessible. This is substantiated by the fact that when controlling on "quality", the correlation between "quantity" and "ease of use" actually increases. A large amount of information is procured from sources where there is little time investment, i.e., reviews, abstracts, Chemical Abstracts, etc. Scientists with more basic orientations generally gave all media lower ratings than scientists with more applied research interests.

In certain hypothetical information-gathering situations, the BASIC group was found to be significantly different from the APPLIED group because of their greater preference for non-personal, literature oriented methods of information procurement. As for choices of cosmopolitan (extra-organizational) or local (in house) sources of information, there were no significant differences between the BASIC and APPLIED groups.

This analysis is another example of how an entirely new arena can be opened in which the methods of social research can be brought to bear and in which sociological theories of the middle range can be constructed to explain the behavioral aspects of information processing. Further explication of the model in the realm of the sociology of science should, in the future, allow us to develop a general theory of information processing which is applicable to many more role configurations.

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The context of this research must be made clear in order that the roles played by all intellectual contributors, mentioned and unmentioned, can be appreciated. My first acknowledgement must go to the National Science Foundation's Grant GN-738 which provided support for the project in which the structure of this dissertation germinated and grew. The grant sponsored the development of an experimental information retrieval system for scientists known as the Pittsburgh Chemical Information Center. I am greatful to the entire staff of the Center for any and all intellectual contributions to this work. Two special acknowledgements are well deserved by Drs. Edward M. Arnett and Carl Beck. As project director, Dr. Arnett provided endless encouragement and intellectual direction as a working scientist upon whom I could pretest many of my ideas. Though a chemist by training, his sociological insights were priceless. Dr. Beck's dual role as dissertation advisor and co-investigator directing the behavioral research of the project makes my debt to him indeed profound. He has been more than generous with his ideas, time, and, most important, friendship.

The other members of my committee, professors Stewart, Seldin, Mitroff, and Kent have all provided valuable aid and assistance throughout the entire process which has led to the completion of this dissertation. A special gratitude is directed to those individuals: Dr. Arnett, Dr. Beck, and Professor Kent who had the insight to create the Behavioral Task Group of the Pittsburgh Chemical Information Center. These data were collected under the auspices of the behavioral research component of the project and these gentlemen had the confidence in me to allow me to develop a portion of the data base for my dissertation. I can only say that I have and will continue to do my best to warrant their confidence. I am also grateful to a close co-worker in the Behavioral Task Group, Mr. Donald L. Shirey. Mr. Shirey helped with the interview and other data collection and provided assistance with some of the analysis.

Finally, I want to close by acknowledging a long-standing personal and intellectual debt to Professors Hilda Lineweaver and Louis Bouchard. During my years as an undergraduate they were more than professors; they were teachers, counselors, friends, and sources of inspiration and encouragement. They taught me how to learn and love it and I might never have gone on to graduate school had it not been for them.

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I. INTRODUCTION

Geometry informs us that we cannot reconstruct or reconstitute a solid object from the images which we project on separate Cartesian planes. Historic and contemporary "scientists of science" have projected their respective images and then argued on behalf of the chosen plane on which they display their findings. These have been valuable exercises, and different orientations and points of view have always been welcomed in science. But, there must come a time when divergence yields to convergence; a time when scholars realize the interdisciplinary nature of their quest; a time when there exists more consensus than dissensus; and *finally*, a time when they realize that their projections are of the same solid object, but shown on different planes. It is at this point in time when they begin to search for a unifying theme.

Recent intellectual developments and the creation of an interdisciplinary discipline have suggested a theme: information. It's deceiving simplicity suggests to many of us that we can examine the full scope of a particular human endeavor, called science, as an "information-processing system." The term "information" is deceiving because it is one of those concepts which everyone knows and thinks he can define, and at the same time no one knows it and no one can define it to the satisfaction of all. It appears in many forms, on many occasions, and at every point in the process. Given this theme, (or variations of it) others in recent years have attempted: to explore science as an information processing activity; to explore the scientist as an information processing agent; and to explore the information environment of science.

As Derek de Solla Price has said "Why should we not turn the tools of science on science itself?" (Price, 1963, iii) Within this framework, and using the theme "information," this study explores the information-processing behavior of research scientists. By so doing I hope to express a new orientation in the behavioral sciences in general and in sociology and the sociology of science in particular.

This orientation has its deepest roots in the sociology of knowledge. But even the early sociologists of knowledge, such as Mannheim, believed that for the most part the content of science was not socially influenced. (Mannheim, 1936, p. 243) Early sociologists of knowledge frequently investigated knowledge processes which could not be classified as science, i.e., much of social philosophy.

Present day sociologists of knowledge, such as Berger and Luckmann, have viewed science as just one of several symbolic universes which pass for knowledge in modern society. They show particular interest in the ways in which science and other institutions legitimate themselves as knowledge creating and transmitting agencies of society. (Berger and Luckmann, 1966, pp. 95-96) Again, remaining primarily on the institutional level of societal processes, Berger in a later work examines the effect of science on the secularization of religion in modern society. (Berger, 1967, pp. 107-111) We can see from this that the sociologists of knowledge are often concerned with science as an institutional form and as a symbolic universe among several competing forms and universes. Their approaches have been highly abstract and concerned primarily with macrosocial processes. One must remember that the great technical nature of sciences such as physics or chemistry have made attempts at studying them extremely foreboding operations for the social scientists. Early sociologists of science began to modify this line of thinking. Merton investigated how the social structure can either "facilitate or obstruct ... the processes through which they (types of social influence on science) operate." (Merton, 1957, p. 607) A vague pattern had begun to emerge. A trend began to take shape when early sociologists of science (not sociologists of knowledge) started to investigate the non-technical aspects of the "hard sciences." Merton's early studies (Merton, 1957, pp. 607-627) are good examples. Using the titles of papers presented during the meetings of the seventeenth-century Royal Society of England, he investigated the relationship of the topics of the papers to the practical needs of English society. The sociology of science was beginning to take a different path from that of the sociology of knowledge.

> The study of scientific ideas as behavior has been historically formulated in the conceptions of the sociology of knowledge and the sociology of science. The former, however, has connotations of a limited nature (usually referring to societal and not to micro-social processes) and does not include a wide variety of studies that might otherwise be considered as directly relevant to the growth and development of scientific ideas in the primary group of researchers ... By contrast, the sociology of science is not concerned with ideational development so much as with relevant social and organizational structures, ... it includes many studies of the small work groups of scientists. (Perry, 1966, p. 233)

Holzner's discussion of science as a social phenomenon helps to clarify the differences in orientation.

> "... the transformation of meaning which accompanies formalization in the sciences is <u>intimately linked</u> with the connection between the immediate experience in the laboratory

> group and the public context of the discipline, or even the scientific community at large." (emphasis mine) (Holzner, 1967, p. 87.)

Perry points out the differences in orientation, but Holzner reminds us that they are "intimately linked."

Given the competing perspectives offered by the sociology of knowledge and the sociology of science and the variability of macroscopic and microscopic orientations to research inherent in the latter, the position which I take to guide this research is that the sociology of science, particularly on the microsocial level, is preliminary to the sociology of knowledge. Since the goals of this present exploratory research must be modest, I intend to stay within the relm of the sociology of science to investigate those microsocial processes which obtain primarily in relatively small units of aggregation. I am conscious of the fact that the competing perspectives are intimately linked and fruitful ideas from the sociology of knowledge and a more macroscopic orientation to research have been selected as needed. Any attempt at research, regardless of the position held by the investigator, needs a unifying principle or theme, which in time will permit broader generalizations to other areas of human behavior. The new orientation in behavioral science of which I spoke has suggested the theme "information" as one that can provide guiding principles for the study of science as a human social activity on many levels of aggregation. This is conceived in the "long-range" perspective of eventually applying what we learn about the information-processing behavior of scientists to other role configurations and to larger or smaller social aggregates of human activity, in the hope that we can transcend contextual influence and move toward a general theory of information processing in the sociology of knowledge.

> Information science meets behavioral science in the study of information needs and uses. Information science and behavioral science need each other. Big Science needs them both. (Paisley, 1968, p. 1)

The research described within is yet another meeting of the two, but the Paisley review alerts us to much more. Sociologists of science have increasingly become aware of the need for an information theoretic stance vis-a-vis the complex social phenomenon known as Big Science. Information scientists have become increasingly aware of the need for behavioral methodology and sociological theories of the middle-range in investigating the information problem of Big Science.

These realizations have evolved from a long history of so-called "user studies." These studies have, by and large, been purely descriptive in nature and have provided a great deal of knowledge about communication patterns, information use, the scientist's needs for information, the means by which scientists procure information, and the channels through which information flows. After surveying this knowledge base, one is still left with many questions to be answered; thus indicating a need for more exploratory investigation. Secondly, one notices that there has been disparity as well as agreement among the findings; thus indicating a lack of theoretical integration in the field. An excellent case in point is that two studies which are acclaimed in the literature of the field are seriously inconsistent. The studied by Meltzer (Meltzer, 1956, p. 37) and Shilling and Bernard (Shilling and Bernard, 1965, pp. 14-15) explicitly contradict each other on several key issues dealing with the relationship between scientific productivity and the organizational setting. Finally, one is depressed by the generally low degree of methodological sophistication and the limited range of techniques that have been brought to bear in any one investigation; thus indicating a need for several methods, used in concert, in order to capitalize on the advantages of each, i.e., an eclectic methodology or "multiple operationalism." (Webb, et.al., 1966, pp. 3-5)

In view of this, my investigation is primarily exploratory in nature. But more than just adding new knowledge to the descriptive base of the field, I have attempted to provide a greater degree of precision, in a quantitative sense, than past exploratory studies. In addition, I feel that greater integration of my findings has been achieved since the study was guided by concepts of a higher order of abstraction than those of the past. To accomplish this, I have developed a theoretical model that permits movement toward a middle-range theory. The model used in this investigation is viewed as such; a vehicle by which we might approach the middle-range. In other words, "for any field of inquiry, 'the middle range' is not self evident; it has to be approached through successive approximations." (Paisley, 1968, p. 25) Finally, I have used several methods for collecting and analyzing data. The methodology employed shows how different techniques of data collection and analysis can be brought to bear in the same analytical domain by maximizing the strengths of each and by showing how the methods serve as internal checks upon one another.

A. Research Design

My methodological approach is one that effects the systematic organization of manifest data. I seek to rise above typological models; particularly the ideal types which are viewed as polar opposites. The term "typical" must be replaced by more precise terms, and to speak of extremes is to forget that concepts can be viewed as analytical gradations. My position is similar to that suggested by Merton in the chapter on "The Bearing of Empirical Research on Sociological Theory." I feel that our methodological sophistication has reached a point where we can "exert pressure for new foci of theoretic interest." (Merton, 1957, pp. 111-114) The invention or novel application of research techniques can bring this about by placing the researcher in a position to generate fresh hypotheses or test previous hypothetical statements from a new orientation and with greater precision. One of the conceptual obstacles to inquiry has always been in devising classifications which were appropriate for the research problem. Classifications have been developed without realizing that these classes themselves are components of the problem. We must always be aware of the fact that a conceptual idea can suggest a new variate which can be used to replace numerous earlier classificatory devices. (Lazarsfeld, 1962, xix-xxii) Paisley (1968) has suggested an "eclectic methodology" or multiple operationalism. The strategy is not to select particular methods, but to use a group of methods, in concert, such that their measures can cross-validate each other. Multiple measures can share in the complexity of various relevant components of the structure under analysis.

> Once a proposition has been confirmed by two or more independent measurement processes, the uncertainty of its interpretation is greatly reduced. The most persuasive evidence comes through a triangulation of measurement processes. If a proposition can survive the onslaught of a series of imperfect measures, with all their irrelevant error, confidence should be placed in it. (Webb, et.al., 1966, p. 3)

We must be able to invoke multiple confirmation of our central propositions within a single investigation, and avoid placing false confidence in a single method.

Being primarily exploratory in nature, this investigation does not necessarily attempt to make a great many generalizations to an entire scientific population. Any inferences drawn can only be viewed as warranted generalizations until more data have been collected and until we achieve better explication of the entire theoretical model. With this in mind, I have purposively chosen a small group of subjects to be used in this study. As Paisley points out, "A small purposive sample generates maximum insight, rather that inference, per unit cost." (emphasis in original) (Paisley, 1968, p. 22) A group of seventy scientists was chosen such that I could be certain to represent the major sectors of the community of chemists in the Pittsburgh area; i.e. academic, non-profit research, industry, and government. The specific locations of the subjects are as follows:

1. academic = a. University of Pittsburgh
   b. Carnegie-Mellon University
2. non-profit research = Mellon Institute
3. industry = a. United States Steel Research Laboratory
   b. Koppers Laboratory
   c. Pittsburgh Plate Glass Inc.
   d. Gulf Oil Corp. Research Laboratory

4. government = U. S. Bureau of Mines

TABLE 1

SUBJECT DISTRIBUTION BY AFFILIATION

AFFILIATION	NUMBER OF SUBJECTS
1. Academic	28
2. Non-profit Research	5
3. Industry	27
4. Government	10
	N = 70

I chose this strategy for the insight which it would provide and to increase the probability of a wider distribution of scores. A random sample might not have guaranteed this and the exploration of information processing behavior in a comparative analysis might have suffered. Some have questioned, in the pragmatics of everyday behavioral research, whether a sample which is initially intended to be random actually can be viewed as random once the data have been collected. Graham and Wagner, using a similar sampling framework have noted:

> The exploratory nature of the study,..., did not demand representative samples. In any event, a sample of people that is randomly selected at the beginning of a study will not necessarily provide a random sample when the data are tabulated. Experience has often shown that many individuals in a random sample will not cooperate, and a considerable percentage will drop out for other reasons. The net effect of such attrition usually is to introduce bias into a human sample. (Graham and Wagner, 1967, p.66)

The primary data gathering instrument has been a partly structured and unstructured interview schedule. Several studies have found that, particularly for exploratory work, the interview provides the most valid and reliable form of data collection. (Herner, 1954; Menzel, 1966a and 1966b; and Paisley, 1968 give excellent discussions) I have used other sources to augment and cross-validate the data obtained from the interviews; professional vitas and publication lists. These documents contain a wealth of demographic and professional information which was coded along with the interviewee's responses.

The interviews were constructed for the Behavioral Task Group of the Pittsburgh Chemical Information Center (P.C.I.C.). The interviews were developed after careful pretesting and preliminary analyses during three pilot phases. The finished interview schedule had already been used in a final pilot study with considerable success for obtaining information from fifty-five chemists, thirty-one of which are subjects for this research. The schedules are completed in one and one-half hour face-to-face interview situations. The great majority of the interviews have been conducted by this investigator, with the remainder being conducted by well trained professional interviewers or a sociological colleague.

The subjects primarily characterized their work orientations as either administrative or laboratory research.

TABLE 2

WORK ORIENTATIONS

ORIENTATIONS	NUMBER OF SUBJECTS
1. Classroom teaching	8
2. Administrative	37
3. Advising or consulting	1
4. Conducting laboratory research	22
5. Assisting in research	2
	N = 70

The predominate educational level of the group was the Ph.D. degree.

TABLE 3

EDUCATIONAL LEVEL

LEVEL	NUMBER OF SUBJECTS
1. Bachelors degree	5
2. Multiple Bachelors	0
3. Masters degree	4
4. Multiple Masters	1
5. Ph. D. degree	59
6. Multiple Ph. D.	1
	N = 70

The group had a broad range in professional age as indicated by the number of years since receiving the bachelor's degree.

TABLE 4

YEARS SINCE BACHELORS DEGREE

YEARS	NUMBER OF SUBJECTS
1. 1 through 4	0
2. 5 " 8	6
3. 9 " 12	12
4. 13 " 16	8
5. 17 " 20	15
6. 21 " 24	6
7. 25 " 28	1
8. 29 " 32	9
9. over 32	13
	N = 70

The major and related fields of chemistry were represented in the group.

TABLE 5

FIELDS OF CHEMISTRY

FIELD	NUMBER OF SUBJECTS
1. Analytical	9
2. Inorganic	3
3. Organic	22
4. Physical	20
5. Biochemistry	4
6. Related Chemical Specialties (primarily Chemical Engineering)	12
	N = 70

II. THE SCIENTIST'S MISSION

A. The Mission

It is frequently profitable in the formulation of a research problem, to develop a concept that can serve as a vehicle for guiding, focusing and integrating one's approach. Many studies, when investigating various dimensions of science, have relied upon classification typologies. One of the most frequently used is that which classifies science as either "pure" (basic) or "applied." The strategy has usually been to define the types *a priori*, find scientific settings where such types are felt to exist (university vs. industry or government are probably the classical examples), and then perform a comparative analysis relative to certain test criteria. A second strategy, similar to the first, defines the two types (again, *a priori*), shows that one of the two has been ignored with regard to certain test criteria, and instead of doing a comparative analysis, concentrates on the exploration of the ignored type.

My position is that with regard to modern science... Big Science ... both of these strategies leave much to be desired. *A priori* definitions of polar types are vague, imprecise, and awkward for purposes of operationalization. Defining the location of these types, i.e. basic science in the university and applied science in industry and government, is to invoke premature closure. Given this situation, it follows that comparative analysis suffers from serious weaknesses. Finally, to say that one area has been ignored, for instance "applied" and then ignore the other (basic), is to work at counter purposes. I propose that these problems can be overcome.

It has been suggested that to speak of science as "basic" versus "applied" is to use "tired labels." (emphasis mine) (Paisley, 1968, p. 24) I totally agree with this point of view; that as "labels" they are tired, and as the literature in this area shows; "overworked." I do not feel that this is because they now lack theoretical utility; their "tiredness" derives from their use as labels in a dichotomous typology. As labels, they have forced us to try to search for distinctions between scientist X working at a university and scientist Y doing the same research in the employ of a petroleum company. The changing complexion of science has made the task of pigeonholing analytical distinctions, into one of two "types," a rather pedantic undertaking. I do not deny that distinctions exist, but I propose that they cannot be viewed using an a priori "two-type dichotomy.

The present complexion of science shows us that the old "havens" for pure and applied science have themselves changed in character. A national survey has shown that 19% of the scientific population (1 in 5) report that they are "doing applied science" while at a university. (Vollmer, 1969, p. 245) Bernal, as early as 1939, said..."The position of the research worker in the universities is still anomalous. He has no recognized place but is treated as part student and part teacher." (Bernal, 1939, p. 37) It has been reported that at Berkeley (though I am sure this phenomenon can be found in many universities) "a new class of university personnel-the researchers" exists and is growing in size relative to the size of the faculty. Some 333 persons were identified with research titles (although, totally, 1,142 persons were identified as non-faculty researchers without specific research titles.) These persons are characterized by a predominence of extra-mural funding; 84% receiving all or part of their salaries in this manner. I might add that these are primarily "first line" scientists, with 87% holding the Ph. D. degree. (Kruytbosch, 1968, pp. 33-35) On the other hand, examples of basic research support in industry are found at the General Electric Corporation and the Bell Laboratories. The director of Bell Laboratories, James Fisk, has advocated this point:

> Basic research should be organizationally autonomous. It should not be confused with or subservient to development, or it will not survive. This does not mean that research requires a special or remote tower, on the contrary. Research, development, and development planning all have much to gain from close physical proximity, but one may not be responsible to the other if each is to do its very special and demanding work. (Fisk, 1969, pp. 164-165)

Another factor which contributes to blurring the distinction between the two, stems from the changing character of funding for scientific research. Funds for basic research are becoming increasingly more difficult to obtain. Under the contractural arrangements of scientific funding, many scientists in universities are writing vague proposals "in an applied vein" and hoping to "bootleg" some basic work under the contract while giving an appearance of practicality. (Marcson, 1960, p. 103) The recent National Science Foundation budget crisis seems to point up the fact that many administrators of funding agencies were no longer looking at basic research as "science for science's sake" but instead, "science for scientist's sake." (Bennet, 1969, pp. 1592-1603) Speaking of basic research, LaPorte observes that:

> ...opportunities for research funding in these areas have been scant and have tended to be seen as carrying with them strings of applied research, that is, problems largely defined and delimited by the source of funds;... (LaPorte, 1967, p. 27)

The three major sectors; academic, government, and industry are far from independent of one another. Basic research in the university setting has increasingly become dependent upon support in the form of grants from government and industrialists. In addition, the scientific societies are in all three camps at the same time. Their active personnel are largely from universities, they administer government funds for agencies, they become members of or consultants to government departments, and are consulting, or in other ways, in close touch with industry, i.e. through their work with government they may be in touch with the armaments or aircraft industry. Research in the university has greatly increased with the added number of post-graduate students, post-doctoral fellows, and full-time researchers. (Bernal, 1939, p.37)

The essence of the juxtaposition of basic and applied research can be thought of as the evolution of the interdependence of science and organization, whereby the organization may specify not only the content but also the goals of research. Depending on which objectives are more highly valued, similar (or sometimes identical) projects may be evaluated as either basic or applied. It can be the case that research with practical goals may lead to basic advances in knowledge, and certain areas of basic research have immediate practical applications. Nuclear physics is a case in point and may be reshaping the relationship between applied and basic research, i.e. the Manhattan Project. (Kornhauser, 1962, pp. 16-17)

Distinctions between basic and applied science are often a function of the research units involved. If an organization has a technological base which is broad in scope, it may more readily support basic research because, no matter which direction the paths of research take, there is an increased probability that the results will be of some value to the corporation or multiproduct conglomerate. On the other hand, if there exists a confined technological base, research will only be supported if it can solve the firm's problems by being easily and quickly transulated into processes or porducts which can be patented. (Nelson, 1959, p. 302) The distribution of responsibilities among research units is crucial. The problem is one of "who" shall choose goals and "how" policy is to be made; by the scientist or management personnel? Basic research has goals which are less specific and there are fewer sources of external frustrations in attaining them. Merton has called this the "pure science sentiment." He warns:

> As the pure science sentiment is eliminated, science becomes subject to the direct control of other institutional agencies and its place in society becomes increasingly uncertain. The persistent repudiation by scientists of the application of utilitarian norms to their work has as its chief function the avoidance of this danger...pure science is thus seen to be a defense against the invasion of norms which limit directions of potential advance and threaten the stability and continuance of scientific research as a valued social activity. (Merton, 1957, p. 543)

The research units by which work is organized may serve as yet another distinction between basic and applied science. Kornhauser suggests that "specialist groups" may be more effective in basic research while "task groups" are more effective in applied research.

Specialist groups are more stable than task groups and are thus often prefered by basic researchers. They (specialist groups) "are more consistent with professional orientations, while task groupings are more consistent with orientations toward the organization." (Kornhauser, 1962, p. 53)

Storer has justly pointed out that a real distinction between basic and applied research is "in the scientist's motivation rather that in the consequences, if any, of his work." He goes on to note that this has ramifications for the attitudes that incumbents of one domain hold about the incumbents of the other.

> The basic scientist feels that applied scientists are not creative, that applied work attracts only mediocre men, and that applied research is like working from a cookbook. For his part, the applied scientist might well counter with the imprecation: The basic scientist is a snob, working in his ivory tower and afraid to put his findings to a real test;... The expression of such attitudes toward "basic" vs. "applied" researchers may be said to be oriented toward myths or ideal types rather than toward specific individuals. (Storer, 1966, p. 108)

Kidd has pointed out that "it is almost impossible to define pure or basic research operationally;..." (Kidd, 1965, pp. 62-85) As a "label," "catagory," or "type" unto itself, I would agree. But it seems obvious, in light of the above discussion, that basic research can only be defined (operationally or otherwise) respective of its position along an analytical continuum from basic to applied, with the ends of the continuum undefined (undefined in the sense of not being able to define them as the "most basic" or the "most applied"). In other words, the polar extremes are viewed as ideal types and therefore not empirically recognizable. This is justifiable on the grounds that the ends of the continuum lie on the boundaries of a discipline and the boundaries are constantly being redefined.

Therefore, we can conceive of allocating the vast majority of scientists in a discipline to positions along this continuun and I would expect a tendency toward the middle. In the past, investigators have established polar opposites on a continuum and left the "middle area" undefined. My position is, that in view of the changing complexion of science, the investigation is better served by concentrating instead on being able to rank the scientist and his work somewhere along this continuum. Thus, the work of a scientist can be discussed relative to the work of other members of his scientific community (relative in the sense of their respective positions on the continuum). By so doing, we are no longer dealing with labels or typologies. We have an abstract continuum which can be thought of as a theoretical dimension in the study of science, and we open up this "gray" but increasingly important, middle area to empirical investigation.

It is felt that this strategy will not "blurr" the distinction between pure and applied science, but conversely, it has allowed me to investigate them with greater precision and clarity by opening up an area which has been heretofore relatively unexplored. I have, therefore, explored the information processing behavior of scientists respective of their relative positions along a theoretical dimension. The theoretical dimension in question will be known as the scientist's "mission;" whereby the breadth of his professional "work-interest" space will be represented by the position he occupies on the continuum and his respective locus about that position.

Since the theoretical dimension of pure to applied science can be viewed as an analytical continuum, measurement is conceived as allocating people to points along this continuum. As with all continua, there is a point where the numerical values begin and a point where they end. But, we should keep in mind that the continuum which is used in this measure (as are the continua used or implied in all measurement) is an abstraction. The continuum has some high or low, positive or negative sectors and a neutral point or sector. The end points of the continuum are not felt to be problematic in that "the end points are based on very few overlapping cases,..." (Saffir, 1937, p. 190)

I have chosen the method of "Equal Appearing (or Successive) Interval" scale construction, devised by L. L. Thurstone (1927 and 1931), to construct the pure-applied continuum. Though this technique has been primarily used in attitude scaling, I have shown that it can be used in a novel way; to characterize the current interests of scientists along the pure to applied dimension of their discipline. If we can conceive of attitudes as extending along abstract continua, why should we not also consider one's professional interests as being reflected by a position on an abstract continuum? In situations involving measurement where there is a manifest or implied continuum, the allocation along the continuum of the object which is being measured is accomplished with indirect means by the use of an index. (Thurstone, 1931, p.263)

I have chosen an indicator of the scientists' interests which can serve as an index by which to assign them positions on the continuum (known as scale scores). Conversations with several scientists and the results of previous research (Amick; and Amick and Shirey, 1969) have indicated that the scientist's current professional interests are, to a great degree, reflected in the types of periodical literature which he either scans, reads, or in any way, uses in connection with his work. Thus, the contents of journals which come under this criterion can be used as indicators of the scientist's professional interest. The contents of 115 popular journals in chemistry have been assessed, using a panel of highly qualified professional members of the discipline (roughly 100 professional chemists in university, industrial, and governmental laboratories), as to whether their contents are:

1. entirely applied
2. primarily but not entirely applied
3. equally applied and pure (the neutral zone)
4. primarily but not entirely pure
5. entirely pure

Using a method very similar to the Thurstone technique, each member of the panel was asked to place a mark on a continuum as shown in the following example:

EXAMPLE 1

ENTIRELY PURE		EQUALLY APPLIED AND PURE		ENTIRELY APPLIED
5	4	3	2	1

Journal of Organic Chemistry

Placing a check on one of the five marks is directly analogous to the Thurstone method of having judges place items in one of five piles. There is also a provision for not responding, in that if a member of the panel does not feel that he is familiar enough with the journal in question to assess its contents, he merely checks a catagory indicating this. I feel that this provision increases the already highly valid responses of the panel.

Each journal in the list then received a score which was its average score computed from the ratings of the expert panel.* Thus, when I asked each of my subjects to indicate all those journals which they "habitually scan, read, or use in connection with your (their) professional interests," I was able to indicate their positions on the pure-applied continuum by computing their scale scores. The score is computed as the arithmetic average, or mean, of the scores of the journals which the respondent mentions, and he can be allocated with other members of his discipline along the continuum according to their respective scale scores.

I can locate a scientist on the continuum by the mean of his journal scores and discuss the variance about that mean in terms of standard deviations or standard scores. These are the operational indicators of the scientist's mission. His mission is represented by his mean score and the breadth of his work-interest space is represented by the variance of his distribution of journal scores. Parker and Paisley have discussed this variance as "the diffuseness of the scientist's (interest)...area" which they refer to as "an i guing variable for

*The list of journals was composed in a pilot study done in 1968 by the Pittsburgh Chemical Information Center and represents a relatively exhaustive list of the major periodicals in chemistry and related fields. See Appendix I for the list of journals and the scores which they recieved from the panel of experts. Remember, the scores reflect the journals position on the pure-applied continuum.

the study of information (processing)..." But, they point out, "The functional relationship of diffuseness and information processing was left largely unexplored." (Parker and Paisley, 1966, pp. 1067-1068)

Before presenting my findings with regard to these variables, I feel that I should provide a more precise treatment of the concepts of "mission" and the "diffuseness of the scientist's work-interest space." The scientist's mission, for the purposes of this essay, is thought of as the set of interests and activities which define his orientation to his work. His interests and activities can be those generated by (a) his professional training (i.e. a Ph. D. in organic chemistry), (b) developments in his field (i.e. carbon bonding of hydrogen atoms), and/or (c) the interests of those providing him with funds for his research (i.e. working for a petroleum company or working on a grant from the Office of Naval Research). The scale score, then, is only an anchorage point on the continuum and the mean was chosen (as opposed to the median or mode) because we can think of it as providing a balance point for an individual's distribution of journal scores. It is directly analogous to the balance point for two children on a seesaw. It provides a point at which the seesaw can operate efficiently, but its position is really a function of how much the two children weigh and how far they are from the balance point. These become the truly interesting questions of seesawing and the balance point is only a place for anchoring the seesaw. The mean gives me an anchorage point which allows me to calculate some precise statistics such as the variance and standard deviation to answer the truly interesting questions about the way individuals' journal scores were distributed about their means. These questions are answered by conceptualizing this distribution as the scientist's "work-interest space" and using the variance of the distribution as the indicator of the degree to which his interests are diffuse. It is reasonable that some scientists would have broadly defined, very diffuse interests, while others would have more narrowly defined, less diffuse interests. The degree of diffuseness should therefore have implications for the amount and types of information which the scientist processes.

There are interesting statistical notes which should be mentioned concerning Equal Appearing Interval scale construction. Thurstone shows that in using his method, one can argue for interval level measurement in that:

> ...it is possible to plot frequency distribution(s) ...This distribution has a central tendency or average and it has a measureable dispersion... The degree of heterogenity...of a group of people is directly measured by the standard deviation of the frequency distribution of their...scores. This is an important aspect of group comparison which can be reduced easily to measurement in terms of the dispersion... (Thurstone, 1931, pp. 257-257)

The mission dimension is therefore constructed as shown in Figure 1. Those scores to the right of the center line represent academic chemists at either the University of Pittsburgh or Carnegie-Mellon University (Mellon Institute) and those scores to the left of the line are non-academic chemists from industry and government. No analytical dichotomy is implied; this is done for illustrative purposes only.

The argument for interval level measurement is strengthened by the metholological and statistical study by Saffir, where he found:

> In each case where the Method of Successive Intervals was used, the check on internal consistency mentioned above was made...(The check) bears out our fundamental

FIGURE 1:
PURE TO APPLIED RESEARCH INTEREST CONTINUUM

Distribution of Scale Scores
N = 70

MOST	PURE
	4.21
	4.08; 4.10
3.90	3.94; 3.91
3.85	3.83; 3.82; 3.81; 3.80; 3.80
3.70	3.78; 3.71; 3.70
3.65; 3.66	3.68; 3.67; 3.66; 3.62; 3.60
3.59	3.59; 3.57; 3.53
3.50; 3.51	3.52; 3.52; 3.51; 3.50
3.41; 3.45	3.42;
3.35; 3.36; 3.36; 3.37; 3.37	3.39
3.30; 3.31; 3.31; 3.34	3.30
3.20; 3.26; 3.26	3.26; 3.20
3.18; 3.14	
3.09; 3.09; 3.05; 3.03; 3.01	
2.97	2.99
2.89	
2.77	
	2.64
2.56	
2.42; 2.44; 2.48; 2.48	
2.28	
MOST	APPLIED

> assumption, that by allocating each pile to a definite position on the scale, the distribution of all stimuli become normal. (emphasis mine) (Saffir, 1937, pp.189-190)

This is easily checked by converting the scale scores to standardized scores with a mean of zero and a standard deviation of one. (Hays, 1963, pp. 186-189) One can plot the distribution of standard scores, or z scores, as a histogram and perform a goodness of fit test to indicate whether or not one can assume normality. The distribution of z scores is shown in the histogram in Figure 2. In the goodness of fit test, we wish to determine whether a sample distribution of scores might have arizen from a theoretical distribution; in this case the normal distribution. With N = 70, the intervals expected in the normal distribution are:

n_1 = 48, or 68% of the cases at the interval of + one to - one standard deviation from the mean

n_2 = 20, or 28% of the cases at the interval of + one to two standard deviations and - one to -two standard deviations from the mean.

n_3 = 2, or 4% of the cases at the interval of + two to three standard deviations and -two to -three standard deviations from the mean

χ^2 is then:

$$\chi^2 = \frac{(49-48)^2}{48} + \frac{(16-20)^2}{20} + \frac{(5-2)^2}{2}$$

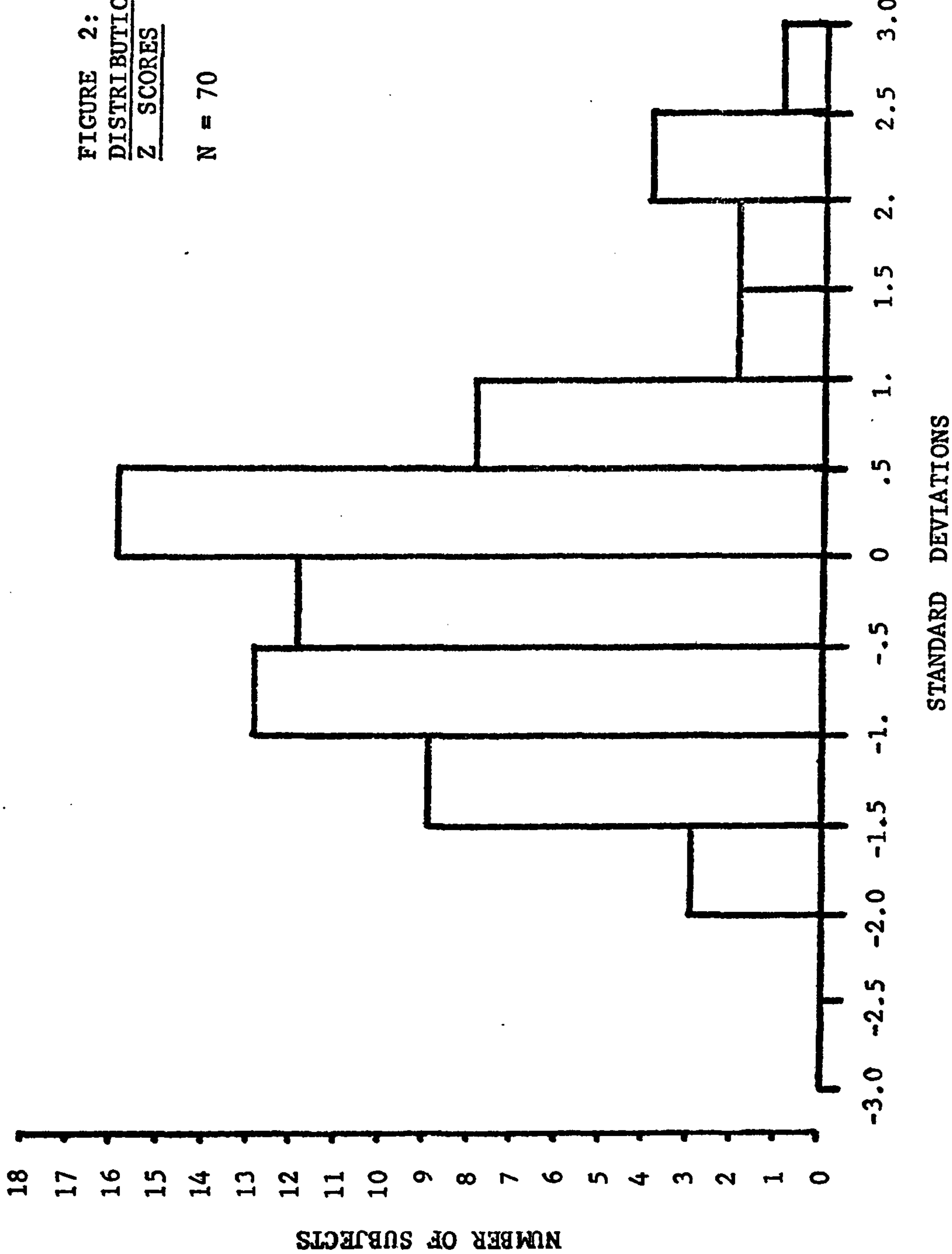
with J - 1 degrees of freedom, where J is the number of intervals considered

χ^2 = 3.81 with 2 degrees of freedom

This value is very low (approximately .25 significance level), and thus we can feel confident in the assumption that the scores are normally distributed. (Hays, 1963, pp. 586-588)

FIGURE 2: DISTRIBUTION OF Z SCORES

N = 70



The distribution of scale scores along the continuum can be valuable in several ways. A vital function of social research has always been to "break" or refute stereotypes. As can be seen, we do not have a dichotomous situation with clusters at the poles of the continuum. There is a distinct tendency toward the middle with only three cases in the four to five "most pure" range and zero cases in the one to two "most applied" range (though, the reader will notice in Appendix I that many journals had scores in these ranges). In addition, we can notice that there is a sizable amount of pure research interest among the industrial-governmental group as well as in the standard haven of academia. Notice also, the fact that there are five academic chemists whose interests can be considered, at least by our first look at the continuum, to be relatively applied in character. We are reminded of Hirsch's remarks that "...pure research is being replaced by applied research within the inner courtyard of the holy temple," (academia) and that "basic research is also...conducted in governmental and industrial laboratories." (Hirsch, 1968, pp. 54-55)

The fact that I did not find clusterings of scores at the ends of the continuum indicates, I feel, that we are not dealing with a social institution whose members are separated by some great schism into two camps. My discussions with several of my interviewees further substantiated this feeling. Though basic research in industry may be called "pioneering applied research," in many ways it is similar or identical to basic research in the academic world. It is also apparent that since scientists with applied interests are found in academic settings and scientists with basic research interests are found in government and industry; previous comparative research which catagorized its subjects by affiliation, left much to be desired. I hope that this has exposed some fallacious assumptions of the past.

The scientist's professional interests, when viewed as gradations along the pure-applied continuum, provide a scale which allows greater precision in investigating functional relationships. Working with the two-type dichotomy of the past, investigators were greatly limited with regard to the range of analytical techniques which could be used in studying such relationships. I also suspect that since the analytical aspects of the investigation were limited, this had the effect of limiting the conceptualization of earlier studies. We often tend to conceptualize our research problems within the bounds of the analytical procedures which are appropriate and/or within the bounds of the techniques with which we have some facility.

Shilling and Bernard have investigated the degree of professional involvement in relation to the scientist's organizational affiliation: university, private research institute, industry, and government. They were concerned with non-directly work related activities which were not connected with the day-to-day occupational role, but which were considered to be a "form of service to the profession of a presumably scientifically useful nature..." (Shilling and Bernard, 1964, p. 16) They found that when considering such "outside activities," industrial and governmental scientists had so few of them that they were in a "different statistical universe" from the university and private research institute scientists. (Shilling and Bernard, 1964, p. 20) These assertions can now be tested, not with regard to affiliation, but with regard to the scientist's mission.

The subjects' vitas provided a great deal of information with regard to their professional involvement and supplementary information was obtained from the interview when not provided on the vita. Totally seven variables were chosen to represent professional involvement:

1. the number of journals for which the subject served as editor (EDI)
2. the number of journals for which the subject refereed submitted papers (REF)
3. the number of memberships in professional organizations(ORG)
4. the number of professional meetings attended in the past two years (ATT)
5. the number of papers delivered at professional meetings in the past two years (PAP)
6. the number of times that the subject "actively participated" in professional meetings above and beyond attending or presenting papers, i.e., chairman, discussant, organizer, keynote speaker, etc." (PAR)
7. the number of times that the subject was invited to give a lecture or seminar at a college or university other than the one(s) at which he studied (LEC)

As a first step, I wanted to determine if the variables constituted a scale of professional involvement. This is what Cooley and Lohnes refer to as "scaling a set of responses that sample a particular psychological or sociological domain." This is often called the "construct seeking" function of a statistical technique known as principal component factor analysis. (For an accurate and concise explanation of this technique see Stewart, 1967, Appendix I. pp. 60-63) Factor analysis "analyzes the intercorrelations within a set of variables ... to determine the minimum number of independent dimensions needed to account for most of the variance in the original set of variables." (Cooley and Lohnes, 1962, p. 151) The intercorrelations matrix of the seven variables appears in Appendix II. The principal components analysis substantiated the feeling that the items constituted a scale of professional involvement. Only the first principal component had an eigenvalue in excess of unity; 3.71, and accounted for 53.1% of the variance in the seven variables. All of the seven variables loaded highly positive on this factor. Since only one factor had an eigenvalue greater than one, and interpretation of this factor was very straight forward; a rotation was not necessary. The loadings for the first principal component are shown in table 6. For the total factor pattern see Appendix II.

TABLE 6

LOADINGS FOR ONE PRINCIPAL COMPONENT

DEFINING A SCALE OF PROFESSIONAL INVOLVEMENT

VARIABLES	LOADINGS
1. EDI	.57
2. REF	.85
3. ORG	.75
4. ATT	.78
5. PAP	.69
6. PAR	.60
7. LEC	.82

With these results, I feel confident that the seven variables of professional involvement constitute a scale which will serve as a valuable analytical construct for the analysis which follows. I will first attempt to relate professional involvement to the scientist's mission.

Certain missions along the pure-applied continuum may exhibit a higher degree of professional involvement than others. This assertion was initially tested by performing a multiple correlation between the set of seven predictor variables and the respondent's scale score, or mission. The results are:

Multiple R = .581

Multiple R^2 = .338

F for the significance of R = 4.517

with N.D.F. 1 = 7 and N.D.F. 2 = 62

R is significant beyond the .01 level

(See correlation matrix in Appendix II)

It is instructive to look at the configuration of supplementary statistics which are calculated when the R is determined.

PREDICTOR	BETA	R(CRITERION)	BETA*R	STRUCTURE R
EDI	0.058	0.275	0.016	0.473
REF	0.171	0.404	0.069	0.694
ORG	-0.306	0.176	-0.054	0.303
ATT	-0.168	0.245	-0.041	0.421
PAP	0.213	0.256	0.055	0.441
PAR	-0.071	0.156	-0.011	0.268
LEC	0.588	0.517	0.304	0.890

The BETA's are regression coefficients, but are not reproducible from sample to sample. The R(CRITERION) is the indication of how each predictor correlates with the mission scale score. BETA*R gives a precise indication of the contribution of each predictor to R. But, since this is a function of each BETA, it too is not reproducible.

Finally, we have STRUCTURE R, which is the correlation between the predictor and the prediction, or the R (CRITERION) for each variable divided by R. This statistic is transferable from sample to sample, and is analogous to the factor loading in a factor analysis. The STRUCTURE R indicates that EDI, REF, PAP, and LEC define the more significant variables in the relationship between professional involvement and the scientist's mission. The R indicates that the higher one's degree of professional involvement the higher his scale score, or the more "basic" are his research interests. Scientists whose research interests are more "basic" or "pure" in character tend to exhibit a higher degree of professional involvement than scientists whose interests are more "applied" and this is accounted for by their great tendency to serve as editors and referees of scientific journals, attend and present papers at professional meetings, and entertain more speaking engagements than scientists with applied interests.

Since there is a relationship between professional involvement and mission, it seems to follow that one would test the relationship between professional involvement and the diffuseness of the scientist's mission. This is tested in the same manner; a multiple correlation between the seven predictor variables and the indicator of diffuseness, the variance of the scientist's distribution of journal scores. The results are:

Multiple R = .488

Multiple R^2 = .238

F for significance of R = 2.765

with N.D.F. 1 = 7 and N.D.F. 2 = 62

R is significant; an F of 2.77 is significant beyond the .025 level of significance. (See correlation matrix in Appendix II)

Notice that all seven variables are negatively correlated with diffuseness, the eight variable. Though the multiple R is computed such that it cannot assume a negative value, the interpretation of R must be negative. The correlation matrix indicates that professional involvement has a negative multiple correlation with diffuseness. The evidence, therefore, indicates that as one becomes more professionally involved, his interests become more narrowly defined and less diffuse.

The configuration of supplementary statistics can provide an indication of the role played by each of the professional involvement variables.

PREDICTOR	BETA	R(CRITERION)	BETA*R	STRUCTURE R
EDI	0.015	-0.179	-0.003	-0.367
REF	-0.376	-0.239	0.090	-0.489
ORG	0.003	-0.230	-0.001	-0.471
ATT	0.536	-0.053	-0.029	-0.109
PAP	-0.518	-0.318	0.165	-0.651
PAR	0.108	-0.036	-0.004	-0.074
LEC	-0.083	-0.233	0.019	-0.478

Notice also that all values for STRUCTURE R are negative as are the correlations in the correlation matrix. REF, ORG, PAP, and LEC define the more significant variables in the relationship between professional involvement and diffuseness.

This leaves a very interesting situation: mission is positively correlated with professional involvement while diffuseness is negatively correlated with the same set of variables. This indicates that more basic scientists (higher scale scores) are more professionally involved, and individuals with less diffuse interests are more professionally involved. This possibly indicates that scientists with more basic interests may have less diffuse interest spaces. This suggests a zero order correlation of mission (mean scores) and diffuseness (variance scores). The expectation is, therefore, that one should obtain a negative correlation between the two. The analysis shows that mission and diffuseness correlate; $r = -.40$. When performing the significance test for r using the t-ratio, $r = -.40$ is significant beyond the .01 level since $t = -2.75$ with N-2 (68) degrees of freedom. (Hays, 1963, p. 529) The indication is that as one moves higher on the pure-applied scale (reflecting more basic research interests), subjects exhibit less diffuse interest spaces, i.e., as scale score increases the variance decreases.

Finally, the relationships between mission and scientific productivity and diffuseness and scientific productivity should be investigated. The initial feeling is there can be several forms of productivity depending on what is expected of the scientific researcher by those supplying him with his operating funds. But his orientation to his work in terms of his basic or applied interests must be considered.

Scientific productivity must be viewed as a very complex phenomenon unto itself, even disregarding its relationships to the scientific mission and information processing behavior. Scientific output has usually been measured in terms of the printed page; the scientific paper, journal article, or book. The "publish or perish" syndrome has many manifest consequences. But we must remember that scientific output need not be published, in the same sense as the above.

The scientific paper presented at a professional meeting may never be published, but it still represents the product of its author and a contribution to his profession. The output of the research scientist can take several forms. It may be a process or a physical product, which often is placed under patent (I realize that a patent is a special type of publication). Scientists in the university seem to be characterized by the fact that their output is more frequently of the published type, while the output of a scientist in industry is characterized more frequently by instances of the latter. I am trying to make the point that my experience has led me to feel that there is less pressure or internal need to publish in one setting than in another; more pressure to produce a workable process or product in one setting than in another; more emphasis on organizational rather than professional status in one setting than another; less freedom in one setting than in another; and last but not least, more money in one than another. But, most importantly, scientific researchers are as aware of this as much as (and probably more than) the behavioral scientists who study them. I feel that an obvious self-selection factor operates as to the mission that the scientist has chosen for himself. Productivity, in turn, may be a different dimension for different missions and this may well stem from the differences mentioned above. Though it is not within the scope of this essay to thoroughly investigate this interesting problem, I want to at least acknowledge its existence. But, in addition, it may have an immediate lession; to think of productivity only in terms of formal publication may introduce a bias which favors basic scientists. With this in mind, I am using the number of publications, the number of papers presented at meetings, and the number of patents as indicators of productivity. This strategy may also be introducing a form of bias, but I am in the position of trading-off one form for another. Given the task of exploring a pure-to-applied continuum in science, the choice I have made seems to have a smaller negative utility.

For the analysis; number of patents (PAT), number of papers presented at scientific meetings (PAP), and number of articles (solely or jointly) published (ART) were correlated with the mission scale score. The correlation matrix is as follows:

	PAT	PAP	ART	Mission
PAT	1.00	-.20	-.14	-.21
PAP	-.20	1.00	.54	.26
ART	-.14	.54	1.00	.37
Mission	-.21	.26	.37	1.00

It is immediately apparent that PAT is negatively correlated with the other three variables. Those subjects with a high number of patents tend to have a low number of papers presented at professional meeting, a low number of published articles, and generally low scale scores (indicating that their interests are more applied in character). On the other hand, Mission is positively correlated with both PAP and ART, indicating that those scientists with more basic research interests tend to present more papers at meetings and publish more articles. Notice also that PAP and ART have the highest correlation r = .54. This would indicate that those scientists who frequently present papers at meetings also tend to publish articles in scientific journals, many of which are probably revised versions of the papers presented at meetings. The separate findings are all intuitively satisfying, but one needs an indication of how prodictivity "generally" is related to mission, or in other words, how the three indicators of productivity in concert relate to the scientist's mission. This suggests a multiple correlation of PAT, PAP, ART, and Mission. The results are

Multiple R = .408

Multiple R^2 = .166

F for significance of R = 4.386

with N.D.F.1 = 3 and N.D.F.2 = 66

R is significant beyond the .01 level

The three variables of productivity are significantly related to the scientists mission. The supplementary statistics which were computed are useful in determining each predictor's role in the analysis:

PREDICTOR	BETA	R(CRITERION)	BETA*R	STRUCTURE
PAT	-0.157	-0.212	0.033	-0.519
PAP	0.050	0.256	0.013	0.629
ART	0.323	0.372	0.120	0.912

STRUCTURE R indicates that all three variables play an important role in the multiple correlation with Mission. The negative STRUCTURE R for PAT shows that it is a "supressor variable" and, as the name implies, tends to suppress the value of mission. Of the remaining two variables, ART seems to play the more influential role in the multiple correlation with mission.

Next, the relationship between the variables of productivity and diffuseness will be investigated using the same strategy as above. The correlation matrix is as follows:

	PAT	PAP	ART	Diffuseness
PAT	1.00	-.20	-.14	.40
PAP	-.20	1.00	.54	-.26
ART	-.14	.54	1.00	-.25
Diff.	.40	-.26	-.25	1.00

The intercorrelations of PAT, PAP, and ART, of course, remain the same. But, with regard to diffuseness, we have somewhat of a reversal from the previous analysis with mission. Now PAT is the only variable positively correlated with diffuseness, while PAP and ART are negatively correlated with it. This could possibly have been expected from the results of the correlation analysis of mission and diffuseness, where the two were found to be negatively correlated; -.40. The present results indicate that those with broader, more diffuse interests tend to produce more patents. On the other hand, those individuals who frequently present papers at scientific meetings and frequently publish articles in professional journals, tend to have less diffuse interests.

The multiple correlation of PAT, PAP, and ART with diffuseness shows some interesting findings.

Multiple R = .456

Multiple R^2 = .208

F for significance of R = 5.766

with N.D.F.1 = 3 and N.D.F.2 = 66

R is significant beyond the .01 level

The three variables of productivity are significantly related to the diffuseness of the scientist's interest space.

PREDICTOR	BETA	R(CRITERION)	BETA*R	STRUCTURE
PAT	.358	.400	.143	.878
PAP	-.111	-.259	.029	-.569
ART	-.;42	-.251	.035	-.550

Now, we have the occasion to see PAP and ART acting as supressor variables and PAT is playing the most significant role in the relationship of productivity and diffuseness. In summary, both mission and diffuseness are related to scientific productivity in general, but the relationships of specific indicators must be taken into account in order to clarify their association.

Since the scale of professional involvement has been used with some success in relating its set of variables to both mission and diffuseness, it may be useful in another task. For analytical purposes, we can divide the total group of seventy subjects into subgroups depending upon their distribution of scale-scores on the pure-applied continuum. The total group can be divided into 3 subgroups:

1. More basic research oriented (BASIC): $N_B = 25$
   all individuals with z scores; $z \leq -.5$
2. Mixed pure and applied research oriented (MIXED): $N_M = 28$
   all individuals with z scores; $.5 < z \geq -.5$
3. More applied research oriented (APPLIED): $N_A = 17$
   all individuals with z scores; $z \geq .5$

One wishes to know whether there are significant differences between these groups with regard to the seven variables of professional involvement, i.e., with regard to the groups' positions in this seven dimensional criterion variable space. If the groups are significantly different, one is then interested in determining the contribution of each variable to the discriminating power of the total test battery. The first question is answered using "Multivariate Analysis of Variance" (MANOVA) and the second by using "Multiple Discriminant Analysis" (DISCRM). (Cooley and Lohnes, 1962, chaps. 4 and 6)

MANOVA provides a generalization of the test from univariate analysis of variance. It tests the significance of differences between groups. Basically, two tests are involved. H_1 tests the homogeneity of dispersion of the groups, or in other words tests to determine whether the researcher can assume that the groups have similar variances.

> Research workers will presumably at times desire to bypass H_1 in computing the generalized analysis of variance, and report only the results of the test of the equality of group centroids, called H_2... This is a common practice because H_2 is <u>rather insensitive to moderate departures</u> from homogeneity of dispersions. (Cooley and Lohnes, 1962, p. 61)

H_2 tests the equality of group centroids. The centroid is analogous to the group mean in this multidimensional space. The discriminating power of the test battery is reflected in the degree to which the two groups differ. Let $|T|$ be the determinant of matrix of the sums of squares and cross products of deviations from the grand means, and let $|W|$ be the determinant of the pooled within-groups deviation score cross products matrix. As the ratio $|W|/|T|$ decreases $|T|$ is increasing relative to $|W|$ and the differences between the two groups increase.

To summarize, one seeks a small F value on H_1 in order to reject the hypothesis of differences in variances, and a large F value on H_2 to entertain the hypothesis of differences in the positions of the group centroids.

The results of MANOVA to test the differences between the BASIC, MIXED, and APPLIED groups according to the seven variables of professional involvement are:

H_1: (Equality of Dispersions)

$F = 0.425$; with N.D.F.1 = 56 and N.D.F.2 = 8966.26 degrees of freedom

This F value is extremely small and thus we can feel quite confident in assuming that the groups have homogeneous variances.

H_2: (Overall Discrimination)

$F = 1.83$; with 14 and 122 degrees of freedom

This F value is significant beyond the .05 level, and we can conclude that the groups are statistically significantly different.

DISCRM is used to derive the discriminant function of the seven variables which is the linear function which best discriminates between the two groups. In this situation, "best" is defined specifically as those weightings of seven variables such that the ratio of between groups sums of squares of the linear function to its within groups sums of squares has a larger value than that for any other possible linear function of the same variables. This ratio is called the discriminant criterion. In the three group case, two discriminant functions are derived. Since one function may not totally account for the predictive power of the test battery, a second function is derived which is orthogonal to the first. This is analogous to the situation in factor analysis where the second principal component is derived as orthogonal to the first in order to account for a portion of the variance not accounted for on the first principal component. Principal components factor analysis (PRINCO) identifies the major dimensions along which individuals differ and DISCRM identifies the major dimensions along which groups differ. The orthogonal factors in PRINCO are constructed to maximize within-group variance and the orthogonal functions of DISCRM are constructed to maximize among-groups variance.

The significance of the functions derived by DISCRM are indicated by the magnitude of the Canonical R associated with each function. There is a chi-square test associated with each Canonical R to determine the level of significance for each of the derived functions. The results are:

Discriminant Function 1:

Canonical R	Chi-square	Degrees of freedom
.534	24.38	14

The first function is significant beyond the .05 level.

The Canonical R of the second function is computed with the variance associated with the first function removed.

Discriminant Function 2:

Canonical R	Chi-square	Degrees of freedom
.044	2.87	6

This function does not even approach a significant level, and the indication is that the first function had already accounted for the significant proportion of the variance between the groups before the second function was derived. Each variable's association with the derived functions is indicated by the pattern of function loadings. Each entry (loading) can be interpreted as the variable's correlation with the derived function, and the magnitude of the loading is the indication of the contribution of each variable to the discriminating power of the function.

TABLE 7

BASIC, MIXED, AND APPLIED PROFESSIONAL INVOLVEMENT:

FUNCTION LOADINGS

VARIABLE	FUNCTION #1	FUNCTION #2
1. EDI	.294	.401
2. REF	.611	.308
3. ORG	.267	-.024
4. ATT	.248	.740
5. PAP	.335	.650
6. PAR	.224	-.091
7. LEC	.852	.017

The positions of the groups' centroids on the functions (which can be thought of as newly derived variates) are helpful in interpreting the pattern.

	Function 1	Function 2
BASIC	0.614	-0.141
MIXED	-0.080	0.253
APPLIED	-0.771	-0.209

Since the second function is not significant, we will concentrate on interpreting the first function.

It is interesting to note that the centroid of the MIXED group is almost equidistant between the BASIC and APPLIED groups, indicating that our "z score criterion" for forming these subgroups was a good one. Since the loadings on the first function are all positive and the centroid of the BASIC group is positive, while the centroid of the APPLIED group is negative, the indication is that the BASIC group scores highly on these variables while the APPLIED group exhibits low scores. The mixed character of the MIXED group is reflected in its centroid's position, near 0 which is the mid-point of the function, i.e., some members tending toward high scores on these variables and others tending toward low scores. The REF and LEC variables seem to be far and away the two must powerful discriminators in the test battery.

Since the MIXED group seems to occupy the space midway between the BASIC and APPLIED groups, and the second discriminant function is not significant, it seems that the situation could be clarified even further by removing the MIXED group and redoing the analysis with only the BASIC and APPLIED groups. We will be able to do away with some of the extraneous variance associated with the MIXED group and reduce the number of discriminant functions to one, since the number of functions computed is one less than the number of groups involved.

The results are more encouraging than those of the previous analysis. The professional involvement scale shows even greater discriminating power when dealing with the two groups on the ends of the distribution. The variances of the two groups are again homogeneous:

H_1: (Equality of Dispersions)

$F = -.088$; with 28 and 4120 degrees of freedom

Again, the value for F is extremely small and the assumption of homogeneous group variance can easily be accepted.

H_2: (Overall Discrimination)

$F = 3.46$; with 7 and 34 degrees of freedom

This F value is significant beyond the .01 level, and thus all evidence indicates that the two groups are statistically significantly different.

As indicated, one discriminant function was computed for the two groups. Its Canonical R and significance are higher than in the previous analysis.

Canonical R	Chi-square	Degrees of freedom
.645	19.62	7

This function is significant beyond the .01 level and approaches the .005 level of significance.

TABLE 8

BASIC AND APPLIED PROFESSIONAL INVOLVEMENT:

FUNCTION LOADINGS

VARIABLE	LOADING
1. EDI	.325
2. REF	.670
3. ORG	.281
4. ATT	.302
5. PAP	.423
6. PAR	.218
7. LEC	.843

The positions of the group centroids on the function are:

	Function
BASIC	.525
APPLIED	-.773

Again, scientists with more basic research interests tend to score high on these variables which discriminates them from scientists whose interests are more applied in character. Notice that even with the MIXED group removed, the centroids of the BASIC and APPLIED groups still occupy relatively the same positions of the derived function. We can conclude from these two analyses that the scale of professional involvement is a good discriminator with regard to individual's positions on the pure-applied continuum of science.

B. Scientific Elitism

The author has had an interest in certain corollary developments in relation to the scientific mission. These corollaries relate to what other researchers have referred to as variables of elitism in science. Though it is not within the scope of this essay to develop a detailed analysis and account of scientific elitism, I feel that it is both interesting and instructive to take note of the fact that "mission" and certain variables of elitism indicate hypothetical relationships. I am not suggesting that a scientist's mission is to be an elite. I am suggesting that the two are related.

Many of the variables considered here have been dealt with extensively in the literature; none of them are original. Previous investigators have developed standard procedures for operationalizing some of them and have shown considerable success in their application. They are all, to a good degree, related on both theoretical and methodological grounds. But, to this writer's knowledge, all of them have never been combined into a single index of scientific elitism. My intrinsic interest in these variables has prompted me to investigate their intercorrelations and attempt to develop a scale which could be used in behavioral research to define a conceptual and analytical domain known as scientific elitism.

When a scientist has risen to a position of prominance and expertise in his chosen area of specialization, he is often called upon to assume editorial duties in one of the journals covering his special interests. In addition, he may be asked to judge the merit of papers submitted to journals in his special interest area. His expertise has placed him in a position where it is felt that he can adequately referee submitted papers. Shilling and Bernard have investigated these variables in relation to the affiliation of scientists. (Shilling and Bernard, 1964, p. 16) In the same vein, when scientists are recognized as significant contributers to a special area and have shown particular competence therein, they are often called upon by the editors of scientific journals to write articles reviewing the "state of the art" in their own field. Crane has called these prestigeous position holders as "The Gatekeepers of Science" (Crane, 1967, pp. 195-201)

Rising to positions of prominance might encourage the scientist to join several professional organizations to thereby broaden his base of professional relationships and contacts. But, in addition, the eminent scientist is given memberships in honorific organizations, i.e., the American Academy of Science. Such honors place the scientist in a position of great "visibility in the national community of (their discipline);" (Merton, 1968, p. 59) The subjects in my group received scores for professional visibility and were rated according to the number of honorific awards which they had received. My ignorance of the relative value of these awards made a weighted scoring system impossible; therefore the number of awards received served as the indicator of visibility.

In view of their prominent positions, such scientists are often called upon to actively participate in the functioning of their professional organizations. This usually takes the form of being called upon to hold office, preside over meetings, accept appointments to chair special interest sessions, and in general to "actively participate" in the functions of the organization, particularly at annual meetings. Due to his known expertise in a special area, the eminent scientist is frequently called upon to participate outside of his professional organization by making a guest lecturing appearance at a college or university which is also interested in his area of competence. Professional participation though, it should be pointed out, is often considered to be a "time consuming hinderance which takes (the scientist) from his research, but which is often necessary in paying professional debts." (A quote from one of my more eminent respondents.)

Scientific productivity has always been a variable (or set of variables) associated with a scientific elite. Interesting and significant relationships dealing with productivity in an undisputed elite, a group of Nobel Laureates, have been disclosed. (Zuckerman, 1967, pp. 391-403) Merton has referred to those scientists which have "achieved excellence," the "scientific stars," as "highly productive." (Merton, 1968, pp. 59-63)

The reader should recall the earlier discussion of the relationship of scientific productivity to the scientist's mission and diffuseness of interests. It was mentioned that productivity may have different emphases in research areas which are more basic than applied in character. It is for this reason that all three indicators of scientific productivity will be included in the set of variables dealing with elitism. In this way, it can be certain that all of the major avenues of productivity have been included, rather than to rely on only one indicator and run the risk of introducing a bias favoring one end of the continuum or another.

Therefore, I have been able to isolate ten indicators of scientific elitism:

1. the number of journals for which the subject served as editor (EDI)
2. the number of journals for which the subject served as referee (REF)
3. the number of review articles written by the subject (REV)
4. the number of patents issued (solely or jointly) (PAT)
5. the number of memberships in professional organizations (ORG)
6. visibility - awards received (VIS)
7. the number of papers delivered at professional meetings in the past two years (PAP)
8. the number of times that the subject "actively participated" in professional meetings above and beyond attending or presenting papers, i.e., chairman, discussant, organizer, keynote speaker, etc. (PAR)
9. the number of times that the subject was invited to give a lecture or seminar at a college or university other than the one(s) at which he studied (LEC)
10. the number of articles published (solely or joint) in professional journals (ART)

A principal components factor analysis can be used to reveal the underlying dimensionality of the intercorrelations among this set of variables. The correlation matrix of the ten variables appears in Appendix II. Notice initially that PAT correlates negatively with all of the remaining variables with the exception of PAR where there is practically no relation at all.

Using the same factor analytic strategy of scale construction described previously, I submitted the ten variables to a principal components factor analysis. The factor solution contained two factors with eigenvalues in excess of unity:

FACTOR	EIGENVALUE	PERCENT TRACE
1	5.01	50.1
2	1.10	11.0

The two factors were rotated using a varimix orthogonal rotation scheme. The resulting factor pattern is as follows. Each loading (ij) in the i = 10 x j = 2 matrix is the correlation of the ith test with jth factor.

TABLE 9

FACTOR PATTERN: ELITE VARIABLES

VARIABLE	FACTOR 1	FACTOR 2
EDI	.609	-.328
REF	.830	-.005
REV	.687	-.141
PAT	-.237	.672
ORG	.778	.110
VIS	.838	.134
PAP	.630	-.098
PAR	.512	.685
LEC	.848	.048
ART	.859	-.112

We can see that all of the variables load highly on the first principal component with the exception of PAT which loads highly on the second factor. Notice also that PAR loads higher on the second factor than the first, and it was the only variable which correlated positively with PAT in the original correlation matrix (See Appendix II). The first principal component with the exception of PAT defines elitism. PAR is a marginal variable on the first component and is probably more closely associated with PAT in defining the second component. The second component seems to reflect another dimension of elitism, I would suspect, in more applied science. These are individuals who are very productive, in the sense of producing many patents, and as is true of more basic researchers, they exhibit a high degree of participation in professional meetings. Notice also that ART loads high positive on the first factor and negative on the second, again seeming to go along with the trend toward "applied" status for the second factor. This is interesting when reflecting on an earlier speculation that there seems to be less pressure to publish articles and more pressure to secure patents in more applied research areas. Thus, the initial indication seems to be that we are measuring a conceptual domain (which will be called elitism) but, that domain may have two significant underlying dimensions (though clearly when considering the relative sizes of the eigenvalues and the percentages of the trace explained by each factor, the first dimension is much more significant than the second). This should be kept in mind during the continuing analysis dealing with these variables of elitism.

An operational indicator had to be chosen which could be used in identifying elite members in the group of subjects being studied.

Merton has used the word scientific "star" when referring to "eminent men of science" who have been accorded "recognition" in their disciplines; who are "great talents in science," who are "visible" in their professional community; who are "highly productive;" and who "achieve excellence." (Merton, 1968, pp. 56-63) Merton's use of the term "star" is one of the keys to the operationalization of elitism in science. I am reminded of the "sociometric star" in the studies by Moreno (1953). This is a person who is frequently chosen, according to a designated criterion, by a well defined group. Sociometric techniques have proven to be useful methods for discovering technical communication patterns and...

> sociometric stars in the communication network who provide other members of the organization with information...(by making) greater use of individuals outside of the organization or read(ing) the literature more than other members of the laboratory. (Allen and Cohen, 1969, p. 12)

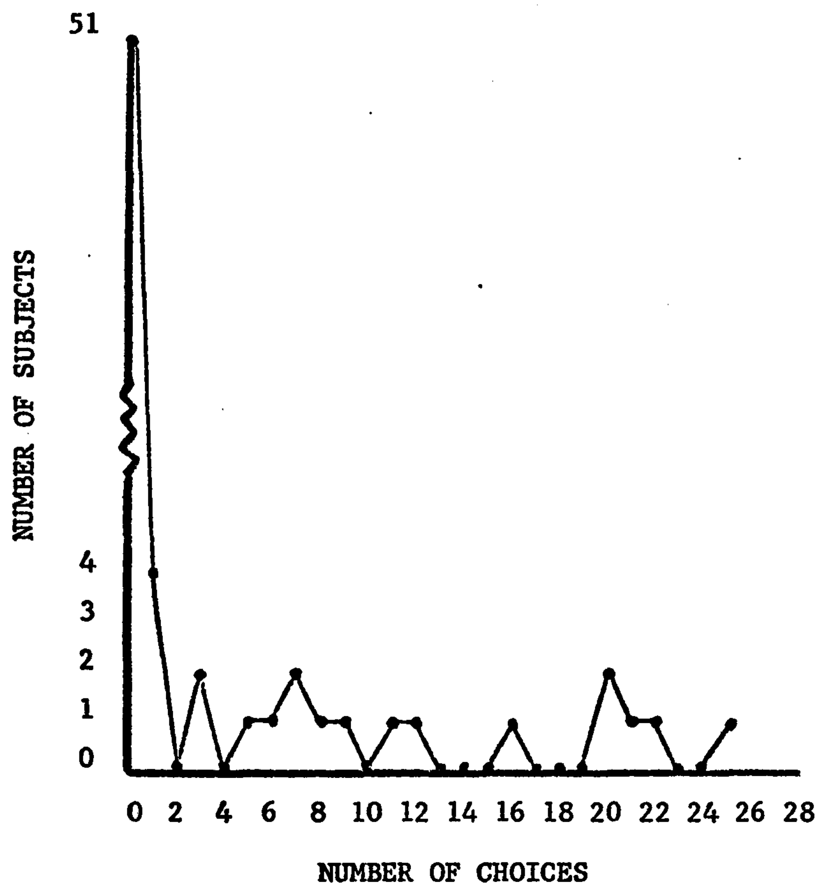
In addition, sociometric techniques have been used successfully in the investigation of the diffusion of innovations and its relationship to communication in the medical profession. (Coleman, Katz, and Menzel, 1966) In my study I have asked over 150 chemists in the Pittsburgh area, from all sectors of the discipline, the following question: "Would you please identify those who are, in your opinion, the five outstanding chemists in the Pittsburgh area; not just in your own field?" The frequency distribution of choices is an example of the "reputational approach" used in other behavioral research. (See Hunter, 1953 and 1959; Agger, et al, 1964; Gusfield, 1963; Dahl, 1961)

The distribution of sociometric choices is shown in Figure 3.

FIGURE 3

DISTRIBUTION OF SOCIOMETRIC CHOICES

FOR ELITES AND NON-ELITES



Of the seventy subjects fifty-one were never chosen as being one of the five outstanding chemists in the Pittsburgh area. Four subjects were chosen once. This seemed, in each case, to result from the fact that these individuals were chosen by respondents in their own organization. Two subjects were chosen three times. These are both young "up and coming" chemists at the University of Pittsburgh. Several informants who ranked very high on number of choices were in agreement that these two are potential members of the elite group, but due to their young professional age could not as yet be considered within that group. On the other hand, the same set of informants were also in perfect agreement that all of the remaining thirteen subjects at ≥ 5 choices should rank as members of the elite group of chemists in the Pittsburgh area. Though there seem to be no "hard and fast" formal or statistical criteria for separating elites and non-elites relative to their choice frequencies, I have relied upon the validity of the judgements of my informants. Therefore those thirteen subjects with ≥ 5 choices will constitute the elite group. It might be noted, in passing, that an interesting follow-up study could be performed by locating "the total population" of elites in Pittsburgh and then analyzing their choices for individuals who are "the five outstanding chemists in the Pittsburgh area." One would, for instance, be interested in the creation of "choice nets," the ratio of in-group to out-group choices, and/or the ratio of reciprocal to non-reciprocal choices in the group. In summary, the elite group has thirteen members and the non-elite group has fifty-seven. Using the variables of elitism, the analysis which follows will explore the differences between these groups with respect to their scientific missions and with respect to their information processing behavior.

Earlier indications are that certain missions are characterized by elite-type variables, i.e., professional visibility, productivity, recognition, etc. It has been suggested that "eminent scientists" usually decide on careers that give them a great deal of freedom and "personal independence." The implication is clear that this is usually found when working in settings of basic research and not applied. (Whyte, 1956, p. 232) This would indicate that there should be a tendency for elites to cluster along sections of the continuum and particularly those sections of the continuum which are thought of as being more basic research oriented. (See Figure 4).

Of the total of thirteen elites in the group of seventy, notice that of the eleven highest scale scores indicating those members of the group with the most basic research interests, eight of the eleven are elites. Notice also that seven of the eight highest scores are elites, and that the five highest scores are elites. The scale shows that a distinct clustering effect is evident when 62% of the elite group is found in the top (most basic research oriented) 16% of the total group. But what of the remaining five members of the elite group; how do we "explain" their positions on the continuum? Possibly a more qualitative and insightful approach is appropriate since their number is relatively small. This may be one great advantage of the interview technique of data collection, in that, it gives the researcher the personal contact that is necessary in gaining insight as to the more qualitative aspects of his investigation. The case histories and vitas provided by these five subjects may help us explain their scale positions, if only in a qualitative sense. The highest two of the five are still above the

FIGURE 4 : DISTRIBUTION OF ELITES (E's)

N = 70
N_e = 13

MOST	PURE
	4.21(E)
	4.08(E); 4.10(E)
3.90	3.94(E); 3.91(E)
3.85(E)	3.83(E); 3.82; 3.81; 3.80(E); 3.80
3.70	3.78; 3.71; 3.70
3.65; 3.66	3.68; 3.67; 3.66; 3.62; 3.60
3.59	3.59; 3.57; 3.53
3.50; 3.51	3.52(E); 3.52; 3.51; 3.50
3.41; 3.45	3.42
3.35; 3.36; 3.36(E); 3.37; 3.37	3.39(E)
3.30; 3.31; 3.31; 3.34(E)	3.30
3.20; 3.26; 3.26(E)	3.26; 3.20
3.18; 3.14	
3.09; 3.09; 3.05; 3.03; 3.01	
2.97	2.99
2.89	
2.77	
	2.64
2.56	
2.42; 2.44; 2.48; 2.48	
2.28	
MOST	APPLIED

mean (3.38) of the distribution; 3.52, 3.39. The subject at 3.39 holds a department chair. Although he may enjoy his elite position due to his research contributions, his administrative position may affect his professional interests in such matters as training students who will work in more applied research settings, planning curricula, faculty recruitment, etc. All of these can tend to deflate his scale score, and the time alloted to them is time away from his research activities. The subject at 3.52 is working at Mellon Institute, but has served as science advisor to Governor Scranton and presently to Governor Shaffer of the Commonwealth of Pennsylvania. As he has said, much of his time is spent "in conference rooms, airplanes, and airports." The science--government interface may tend to affect his interests which are generally scientific in character but not directly related to his specific research endeavor.

The remaining three elites are found on the non-academic side of the continuum. The subjects at 3.36 and 3.26 are both found at the U.S. Bureau of Mines. Again, the science--government interface may tend to affect their general scientific interests while not detracting from those professional qualities which have made them members of the elite group. The subject at 3.34 is <u>presently</u> in the employ of a large industrial firm, but he has only been there for a period of two years. The vast proportion of his professional career has been spent in the academic world (he held the department chairs at two large, well-known universities before joining the industrial firm late in his career). The scale reflects the scientist's <u>current</u> research interests. This may be a case where the subject's interests have tended to shift as he changed positions, though his reputation as a scientist stems from his more basic research which was done before he changed employment positions. This discussion is, for the most part, speculative in character, but one is sometimes forced to "go beyond the data" to seek explanations for those cases which do not have a quantitative explication within the scope of the model.

The tasks which follow are now to discover differences between members of the elite and non-elite in the context of the present study. Previous research in this area suggests some possible avenues to explore. Shaw has found that "higher ranking scientists" subscribe to more journals. (Shaw, 1956) It is implied that there is a need to process a larger amount of information among scientists of such rank. This assertion can be easily tested with the present data configuration. All members of the group of subjects were asked to indicate all professional journals to which they personally subscribe. When determining differences between elite and non-elite members of the group with respect to this criterion, the median test for independent groups is appropriate. First one computes the median number of journal subscriptions for each subgroup; elite and non-elite. Then the grand median is determined for the total group. The results are:

Median Elite; $MD_e = 5.00$

Median non-elite; $MD_{ne} = 2.95$

Median Total; $MD_t = 3.16$

One then compares each score for each of the J groups with M_t. If a score is above M_t it is assigned to a plus (+) category; and below M_t assignment is made to a minus category (-). Let a be the total number of +'s, a_j be the number of +'s in group j and $n_j - a_j$, the number of -'s in group j. We then have the 2 x j table as follows:

TABLE 10

MEDIAN TEST: JOURNAL SUBSCRIPTION

	ELITE	NON-ELITE	
PLUS	10	27	37
MINUS	3	30	33
	13	57	N = 70

We now have a simple contingency table and the significance of the difference between the groups is found from the statistic

$$\chi^2 = \frac{(N - 1)}{a(N - a)} \sum_{j = 1}^{J} \frac{(N a_j \quad {}_j a)^2}{N n_j} .$$

For $N \geq 20$ and $n_j \geq 5$, this statistic is distributed approximately as chi-square with J - 1 degrees of freedom. The results are as follows: $\chi^2 = 6.98$ with J - 1 = degree of freedom and is significant beyond the .01 level. (Hays, 1963, pp. 620-623) Our elites do subscribe to signifncantly more journals than non-elites.

It has been reported that "creative chemists ... read more technical literature, ... read more extensively and have <u>broader</u> <u>interests</u>." (emphasis mine) (Maizell, 1960, pp. 9-17) In this context, it is appropriate to determine whether elites have a more diffuse interest space, in the sense of having greater variances connected with their missions than non-elites. Given the type of data on diffuseness, the variance of the subject's distribution of journal scores, the t-test for a difference between means is appropriate. (Hays, 1963, pp. 320-322) One first computes the mean, variance, and standard deviation of the diffuseness scores for the elite and non-elite groups.

ELITE	NON-ELITE
$N_e = 13$	$N_{ne} = 57$
$M_e = .35$	$M_{ne} = .50$
$S_e^2 = .052$	$S_{ne}^2 = .044$
$S_e = .23$	$S_{ne} = .21$

(Notice that the $M_e < M_{ne}$.) The t ratio is then:

$$t = \frac{(M_e - M_{ne}) - E\,(M_e - M_{ne})}{\text{est.}\sigma\text{diff.}}$$

where $\text{est.}\sigma\text{diff.} = \sqrt{\text{est}\,\sigma^2 \left(\frac{1}{N_e} + \frac{1}{N_{ne}}\right)}$

where $\text{est.}\sigma^2 = \dfrac{N_e\ S_e^2 + N_{ne}\ S_{ne}^2}{N_e + N_{ne} - 2}$

where S^2 = sample variance for each group.

We have:

$$t = \frac{(.35 - .50)}{.04\left(\frac{1}{13} + \frac{1}{57}\right)} = \frac{(.35 - .50)}{.06} = \frac{-.15}{.06}$$

$$t = -\ 2.50$$

with $(N_e - 1) + (N_{ne} - 1) = 68$ degrees of freedom

The value of t shows the two groups to be statistically significantly different beyond the .01 confidence interval. The evidence indicates that elites are different from non-elites, <u>but</u> these results are contrary to those suggested by Maizell. The elites in our group do <u>not</u> have broader interests than non-elites. The elite members of the group have more narrowly defined, less diffuse interests than non-elites. Though, "creativity" is not one of the variables considered in this study in connection with elitism, though intuitively the two are related, this evidence does not indicate that elites have broader interests.

Cole and Cole have found that persons which are considered to have high "professional visibility" are frequently characterized as members of the scientific elite. (Cole and Cole, 1968, pp. 397-413) My indicator of visibility is based on the number of honorific awards which the subjects have received in their professional careers. In addition to those shown on their vitas, the subjects were asked:

> Have you ever received any: titles, honorary degrees, citations, appointments, or other forms of awards?

As mentioned each award was counted and weighted equally. The median test, as employed earlier, is appropriate for testing the difference in professional visibility between elites and non-elites. The results are:

Median Elite; $MD_e = 3.00$

Median Non-elite; $MD_{ne} = .87$

Median Total; $MD_t = 1.00$

We have the following contingency table:

TABLE 11

MEDIAN TEST: PROFESSIONAL VISIBILITY

	ELITE	NON-ELITE	
PLUS	13	22	35
MINUS	0	35	35
	13	57	N =70

where $\chi^2 = 19.6$ with J - 1 = 1 degree of freedom and is significant beyond the .001 level. The evidence seem conclusive that elites have significantly higher professional visibility in terms of awards received than do non-elites.

It was implied earlier when discussing the variables of elitism that members of the elite tend to participate to a high degree in various professional activities. Since we have developed a scale of professional involvement, we can test to determine if the difference in professional involvement between elites and non-elites is significant. In other words, I want to determine if the variables of professional involvement discriminate between the groups of elites and non-elites. The first step in this process is to determine whether or not the two groups are significantly different with regard to their positions in this seven-dimensional criterion variable space. If the groups are significantly different, one is then interested in assessing each variable's contribution to the process of discriminating between the two groups. Again, the questions which are being asked suggest a strategy imployed earlier in this essay: MANOVA and DISCRM. The results of the MANOVA to test differences in the elite and non-elite groups according to the seven variables of professional involvement are as follows:

H_1: (Equality of Dispersions)

$F = 4.07$ with 28 and 1646 degrees of freedom

This F value is larger than hoped for, and exceeds the acceptable range for rigorously satisfying the assumption of equality of dispersions. Recalling the earlier remarks by Cooley and Lohnes that H_2 is "rather insensitive to moderate departures from homogeneity of dispersions," it seems left to the individual researcher to decide how much of a "moderate departure" he is willing to tolerate. William Cooley has indicated that H_2 is "rather robust" with regard to departures from the assumptions underlying H_1 (Cooley, 1968, discussion), and given the exploratory nature of this study, the author has decided to accept the assumption of homogeneous group variance in order to test H_2. The results are:

H_2 (Overall Discrimination)

$F = 22.33$ with 7 and 62 degrees of freedom

This F value is significant far beyond the .001 level, though its great magnitude may be due in part to the fact that the group variances do depart from homogeneity. For the purposes of this study, though, I am willing to accept significant differences between elites and non-elites on the scale of professional involvement.

By accepting that the groups are significantly different, we are then encouraged to go on to DISCRM to derive the discriminant function of the professional involvement variables which best separates (discriminates between) the elite and non-elite groups. In the two group case, one discriminant function is derived. The significance of the discriminant function describing the differences between elites and non-elites is reflected in the magnitude of the CANONICAL R of the function which has a chi-square value of 81.18 with seven degrees of freedom. This is significant beyond the .001 level. The percentage of the variance explained is indicated by the square of the Canonical R associated with the function; $R^2 = .716$. This is the amount of variance in discriminating the two groups in the test battery which is explained by the discriminant function. All of the variables have high negative loadings on the derived function:

TABLE 12

ELITE AND NON-ELITE PROFESSIONAL INVOLVEMENT:
FUNCTION LOADINGS

VARIABLES	FUNCTION LOADINGS
1. EDI	-.66
2. REF	-.73
3. ORG	-.75
4. ATT	-.64
5. PAP	-.62
6. PAR	-.62
7. LEC	-.84

The position of the groups' centroids on the function were:

ELITE = -1.759

NON-ELITE = .401

Thus, members of the elite would tend to score high on these variables and the non-elites would score relatively low. In every case, the means on the seven variables were much higher for the elites than the non-elites (See Appendix II). Therefore, it can be concluded that professional involvement is a significant analytical dimension upon which to discriminate elites and non-elites. All seven variables seem to be good discriminators (as indicated by their similarly high loadings) and in concert provide a good scale for discrimination as shown by this analysis.

C. Summary

Using Equal Appearing Interval scale construction, I have been able to construct an analytical continuum which is refered to as the pure-applied continuum. The subjects have been assigned positions on the continuum based on the periodic literature which they read. This serves as an indicator of their professional interests relative to the basic and applied research orientations in their discipline. The distribution of scores, after a goodness-of-fit test, can be assumed to be normal. The individual's scale score in known as his mission, and the locus about that score indicates the degree of diffuseness of his interests. The intent of the study was to investigate the scientist's information processing behavior relative to his mission and diffuseness of interests.

As hypothesized, there were no clusters of subjects at the ends of the continuum, indicating that the stereotype of two distinct research environments may be misleading. There was a distinct tendency for scores to be found near the middle of the continuum. Several scientists in industrial and governmental research establishments exhibited very basic research interests and this was complimented by the fact that several scientists working in the university had interests of a rather applied character.

A seven item scale of professional involvement was developed using a factor analytic technique. Scientists whose interests are more "basic research oriented" tend to exhibit a higher degree of professional involvement than the "applied research oriented" scientists.

In addition, scientists with more narrowly defined, less diffuse interests also tend to be more professionally involved. The following analysis, therefore showed that more basic research oriented scientists tended to have less diffuse interests.

Three indicators of scientific productivity were used: number of patents (PAT), number of papers presented at scientific meetings(PAP), and number of published articles (ART). There was a significant multiple correlation with mission while PAT had a negative zero-order correlation, indicating that more basic researchers tend to have more articles and papers while more applied researchers tend to have fewer of these but more patents. The total effect was that PAT tended to suppress the prediction of mission. Again, there was a significant multiple correlation of the three variables with diffuseness, but the roles of the predictors were reversed. PAT was positively correlated with diffuseness while PAP and ART were negatively correlated and suppressed the prediction of diffuseness. The indication was that those individuals with a high number of patents tended to have more diffuse interests and those with a high number of articles and papers tended to have less diffuse interests.

The scale of professional involvement was used successfully a second time to discriminate three groups of subjects (BASIC, MIXED, and APPLIED) using Multiple Discriminant Function Analysis. The scale had greater discriminating power when disregarding the MIXED group. The BASIC and APPLIED groups were in different statistical universes with regard to their positions in the seven dimensional criterion variable space defining professional involvement. The BASIC group exhibited significantly greater professional involvement.

As correlaries to many of these results, the investigation of scientific elitism disclosed an interesting set of findings. A ten item scale of elitism was constructed using a factor analytic technique. Only PAT was negatively associated with the scale indicating that a second dimension might be necessary to account for elitism in applied science. The members of the elite group were identified using a sociometric technique. The correlaries to earlier findings stem from the important fact that there was a distinct tendency for elites to cluster at the basic research oriented end of the distribution of scores. It was found that elites subscribe to significantly more journals than non-elites, have more narrowly defined, less diffuse interests, and significantly greater professional visibility than non-elites. The scale of professional involvement successfully discriminated between elites and non-elites. Elites exhibited a significantly higher degree of professional involvement.

These findings are useful for placing the following analysis of information processing behavior in context. We can now have greater confidence in a comparative analysis, since the groups to be compared were not constituted in an *ad hoc*, *a priori* fashion; but were instead constituted analytically, shown to be significantly different regarding several important criteria, and their members were described relative to their basic or applied research interests.

III. INFORMATION PROCESSING BEHAVIOR

A. The Model

I am attempting to develop a theoretical model which, when used with concepts of a higher order of abstraction than those of the past, will allow me to move in the direction of a middle-range theory as a result of this study. The model, given the scope of this essay, is modest in its attempt at approximating the middle-range. At this early stage, it must make clear what is and what is not considered to be "scientific research as an information-processing activity," and therefore, what is and what is not to be within the relm of this investigation. I am not invoking early closure upon the model. I am merely attempting to define and delimit this present effort. To properly explicate the entire model to the point where one can claim a theory of the middle-range can only come after several attempts. This study is viewed as the first attempt and its results, I feel, have significant bearing on directions for future research by pointing out components of the model where more investigation is needed for better explication. The model also indicates where other behavioral scientists (since work in this area has always been of a highly interdisciplinary nature) can contribute to the development of the theory, e.g., psychologists investigating the cognitive states inherent in the scientist's information-processing activities.

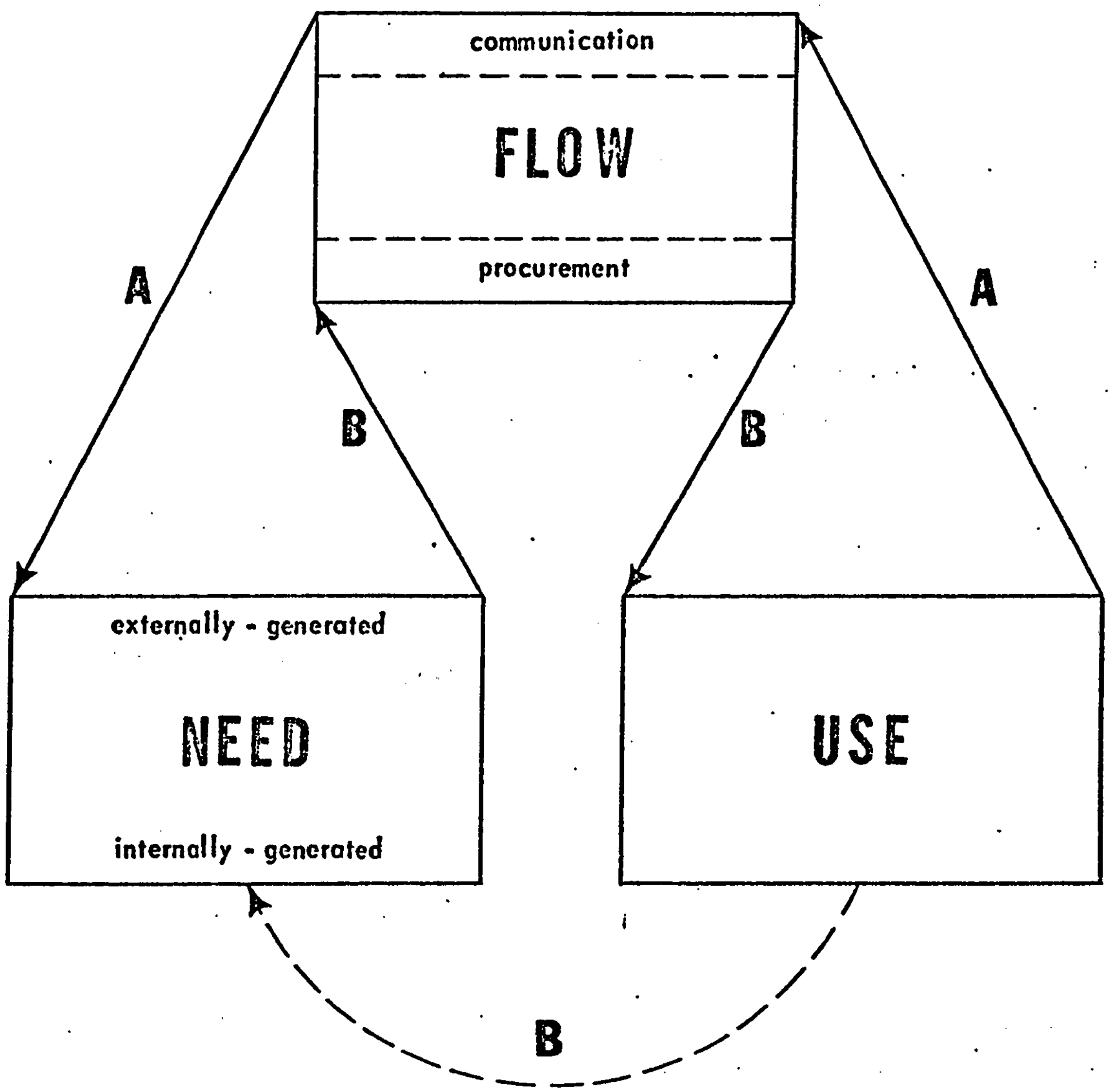
The model is an initially over-simplified ego-centered model of the scientific researcher as an information-processing agent. The complexity of the problem suggests that I take a systemic view of the process, though I realize initally that I am dealing with a loosely organized system. The system is shown in Figure 5.

Before going further, it is necessary to explain the system model and the connections of its components in order that we have a firm understanding of what is meant by "information-processing." As is the case with many models of ongoing processes, the choice of where to begin is arbitrary. Let us begin with information need. Once a need is perceived by the scientist, to be referred to as Ego, he takes steps to satisfy that need through procuring information from selected information channels. By engaging in procurement behavior he has now entered the "flow" component of the system, in that as a result of his action, some quanta of information is flowing through one or more channels. In a sense, information is always flowing through these channels, but by the selective procurement of information (selective channel use) certain channels are chosen and others are not; and of those channels chosen, some are used more frequently than others. The procurement process not only implies selection of channels, but also selection of information from selected channels.

The selected information is "used" by Certain basically cognitive states (evaluation, experimentation, determination, synthesis, etc.) are brought to bear on the information inputs. It is quite possible that as a result of this activity a need for additional information becomes manifest.

> Information may serve, and may be needed to indicate the existence of a problem, or to increase or decrease the scientist's confidence in a message previously received. These and similar effects of the information received

Figure 5: Information – Processing System



> constitute changes in the recipient's cognitive states. (emphasis in original) These cognitive changes may lead to decisions, and science information needs may hence be specified as needs for that information which will allow decisions on varying issues: (Menzel, 1966a, p. 283)

This is referred to as an "internally generated need;" a need that is perceived while cognitive states are acting upon information in the use component of the model. This need once again forces Ego to procure an additional quanta of information, such that this new quanta will itself eventually become part of the use component. As the cycle runs its course from need to flow (procurement) to u a moving force in the process can be an internally-generated need. It is a "pure-B process" (note arrows labeled B), in that it moves through the model only by way of those arrows labeled "B".

Ego may informally communicate information to a fellow researcher or formally communicate information to the scientific community at large. Those to whom the scientist could possibly communicate will be known as "Alter." Alter may be another person, a research group, a scientific discipline, the entire scientific community, or the world. Ego's perception of Alter will indicate whether he communicates formally or informally. Ego's perception will be determined by the way in which, given the constraints of his situation, he feels he should communicate to various levels of aggregation. Therefore, if I can determine Ego's perception of Alter, I can predict his choice of communication medium. The level of aggregation is an important consideration with respect to formal and informal communication. As Garvey and Griffith point out "... formal elements in the system are public, (and) have potentially larger audiences...; many informal elements are restricted and have smaller audiences." (Garvey and Griffith, 1967, p. 1013)

Before going further, it is instructive to appreciate the vital part played by communication channels in the scientific process. This will give us a better understanding of the role played by the flow component of the model. The channels are of two types: formal and informal. Holzner's distinction between the two is relevant here:

> ... we observe often in the work methods of a laboratory group of researchers an "informality" that does not only define the nature of their social relations, but also the way in which they deal with the phenomena under study. The contrast between this nature of scientific work and formalization of theory is striking. Often the recorded experiences are seemingly vaguely described by the researchers to each other; maybe they are given a nickname. "Hunches", "feelings" about the meaning of observations or the possiblilty of future observations are discussed and communicated in a style that very frequently creates a local lingo, shared by the immediate research colleagues but not by anyone else. They establish, then, a highly specialized language community within the larger one of their discipline and science generally, a community in which there is a very close link between experience and expression; albeit in a frequently informal way. Scientific work, then, involves the translation of experiential meanings into formal ones, a transformation which accompanies the communication to the wider scientific public via institutionalized channels. "Official" scientific communications, of course, are highly stylized and formalized, omitting much of the information which was still significant to the scientists in the laboratory situation itself. (Holzner, 1967, p. 85)

Formal channels have some "officialness" to them, with highly specialized and stylized language, and they are institutionalized in the sense that there is some established screening device which acts as a regulatory mechanism determining what information will and will not flow through that channel. The informal channels are non-official, with a great deal of "local lingo," and there are few if any established and institutionalized regulatory mechanisms. Those which do exist are highly flexible.

When Ego communicates, he is in the flow component of the model. Information is flowing again, but now in a different direction ... away from Ego. Information channels are in use, but now for purposes of communication and not procurement. At the other end of the information channel, we find Alter as a receiver. It may be the case that feedback from Alter is forthcoming; for instance, in the informal situation Alter responds "would you clarify that," or "what about..." or "but have you considered ..." or "the paper by... is related to that. He says, ..." Or in the formal situation; Ego's work is cited by another author, a complimentary or unfavorable review of Ego's paper is published, or a letter is written to the editor by another scientist claiming priority to Ego's work. This feedback can create what I refer to as an "externally-generated" need for information and, of course, the appropriate procurement behavior will be brought to bear to satisfy the need, e.g., Ego may go to a journal to check a reference, he might ask Alter (when Alter is a colleague, for instance) for assistance or more information, or he may go to a third scientist thus elciting more feedback. This is referred to as an "A+B process," incorporating both A and B arrows. Since feedback is very important in this situation, informal means of communication are predominate. In other words,

> ... the active cooperation of the disseminator is required in the informal domain. Such cooperation is fully granted only if the disseminator believes he can use information that is generated by the <u>exchange</u>. (Garvey and Griffith, 1967, p. 1013)

The emphasis is mine in that I would view such "exchanges" as feedback processes.

Another form of the A+B process can occur when Ego seeks no feedback (in an active sense). Ego may have an externally-generated need as a result of receiving communicated information (getting an idea from a journal article, getting a pre-print, receiving an alert from a computer-based information retrieval service, etc.) which allows no reasonable opportunity for feedback. The information-flow process is undirectional; Ego cannot, will not, or does not want to interact with Alter, the source of the information flowing to him. I feel that this is another form of the A+B process because it has brought about an externally-generated information need, but Ego : not employing feedback mechanisms with Alter to procure information. Figure 6 describes the types of A+B processes. In other words, A+B processes are those in which another actor (Alter), through formal or informal mechanisms has actively (by way of feedback or bi-directional information flow) or passively (non-feedback or uni-directional information flow) created an externally-generated information need for Ego.

Finally, though it seems problematic, we should consider a process where no feedback is forthcoming from Alter even though it was desired by Ego. For instance, in the informal situation Alter says "I've got to run; I have a class," or "Put it in the suggestion box, Charlie" or "(nothing)." Or in the formal situation, "Due to lack of space we cannot publish your paper" or "the section on ... of the meeting of the Southeastern .. Society is filled;" or if the paper does make it into print, it is never cited, or reviewed (positively or negatively). This is referred to as a "pure-A-process," in that no feedback is forthcoming and no information need is generated. (I realize

Figure 6: A + B Processes*

	active - bidirectional information - flow	passive - undirectional information - flow
formal information channels	1) review of Ego's work 2) editorial comments about Ego's work 3) letter to the editor about Ego's work	1) Alter's journal article 2) computer-based citation alert 3) proceedings of professional meeting
informal information channels	1) conversations a) face-to-face b) telephone c) correspondence	1) preprint 2) draft of manuscript 3) lecture; no questions

*The cells of the figure are not complete; their entries merely serve as examples.

that it may be the case that no feedback, or no feedback considered as negative feedback, may bring about a need for information; to work harder, to produce more, to try again. But whether this is to be considered as an internally or externally generated need is problematic.) In the "pure-A process" (only encompassing those arrows labeled "A") no need for information is generated as a result of communication because bi-directional information flow is non-existent and uni-directional flow went from Ego to Alter. I view the pure-A process as not within the field of inquiry due to the fact that no information need was generated.

The model leads me to point out that a process may start as pure-B, but <u>must</u> become A+B in order to be considered as scientific research. For a process to begin as pure-B and stay there, never becoming A+B, is to do research in a vacuum and thus not scientific research, i.e., if the scientist never communicates the results of his work, who will know it exists? If the process is pure-A, and remains that way, Ego can never be a scientific researcher. The scientific researcher cannot exist without communication; either bi-directional with Alter or uni-directional from Alter. This is like trying to hear or shout in a vacuum. The process may change from pure-B to A+B and back again, but if it is to ever reach a terminal point (and in the practical sense, for Ego, all research must end sometime); whether the terminal point is in the pure-B or A+B process will have significant consequences for the actor's research. Naturally, the process may start in A+B and remain there until the terminal point.

As a general summary, let us review the explication of the model as it has been used in this study. The elements of the model are: need, flow, and use. Need can be externally or internally generated, depending on its relation with the other components of the model. Internally generated needs are defined by the relation between need and use. The use of information can create needs for more information. Externally generated needs are defined by the relation between need and flow. Information communicated from Alter to Ego through the flow component can create a need for more information.

The flow component is composed of information channels. The channels are either formal or informal in character. When information passes from Ego's use component through the flow component, we define the communication relationship. When information passes to Ego's use component from the flow component, we define the procurement relationship. Procurements are prompted by needs in that the relationship between need and procurement is a catalytic one. (This may not hold in the case of "accidental acquisition," where information is brought to Ego's attention though he was not engaging in information seeking activity. (Menzel, 1966c, p.3)) The components and the relationship between components are combined to define the information-processing processes; pure-B, pure-A, and A+B.

Pure-A processes will not be investigated. Pure-B processes involve only actions by Ego and are indicated through the connections of the components by relationships labeled "B". Pure-B processes have internally generated needs as their catalytic force. A+B processes involve actions by both Ego and Alter and are indicated through the connections of the components by the relationships labeled "A" and "B." A+B processes have externally generated needs as their catalytic force. I have concentrated on A+B processes, and pure-B processes are considered when they serve as a beginning or terminal stage of the information processing activity, or when evidence shows that at certain distinct stages throughout the activity, the pure-B process is dominant for some discernible period of time.

B. The Model as a Methodological Guide

Models are effective to the extent which they simulate the real world. Only then can they be used to form statements about reality. Of course, the researcher must be flexible enough to modify his model in the light of evidence, and not to modify it in an *ad hoc* way to escape refutation. We must always keep in mind the purpose for which our model is intended; i.e., Alpha is a model of a process if studying Alpha helps us understand the process.

A model may be useful in directing attention to new or reconstituted variables. The structure of the model can imply the existence of relationships between variables and clarify relationships which are already felt to exist. A good model should prompt the investigator to search for explanatory statements that specify the relationships between components of the model. For example, using the model in this essay, one is forced to explain Ego's choice of either formal or informal communication with Alter; thus the hypothetical statement dealing with Ego's perception of the level of aggregation of Alter.

Using a model permits the researcher to invoke a more parsimonious approach in dealing with conceptualization. To use another example from my model, I am no longer required to speak of two separate components in an information processing system; i.e., procurement *and* communication. I can speak of one component; information flow. Whether that flow is to be considered communication or procurement is specified in the parameters of the process; i.e., whether the flow is uni-directional or bi-directional, whether Alter and Ego are passive or active, etc. The elements that constitute the flow component, the information channels, do not have to be respecified and redefined when the process changes from communication to procurement. Information is always flowing through the channels, but the parameters of the model specify their operative condition. We know that with uni-directional flow of information we are either talking about communication from Ego to Alter or procurement by Ego from Alter. Likewise, bi-directional information flow implies a feedback mechanism, but the distinction between disseminator and receiver for Ego and Alter is no longer clear-cut.

> ... the active cooperation of the disseminator is required in the informal domain. Such cooperation is fully granted only if the disseminator believes he can use information that is generated by the exchanges, and in this case the roles of user and disseminator become very blurred. (Garvey and Griffith, 1967, p. 1013)

Thus, one's model has many methodological implications. The most pronounced, but often least understood is the fact that the model serves as a guide for determining the empirical boundaries of each and every investigation. Each piece of research dealing with the model must specify its boundaries by "carving out that portion" of the model which it seeks to explicate. Only the most ambitious research project could hope to explicate an entire model of the scope present in this essay. Remembering Paisley's remarks (supra), each time an investigator selects a portion of the model for research, he attempts to make a contribution by achieving a closer approximation to a middle-range theory. As successive researchers build on the work of the past and select to explicate other portions of the model (the portions are not necessarily non-overlapping), we achieve additional approximations to a legitimate and well tested middle-range theory. We must be aware, though, that problems are encountered in two contexts: (a) when the portion of the model that is selected is too ambitious for the data; or (b) when the data allow a more comprehensive explication of the model than is achieved in a particular piece of research, i.e., the conceptual problem is understated and/or the data are underanalyzed.

In using the model for drawing empirical boundaries, the investigator is always wavering between these two problems, trying not to fall prey to either of them. Reflection on this has led me to assert that, for _this_ piece of research, the "use" component of my model will be considered as a node through which the process passes. It will not be explored and that portion of the model will not be explicated. This, obviously, does not imply that it will never be explicated. The results of this investigation can encourage me or other behavioral scientists, e.g., psychologists, to investigate the cognitive states inherent in information use; thus providing yet another approximation to a middle-range theory. In addition, I have attempted, with the help of the model, to make my empirical boundaries even less encompassing. Earlier, I stated that I would be concentrating _primarily_ on A+B processes, _secondarily_ on pure-B processes, and _not at all_ on pure-A processes. The portion of the model to be explicated is now determined as encompassing the A+B processes of information processing, with empirical attention being given to Pure-B processes only when specified conditions (see above) obtain.

C. Analysis

Previous studies have, by and large, been concerned with what has been referred to as A+B processes, where Ego is passively or actively interacting with Alter, i.e., studies of diffusion, formal and informal communication, information channel-use, critical incident studies, dissemination studies, "accidental" information exposure studies, information exposure by measures of success (productivity), and evaluative research of computer-based information retrieval systems. Of course, pure-B processes enter into every one of these, but any mention of that activity is seldom found. The focus, then, is the A+B activity of information-processing along the continuum of pure and applied science.

The greater majority of work done in the investigation of information-processing behavior has focused on the "pure" "basic" or "university-oriented" scientific researcher. With a few outstanding exceptions, it has been only recently that more and more investigators are taking a serious look along the applied side of the spectrum. Many agree that "(information-processing) in the two areas of activity are not independent of one another, but qualitatively different in their nature." (Marguis and Allen, 1966, p. 1052) Scientists with different missions may have similar goals, such as "keeping abreast" of the literature, but we see "quite striking differences in the ways scientists (at different sectors of the continuum) ...accomplish their similar goals." (Marquis and Allen, 1966, p. 1053)

These assertions can be tested by using the two groups found to be significantly different with respect to their professional involvement: Basic (N_B=25) those $\leq -.5$ z scores on the continuum; and APPLIED (N_A=17); those $\geq .5$ z scores. Each subject was given a list of twenty-two "Media of Communication" (See Appendix III) and asked "Which medium best fulfills each of the following functions?"

1. general awareness of the current state of your field of chemistry (AWARE)
2. finding out who is working in what area or on what problems (WHO)
3. source of specific ideas for work in progress (PROG)
4. source of specific ideas for new work (NEW)
5. inform others of your research activities (INFOR)
6. getting up to date in a new area (UP)
7. general browsing and stimulation (BROW)

The results are:

AWARE

Medium mentioned	Total freq.	BASIC freq.	APPLIED freq.
1	23	13	10
7	3	2	1
8	2	2	0
10	2	1	1
12	5	3	2
15	2	1	1
17	4	2	2
18	1	1	0
	42	25	17

Recent journal articles are by far the most important medium for performing this function. The review articles are a distant second. This appears to be the case in both BASIC and APPLIED groups.

WHO

Medium mentioned	Total freq.	BASIC freq.	APPLIED freq.
1	19	9	10
3	1	1	0
6	1	0	1
7	3	3	0
8	9	8	1
9	3	2	1
10	1	0	1
12	2	1	1
13	1	0	1
17	1	0	1
18	1	1	0
	42	25	17

Again, recent journal articles seem to be the dominant medium which best fulfills this function, and there is again close agreement in both the BASIC and APPLIED groups. There is an interesting note with medium 8, "face to face discussions with persons not currently working at your own institution (e.g. at scientific meetings, etc.)." Of the total of nine respondents choosing this medium, eight of them are from the BASIC group. This is reasonable, since earlier it was found that this group attended and participated in more porfessional meetings than the APPLIED group.

PROG

Medium mentioned	Total freq.	BASIC freq.	APPLIED freq.
1	22	12	10
2	1	1	0
4	1	0	1
6	1	0	1
7	7	4	3
8	5	5	0
9	2	2	0
10	1	0	1
17	2	1	1
	42	25	17

One can quickly appreciate the prominence of the professional journal in the communication system of science. Medium 8 is again highly chosen among the BASIC group as compared to the APPLIED.

NEW

Medium mentioned	Total freq.	BASIC freq.	APPLIED freq.
1	17	8	9
2	4	4	0
3	3	2	1
7	3	3	0
8	6	4	2
9	5	2	3
12	2	2	0
17	2	0	2
	42	25	17

There is agreement again on journals, but notice that four of the BASIC group mentioned reprints while none of the APPLIED group did so. The small sizes of the groups and the total of course preclude any attempt at generalizations, but a few insights seem to be possible.

INFOR

Medium mentioned	Total freq.	BASIC freq.	APPLIED freq.
1	18	15	3
4	7	2	5
6	2	0	2
7	6	2	4
8	1	0	1
9	8	6	2
	42	25	17

Difference are readily apparent with regard to this function. The BASIC group shows a much higher tendency for choosing journal articles as the primary medium for communicating the results of their research. While on the other hand, the APPLIED group seems to primarily rely on the "technical report distributed within their own institution" (medium 4) and "discussions with persons at their own institutions" (medium 7). The reports are in most instances written to the management personnel of the industrial concern, government agency, or granting agency involved. The face-to-face discussions are usually to immediate supervisors in close physical proximity.

UP

Medium mentioned	Total freq.	BASIC freq.	APPLIED freq.
1	5	4	1
2	3	3	0
7	5	3	2
8	1	0	1
9	1	0	1
12	20	13	7
17	4	2	2
18	1	0	1
22	2	0	2
	42	25	17

There again seems to be agreement among the BASIC and APPLIED groups as to the importance "review articles" as the primary medium for "getting up to date in a new area." Notice that three members of the BASIC group chose "reprints of more dated articles" as compared to zero for the APPLIED group, and two members of the APPLIED group chose the patent literature as compared to zero for the BASIC group. The table of selections for BROW follows.

BROW

Medium mentioned	Total freq.	BASIC freq.	APPLIED freq.
1	21	14	7
3	1	0	1
7	3	3	0
8	1	1	0
9	2	0	2
10	1	0	1
12	8	6	2
13	1	1	0
14	2	0	2
16	1	0	1
21	1	0	1
	42	25	17

Again, as the last case, the journal articles are by far the leading medium for browsing and stimulation. There seems to be relatively good agreement about this in both BASIC and APPLIED groups. It is also worth noting that review articles are mentioned again in this situation.

By way of general summary, certain insights can be drawn from these simple frequency statistics. The scientific journal seems to be the predominant medium for fulfill all but one of the above functions; the only exception being "getting up to date in a new area" for which the review article was most highly chosen. This analysis did not find major differences between the BASIC and APPLIED groups regarding six of the seven functions. Only concerning the media chosen to "inform others of ... research activity" did the two groups show marked differences.

The list of media (Appendix III) was useful in another way. All of the media can be thought of as information channels; i.e. means by which information can flow to or from Ego. Some channels are considered to be formal and others informal. This provides a setting in which we can ask certain questions about the elements of the FLOW component of the model; specifically, questions about procurement behavior. Research has been done to investigate scientists' perceptions of some of these channels with regard to many variables dealing with the procurement of information. Unfortunately only scientists at one end of the pure-applied continuum were questioned, and the channels which they were asked to assess were far from comprising a comprehensive group. Nonetheless, the results are very interesting and can serve as a basis for beginning a discussion of procurement.

Allen and Gerstberger investigated how applied scientists in research and development "ranked nine information channels on the basis of perceived accessibility, perceived ease of use, perceived technical quality, and amount of previous use." Channel accessibility and ease of use had a stronger correlation with amount of use than with quality. Channel accessibility, after partialling, was the strongest correlate of amount of use. One might be led to believe that the experience with a channel would be the highest correlate of channel use, because it is intuitively satisfying that scientists might be using the channels with which they have the most experience. When they used techniques of partial correlation, they showed this relationship to be spurious. When partialling on accessibility the relationship between experience and use disappeared, in that accessibility was highly correlated with both experience and use. (Allen and Gerstberger, 1967, p. 24) See also (Barrett, Thornton, and Cabe, 1968, pp. 431-436) This interesting set of findings in applied science should now be investigated respective of the scientists' missions. Do scientists along the entire continuum, with different missions, differently perceive information channel accessibility, ease of use, and technical quality and do they differentially use channels (in terms of amount of use)?

All of these questions can now be approached from a much more ambitious stance, in that, we have responses which can reflect procurement behavior from a much broader spectrum of the pure-applied continuum rather than just the applied section. In addition, the set of twenty-two media provide a much more comprehensive list of information channels than used in previous research. The subjects were asked to rate each of the media relative to four criteria:

1. quality of information;
   5= excellent
   4= good
   3= fair
   2= poor
   1= unacceptable

2. amount of information
   5= very much
   4= much
   3= some
   2= little
   1= very little

3. ease of use and accessibility
   5= very easy
   4= relatively easy
   3= neutral
   2= relatively difficult
   1= very difficult

4. amount of experience (time) using each
   5= very much
   4= much
   3= some
   2= little
   1= very little

The scores on each of the four were ordered for each subject and each subjects median was determined. This resulted in four scores for each subject, each of which was the median score of his ratings of the media on each of the four criteria. In other words, each subject had a quality score (QUAL), the amount of information, or quantity score (QUAN), an ease of use score (EAS) and an experience score (EXP). The data were now in an acceptable summary form to test the assertions made above. Do accessibility and ease of use (EAS) have a stronger correlation amount of use (EXP) than with quality (QUAL)? The new median scores derived for the subjects were submitted to a correlation analysis. The correlation matrix follows:

	QUAN	EXP	QUAL	EAS
QUAN	1.00	.61	.53	.26
EXP	.61	1.00	.52	.31
QUAL	.53	.52	1.00	.40
EAS	.26	.31	.40	1.00

EAS is not highly correlated with any of the other three variables. It is most highly correlated with QUAL. Those channels of highest quality also tend to be rated highest on EAS. This indicates that those channels which are thought to be "easiest" to use are also perceived as the "best" qualitatively. EAS may have a confounding effect, therefore, in the relationships between QUAL and the other two variables. The effect of EAS on these other relationships can be assessed using a statistical technique known as multiple partial correlation. It enables the researcher to examine the correlations between a set of n-1 variables with the effect of the nth variable held constant. (Hays, 1963, pp. 574-576). In our case we can hold the effect of EAS constant and develop a new correlation matrix of QUAN, EXP, and QUAL.

	QUAN	EXP	QUAL
QUAN	1.00	.29	.19
EXP	.29	1.00	.32
QUAL	.19	.32	1.00

We can see from the new correlation matrix that the effect of EAS was rather pronounced in several of the relationships. It's effect was that it tended to inflate the correlations between the other variables:

r of EXP + QUAL from r = .52 to r = .32

r of EXP + QUAN from r = .61 to r = .29

r of QUAN + QUAL from r = .53 to r = .19

The Allen and Gerstberger study seems to be, at least in part, substantiated by these results. Partialling on EAS seems to have significantly reduced the correlations among some of the other variables. In particular, the formerly significant correlation QUAN and QUAL (r = .53 and significant beyond .01) is now spurious (r = .19 and not close to being significant). The initial correlation of .53 between QUAN and QUAL would lead one to believe that scientists get the largest quantity of their information from those sources which they believe to be of the highest quality, and this might seem to be intuitively satisfying. But, the presence of the intervening variable EAS, when taken into account, indicates that this is not the case. Scientists tend to get the largest amount of information from those sources which are easier to use and more accessible and these sources are perceived as being best qualitatively.

This seems to be substantiated even further in the next analysis where a partial correlation is performed controlling on QUAL. The original correlation matrix is:

	EXP	EAS	QUAN	QUAL
EXP	1.00	.31	.61	.52
EAS	.31	1.00	.26	.40
QUAN	.61	.26	1.00	.53
QUAL	.52	.40	.53	1.00

After partialling on quality we have:

	EXP	EAS	QUAN
EXP	1.00	.09	.29
EAS	.09	1.00	.31
QUAN	.29	.31	1.00

Notice that the correlation between EAS and QUAN has actually increased from r = .26 to r = .31 attesting to the fact that there is still a strong relationship between EAS and QUAN; i.e. even when controlling on the quality of the information, scientists still tend to get the larger amounts of information from those sources which are easier to use and access. The relationship between QUAN and EXP decreased from r = .61 to r = .29 due to the fact that QUAL was highly correlated with both EXP and QUAN, r = .52 and r - .53 respectively. The correlation of EXP and EAS dropped significantly from r = .31 to r = .09. We see that controlling on QUAL has tended to make the formerly good relationship between EXP and EAS a spurious one. This indicates that the subjects are not necessarily most experienced (time investment) with the easier to use and access channels, though that is where they get alot of their information; i.e. reviews, abstracts, and Chemical Abstracts rated high on QUAN -- and all three provide a "large volume" of information, are easy to use and accessible, and do not require much <u>time</u> per unit of information procured.

Within the context of this essay, we will want to know whether perceptions of QUAN, EXP, QUAL, EAS relate to the scientist's missions. This can be tested using a multiple correlation of the four variables and the mission variable. The correlation matrix can indicate the direction (positive or negative) of the multiple R.

	QUAN	EXP	QUAL	EAS	MISSION
QUAN	1.00	.61	.53	.26	-.10
EXP	.61	1.00	.52	.31	-.13
QUAL	.53	.52	1.00	.40	-.05
EAS	.26	.31	.40	1.00	-.03
MISSION	-.10	-.13	-.05	-.03	1.00

Although none of the variables correlate highly with the scientists' missions, the fact that all of them correlate negatively indicates that as scientists tend to have more basic research interests (higher scale scores) they tend to have lower evaluations of the media on all four criteria. The multiple correlation is not high and not significant:

Multiple R = .137

Multiple R^2 = .019

F for the significance of R = .311

with N.D.F. 1 = 4 and N.D.F. 2 = 65

R is not significant

Though the magnitude of R is not significant, its directionality is still felt to be important. We might be willing to speculate that basic researchers have a generally lower opinion of these media of communication than applied scientists. Could it be the case that they rely on other channels which were not included in the list? Or could it be that they rely on a smaller number of channels and rate them highly and give all other channels low ratings, i.e. the median rating derived for them may not reflect this and there may be a precision problem?

The same type of analysis performed using the diffuseness score(the subject's variance score) was not significant ($R = .263$). Since diffuseness and mission are negatively correlated, this was reflected in the fact that the four predictor variables now had low positive correlations with diffuseness (with the exception of EAS, whose correlation with diffuseness was $r = -.004$ and with similar data could have just as easily been low positive: See correlation matrix in Appendix II).

The methods of procuring information (the activity involved in being able to access information channels which precedes or leads up to the actual accessing process) have been investigated with regard to their association with the amount of information which was actually expected once the channel is accessed. This refers to such activities as "going to the library," "seeking out a colleague," "writing a letter," etc. It was found that the method chosen did not correlate with the amount of information expected from the source.

(Rosenberg, 1967, pp. 124-127) During the interviews, the subjects were given four hypothetical situations in which they were asked to indicate the methods which they would use to procure information. They were given a list of eight methods and asked to order the methods according to which method they would use first, second, and so on for only those methods which they would use (seldom would anyone desire to use all eight methods). The four hypothetical situations were:

1. You are working on a design for a procedure or experiment in a field in which you are familiar and you wish to know if similar work has been published or is currently being done by someone else.

2. You are preparing a proposal (involving approximately $60,000.00) for a new project either to the management of your organization or to an outside granting agency. You wish to substantiate the proposal with a thorough bibliography.

3. You want to gather information in order to write an article in your area of specialization for a review journal.

4. You are about to begin work on a research project in an area in which you have not done any previous research.

The eight methods of procurement were:

1. Search your personal library

2. Search material within your organization's library

3. Use some other library outside of your organization

4. Consult a reference librarian

5. Telephone a knowledgeable person who may be of help

6. Visit a knowledgeable person within your organization

7. Visit a knowledgeable person outside of your organization

8. Write a letter to request information from a knowledgeable person.

After ranking the methods in each situation according to order of use, the subject were then asked to rank them in each situation according to how significant they would be for providing the necessary information. The problem was now to determine if the subjects' order of method use correlated with the order of method significance. The first three and the last choices for order of use and the first three and least significant methods for each subject were chosen to use in a correlational analysis. For each situation we have four variables indicating order of use (1st, 2nd, 3rd, last) and four variables indicating order of significance (1st, 2nd, 3rd, last) and we want to know how these two sets of variables correlate. This situation suggests a special form of correlation known as "Canonical Correlation" (CANON). (Cooley and Lohnes, 1962, p. 35-37).

A CANON was performed for each of the four hypothetical situations to determine the relationship between order of use and significance in each situation. The canonical correlation coefficient is the result of the maximum correlation between the derived linear functions of the "order of use" (USE) set of varialbes and the linear function of the "significance" (SIG) set of variables. Though there may be several linear combinations possible, each linear function is derives "to maximize the correlation between the new pair of canonical variates, subject to the restriction that they be independent of previously derived linear combinations." (Cooley and Lohnes, 1962, p. 35). Since our problem is very straightforward, only the canonical correlation coefficients of the first solution will be reported for each of the four hypothetical situations. (For the full canonical solution in each situation, see Apendix II).

Situation 1: CANON R = .8745

Situation 2: CANON R = .9754

Situation 3: CANON R = .9761

Situation 4: CANON R = .9337

The findings show that in all four hypothetical situations, there is a high degree of agreement between the order of use and the order of significance for the methods of procurement. This would indicate that the scientists in the group use those methods which seem to have the highest significance for providing the information which they seek.

The high correlation of "order of use" and "significance" for the procurement methods, indicates that these data may be valuable for comparative analyses dealing with procurement behavior. The purpose is to compare the two end sectors of the distribution (BASIC and APPLIED as used before) to determine whether there are differences in procurement behavior as reflected in these two groups' choices of methods of procurement.

In previous research it was found that the scientists in our sample (university chemists) received what they considered to be their "most stimulating" information from "human-personal sources," e.g., face-to-face discussion, telephone conversations, etc. (Amick and Shirey, 1969, p. 17). These would fall under the heading of feedback activities of A+B processes. Personal contacts, and the resulting feedback, can have differential effects on different scientific missions. The research question is then, are missions which are most stimulated by personal contacts likely to be found along particular sectors of the analytical continuum? If this is the case, which sector of the continuum is most dependent upon human-personal sources of information? In observations along what <u>he</u> calls the "Basic-Applied Continuum" (his phraseology) of science, Menzel points out,

> When scientific specialties are arranged along a continuum from the most basic to the most applied, many of the factors enumerated above vary in the same order. This leads one to predict that corresponding information in the usage of (personal and non-personal) information channels would occur ... Sufficient comparative data are, however, not yet in hand.

He goes on the hypothesis:

> By and large, the groups near the basic-research end of the continuum are much smaller in size. In addition, they define their interests more narrowly... Basic researchers, by and large, are probably more dependent on colleagues... (Menzel, 1966c, pp. 16-17).

These assertions would lead one to believe that members of the BASIC group would rely more heavily on human-personal sources for procuring information than would members of the APPLIED group. The choices of methods of procurement for these two groups provide the comparative data which Menzel rightfully suggests is necessary to test his assertions.** The first four methods of procurement on the list of eight, are literature oriented, non-personal methods of procurement. The second four are non-literature oriented, personal methods. We need to take account of the relative frequencies with which the personal methods of procurement are used as compared to the non-personal methods for each group (BASIC and APPLIED) in each hypothetical situation. The first, second, and third choices for each subject will be pooled so that there will be ($3 \times N_B$ or $3 \times 25 = 75$) choices for the BASIC group and ($3 \times N_A$ or $3 \times 17 = 51$) choices for the APPLIED group.

This enables us to construct contingency tables for each of the four situations, and use chi-square to test for the independence of the BASIC and APPLIED groups.

**Notice, also, that this essay has already tested one of Menzel's assertions: that scientists "near the basic-research end of the continuum... define their interests more marrowly...," i.e. the correlation between mission and diffuseness or breadth of interest was $r = -.40$, indicating that the higher one's scale score (more basic-research oriented) the lower his variance score (less diffuse, more narrowly defined interests).

TABLE 13

PROCUREMENT SITUATION ONE : BASIC vs. APPLIED

	BASIC	APPLIED	
Methods 1-4	51	38	89
Methods 5-8	24	13	37
	75	51	126

χ^2 = .64 with 1 degree of freedom

This value is not significant, and therefore we must conclude that in the first hypothetical situation there is no significant difference in the choices of procurement methods between the BASIC and APPLIED groups. The BASIC group does not appear to be more dependent upon personal methods of procurement.

TABLE 14

PROCUREMENT SITUATION TWO : BASIC vs. APPLIED

	BASIC	APPLIED	
Methods 1-4	59	41	100
Methods 5-8	16	10	26
	75	51	126

χ^2 = 0.0 with 1 degree of freedom

This value is zero due to the fact that the expected cell of frequencies were identical to those observed. On this criteria, there is no difference between the two groups in the types of procurement methods used in this hypothetical situation. Again, the BASIC group is not more dependent upon personal sources.

TABLE 15

PROCUREMENT SITUATION THREE : BASIC vs. APPLIED

	BASIC	APPLIED	
Methods 1-4	62	29	91
Methods 5-8	13	22	35
	75	51	126

$\chi^2 = 12.03$ with 1 degree of freedom

This value is significant beyond the .001 level. But the findings are contrary to those asserted earlier by Menzel. The BASIC group, in this situation, is significantly more dependent upon the non-personal, literature oriented methods of procurement.

TABLE 16

PROCUREMENT SITUATION FOUR : BASIC vs. APPLIED

	BASIC	APPLIED	
Methods 1-4	48	17	65
Methods 5-8	27	34	61
	75	51	126

$\chi^2 = 11.31$ with 1 degree of freedom

This value is significant beyond the .001 level. Again, the findings are contrary to those suggested by Menzel. The BASIC group is more dependent on the non-personal, literature-oriented methods of procurement, while the APPLIED group is more dependent upon the personal, non-literature oriented sources. We can see that procurement behavior varies considerably with the information-seeking situation, and that differences between the BASIC and APPLIED groups were only evident in the last two situations; both of which were contrary to expectations.

One can approach the problem of information seeking in science by investigating the "style" of procurement on the part of BASIC and APPLIED researchers. Two particular styles seem to be relevant to our discussion. Basic research has been found to produce more "cosmopolitan" information-seeking on the part of its incumbents; i.e., the extensive use of written information sources outside of their organization, more personal information contacts outside of the organization, and more frequent attendance of scientific meetings. The "locals" were characterized as being affiliated with "applied science" and exhibited the converse of the above mentioned attributes. (McLaughlin, Rosenbloom, and Wolek, 1965). One can use the mission scores along the pure-to-applied continuum to test these assertions with regard to the above mentioned cosmopolitan or local characteristics and discover whether cosmopolitan information-seeking is found along the pure sector and whether local information-seeking is found along the applied sector. It is significant that in a later study (Rosenbloom and Wolek, 1967, p. 72) a correlational analysis showed a preponderance of negative correlations of many of the key variables (mentioned above) with the measure of "localism" (using information sources within their own firm). It might be added that these findings were substantiated in their second study by a discriminant function analysis, where cosmopolitans and locals were discriminated on the basis of these variables.

In the data base, there is a set of similar variables which could be used to indicate the subject's style of information seeking, i.e. cosmopolitan or local. In addition we already have two groups of subjects which have been discriminated on previous analyses using other criteria; the BASIC and APPLIED groups. The variables are derived from the following interview questions:

1. About how many times per week do you use the telephone locally (within the 412 area code) for getting work related information. (LOC)

2. About how many times per week do you make long-distance phone calls outside of the Pittsburgh area (outside the 412 area code) for getting work related information. (LONG)

3. Would you please identify the two or three persons with whom you most frequently correspond on scientific and technical matters, and where are they located. (DIST)

    1. within the organization
    2. locally, outside of the organization
    3. within the region
    4. within the nation
    5. foreign

4. Have you attended any national or invitational meetings held outside of your organization within the past two years. (MEET)

The strategy was to determine whether or not the BASIC and APPLIED groups were significantly different with respect to these variables and which variables in the set contributed most to discriminating between the two groups, i.e. another problem for MANOVA and DISCRM. The results are:

H_1: (Equality of Dispersions)

$F = .615$; with N.D.F.1 = 10 and N.D.F.2 = 5514.35 degrees of freedom

This value of F is very small and the assumption of homogeneous variances can confidently be accepted. Unfortunately, the value for F on H_2 is also very small.

H_2: (Overall Discrimination)

$F = .56$; with N.D.F.1 = 4 and N.D.F.2 = 37 degrees of freedom.

This F is also not significant. Not only are the dispersions of these two groups homogeneous; the positions of their controids are also. The BASIC and APPLIED groups seem to occupy the same positions in this four dimensional criterion space, and show no differences in the styles (cosmopolitan vs. local) of information seeking as indicated by their scores on these four variables.

Often, there can be constraints upon information exchange and communication in science. Though Merton has stressed "communism" as one of the norms of science, whereby "The substantive findings of science are a product of social collaboration and are assigned to the community ..." he also points out many departures from normative behavior. (Merton, 1957, p. 556) Proprietary rights, questions of national security, and priority considerations are examples of the antithesis of this norm. It has been found that researchers in industry are much more reluctant than those in universities (55% as compared with 26%) to "discuss new research plans with people outside of their own laboratories." (Graham, 1967, pp. 132-133). Perhaps the question of constraints upon information exchange can be approached by considering the "push and pull" of organizational and professional pressures upon the research scientist, i.e. competition within and outside of the organization, identifying with one's professional group (professional identification), professional standards of performance, and organizational policies and practices monitoring internal and external communication.

March and Simon have suggested that as the amount of competition increases between members of a group and an individual, the individual will tend not to identify with the group. (March and Simon, 1958, pp. 66-70). If a scientist views his discipline as being a group of individuals who are in competition with him, he will tend not to identify with it. At the extreme, we can see that being the first scientist to discover something is like being the winner in an n-person zero-sum game, in that only one scientist can be the "first" and what he gains in being first, all others must lose. The scientist's identification with his professional group may well be determined by the degree to which the group is influential in providing standards for his work. In relation to the March and Simon statement about competition, it may be lowest when the individual identifies with his profession and its standards. This seems to be substantiated by Blau,

> The least competitive (subjects) in any of the sections in Department X were persons identified with reference groups that supplied them with professional standards... (Blau, 1955, p. 66).

The crux of the matter often centers on standards of performance. March and Simon again point out "...(T)o the extent that a job is professionalized, ...(the) standards of performance are defined by other members of the profession." (March and Simon, 1958, p. 70). This suggests that the relationship between professional identification and perception of competition should be investigated. Since the scale of professional involvement has been used successfully in earlier analyses in this study, the author will make one assumption: The more a scientist is professionally involved, the more he will tend to identify with his professional group and its standards of performance. This enables us to use the scale of professional involvement as an indicator of professional identification. This permits the test of the scale's relationship with perception of competition. The competition variable was derived from the following question in the interview schedule:

> Does a competitive atmosphere exist in chemistry, such that others might encroach upon your ideas? (COMP)

The responses were coded on a scale from zero to six, where zero indicated a perception of no competition to six which indicated an extremely competitive atmosphere. The relationship of the seven variables of professional identification (involvement) to the scientist's perception of competition can be tested using the multiple correlation technique. The correlation matrix of these variables appears in Appendix II. The results of the Multiple Correlation are as follows:

Multiple R = .488

Multiple R^2 = .238

F for significance of R = 2.768

with N.D.F.1 = 7 and N.D.F.2 = 62

R is significant beyond the .025 level

The supplementary statistics will be helpful for interpreting these results:

PREDICTOR	BETA	R(CRITERION)	BETA - R	STRUCTURE R
EDI	-0.106	-0.252	0.027	-0.516
REF	-0.043	-0.330	0.014	-0.677
ORG	-0.002	-0.318	0.001	-0.653
ATT	-0.131	-0.215	-0.028	-0.440
PAP	-0.099	-0.240	0.024	-0.493
PAR	-0.237	-0.365	0.087	-0.749
LEC	-0.267	-0.420	0.114	-0.878

The R(CRITERION) shows us the correlation of each predictor with the COMP. Notice that they all correlate negatively with the criterion variable, indicating that the interpretation of the Multiple R should be negative. This indicates that as scientists identify closely with their professional group and its standards (reflected in a high degree of professional involvement) they tend to perceive a low degree of competition in their profession. This finding substantiates the assertions by both Blau and March and Simon.

In conjunction with some of the earlier findings of this study; i.e. that basic - research oriented scientists tend to be more professionally involved than applied scientists, it would follow that members of the APPLIED group would exhibit perceptions of a higher degree of competition in chemistry than would members of the BASIC group. This provides insight as to the question of competition in pure and applied science. I would argue that applied scientists would have less identification with their profession than basic scientists because their standards of performance are not defined by their profession, but are instead defined by the administrative unit of their respective organizations. In view of this, the converse of Blau's proposition would lead me to believe that there would be a greater sense of competition perceived by applied scientists because of their lack of identification with their professional group and its standards.

This difference in the perception of competition can be determined using the median test as it was employed earlier in this study. (Hays, 1963, pp. 620-623). We derive the median score of COMP for the total of fourty-two responses $(N_B = 25) + (N_A = 17) = N_T = 42$ and assign the scores which are above the median to the plus category; below the median to the minus category. We construct the following contingency table:

Median BASIC; MD_B = 2.00

Median APPLIED; MD_A = 5.5

Median Total; MD_T = 4.5

TABLE 17

MEDIAN TEST : COMPETITION

	BASIC	APPLIED	
+	10	11	21
-	15	6	21
	25	17	42

For this table, χ^2 assumes a value of 2.34 with one degree of freedom. This value approaches the .10 level of significance. Though the value is not a high as we had hoped for, the indication (though not a strong one) is still that there is a greater sense of perceived competition among the APPLIED group.

It was mentioned earlier that often the standards of performance are set by the administrative group (as distinct from the research group) in research areas which are more applied in nature. These administrators are cognizant of the competitive atmosphere and the potential for industrial exploitation of research findings. This may prompt a desire on the part of administrators to monitor and/or control the means by which their scientists communicate both within and outside of the organization. They may invoke formal policies (e.g. clearing all written and oral communication that leaves the organization through the patent office) and/or encourage informal practices (e.g. submitting papers to in-house reviewers before submitting them for outside publication) in order to protect organizational proprietary rights on information.

We will again focus upon the BASIC and APPLIED groups to determine whether such constraints on communication exist and whether certain types seem to be more prevalent in one group than in another. The members of each group were asked the following two sets of questions:

1. Are you subject to any formal, written organizational policy regarding communication to others within your organization?

   Can you think of any informal practices carried out among you and your colleagues regarding communication to others within your organization?

2. Are you subject to any formal, written organizational policy regarding communication to those outside of your organization?

   Can you think of any informal practices carried out among you and your colleagues regarding communication to those outside of your organization?

The results are shown below:

	BASIC freq.		APPLIED freq.	
	within	outside	within	outside
formal policy only	0	0	0	2
informal practice only	6	4	4	2
both formal and informal	12	7	11	10
neither formal or informal	7	14	2	3
	25	25	17	17

The data are sketchy but certain insights can be drawn from the findings. None of the members of the BASIC group were subject to only formal policies, though some felt that only informal practices existed, e.g. making a point of seeing your research advisor or supervisor to check your results before telling anyone else. Two members of the APPLIED group were not aware of informal practices but felt that their communication was governed by formal policy. And again, some members of the APPLIED group were not aware of formal policy, but indicated the existence of informal practices. A good number of both the BASIC and APPLIED groups felt that there were both formal policies and informal practices which they had to observe in their communications both within and outside of the organization. Finally, the last category seems to be most interesting. Many more of the members of the BASIC group than the APPLIED group felt that there was neither formal policies nor informal practices governing their communication either within or outside of the organization. There is obviously no claim of statistical significance for these results; though they do provide a certain insight into differences in communications behavior in the BASIC and APPLIED groups.

D. Summary

I have attempted to develop a theoretical model of information processing behavior and explicate certain of the elements and relationships described therein. The model is viewed as a vehicle by which we might approach a middle-range theory. This exploratory research is considered by the author to be a first approximation which can be useful for setting the stage for future research. The elements of the model of the information processor (Ego) are need, flow, and use. Needs for information are internally or externally generated. The flow component is composed of information channels. When information flows to Ego, this is defined as procurement and when information flows away from Ego we have communication. Needs act as a catalyst to procurement except for the accidental acquisition of information. Use is defined as the cognitive component of the model; i.e. evaluation, synthesis, experimentation, etc. by Ego, and is not investigated in this study. It acts as a node through which the processes pass. The processes investigated are of two types. Pure-B processes involve only Ego and have internally generated needs as their catalytic force. A + B processes involve actions by both Ego and Alter (others) and have externally generated needs as their catalytic force. Externally generated needs eminate from unidirectional information flow from Alter to Ego or bidirectional information flow between Alter and Ego (information exchanges).

It was found that from a list of twenty-two media of scientific communication, "recent journal articles" were by far the most popular medium chosen to fulfill six of seven information processing functions.

The exception was that "reviews" were most highly chosen for "getting up to date in a new area." Both BASIC and APPLIED groups showed a relatively high degree of agreement on six of the seven functions. The exception was that members of the BASIC group generally prefered "recent journal articles" for informing others of their research activities, while the APPLIED group generally prefered "technical reports distributed within their own institutions."

The subjects rated the twenty-two media of scientific communication on four criteria: quality of information(QUAL), quantity of information(QUAN), ease of use and accessibility(EAS), and amount of experience(time investiment) using each(EXP). Correlation and partial correlation techniques provided interesting results:

a. Those media which are thought to be "easiest" to use are also perceived as the "best" qualitatively.

b. When controlling on EAS the correlation between QUAN and QUAL is significantly reduced. Though at first it may appear that scientists get the largest quantity of information from the highest quality media, this relationship is reduced. Scientists get the largest amount of information from those sources which are easiest to use and most accessible. This is substantiated further, in that, when controlling on QUAL the correlation between QUAN and EAS is actually increased.

c. Subjects procure a large quantity (QUAN) of their information from media which are easier to use and access (EAS) <u>and</u> with which they have relatively little experience in terms of time investiment(EXP), i.e. reviews, abstracts, and Chemical Abstracts

d. QUAL, QUAN, EAS, and EXP all correlate negatively with mission, indicating that basic research oriented scientists tend to provide low ratings of the media on all four criteria.

The subjects were given four hypothetical situations in which they were to procure information using any number of eight possible methods. The order in which the methods were used correlated highly with the order of significance assigned to the methods by the subjects, i.e. significance for providing the necessary information. The BASIC and APPLIED groups were compared relative to the types of methods chosen in each situation; i.e. personal, non-literature oriented methods vs. non-personal, literature oriented methods. There were no significant differences between the groups in two of the situations, and significant differences in two. Those situations where the groups were different was attributed to the result that members of the BASIC group were more dependent on non-personal, literature oriented methods than the APPLIED group. This finding was contrary to an assertion by Menzel. Concerning the "style" of information procurement; i.e. cosmopolitan (extra-organizational sources) vs. local (inhouse sources), there were no significant differences between the BASIC and APPLIED groups.

The scale of professional involvement was found to have a significant multiple correlation with the "perception of competition" in the discipline of chemistry. All the variables of the scale correlated negatively with competition perception, indicating that the higher the scientist's degree of professional involvement, the lower his perception of competition. This leads to the finding that members of the APPLIED group had a higher perception of competition than members of the BASIC group. It was felt that the greater sense of competition in the APPLIED group might lead one to expect a higher frequency of formal organizational policies and informal practices enacted to monitor or control scientific communication in that group. In general, this was the case. In the converse, there was a greater sense of freedom from such policies and practices in the BASIC group.

IV. CONCLUSION

The sociology of science is relatively new and in recent years has developed considerably. Much of this development has been stimulated by the interdisciplinary approaches encouraged by the close interaction of sociologists of science with information scientists, communications researchers, psychologists, sociologists of knowledge, psycholinguists, etc. We have seen the development of a small interdisciplinary group, each with close ties to their own discipline, bringing to bear a "high degree of creative symbiosis" to the area of "research on research." The development of this area is well illustrated by the current annual review of the field:

> The number of studies concerned with social and behavioral scientists has become quite large in the past three years and is growing at a prodigious rate. The reasons for this can be found quite easily. First of all, studies of information (processing) have now become a recognized area of activity for behavioral scientists. This legitimization of the field has attracted a greater number of competent behavioral researchers to it. (Allen, 1969, p. 25)

A major intent of this study was to point out that in comparative research, one is much more effective if analytical techniques are used to develop classificatory schemes rather than relying on *a priori* typologies which do not necessarily reflect the natural distribution of the population over the range of the variable(s) in question. Some researchers tend to reify their classes of subjects and the problem becomes acute when the classes were chosen *a priori* and the selection rule was intuitive and not analytic. Since comparative analyses of basic and applied scientific researchers have become so popular in the field, it seems that the development of the mission concept, or the pure-applied continuum, can be a contribution to future research. But, the basic methodological approach does not have to be tied to pure-applied interests. The same basic approach can serve as a vehicle for the development of any number of analytical continuua for the study of science; i.e. generality--specificity, well defined problem area--not well defined problem area, and paradigm agreement--paradigm disagreement. Any of these can provide a different orientation from which the information processing behavior of scientists can be studied, and the model can be more thoroughly tested.

I feel that it is both interesting and significant that on several occasions, the results of one analysis tended to cross-validate the results of another. It was found that mission score correlated positively with professional involvement implying that scientists who were more basic research oriented were more professionally involved. Then in a later analysis, the BASIC and APPLIED groups were shown to be significantly different because the BASIC group exhibited a higher degree of professional involvement. Perception of competition was negatively associated with professional involvement indicating that those who were more professionally involved exhibited lower perceived competition, and the BASIC group had significantly lower perceptions of competition than the APPLIED group. Elites tended to cluster the more basic research oriented end of the distribution, and they were discriminated from non-elites due to a higher degree of professional involvement. The degree of agreement among all of the findings was extremely high. And even from this brief review, it is obvious that the scale of professional involvement constitutes a valuable analytical construct.

The pure-applied mission dimension has provided an excellent conceptual vehicle by which to firmly ground this study in the context of the sociology of science, a field which draws heavily upon other fields of sociology and other disciplines. The techniques involved in the construction of the pure-applied continuum show that the sociology of science has not forgotten its heritage, but instead provides another arena in which older approaches can be modified and used to construct new analytical variates, i.e. mission and diffuseness of interest space. The second, diffuseness, was conceptualized and derived <u>after</u> reading the original 1927 and 1931 Thurstone articles, though initially the author's purpose in reading them was to pursue the possibility of using the method to construct the pure-to-applied scale. Since the primary emphasis of the study of information processing was on A + B processes, the flow component of the model received a great deal of attention due to the fact that all A + B processes must pass through it. Without question, more research must be done in the future to emphasize the Pure-B and Pure-A processes. Only by focusing on these two processes can the use and need components of the model be explored. The Pure-B process, for example, seems to be highly cognitive in nature, and almost anti-social; i.e. the times when the scientist wants to be alone with his work, to ponder his findings, to read, to evaluate, etc. This becomes an extremely difficult facet of human behavior to study and analyze. The first problem, of course, is to recognize it when it occurs and determine whether there are any distinct periods during the scientist's activities in which it can be isolated for study.

The A + B processes are not as formidable, at least in the sense of observing overt behavior or its artifacts. This is a relm which can unquestionably have great potential for exploration by the sociologist of science, and as this analysis shows, opens up an entirely new arena in which the methods of social research can be brought to bear and in which sociological theories of the middle-range can be constructed to explain the behavioral aspects of information processing. The model allows the researcher to borrow from many established sociological fields: information exchange --- exchange theory; communication --- formal mathematical sociology(theory of directed graphs and markov processes); creating and legitimating information --- the sociology of knowledge; informal communication --- small groups or social psychology; Ego-Alter relationships --- social stratification and status; policies and practices influencing communication and procurement of information--- organizational sociology; and the list could go on. The purpose of exploratory research is not only to show what a specific set of variables and their relationships are related to; but also to stimulate the minds of the researcher and the readers of his research to see relationships with areas both near to and far from the initial domain of discourse. For this, the investigation of A + B processes has great import.

The comparative analysis showed that there were several interesting and significant differences between the analytically constituted BASIC and APPLIED groups with regard to information processing. The fact that the relationships revealed by the findings of this study were at times in agreement and at times disagreeing with hypothetical statements taken from the "infant" literature of the field, can only be viewed as a challenge for future research. These differences should serve as the beginning and not the end of research. They have only provided insights which should stimulate further conceptualization and encourage further investigation using more focused and sophisticated research designs. The results, as they now stand, are limited to the local situation, but that is where all exploration must begin.

APPENDIX I

LIST OF CHEMISTRY JOURNALS

Journal	Panel rating
1. Accounts of Chemical Research	4.20
2. Acta Chemica Scandinavica	3.78
3. Acta Crystallographica	3.71
4. Am. Chemical Society, Journal	3.86
5. Am. Electrochemical Society, Journal	2.98
6. Am. Inst. of Chemical Engineers, Journal	2.35
7. Am. Mineral	3.16
8. Am. Scientist	3.65
9. Analyst	2.29
10. Analytica Chemeca Acta	2.50
11. Analytical Chemistry	2.80
12. Angewandte Chemie	3.61
13. Annalen der Chemie	4.00
14. Annales de Chimie	3.90
15. Annals of N.Y. Academy of Science	3.84
16. Applied Spectroscopy	2.62
17. Atomic Scientists Bulletin	2.85
18. Biochimica et Biophysica Acta	4.10
19. Canadian Journal of Chemistry	3.75
20. Ceramic Industry	1.68
21. Chemical Communications	3.97
22. Chemical Engineering	1.84
23. Chemical and Engineering News	2.21
24. Chemical Engineering Progress	2.07
25. Chemical Instrumentation	2.06
26. Chemical Processing	1.72
27. Chemical Reviews	4.11
28. Chemical Society (London), Journal	4.25
29. Chemical Week	1.60
30. Chemische Berichte	4.17
31. Chemistry and Industry	2.27
32. Chemistry in Britian	2.58
33. Chimica e l'industria	1.75
34. Current Chemical Papers	3.71
35. Current Contents in Chemistry	3.45
36. Current Papers in Physics	3.90
37. Deutschen chemische Gesellschft, Berichte	4.14
38. Electrochemica Acta	4.16
39. Electrochemical Society, Journal	3.16
40. Engineering Opportunities	1.50
41. Faraday Society Trans.	4.05
42. Federation of Am. Soc. for Exptl. Biol. Proc.	4.50
43. Federation of the Soc. for Paint Technology	2.12
44. Fortschritte der chemischen Forschung	3.85
45. Franklin Institute Journal	3.70
46. Gazzetta Chimica Acta	4.07

47.	Helvetica Chimica Acta	4.07
48.	High Energy Chemistry	4.00
49.	Hoppe-Seyler's Z. fur physiologische Chemie	3.50
50.	Hydrocarbon Processing	2.05
51.	Industrial and Engineering Chemistry	2.07
52.	Industrial Research	2.13
53.	Inorganica Chimica Acta	3.92
54.	Inorganic Chemistry	4.18
55.	Intra-Science Chemistry Reports	4.00
56.	Journal fur praktische Chemie	3.34
57.	Journal of the Am. Ceramic Soc.	3.00
58.	Journal of the Am. Oil Chem. Soc.	2.75
59.	Journal of the Am. Vacuum Soc.	2.50
60.	Journal of Analytical Chemistry	3.20
61.	Journal of Applied Chemistry	2.51
62.	Journal of Applied Physics	2.81
63.	Journal of Biological Chemistry	4.28
64.	Journal of Catalysis	3.47
65.	Journal of Chemical Education	3.00
66.	Journal of Chemical Engineering Data	2.42
67.	Journal of Chemical Physics	4.39
68.	Journal of Colloid Science	3.94
69.	Journal of General Chemistry	3.97
70.	Journal of Inorganic and Nuclear Chemistry	3.97
71.	Journal of Medicinal Chemistry	3.25
72.	Journal of Metals	3.15
73.	Journal of Organic Chemistry	4.12
74.	Journal of Organic Chemistry of the USSR	4.05
75.	Journal de pharmacie et de chimie	3.50
76.	Journal of Physical Chemistry	4.25
77.	Journal of Physics-Chemistry of Solids	3.71
78.	Journal of Polymer Science	3.50
79.	Journal of Structural Chemistry	4.23
80.	Kunstatoffe	2.00
81.	Macromolecules	3.63
82.	Modern Plastics	1.60
83.	Molecular Physics	4.32
84.	Monatshebte fur Chemie	3.96
85.	Nature	3.41
86.	Oil and Gas Journal	1.46
87.	Organic Reactivity	4.16
88.	Petroleum/Chemical Engineering	1.85
89.	Petroleum World	1.58
90.	Philosophical Magazine	4.30
91.	Physical Review	4.13
92.	Physical Society of Japan, Journal	4.35
93.	Plastics Technology	1.64
94.	Pure and Applied Chemistry	3.22
95.	Quarterly Reviews(Chem. Soc. of London)	4.13
96.	Record of Chemical Progress	3.98
97.	Recueil des travaux chimiques	3.96
98.	Review of Scientific Instruments	2.31
99.	Review of Modern Physics	4.44

100.	Royal Society of London Proceedings	4.29
101.	Russian Chemical Reviews	3.92
102.	Russian Journal of Physical Chemistry	3.86
103.	Science	3.42
104.	Science News	2.63
105.	Science and Technology	2.40
106.	Scientific American	3.11
107.	Scientific Research	2.89
108.	Soc. Exptl. Biology and Medicine Proc.	3.39
109.	Society for Analytical Chemistry Proceedings	3.19
110.	Talanta	3.32
111.	Tetrahedren	4.33
112.	Tetrahedren Letters	4.38
113.	Theoretica Chimica Acta	4.36
114.	Z. fur analytische Chemie	3.27
115.	Z. fur physiologische Chemie	3.81

APPENDIX II

SUPPLEMENTARY STATISTICAL FINDINGS NOT DIRECTLY REPORTED IN THE TEXT OF THIS STUDY

CORRELATION MATRIX OF SEVEN VARIABLES

OF PROFESSIONAL INVOLVEMENT

	EDI	REF	ORG	ATT	PAP	PAR	LEC
EDI	1.00	0.45	0.43	0.32	0.33	0.07	0.44
REF	0.45	1.00	0.54	0.68	0.43	0.40	0.72
ORG	0.43	0.54	1.00	0.38	0.45	0.38	0.61
ATT	0.32	0.68	0.38	1.00	0.66	0.38	0.48
PAP	0.33	0.43	0.45	0.66	1.00	0.31	0.37
PAR	0.07	0.40	0.38	0.38	0.31	1.00	0.45
LEC	0.44	0.72	0.61	0.48	0.37	0.45	1.00

PRINCIPAL COMPONENTS FACTOR ANALYSIS OUTPUT

FOR SEVEN PROFESSIONAL INVOLVEMENT VARIABLES

FACTOR	EIGENVALUE	PERCENT TRACE	CUM PERCENT	N.D.F.	CHI-SQUARE
1	3.7142	53.1	53.1	21.0	210.40
2	0.9390	13.4	66.5	15.0	58.43
3	0.8359	11.9	78.4	10.0	42.87
4	0.5790	8.3	86.7	6.0	23.80

FACTOR PATTERN. FACTORS ARE COLUMNS, TESTS ARE ROWS.

EDI	0.5864562	0.6851301	0.0177310	0.0630830
REF	0.8502371	0.0356819	0.0631722	-0.4878330
ORG	0.7503325	0.1308300	0.2753130	0.4289289
ATT	0.7797582	-0.1739231	-0.4522830	-0.2536683
PAP	0.6945401	-0.1058615	-0.5658069	0.3449531
PAR	0.5692764	-0.6380636	0.3247368	0.1320872
LEC	0.8184418	0.0514090	0.3544478	-0.1576845

TEST	COMMUNALITY	MULT R SQUARE
EDI	0.818	0.312
REF	0.894	0.687
ORG	0.840	0.474
ATT	0.907	0.645
PAP	0.933	0.501
PAR	0.854	0.292
LEC	0.823	0.617

CORRELATION MATRIX OF SEVEN VARIABLES OF

PROFESSIONAL INVOLVEMENT AND MISSION

	EDI	REF	ORG	ATT	PAP	PAR	LEC	MISS
EDI	1.00	0.45	0.43	0.32	0.33	0.07	0.44	0.27
REF	0.45	1.00	0.54	0.68	0.43	0.40	0.72	0.40
ORG	0.43	0.54	1.00	0.38	0.45	0.38	0.61	0.18
ATT	0.32	0.68	0.38	1.00	0.66	0.38	0.48	0.24
PAP	0.33	0.43	0.45	0.66	1.00	0.31	0.37	0.26
PAR	0.07	0.40	0.38	0.38	0.31	1.00	0.45	0.16
LEC	0.44	0.72	0.61	0.48	0.37	0.45	1.00	0.52
MISS	0.27	0.40	0.18	0.24	0.26	0.16	0.52	1.00

CORRELATION MATRIX OF SEVEN VARIABLES OF

PROFESSIONAL INVOLVEMENT AND DIFFUSENESS

	EDI	REF	ORG	ATT	PAP	PAR	PAR	DIFF
EDI	1.00	0.45	0.43	0.32	0.33	0.07	0.44	-0.18
REF	0.45	1.00	0.54	0.68	0.43	0.40	0.72	-0.24
ORG	0.43	0.54	1.00	0.38	0.45	0.38	0.61	-0.23
ATT	0.32	0.68	0.38	1.00	0.66	0.38	0.48	-0.05
PAP	0.33	0.43	0.45	0.66	1.00	0.31	0.37	-0.32
PAR	0.07	0.40	0.38	0.38	0.31	1.00	0.45	-0.04
LEC	0.44	0.72	0.61	0.48	0.37	0.45	1.00	-0.23
DIFF	-0.18	-0.24	-0.23	-0.05	-0.32	-0.04	-0.23	1.00

CORRELATION MATRIX OF TEN VARIABLES

OF SCIENTIFIC ELITISM

	EDI	REF	REV	PAT	ORG	VIS	PAP	PAR	LEC	ART
EDI	1.00	0.45	0.39	-0.10	0.43	0.39	0.33	0.07	0.44	0.59
REF	0.45	1.00	0.50	-0.21	0.54	0.67	0.43	0.40	0.72	0.70
REV	0.39	0.50	1.00	-0.11	0.52	0.51	0.42	0.18	0.48	0.56
PAT	-0.10	-0.21	-0.11	1.00	-0.09	-0.21	-0.20	0.06	-0.23	-0.14
ORG	0.43	0.54	0.52	-0.09	1.00	0.65	0.45	0.38	0.61	0.56
VIS	0.39	0.67	0.51	-0.21	0.65	1.00	0.42	0.50	0.69	0.64
PAP	0.33	0.43	0.42	-0.20	0.45	0.42	1.00	0.31	0.37	0.54
PAR	0.07	0.40	0.18	0.06	0.38	0.50	0.31	1.00	0.45	0.30
LEC	0.44	0.72	0.48	-0.23	0.61	0.69	0.37	0.45	1.00	0.73
ART	0.59	0.70	0.56	-0.14	0.56	0.64	0.54	0.30	0.73	1.00

ELITE AND NON-ELITE MEANS ON THE

SEVEN VARIABLES OF PROFESSIONAL INVOLVEMENT

	ELITE	NON-ELITE
EDI	0.54	0.02
REF	4.77	1.25
ORG	7.69	3.51
ATT	5.92	2.79
PAP	3.92	1.12
PAR	1.38	0.21
LEC	7.85	1.60

CORRELATION MATRIX OF MEDIA RATINGS; QUAN,

EXP, QUAL, AND EAS WITH DIFFUSENESS

	QUAN	EXP	QUAL	EAS	DIFF
QUAN	1.00	0.61	0.53	0.26	0.19
EXP	0.61	1.00	0.52	0.31	0.24
QUAL	0.53	0.52	1.00	0.40	0.08
EAS	0.26	0.31	0.40	1.00	-0.00
DIFF	0.19	0.24	0.08	-0.00	1.00

FULL CANONICAL SOLUTION:
HYPOTHETICAL SITUATION #1

FACTOR STRUCTURE FOR LEFT SET. COLUMNS ARE CANONICAL FACTORS. ROWS ARE TESTS.

1	0.447	-0.058	0.294	0.843
2	0.500	-0.368	0.481	-0.619
3	0.451	0.772	-0.342	-0.289
4	-0.563	0.629	0.532	-0.059

FACTOR	VARIANCE EXTRACTED	REDUNDANCY
1	0.243	0.186
2	0.283	0.199
3	0.179	0.062
4	0.295	0.078

TOTAL VARIANCE EXTRACTED FROM LEFT SET = 1.000

TOTAL REDUNDANCY FOR LEFT SET, GIVEN RIGHT SET = 0.524

NOTE THAT ALL VALUES ARE PROPORTIONS.

FACTOR STRUCTURE FOR RIGHT SET. COLUMNS ARE FACTORS. ROWS ARE TESTS.

1	0.469	-0.111	0.223	0.847
2	0.519	-0.132	0.608	-0.587
3	0.425	0.679	-0.568	-0.191
4	-0.575	0.677	0.457	0.046

FACTOR	VARIANCE EXTRACTED	REDUNDANCY
1	0.250	0.191
2	0.237	0.167
3	0.238	0.082
4	0.275	0.073

HYPOTHETICAL SITUATION 1 (CON'T)

TOTAL VARIANCE EXTRACTED FROM RIGHT SET = 1.000

TOTAL REDUNDANCY FOR RIGHT SET, GIVEN LEFT SET = 0.513

NOTE THAT ALL VALUES ARE PROPORTIONS.

WILKS LAMDA FOR TOTAL SET = 0.0336545

CHI SQUARE FOR TOTAL = 222.1503296

N.D.F. = 16

CHI SQUARE TESTS WITH SUCCESSIVE ROOTS REMOVED

ROOTS REMOVED	CANONICAL R	R-SQUARED	CHI-SQUARE	N.D.F.	LAMDA PRIME
0	0.8745	0.765	222.15	16	0.0337
1	0.8383	0.703	127.35	9	0.1431
2	0.5879	0.346	47.89	4	0.4814
3	0.5143	0.264	20.12	1	0.7355

FULL CANONICAL SOLUTION:
HYPOTHETICAL SITUATION # 2

FACTOR STRUCTURE FOR LEFT SET. COLUMNS ARE CANONICAL FACTORS. ROWS ARE TESTS.

1	0.257	0.736	-0.087	-0.620
2	0.065	0.501	0.522	0.687
3	-0.407	0.228	-0.701	0.395
4	-0.081	0.094	0.117	-0.110

FACTOR	VARIANCE EXTRACTED	REDUDANCE
1	0.300	0.285
2	0.312	0.190
3	0.230	0.097
4	0.257	0.096

TOTAL VARIANCE EXTRACTED FROM LEFT SET = 1.000

TOTAL REDUDANCY FOR LEFT SET, GIVEN RIGHT SET = 0.669

NOTE THAT ALL VALUES ARE PROPORTIONS

FACTOR STRUCTURE FOR RIGHT SET. COLUMNS ARE FACTORS. ROWS ARE TESTS.

1	0.216	0.738	-0.121	-0.628
2	0.088	0.583	0.515	0.623
3	-0.302	0.161	-0.871	0.354
4	-0.980	0.065	0.101	-0.077

FACTOR	VARIANCE EXTRACTED	REDUNDANCY
1	0.281	0.268
2	0.228	0.204
3	0.262	0.111
4	0.228	0.085

HYPOTHETICAL SITUATION 2 (CON'T)

TOTAL VARIANCE EXTRACTED FROM RIGHT SET = 1.000

TOTAL REDUNDANCY FOR RIGHT SET, GIVEN LEFT SET = 0.667

NOTE THAT ALL VALUES ARE PROPORTIONS.

WILKS LAMDA FOR TOTAL SET = 0.0018965

CHI SQUARE FOR TOTAL = 410.5375977

N.D.F. = 16

CHI SQUARE TESTS WITH SUCCESSIVE ROOTE REMOVED

ROOTS REMOVED	CANONICAL R	R SQUARED	CHI-SQUARE	N.D.F.	LAMDA PRIME
0	0.9754	0.951	410.54	16	0.0019
1	0.9444	0.892	212.33	9	0.0391
2	0.6507	0.423	66.67	4	0.3614
3	0.6109	0.373	30.60	1	0.6268

FULL CANONICAL SOLUTION:
HYPOTHETICAL SITUATION # 3

FACTOR STRUCTURE FOR LEFT SET. COLUMNS ARE CANONICAL FACTORS. ROWS ARE TESTS.

1.	-0.380	0.760	0.310	0.427
2	-0.388	0.515	-0.118	-0.755
3	0.738	-0.137	0.588	-0.301
4	0.683	0.425	-0.593	-0.040

FACTOR	VARIANCE EXTRACTED	REDUNDANCY
1	0.326	0.311
2	0.261	0.222
3	0.202	0.142
4	0.211	0.118

TOTAL VARIANCE EXTRACTED FROM LEFT SET = 1.000

TOTAL REDUDANCY FOR LEFT SET, BIVEN RIGHT SET = 0.793

NOTE THAT ALL VALUES ARE PROPORTIONS

FACTOR STRUCTURE FOR RIGHT SET. COLUMNS ARE FACTORS. ROWS ARE TESTS.

1	-0.363	0.757	0.335	0.427
2	-0.293	0.456	-0.090	-0.835
3	0.728	-0.143	0.562	-0.365
4	0.758	0.241	-0.606	0.004

FACTOR	VARIANCE EXTRACTED	REDUNDANCY
1	0.331	0.315
2	0.215	0.183
3	0.201	0.141
4	0.253	0.142

HYPOTHETICAL SITUATION 3 (CON'T)

TOTAL VARIANCE EXTRACTED FROM RIGHT SET = 1.000

TOTAL REDUNDANCY FOR RIGHT SET, GIVEN LEFT SET = 0.782

NOTE THAT ALL VALUES ARE PROPORTIONS

WILKS LAMDA FOR TOTAL SET = 0.0009088

CHI SQUARE FOR TOTAL = 458.7221680

N.D.F. = 16

CHI SQUARE TESTS WITH SUCCESSIVE ROOTS REMOVED

ROOTS REMOVED	CANONICAL R	R-SQUARED	CHI-SQUARE	N.D.F.	LAMDA PRIME
0	0.9761	0.953	458.72	16	0.0009
1	0.9232	0.852	258.73	9	0.0193
2	0.8392	0.704	133.47	4	0.1303
3	0.7478	0.559	53.66	1	0.4408

FULL CANONICAL SOLUTION:
HYPOTHETICAL SITUATION # 4

FACTOR STRUCTURE FOR LEFT SET. COLUMNS ARE CANONICAL FACTORS. ROWS ARE TESTS.

1	-0.037	-0.257	0.964	-0.057
2	-0.241	-0.782	0.016	0.575
3	-0.478	-0.529	-0.381	-0.589
4	-0.854	0.459	0.210	0.120

FACTOR	VARIANCE EXTRACTED	REDUNDANCY
1	0.254	0.222
2	0.292	0.151
3	0.280	0.128
4	0.174	0.035

TOTAL VARIANCE EXTRACTED FROM LEFT SET = 1.000

TOTAL REDUNDANCY FOR LEFT SET. GIVEN RIGHT SET = 0.536

NOTE THAT ALL VALUES ARE PROPORTIONS.

FACTOR STRUCTURE FOR RIGHT SET. COLUMNS ARE FACTORS. ROWS ARE TESTS

1	0.045	-0.341	0.939	0.016
2	-0.225	-0.754	-0.104	0.608
3	-0.628	-0.301	-0.382	-0.608
4	-0.856	0.407	0.307	0.085

FACTOR	VARIANCE EXTRACTED	REDUNDANCY
1	0.295	0.257
2	0.235	0.121
3	0.283	0.130
4	0.187	0.037

HYPOTHETICAL SITUATION 4 (CON'T)

TOTAL VARIANCE EXTRACTED FROM RIGHT SET = 1.000

TOTAL REDUNDANCY FOR RIGHT SET, GIVEN LEFT SET = 0.546

NOTE THAT ALL VALUES ARE PROPORTIONS.

WILKS LAMDA FOR TOTAL SET = 0.268217

CHI SQUARE FOR TOTAL = 237.0145461

N.D.F. = 16

CHI SQUARE TESTS WITH SUCCESSIVE ROOTS REMOVED

ROOTS REMOVED	CANONICAL R	R-SQUARED	CHI-SQUARE	N.D.F.	LAMDA PRIME
0	0.9337	0.872	237.01	16	0.0268
1	0.7186	0.516	102.47	9	0.2092
2	0.6778	0.459	54.88	4	0.4327
3	0.4469	0.200	14.59	1	0.8003

CORRELATION MATRIX OF SEVEN VARIABLES OF

PROFESSIONAL INVOLVEMENT AND PERCEPTION OF COMPETITION

	EDI	REF	ORG	ATT	PAP	PAR	LEC	Comp.
EDI	1.00	0.45	0.43	0.32	0.33	0.07	0.44	-0.25
REF	0.45	1.00	0.54	0.68	0.43	0.40	0.72	-0.33
ORG	0.43	0.54	1.00	0.38	0.45	0.38	0.61	-0.32
ATT	0.32	0.68	0.38	1.00	0.66	0.38	0.48	-0.21
PAP	0.33	0.43	0.45	0.66	1.00	0.31	0.37	-0.24
PAR	0.07	0.40	0.38	0.31	0.31	1.00	0.45	-0.37
LEC	0.44	0.72	0.61	0.48	0.37	0.45	1.00	-0.43
Comp.	-0.25	-0.33	-0.32	-0.21	-0.24	-0.37	-0.43	1.00

APPENDIX III

MEDIA OF SCIENTIFIC COMMUNICATION

1. Recent journal articles
2. Reprints of more dated articles
3. Manuscripts, drafts, or preprinted material
4. Technical reports distributed within own institution
5. Technical reports distributed by other than own institution
6. Telephone conversations
7. Face-to-face discussions with persons working at your own institution
8. Face-to-face discussions with persons not currently working at your own institution (e.g. at scientific meeting, etc.)
9. Oral presentations made at scientific meetings, conferences, or seminars
10. Copies of oral presentations including lecture notes and conference proceedings, papers given at meetings, etc.
11. Private correspondence
12. Review articles
13. Reference books
14. Text books
15. Other books
16. Dissertation Abstracts
17. Chemical Abstracts
18. Chemical Titles (published version)
19. Technical Clearinghouse publications of government agencies
20. Technical Advertisement
21. Science Fiction
22. Patent Literature

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