To the Graduate Council:

I am submitting herewith a dissertation written by Walter Henry Zultowski entitled "An Investigation of the Information Behavior and Attitudes of Research and Development Scientists." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Organizational Psychology.

Robert L. Dipboye, Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

AN INVESTIGATION OF THE INFORMATION BEHAVIOR AND ATTITUDES OF RESEARCH AND DEVELOPMENT SCIENTISTS

A Dissertation

Presented for the

Doctor of Philosophy

Degree

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Walter Henry Zultowski

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ABSTRACT

A fairly large collection of empirical research studies has developed concerning the topic of scientists' technical information behavior. A review of recent empirical literature on this topic, however, revealed that the majority of this research has been conducted for the purpose of improving existing information channels and systems. Little research has been conducted for the purpose of understanding and conceptualizing scientists' information behavior as an independent phenomenon.

Consequently, the present study sought to begin work toward the development of an understanding of scientists' technical information behavior. A number of information-related concepts and constructs were developed and integrated into a theoretical model of scientists' information behavior. The validity of this model was then tested using a specific information system (i.e., a technical library system) and a sample of research and development scientists.

The present study yielded support for only a portion of this newly proposed model of scientists' information behavior. However, potential explanations for the findings in the study along with a revised model of scientists' information behavior were presented. Suggestions for future research on this topic were also discussed.

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INTRODUCTION

Since the end of World War II, the scientist's[1] world has become inundated by a flood of technical knowledge, information, and data. To provide an appreciation for this statement, it has been estimated that books alone are currently being published at a rate greater than 1000 titles per day (Bell, 1966; Escarpit, 1966). Moreover, most writers on this topic concur that the number of scientific and technological journal articles is at least doubling every 10 to 15 years (Licklider, 1966; Kozmetsky, 1970).

Although this "information explosion" may be of little more than passing interest to the layperson, it presents a formidable challenge for research and development organizations to adequately provide for the technical information needs of their professional employees. Consequently, it is not surprising that a great deal of applied research has been conducted on the subject of scientists' acquisition and utilization of technical information. Commonly termed "user studies," the primary purpose of such

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[1]The term "scientist" is used throughout the present paper to refer to all types of professionals engaged in research and development activities. The exception to this rule is when profession is the focus of attention. In such cases, the term "scientist" refers to individuals with training in a scientific field, while the term "engineer" refers to individuals with training in a field of engineering.

research is to improve the flow of technical information within an organization through an analysis of scientists' information needs and information behavior. However, as Parker and Paisley (1966) have argued, the study of scientists' information needs and information behavior also provides an arena for basic psychological research whose purpose is understanding and prediction for its own sake.

Empirical research on the subject of scientists' information behavior is usually viewed as beginning in 1948 with the Royal Society Scientific Information Conference convened in Great Britain. This Conference serves as a benchmark for this field of research because it represents the first time empirical data pertaining to scientists' usage of technical information were presented. Previous "research" in this area was largely characterized by opinions and prescriptions regarding scientists' information needs and information behavior.

Following this Conference a large number of empirical research investigations began to appear on the topic of scientists' acquisition and utilization of technical information. However, it was not until some 18 to 20 years later that the first literature reviews on this topic were published. Specifically, these were the literature reviews of Menzel (1966), Parker and Paisley (1966), Herner and Herner (1967), and Paisley (1968).

The basic conclusions reached by all these authors

were that the first two decades of research in this area had been primarily characterized by user studies which had yielded an abundance of empirical data, but that the collective research effort in this area had been neither integrative nor cumulative in nature. In addition, these authors stated that much of the early empirical research on the subject of scientists' information behavior is of limited value due to the severe methodological problems which often characterize this research. Finally, it was pointed out that researchers studying the information behavior of scientists have rarely ventured beyond their empirical findings, and that there is a serious lack of theory and models to serve as guides for future research in this area.

Thus, given the work which remains to be done on the topic of scientists' information behavior, the broad purposes of the present paper are:

1. To provide a critical review of the empirical research which has emerged in this area since the literature reviews of the mid-sixties.
2. To propose a theoretical model for the purpose of describing and understanding the information behavior of scientists.
3. To test this theoretical model as it applies to a specific technical information system commonly used by scientists in research and development organizations.

CHAPTER I

LITERATURE REVIEW

Before beginning this review of the recent empirical research on the topic of scientists' information behavior, several comments regarding the terminology used throughout this review and the organization of the review may prove helpful to the reader.

As Herner and Herner (1967) have pointed out, a major hinderance to a summarization of empirical research findings in this area is the diversity and ambiguity of language used by investigators in this field. Thus, as a solution to this problem in the present literature review, adoption was made of the terminology used by Herner and Herner (1967) in their description of the technical information communication process.

According to these authors, a message originates with a "source" (i.e., an individual) who writes down or speaks an idea, research finding, etc. This idea, research finding, etc. is then transmitted to a recipient via a "channel" (i.e., a medium) which may be characterized according to one or more dimensions. Such dimensions may be the internal--external dimension (i.e., whether the channel is internal or external to the organization) or the interpersonal--written dimension (i.e., whether the channel is interpersonal or

written in nature). Moreover, it is at this point of availability through an information channel that a message is conceptually converted to information.

Finally, the technical information communication process outlined by Herner and Herner (1967) is extended one step further in the present paper to include the concept of an "information system." This term has been defined by Moor (1969) as:

> A relatively stable set of entities (i.e., men and machines) organized within some form or framework with the predominant goal of manipulating pre-existing information and providing it to entities that are not members of the system (i.e., users) (p. 28).

Thus, a technical information system is an organized body within an organization whose purpose is to administer information emerging from channels characterized by one or more similar dimensions.

Turning to the organization of the present literature review, it should be noted that this review was designed to follow the model shown in Figure 1. This model provides a description of the nature of recent empirical research on the topic of scientists' information behavior, and is divided into two types or groups of research investigations.

The first grouping is composed of studies which have focused on the relationships between scientists' information behavior and a variety of factors generally viewed by researchers in this field as being antecedents of information behavior. Studies of this type dominate recent research in

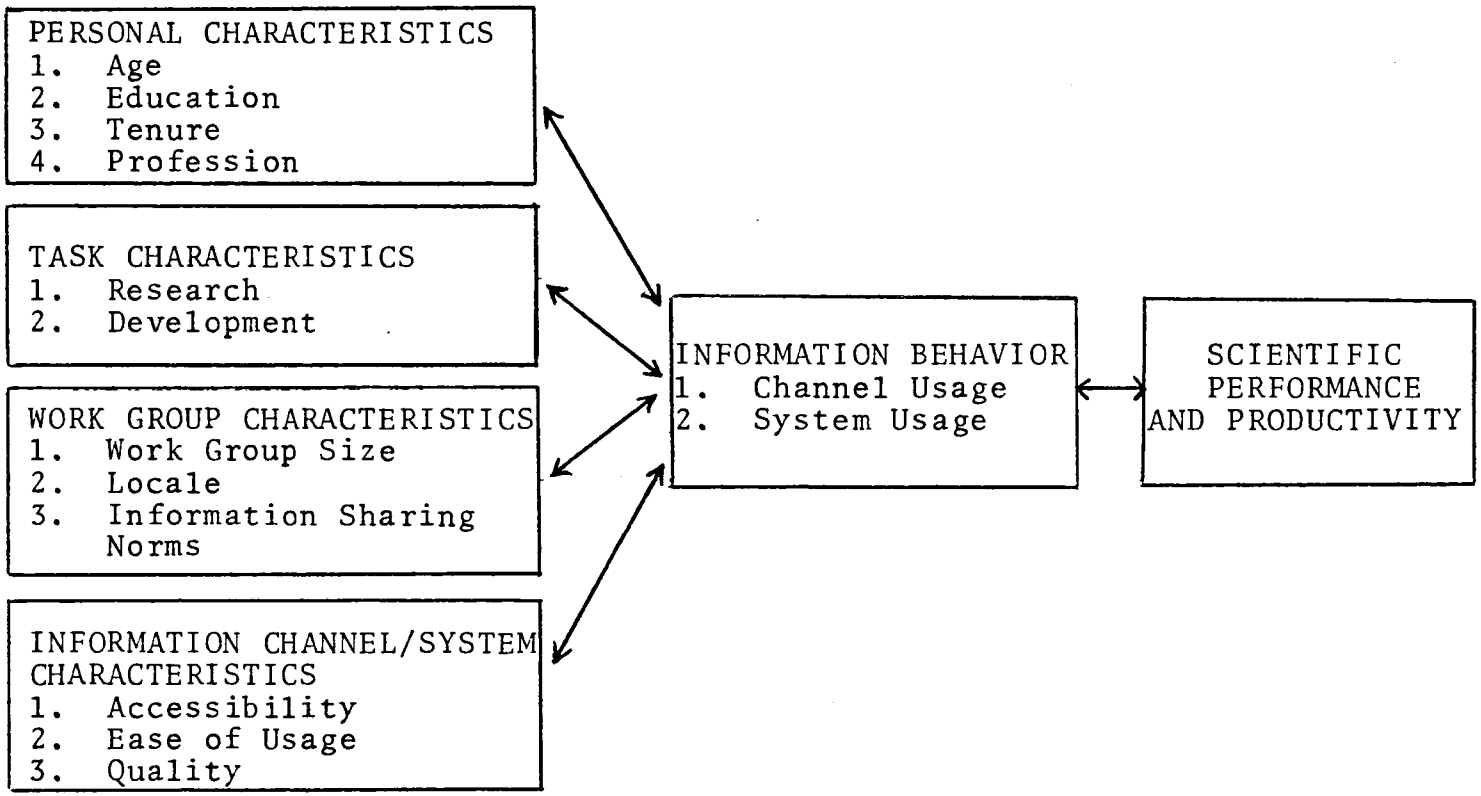


Figure 1. A model describing recent empirical research on the topic of scientists' information behavior.

this area and include investigations of information behavior as it relates to factors from the categories of personal characteristics, task characteristics, work group characteristics, and information channel/system characteristics.

In contrast to the research paradigm described above, a second group of studies has concentrated on the relationships between scientists' information behavior and what researchers in this field have viewed as consequences or outcomes of such behavior. Within recent years, however, there have been only a handful of studies which fall into this category. Furthermore, all of these studies have focused solely on the relationship between information behavior and scientific performance and productivity.

I. INFORMATION BEHAVIOR AND THE ANTECEDENT VARIABLES

Personal Characteristics

Age. Since the literature reviews of the mid-sixties, there appears to have been only one study which has related scientists' information behavior to this demographic variable. Specifically, Fearn and Melton (1969) examined the usage of technical documents and scientific journals by 100 scientists from 11 technical divisions of a large research and development organization. Subjects were grouped into four, 10-year age categories ranging from "under 30" to "50-59," and data

regarding usage of these two specific information channels over a one-year period were obtained through records from the company's technical information center.

The authors of this study reported that the average number of document requests for the four age categories in order of ascending age were 69.9, 47.3, 34.4, and 30.6. Similarly, the mean number of journal requests across the four ascending age categories were reported to be 19.7, 20.4, 21.7, and 29.9. Finally, although not reported in the original study, the average number of both document and journal requests (i.e., overall written channel usage) across the four ascending age categories were calculated by the present author as being 89.3, 67.7, 56.0, and 60.5.

A visual examination of the means shown above indicates that there may be an inverse relationship between age and written information channel usage. However, Fearn and Melton (1969) did not analyze their data statistically, thus making it impossible to rule out the possibility that this trend is attributable to chance variation alone.

Education. Although the relationship between age and scientists' information behavior has received little research attention within recent years, a number of studies have examined the relationship between education and the information behavior of scientists.

Rosenbloom and Wolek (1967), for example, employed a critical incidents methodology to compare the self-reported

information behavior of 457 advance-degreed scientists with that of 194 bachelor-degreed scientists. The results of this analysis revealed that the percentages of external channel usage incidents reported by advance- and bachelor-degreed scientists were 68% and 61%, respectively. The corresponding percentages of internal channel usage incidents were 32% and 39%, respectively. Finally, when these channel usage incidents were categorized according to both the internal--external and the interpersonal--written channel dimensions, the percentages reported by the advance-degreed scientists were: internal--written (6%), internal--interpersonal (26%), external--written (49%), and external--interpersonal (19%). The same percentages reported by the bachelor-degreed scientists were: internal--written (7%), internal--interpersonal (32%), external--written (49%), and external--interpersonal (12%).

Although Rosenbloom and Wolek (1967) did not conduct any statistical analyses on the comparisons outlined above, it would appear safe to conclude that there were essentially no differences between the self-reported information habits of these advance-degreed and bachelor-degreed scientists. Both groups of scientists reported greater utilization of external information channels than internal information channels. Furthermore, of the external information channels reportedly used by both groups of scientists, greater utilization tended to be made of written as opposed to interpersonal information channels.

Dewhirst (1970a) replicated the Rosenbloom and Wolek (1967) analysis and found that the percentages of external channel usage incidents reported by 98 advance-degreed and 174 bachelor-degreed scientists were 79% and 68%, respectively. The corresponding percentages of internal channel usage incidents were 21% and 32%, respectively. Furthermore, when channel usage incidents were categorized according to both the internal--external and the interpersonal--written channel dimensions, the percentages reported by the advance-degreed scientists were: internal--written (9%), internal--interpersonal (12%), external--written (62%), and external--interpersonal (17%). The same percentages reported by these scientists' bachelor-degreed colleagues were: internal--written (8%), internal--interpersonal (24%), external--written (43%), and external--interpersonal (25%).

As with the Rosenbloom and Wolek (1967) study, no statistical analyses were performed on the information channel usage data reported above. Nevertheless, a visual examination of these information channel usage patterns indicates that the results found by Dewhirst (1970a) are very similar to those reported by Rosenbloom and Wolek (1967). Again, both advance- and bachelor-degreed scientists reported greater usage of external information channels than internal information channels. Moreover, of the external information channels used by both groups of

scientists, greater utilization tended to be made of written as opposed to interpersonal information channels.

In a third study which focused on information behavior as a function of education, Fearn and Melton (1969) examined the number of document and journal requests made of an information center by 13 doctor-degreed, 30 master-degreed, and 58 bachelor-degreed scientists. The average number of documents requested by these three groups over a one-year time period were 109.2, 69.9, and 24.5, respectively. As for journals, the average number of requests were 31.7, 20.7, and 19.9, respectively. Finally, for both documents and journals combined, the average number of requests made by these three degree groups were 140.9, 90.7, and 44.4, respectively.

Again, although no statistical analyses were conducted in this user study, these data appear to indicate that higher-degreed scientists rely more heavily on written information channels than lower-degreed scientists. Support for this statement was also provided by Whitley and Frost (1973). Specifically, these authors correlated education with self-reported journal usage for a sample of 46 scientists employed by a British research and development organization. A correlation of .42 ($p < .05$) was found, thus indicating that highly-educated scientists tended to make greater usage of professional and scientific journals than their less educated counterparts.

Finally, as a part of a study already discussed, Dewhirst (1970a) examined the extent to which a research and development organization's technical library system was utilized by both advance-degreed and bachelor-degreed scientists. Library usage in this study was defined as "more than six times in the last 12 months," and the percentages of advance-degreed and bachelor-degreed scientists meeting this criterion were 92% and 63%, respectively. It was not reported, however, whether this difference in library system usage between the advance- and bachelor-degreed scientists was statistically significant.

In summary, there appears to be some evidence that external, written, and external--written information channels are utilized more frequently by advance-degreed scientists than by their bachelor-degreed colleagues. Although none of the authors of the studies discussed above offer an explanation for these results, one possible explanation is that reliance on these information channels reflects a "carry over" of the information habits developed by advance-degreed scientists during their graduate school careers. Related to this possible explanation is Dewhirst's (1970a) suggestion that the frequent usage of library systems by advance-degreed scientists reflects this group's greater experience with this specific type of technical information system.

It should also be recognized, however, that the

apparent impact of education on the information behavior of scientists may be spurious in nature. That is, education may be related to scientists' information behavior only to the extent that it is related to other variables which exert a more direct effect on the information behavior of scientists.

Tenure. Another variable from the category of personal characteristics which has been studied in terms of its relationship to scientists' information behavior has been that of organizational tenure.

Rosenbloom and Wolek (1967), for example, compared the information habits of 1051 scientists grouped into tenure categories of "0-2 years," "3-10 years," and "11 years plus." The percentages of internal information channel usage incidents reported by these three groups of scientists were 61%, 61%, and 69%, respectively. The corresponding percentages of external channel usage incidents were 39%, 39%, and 33%, respectively.

Further percentage breakdowns of information channel usage incidents for the 0-2 year tenure group of scientists were: internal--written (14%), internal--interpersonal (47%), external--written (28%), and external--interpersonal (11%). The same percentage breakdowns for the 3-10 year tenure group were found to be: internal--written (12%), internal--interpersonal (49%), external--written (30%), and

external--interpersonal (9%). Finally, these percentage breakdowns for the 11 year plus group of scientists were: internal--written (11%), internal--interpersonal (56%), external--written (22%), and external--interpersonal (11%).

It is interesting to note that Rosenbloom and Wolek (1967) performed no statistical analyses on these data, yet stated that these findings evidence a definite positive association between seniority and the utilization of internal information channels. It is the opinion of the present author, however, that the empirical findings presented by Rosenbloom and Wolek (1967) provide very little support for the existence of a relationship between organizational tenure and information channel usage.

In a second study which focused in part on the relationship between tenure and information behavior, Fearn and Melton (1969) compared the number of document and journal requests made of an information center by scientists grouped into tenure categories of "under 5 years," "5-9 years," and "10 years and over." The average number of document requests across these three ascending tenure categories were reported to be 68.3, 45.3, and 26.5, respectively. The mean number of journal requests received from the same three tenure groups were 22.0, 19.7, and 22.4, respectively. Finally, the average number of both document and journal requests made by scientists from the three tenure categories were calculated to be 90.3, 65.0, and 48.6, respectively.

Thus, although Fearn and Melton (1969) did not analyze these data statistically, it nevertheless appears that there is evidence in their study of an inverse relationship between organizational tenure and written information channel usage. However, it also appeared that the document information channel accounted for a greater part of this relationship than the journal information channel.

Finally, Dewhirst (1970a) examined usage of a technical library system as a function of organizational tenure. Usage was again defined as "more than six times in the last 12 months," and the two tenure groups were composed of scientists employed by the research and development center for "more than 10 years" and "less than 10 years." The results of this analysis indicated that 77% of the "less than 10 year" scientists were library system users, while 70% of the "more than 10 year" scientists were library system users. It was not reported, however, whether the difference in library system usage between these two tenure groups was statistically significant.

In summary of the empirical research findings pertaining to the tenure--information behavior relationship, there seems to be some evidence for the existence of an inverse relationship between tenure and the usage of external information channels and library information systems. However, many of these findings are weak at best, and there are also data which indicate that organizational tenure and

information behavior are unrelated. Thus at this point it is perhaps best to conclude that the nature of the organizational tenure--information behavior relationship is equivocal.

Profession. Turning to the relationship between profession and the information behavior of scientists, there have been three studies within recent years which have compared the information behavior of scientists in scientific professions versus that of scientists in engineering professions.

In the first of these studies, Allen (1966) compared scientists and engineers with regard to their utilization of eight different technical information channels. A chi square analysis was performed on these data, and it indicated a significant ($p < .01$) difference between the information channel usage patterns of scientists in these two professions. Further analyses of these data seemed to indicate that scientists tended to make the greatest usage of external information channels, especially those in written form. Engineers, on the other hand, were most likely to be found using technical information obtained through internal information channels.

Using their critical incidents methodology, Rosenbloom and Wolek (1967) compared the information channel usage habits of 633 scientists and 890 engineers. The results of

these analyses indicated that the percentages of external channel usage incidents reported by scientists and engineers were 67% and 37%, respectively. The corresponding percentages of internal channel usage incidents were 33% and 63%, respectively. Finally, when these information channels were categorized according to both the internal--external and the interpersonal--written dimensions, the percentages reported by the scientists were: internal--written (6%), internal--interpersonal (27%), external--written (51%), and external--interpersonal (16%). The same percentages reported by the engineers were: internal--written (12%), internal--interpersonal (51%), external--written (26%), and external--interpersonal (11%).

Although Rosenbloom and Wolek (1967) did not perform any statistical analyses on these data, a visual inspection of these findings appears to indicate that there are clear differences in the information channels reportedly utilized by these scientists and engineers. Specifically, the scientists tended to rely on external information channels, especially those in written form. The engineers, on the other hand, were found to make their greatest usage of internal information channels, and especially internal--interpersonal channels.

Finally, Dewhirst (1970a) reported differential utilization of a technical library system among scientists and engineers. Seventy-four percent of the scientists in

this study could be classified as library system users, while 72% of the engineers met the criterion for consideration as library system users. It is doubtful, however, that this difference in library system usage among scientists and engineers is statistically significant.

Thus, in summary of the research studies discussed above, it appears that there is a relationship between profession and information behavior. More specifically, scientists tend to favor the use of external and external--written information channels in their work, while engineers tend to use internal and internal--interpersonal information channels in their work.

These findings with regard to the profession--information behavior relationship are usually attributed to the nature of the work typically performed by scientists and engineers in an organization (Rosenbloom and Wolek, 1967). Engineers are commonly viewed as being predominantly engaged in specific problem-solving research and development tasks. Scientists, on the other hand, are typically seen as being engaged in more basic, investigative activities. Consequently, it has been reasoned that different information behavior is required for scientists involved in characteristically different organizational tasks.

The basic problem with this explanation for the profession--information behavior relationship, however, is that it assumes that all scientists (and likewise all

engineers) are involved in similar organizational tasks and consequently exhibit similar information behavior. In most research and development organizations, though, scientists are involved in both basic research and development tasks. Moreover, Rosenbloom and Wolek (1967) have pointed out that scientists and engineers are not homogeneous groups in terms of information behavior. For example, mechanical and electrical engineers are typically found to have information habits similar to those of engineers in general, while chemical and metallurgical engineers are found to be more like scientists in their information behavior. Thus, it is simply being suggested here that organizational task may not be the most useful or appropriate mediating variable for use in explaining the relationship between profession and the information behavior of scientists.

Task Characteristics

Perhaps the most surprising finding with regard to recent empirical research on the subject of scientists' information behavior is the small number of studies relating information behavior to task characteristics. Specifically, it appears that there have been only three studies within recent years which have focused on such relationships.

In the first of these investigations, Rosenbloom and Wolek (1967) compared the information channel usage habits

of 211 scientists involved in research activities and 262 scientists engaged in development tasks. The percentages of external channel usage incidents reported by these two groups of scientists were 74% and 58%, respectively. On the other hand, the corresponding percentages of internal channel usage incidents reported by these two groups of scientists were 26% and 42%, respectively. Moreover, when these information channels were categorized according to both the internal--external and written--interpersonal dimensions, the percentages of information channel usage incidents reported by the research scientists were: internal--written (5%), internal--interpersonal (21%), external--written (52%), and external--interpersonal (22%). The same percentages reported by the scientists involved in development tasks were: internal--written (6%), internal--interpersonal (36%), external--written (44%), and external--interpersonal (14%).

Again, Rosenbloom and Wolek (1967) did not perform any statistical analyses on these data. However, a visual examination of these results appears to indicate similar information channel usage patterns for research scientists and scientists involved in development tasks. There does, however, appear to be a slightly stronger preference on the part of scientists involved in research activities for the utilization of external information channels.

In a second study focusing in part on the relationship

between organizational task and information behavior, Dewhirst (1970a) used Rosenbloom and Wolek's (1967) methodology and closely replicated their findings which were discussed above. The major difference in the outcomes of these two studies, however, was that Dewhirst (1970a) found less distinctive information channel usage patterns between research scientists and scientists involved in development tasks.

In addition to studying information channel usage of scientists as a function of organizational task, Dewhirst (1970a) also examined the relationship between organizational task and usage of a technical library system. The results of this analysis indicated that more than twice as many research scientists, as opposed to scientists engaged in development tasks, met the criterion for classification as library system users. These percentages were 89% and 44%; however, it was not reported whether this difference in library system usage was statistically significant.

Finally, Whitley and Frost (1973) categorized scientists' tasks into one of four possible groups. These task categories, in ascending scale order, were termed "responsibility/maintenance tasks," "extension development tasks," "new development tasks," and "research tasks." This four-point scale was then correlated with self-reported usage of technical journals and internal reports for a total of 46 scientists.

The results of these correlational analyses indicated a significant positive correlation of .71 ($p < .05$) between this four-point scale and the self-reported use of technical journals. In contrast, a significant negative correlation of -.53 ($p < .05$) was found between this task scale and the self-reported usage of internal organizational reports.

In summary, it appears that there is some evidence for a relationship between organizational task and the information behavior of scientists. More specifically, it appears that there is a tendency for scientists involved in research activities to make greater utilization of external information channels and information systems which administer these channels. Scientists involved primarily in development tasks, on the other hand, appear to make greater utilization of internal information channels in their work. Of course, these empirical findings are consistent with the viewpoint that organizational task is the key determinant of scientists' information behavior.

Nevertheless, it should be remembered that both Rosenbloom and Wolek (1967) and Dewhirst (1970a) failed to find distinctive information channel usage patterns for scientists involved in different types of organizational tasks. Furthermore, it is also possible that the apparent impact of organizational task on the information behavior of scientists may be spurious in nature. In other words, task may be related

to scientists' information behavior only to the extent that it is related to other variables which exert a more direct effect on the information behavior of scientists.

Work Group Characteristics

Although recent years have witnessed a relative lack of empirical research on relationships between task characteristics and information behavior, more research attention in recent than in past years has been devoted to the relationships between work group characteristics and the information behavior of scientists.

Size. In contrast to the findings of an early empirical investigation which reported that information channel usage was independent of work group size (Moss and Wilkins, 1956), Allen (1966) reported an inverse relationship between work group size and scientists' utilization of external information channels. Furthermore, this finding was sustained when work group size was defined as either the total number of work group members or the ratio of the work group's size to the total number of laboratory employees.

As a possible explanation for this finding, Allen (1966) proposed that the usage of external information channels by scientists varies as a function of the number of individuals in the work group who may serve as potential sources of technical information. Thus, work groups characterized by inadequate internal information sources attempt

to compensate for this inadequacy through the utilization of information channels which are external to the work group.

Locale. Another work group characteristic which has been studied with regard to scientists' information behavior has been that of location within an organization. Specifically, Rosenbloom and Wolek (1967) reported few differences in the technical information behavior of closely related and unrelated scientific work groups. Similar findings emerged when distance was defined both organizationally and geographically.

Information sharing norms. Although some early research has indicated that interpersonal information channels are more important to scientists than written information channels (Glass and Norwood, 1959), both Allen (1969) and Allen and Cohen (1969) have pointed out that the use of interpersonal information channels may involve a "psychological cost." Specifically, this "cost" refers to the fact that an information seeker may view such behavior on his or her part as an admission of incompetence or a lack of knowledge. Consequently, it has been reasoned that scientists may be compelled to utilize less accurate or less relevant technical information channels, unless an information sharing norm is perceived as operating within the work group.

To date, however, there has been only one investigation

which has examined information behavior as a function of the strength of an information sharing norm. Specifically, Dewhirst (1970b) reported that the usage of internal--interpersonal information channels was positively related to the strength of a perceived information sharing norm. On the other hand, utilization of internal--written information channels was found to be inversely related to the strength of the information sharing norm. Finally, Dewhirst (1970b) speculated that scientists' information behavior is compensatory in nature. That is, scientists' who use internal information channels (i.e., either written or interpersonal in nature) appear to "balance off" such behavior through the utilization of the correspondingly underused external information channel.

Information Channel/System Characteristics

Turning to the final category of antecedent variables, there appears to have been only one study to date which has focused on the relationship between information behavior and characteristics of information channels or systems. Specifically, this empirical investigation was Gerstberger and Allen's (1968) study of 19 research and development engineers from two divisions of a large electronics firm.

The subjects in this investigation ranked nine different technical information channels in terms of factors such as their accessibility, their ease of usage, the technical quality of the information they provide, and the

extent of their personal experience with each of these channels. These rankings were then compared with data indicating the extent to which each of these information channels were utilized by each subject.

The results of this analysis revealed that information channel accessibility emerged as the single most important predictor of information channel utilization, while the perceived quality of the technical information obtained through a specific channel showed a much smaller predictive relationship with usage of that information channel. Perceived ease of channel usage and channel experience were not found to be directly related to information channel utilization; however, as might be expected, subjects who reported greater experience with a particular information channel also perceived that channel as being more accessible.

On the basis of these research findings, Gerstberger and Allen (1968) concluded that engineers' information behavior appears to follow the "law of least effort" originally proposed by Zipf (1949). In other words, engineers' information behavior appears to be guided by a minimization of effort in the acquisition of technical information.

It is interesting to note, however, that many writers on the subject of scientists' information behavior have either explicitly or implicitly concluded that the information behavior of scientists in general is guided by the "law of least effort." Although the findings of Gerstberger and

Allen (1968) are typically cited to support this conclusion, the generalizability of the findings from this study to the population of scientists in general is at best questionable. This is due to the fact that the findings reported by Gerstberger and Allen (1968) were obtained from a sample of only 19 engineers. Moreover, all of these engineers were involved in design and development tasks, and none possessed a Ph.D. degree.

Thus, on the basis of the argument presented above, it seems appropriate to conclude that the question regarding the nature of the relationship between information behavior and information channel or system characteristics remains largely unanswered.

II. INFORMATION BEHAVIOR AND THE CONSEQUENT VARIABLES

Performance and Productivity

Within recent years there have been three studies which have examined the relationship between information behavior and the performance and productivity of research and development scientists.

In the first of these investigations, Allen (1966) asked contractors to rate the quality of technical proposals developed by parallel research and development project teams. Proposals were categorized according to the information channels utilized in the development of each proposal, and

a chi square analysis revealed a significant difference ($p < .05$) in the rated quality of proposals developed using internal channels only, external channels only, or a combination of internal and external channels. Further analyses of these data indicated that the use of information channels external to the organization was negatively related to rated proposal quality. In contrast, the utilization of internal channels during the development of technical proposals was positively, albeit weakly, related to rated proposal quality.

In a study conducted by Smith (1966), 418 research and development scientists were assigned performance ratings based on indicators such as number of patents, number of professional journal publications, and number of technical reports. Meanwhile, the scientists rated the extent to which they utilize 13 different internal and external information channels in their work, and these two sets of ratings were correlated.

The results of this analysis yielded findings similar to those reported by Allen (1966). Specifically, the utilization of external information channels by these scientists was negatively related to their performance ratings. In contrast to the findings reported by Allen (1966), however, Smith (1966) found that the utilization of information channels within the organization was unrelated to the performance ratings.

Finally, in one of the more extensive investigations of the behavior of research and development scientists, Pelz and Andrews (1966) reported that the utilization of internal--interpersonal information channels was highly related to scientific productivity as measured by a variety of performance indicies. Furthermore, this finding was reported for both Ph.D. scientists as well as engineers, and it also emerged when the effects of variables such as years of job experience and supervisory status were controlled.

Thus, in summary of the studies which have attempted to relate information behavior to scientific performance and productivity, a common finding is that the utilization of external information channels is negatively related to the performance and productivity of scientists. Yet conversely, the use of internal information channels is not necessarily related to high performance and productivity among research and development professionals.

Allen (1966) has attempted to explain this negative relationship between performance and the utilization of external information channels by stating that this finding is not necessarily attributable to the nature or quality of the technical information obtained through these channels. Rather, the fact that a scientist turns to external channels for technical information provides an indication of a more basic lack of knowledge or competence on the part of the

scientist. It is this lack of knowledge or competence, then, which results in lower levels of scientific performance and productivity.

III. A SUMMARY OF RECENT RESEARCH ON SCIENTISTS' INFORMATION BEHAVIOR

A critical review of recent empirical research on the topic of scientists' information behavior has been presented. Although specific comments, criticisms, observations, and summary statements have been presented throughout this literature review, some comments of a more general nature concerning recent empirical research in this area are in order.

First, it appears that the conclusions reached in the literature reviews of the mid-sixties concerning the state of knowledge on the information behavior of scientists are still applicable today. During recent years, the majority of research studies on the topic of scientists' information behavior have again been user studies. Consequently, the recent period of research in this area has witnessed another accumulation of empirical data, but the majority of this recent research has again been neither integrative nor cumulative in nature.

Second, although it has been suggested by Paisley and Parker (1966), little research within recent years has been directed toward the development of information--related

concepts and the empirical testing of hypotheses involving such concepts. Research on scientists' information behavior is still largely characterized by what has been termed "dustbowl empiricism." That is, some form of information behavior is related to a collection of variables without the use of hypotheses as guides to this research. This contention is also supported by the fact that not a single study to date has examined the concept of "user satisfaction" (Parker and Paisley, 1966) and its relationship to the information behavior of scientists.

Fourth, although researchers in this area have begun to venture beyond their empirical data and offer possible explanations for their findings, this area still remains plagued by "conceptual poverty" (Paisley, 1968). This problem is perhaps most clearly evidenced by the fact that a comprehensive model of scientists' information behavior has yet to be proposed.

Finally, it appears that the last 10 to 12 years have witnessed a general decline in the number of empirical research investigations on the topic of scientists' information behavior. All but one of the research studies included in the preceding literature review were published prior to or during 1970. However, given the problems and questions which remain unanswered in this area, this decline is not likely attributable to the notion that this topic has been exhaustively researched.

CHAPTER II

A THEORETICAL MODEL OF SCIENTISTS' INFORMATION BEHAVIOR

As mentioned in the preceding review of recent research on the topic of scientists' information behavior, there still exists a lack of theory and models to serve as guides for research in this area. However, there have been two studies within recent years which have begun work toward the development of a theoretical model of the information behavior of scientists. Namely, these have been the studies conducted by Rosenbloom and Wolek (1967) and Barth and Vertinsky (1975).

The purpose of this chapter of the present paper is to provide a critical review of these two recent attempts at model building in this area. This discussion will be followed by the development and presentation of a new model of scientists' information behavior which will serve as a guide for the empirical research portion of the present investigation. Finally, this chapter will be concluded with an outline of several hypotheses generated from this newly proposed model of scientists' information behavior.

I. EXISTING MODELS OF SCIENTISTS' INFORMATION BEHAVIOR

Rosenbloom and Wolek (1967)

In the first of the two studies mentioned above, Rosenbloom and Wolek (1967) developed a predictive model of scientists' information behavior based on 11 predictor variables such as task, profession, education, and professional experience. A multiple regression analysis indicated that approximately 45% of the variance in scientists' usage of internal information channels could be explained by the variables of profession, commitment to competence (i.e., number of publications regularly read), task, and tenure. Profession and commitment to competence were found to have the highest predictive weights, while task and tenure were found to have almost equal, yet lower, predictive weights.

In summary, Rosenbloom and Wolek (1967) examined information behavior as a function of a number of variables concurrently. This is in contrast to the more commonly used research paradigm of analyzing scientists' information behavior as a function of a number of variables one at a time. Thus, this investigation has served to advance the study of scientists' information behavior since it has provided the first integrative analysis in this area of research. However, there are several problems with the Rosenbloom and

Wolek (1967) model of scientists' information behavior which limit its usefulness for purposes of describing past research and guiding future research in this area of investigation.

First, the Rosenbloom and Wolek (1967) model is exclusive. By this it is meant that the model only relates scientists' information behavior to a variety of variables considered to be antecedents of such behavior. Variables which may be viewed as results, outcomes, or consequences of scientists' information behavior are not included in their model. Consequently, the Rosenbloom and Wolek (1967) model fails to provide an adequate reflection of existing research on the topic of scientists' information behavior.

Second, the Rosenbloom and Wolek (1967) model of scientists' information behavior at least implies that such behavior is directly caused by one or more of these antecedent variables. No consideration is given in the model to the possible existence of mediators or moderators of the relationships between information behavior and these antecedent variables.

Finally, and perhaps the most important consideration for a theoretical model of scientists' information behavior, Rosenbloom and Wolek (1967) provide little in the way of explanations or interpretations of the relationships inherent in their model. Consequently, this model does not serve well in terms of providing a conceptualization or understanding

of the information behavior of scientists.

Barth and Vertinsky (1975)

A second model describing the information behavior of scientists has been presented by Barth and Vertinsky (1975). This model of the information behavior of research and development scientists is an adaptation of a model developed by Werner (1969) to describe the information behavior of medical researchers, and is shown in the present paper in Figure 2.

Upon first glance it should be evident that this model provides a number of additions to the Rosenbloom and Wolek (1967) model which should lead to a greater understanding of the information behavior of scientists. Specifically, it can be seen that the Barth and Vertinsky (1975) model includes variables both antecedent and consequent to information behavior (i.e., their "upstream" and "downstream" variables). In addition, Barth and Vertinsky (1975) have recognized that there may be a number of "other factors" which intervene or interact with the antecedent variables in determining scientists' information behavior. Likewise, a variety of "other factors" is seen as intervening or interacting with information behavior to determine the outcomes or consequences of such behavior. However, despite the improvements over the Rosenbloom and Wolek (1967) model reflected in this second model, there are still limitations in this model which reduce

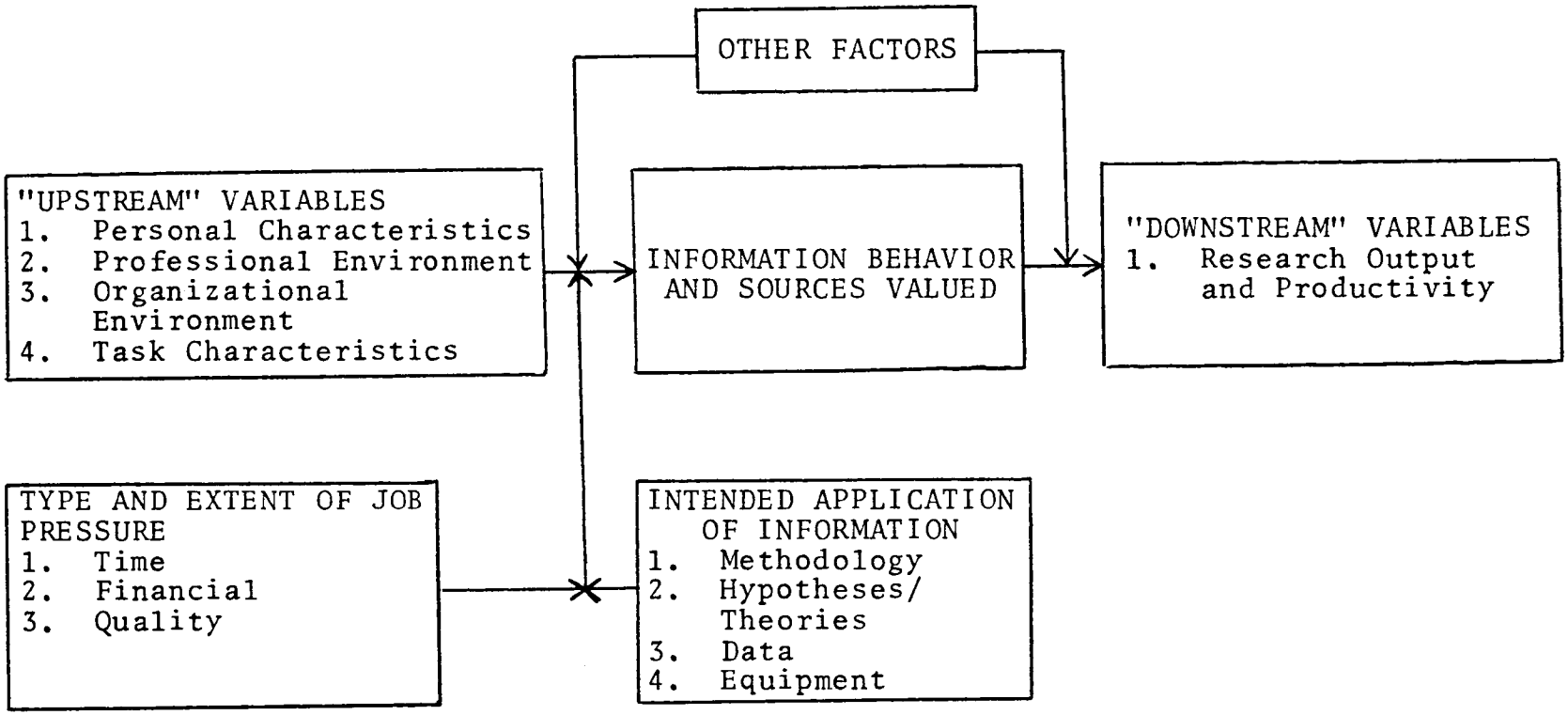


Figure 2. A theoretical model of scientists' information behavior as proposed by Barth and Vertinsky (1975).

its usefulness, especially as a guide for future research in this area.

First, Barth and Vertinsky (1975) have provided little explication of the nature of these "other factors" which, according to their model, serve as mediators or moderators of the relationships between information behavior and both the antecedent and consequent variables.

Second, Barth and Vertinsky (1970) limit the consequent variables in their model to that of scientific performance and productivity. Of course, the inclusion of just this type of outcome in their model is reflective of existing research on the topic of scientists' information behavior. However, for purposes of understanding the nature of scientists' information behavior, it is suggested that other consequences or outcomes of information behavior (e.g., user satisfaction with an information channel or system) should be included.

In conclusion, it should be recognized that the model of scientists' information behavior presented by Barth and Vertinsky (1975) has provided several improvements upon the Rosenbloom and Wolek (1967) model. However, at the same time, the Barth and Vertinsky (1975) model also provides little in the way of alleviating the "conceptual poverty" (Paisley, 1968) which characterizes the majority of the empirical research on the topic of scientists' information behavior.

II. A NEW MODEL OF SCIENTISTS' INFORMATION BEHAVIOR

Having presented a critical overview of some recent attempts at model building in the area of scientists' information behavior, this section of the present chapter is devoted to the development of a new model of scientists' information behavior.

This new theoretical model of the information behavior of scientists is shown in its entirety in Figure 3. This model is intended not only to serve as a guide for further empirical research in this area, but also to serve as an aid to the development of an understanding and conceptualization of scientists' information behavior as an independent phenomenon.

As for the rationale behind the construction of this particular model of scientists' information behavior, it should first be noted that it is consistent with existing research on this topic which indicates that information behavior is related to a variety of antecedent variables. Specifically, these are variables from the categories of personal characteristics, task characteristics, work group characteristics, and information channel or system characteristics.

The present model differs from previous research in this area, however, as to the nature of the relationships

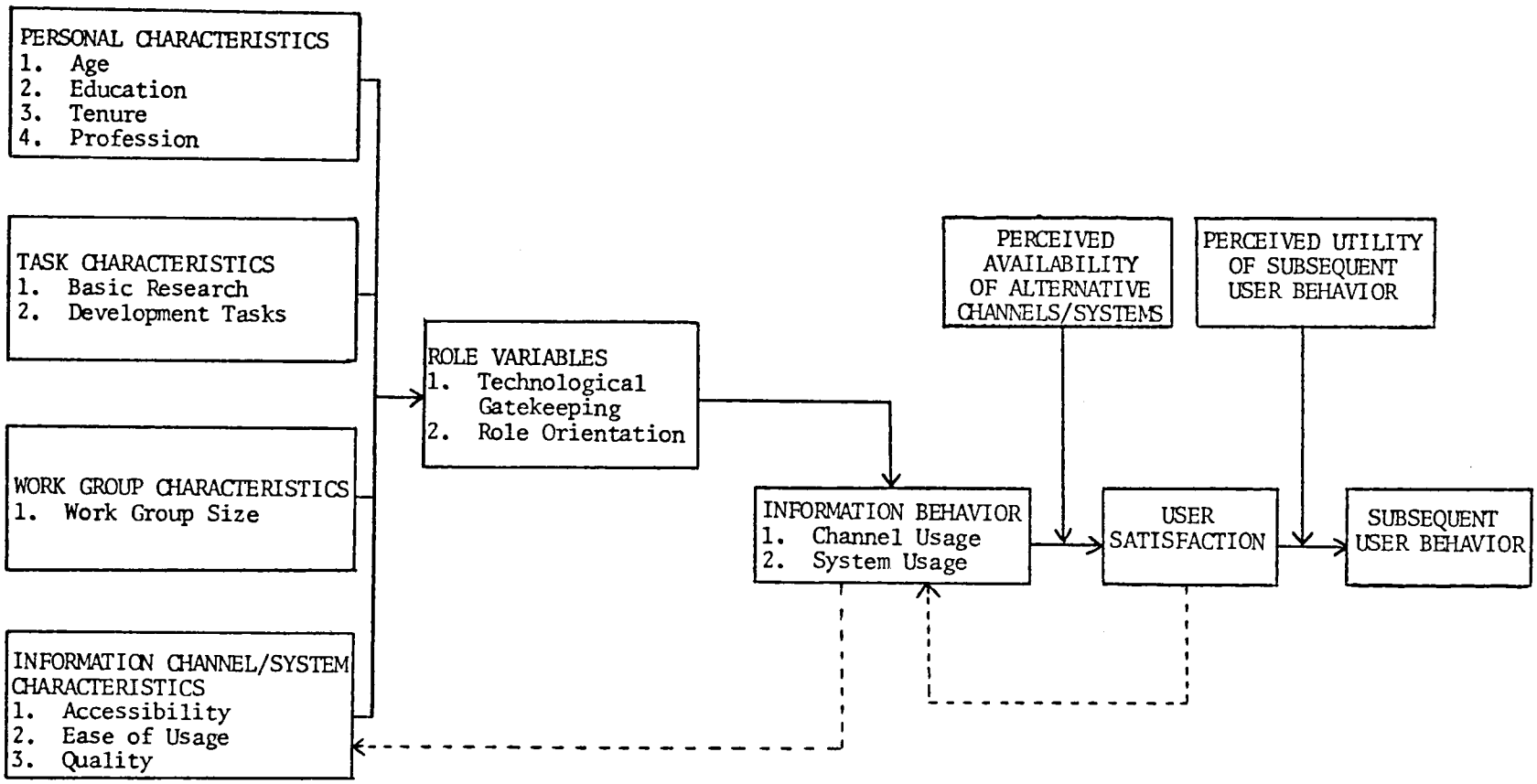


Figure 3. A new model of scientists' information behavior.

between information behavior and these antecedent variables. Whereas earlier researchers in this area have at least implied that scientists' information behavior is a direct function of these antecedent variables, the present model suggests that the effects of these antecedent variables on information behavior are indirect in nature. Moreover, the present model specifically suggests that these antecedent variables are related to information behavior only through their relationships with a set of role variables.

The first of these role variables is that of technological gatekeeping. This concept was popularized by Allen and Cohen (1969) and is analogous to the "opinion leader" concept in Katz and Lazarsfeld's (1955) description of the mass communication process. Gatekeepers are viewed as mediators or boundary spanners who serve to couple an organization to the scientific and technical activity occurring outside the organization. In other words, a technological gatekeeper is an "information leader" who imports technical information into an organization, and then passes this technical information to other members of the organization.

Thus, given the apparent importance of the gatekeeping role concept to an understanding of scientists' information behavior, the present model establishes participation in the gatekeeping role as an important determinant of the level or amount of information behavior exhibited by a scientist.

That is, scientists acting as technological gatekeepers within an organization are expected to be characterized by higher levels of information behavior than non-gatekeepers within an organization.

However, while participation in the gatekeeping role is thought to determine the amount or level of a scientists' information behavior, it is not viewed as determining the specific types of information behavior exhibited by a scientists. Instead, the view expressed in the present model is that a specific type or kind of information behavior exhibited by a gatekeeper will be a function of the gatekeeper's role orientation. In other words, the specific information channels or systems utilized by the gatekeeper will be determined by whether the gatekeeper is attempting to maximize a professional (i.e., cosmopolitan) role orientation or a bureaucratic (i.e., local) role orientation.

In summary of the first stage of the information behavior model presented above, it is being proposed that scientists' involvement in information behavior is primarily determined by whether or not the scientist is playing the role of a technological gatekeeper within the organization. However, more specific forms of information behavior (i.e., usage of specific information channels and systems) are viewed as a joint function of technological gatekeeping and the scientists' role orientation. Finally, it is

proposed that the commonly studied antecedent variables are related to information behavior only through their relationships with technological gatekeeping.

Turning to the second stage of the present model, it can also be seen that this new model is consistent with previous research in this area in that it includes variables which are commonly viewed as outcomes or consequences of information behavior. However, given that the primary purpose of this model is to increase understanding of scientists' information behavior as an independent phenomenon, the present model focuses on the heretofore neglected outcome of information user satisfaction. Specifically, the present model proposes that information behavior directed toward the utilization of a specific information channel or system may be related to the scientist's satisfaction with that specific channel or system. However, it is also pointed out that this relationship may be moderated by the scientist's perceptions regarding the availability of alternative information channels or systems.

The present model also proposes that the scientist's satisfaction with a specific information channel or system may be related to subsequent information-related behavior pertaining to that channel or system. Such behavior may include the expression of complaints regarding a specific information channel or system, the cessation of a specific information behavior, or the reuse of a specific information

channel or system. However, this model also proposes that this relationship between user satisfaction and subsequent information-related behavior may be moderated by the scientist's perceptions regarding the utility of the specific subsequent behavior in question.

Finally, although the present model is presented primarily as a static model of scientists' information behavior, it should be noted that there are two feedback loops inherent in this model. The first of these feedback loops is between information behavior and the antecedent variable category of information channel/system characteristics. In other words, usage of a specific information channel/system may lead to a change in one's perceptions regarding the accessibility, ease of usage, and/or quality of that channel/system. The second of these feedback loops may be viewed as connecting user satisfaction with information behavior. That is, satisfaction with an information channel/system may affect the subsequent user behavior of channel/system usage or cessation of usage.

In summary, a new theoretical model of the information behavior of scientists has been proposed. Before proceeding to a discussion of specific hypotheses which can be generated from this model,, however, several additional comments regarding this new model of scientists' information behavior are in order.

First, it must be emphasized that the primary purpose of the present model is to serve as an aid in the development of an understanding and conceptualization of scientists' information behavior as an independent phenomenon. Consequently, variables which do not contribute to an understanding or conceptualization of the information behavior of scientists per se (e.g., scientific performance and productivity) are not included in the present model.

Second, the approach taken in the development of the present model is one which has been suggested by Paisley and Parker (1966). Specifically, this approach involves the proposal of specific information-related concepts (e.g., technological gatekeeping, role orientation, user satisfaction) and the testing of hypotheses involving these concepts in relation to information behavior. It is believed that this approach of developing and testing specific hypotheses relating to information behavior will in the long run contribute more to an understanding of scientists' information behavior than the "dustbowl empiricism" which characterizes much of the existing research in this area.

Finally, it should be pointed out that the inclusion of concepts such as "user satisfaction" and "complaining behavior" in the present model also reflects a rapidly emerging approach to the study of scientists' information behavior. Specifically, this approach is based on the viewpoint that scientific and technical information represents

a product or commodity which is "consumed" by scientists. Consequently, it holds that the information behavior of scientists can be studied from a consumer behavior perspective (Fearn and Melton, 1969; Rawdin, 1975).

III. HYPOTHESES SUGGESTED BY THE NEW INFORMATION BEHAVIOR MODEL

Having presented a general theoretical model of scientists' information behavior, the final section of this chapter outlines an application of this general model to a specific information system. The particular technical information system to which the model will be applied in the present study will be that of a scientific and technical library system serving a research and development laboratory. A number of specific hypotheses regarding scientists' usage of this particular information system will be presented, along with a discussion of the rationale behind each of these hypotheses.

It should be noted at this point, however, that there is a basic assumption underlying the hypotheses outlined below. Specifically, it is assumed that a scientific library information system is primarily involved in the administration of external information channels which are in written form (e.g., books, journals, external technical reports). Thus it is expected that research findings pertaining to a library information system will be similar to those obtained for external--written information channels.

Hypothesis 1

On the basis of the assumption outlined above, it is first hypothesized that the present study will replicate earlier findings regarding the relationships between external--written information channel usage and the various antecedent variables.

Specifically, from the personal characteristics category of antecedent variables, it is predicted that scientists' age will be unrelated to library system usage, while organizational tenure will be negatively related to library system usage. On the other hand, it is predicted that level of education and profession (i.e., scientist as opposed to engineer) will be positively related to library system usage.

From the antecedent variable category of work group characteristics, it is predicted that work group size will be negatively related to scientists' usage of a library information system. Also, from the antecedent variable category of task characteristics, it is predicted that involvement in basic research, as opposed to development tasks, will be positively related to library system usage.

Finally, from the antecedent variable category of information system characteristics, it is predicted that scientists' utilization of a library information system will be positively related to the perceived accessibility of the system, and unrelated to both the ease of usage and

perceived quality of this technical information system.

Hypothesis 2

The second hypothesis in the present study states that library system usage will be related to both technological gatekeeping activity and scientists' role orientations. More specifically, it is predicted that library system usage will be positively related to gatekeeping activity, positively related to the professional role orientation, and negatively related to the bureaucratic role orientation.

The portion of this hypothesis regarding gatekeeping and library system usage is based on the belief that gatekeepers will exhibit higher levels of information behavior in general than non-gatekeepers. Furthermore, this prediction appears to have some support in past research. Specifically, Allen and Cohen (1969) reported that gatekeepers were characterized by greater usage of external information channels than non-gatekeepers. In addition, Hall (1969) reported that gatekeepers were found to make greater utilization of a library information system than other groups of individuals in an industrial organization. Finally, Allen (1969) reported that gatekeepers generally read more than other individuals in an organization, and this is especially true when it comes to the "hard literature" (i.e., technical journals).

Finally, the portion of this hypothesis involving library system usage and the role orientation variables is based in part on findings reported by Barth and Vertinsky (1975). Specifically, these authors reported significant positive correlations between scientists' preference for the utilization of external--written information channels and four specific role typologies within the professional role orientation. Unfortunately, Barth and Vertinsky (1975) did not include in their study any role typologies from the bureaucratic role orientation. Nevertheless, it is suspected that technical information originating from within an organization will be more important to scientists attempting to maximize a bureaucratic role orientation. Consequently, it is expected that such scientists will tend to make greater utilization of internal as opposed to external information channels and systems.

Hypothesis 3

The third hypothesis in the present study states that the technological gatekeeping and professional role orientation variables will act as mediators of the relationships between library system usage and the antecedent variables from the categories of personal, task, work group, and system characteristics.

More specifically, it is predicted that variables from these categories will be related to library system usage only to the extent that these variables are related

to gatekeeping activity and the professional role orientation of scientists. Thus, it is predicted that the relationships between library system usage and these antecedent variables will disappear once the effects of gatekeeping and professional role orientation have been controlled.

These predictions are based in part on empirical research findings which indicate that the relationships between several of these antecedent variables and external--written information channel usage are similar, at least in direction, to relationships between the same antecedent variables and both gatekeeping and professional role orientation. For example, several studies have demonstrated that level of education is positively related to gatekeeping activity (Allen and Cohen, 1969; Hall, 1969; and Keller and Holland, 1977), while Gerstberger and Allen (1968) reported that individuals who use certain technical information channels on a frequent basis reported these channels as being more easily accessible. Education has also been shown to be positively related to the professional role orientation (Friedlander, 1971; Miller and Wager, 1971), and Miller and Wager (1971) have also reported that the professional role orientation is positively related to involvement in both scientific professions and basic research.

Hypothesis 4

The fourth hypothesis to be examined in the present study states that scientists' usage of a library information

system will be unrelated, or at best weakly related, to their satisfaction as users of this specific technical information system.

This prediction is based on research findings drawn from both the fields of social psychology and consumer behavior. First, with regard to social psychology, it is generally held that attitudes toward a person or object are poor predictors of behavior exhibited toward that same person or object (Ajzen and Fishbein, 1977). Thus, it is predicted that this finding will generalize to information behavior and attitudes, and that there will be at best a weak relationship found between library system usage and user satisfaction with this specific information system.

Within the field of consumer behavior, on the other hand, it has similarly been found that product purchase, service utilization, or store patronization are not necessarily related to consumer satisfaction with that specific product, service, or store. Thus, given the viewpoint that the resources of a scientific and technical library system represent products and services which are "consumed" by scientists, it is believed that library system usage will be found to be at best weakly related to user satisfaction with this information system.

Hypothesis 5

This hypothesis represents an extension of the preceding hypothesis, and states that scientists' perceptions

regarding the availability of alternative library systems will moderate the relationship between scientists' usage of a library information system and their satisfaction with this specific information system.

Specifically, it is predicted that library system usage will be related to user satisfaction with this information system only when the scientist perceives that there are alternative library systems at his or her disposal. On the other hand, it is predicted that library system usage will be unrelated to library system satisfaction when alternative library systems are perceived as being unavailable to the scientist.

This hypothesis is based largely on the supposition that only those scientists who are satisfied with a particular library information system will continue to use it when alternative library systems providing much the same technical information are available to them. Scientists who do not perceive alternative library systems as being at their disposal may continue to use a library information system, regardless of their satisfaction with this system.

It should also be noted, however, that this proposed hypothesis is also consistent with findings from the field of consumer behavior. Specifically, these findings point to the importance of consumers' knowledge of marketplace alternatives to an understanding of the relationship between consumer satisfaction and variables such as product purchase, service usage, and store patronization.

Hypothesis 6

Similar to Hypothesis 5, this hypothesis states that scientists' satisfaction as users of a library information system will be unrelated, or at best weakly related, to their expression of complaints concerning this information system.

As with Hypothesis 5, this hypothesis is also based primarily on findings from studies in the consumer behavior literature which indicate that consumers' complaining behavior is not necessarily related to their levels of dissatisfaction.

Hypothesis 7

Finally, it is hypothesized that the perceived utility of engaging in complaining behavior (i.e., the extent to which complaining is perceived as resulting in a positive outcome) will moderate the library system satisfaction--complaining behavior relationship.

This hypothesis is based in part on the reasoning that only dissatisfied library system users, who see a useful purpose in voicing complaints regarding the library system, will actually engage in such behavior. Dissatisfied users of the library system who view complaining as serving no useful purpose, however, may or may not voice complaints pertaining to the library system.

In addition, there also exists some empirical evidence in the consumer behavior literature for the importance of

this moderator variable. Specifically, some research has shown that a store's perceived interest in providing remedies for consumer problems is an important variable to the understanding of the consumer satisfaction--complaining behavior relationship.

CHAPTER III

METHODS AND PROCEDURES

I. SUBJECTS

The sample for the present study consisted of 450 scientists employed in the 21 research divisions of Oak Ridge National Laboratory, a federally funded research and development organization. These subjects were selected from the population frame of all exempt, permanent, and temporary (i.e., greater than 10 months) employees from these divisions according to a stratified random sampling plan using research division as the stratifying variable.

The sample size of 450 was determined before the start of the study using the sample size estimation formulas provided by Cochran (1963). This specific sample was calculated using a 95% confidence level, a rating scale error of .50, a standard deviation estimate of 1.25 on a seven-point scale (i.e., as obtained from a survey pretest), and an estimated questionnaire return rate of 70% (i.e., as obtained from a survey pretest). Finally, the finite population correction factor was employed since the calculated sample size was found to be greater than 5% of the total number of individuals in the population frame.

A total of 322 of these 450 subjects returned the questionnaire utilized in this study, which represented a

72% return rate. Of these 322 respondents, 304 completed questionnaires in a manner which provided useable data, and background data describing these 304 subjects are presented in Table 1.

II. SURVEY INSTRUMENT

The questionnaire used in the present study is included in Appendix A of the present paper. This questionnaire was designed by the author for use in an evaluation of customer satisfaction with the library information system at Oak Ridge National Laboratory (Zultowski and Dipboye, 1977), and was developed on the basis of information gathered from three primary sources.

First, information was drawn from the general literature regarding the information behavior of scientists, and especially from the literature pertaining to library information systems in research and development organizations. Especially helpful in this regard were the studies conducted by Rosenbloom and Wolek (1967) and Dewhirst (1970a).

Second, in order to obtain the input and viewpoints of library system personnel, unstructured personal interviews ranging from one-half to two hours were conducted by the present author with each of 11 ORNL Library System staff members. These staff members included the Director and the Associate Director of the Library System, Central Research Library department heads (e.g., Reference, Circulation,

TABLE 1

DEMOGRAPHIC DATA FOR THE TOTAL SAMPLE OF SURVEY RESPONDENTS

Variable	Category	Percentage
Age	22-32	22.3
	33-42	27.2
	43-52	28.6
	53-64	21.9
Years at ORNL	0-10	50.7
	11-20	22.2
	21-30	24.2
	>30	2.9
Level of Education	Bachelor's Degree	13.8
	Credits toward Master's	15.1
	Master's Degree	18.1
	Credits toward Doctor's	6.6
	Doctor's Degree	46.4
Profession	Engineer	43.1
	Scientist	56.9
Supervisory Level	Manager	26.0
	Non-manager	74.0
Organizational Area	Administration	1.3
	Services	9.2
	Nuclear and Engineering Technology	34.9
	Physical Sciences	22.0
	Biomedical and Environmental Sciences	19.0
	Advanced Energy Systems	13.6

Acquisition), Branch Library heads, and special library services personnel (e.g., translators, computerized reference search staff members). In addition, all the above-mentioned staff members later participated in a two-hour workshop conducted by the present author on the topic of customer satisfaction. As a part of this session, these staff members were provided with an opportunity to critique an initial draft of the questionnaire and provide further input into the survey as a group.

Finally, in order to obtain the input and viewpoints of Library System users, complainant and "kudos" letters received and retained by the Library System were studied by the present author. User input regarding the survey was also obtained through a pretest of the survey conducted approximately two weeks preceding the primary study. This pretest of the survey was conducted with 50 randomly selected subjects in a manner identical to that used in the conduct of the primary study.

The questionnaire shown in Appendix A was distributed to each subject in the selected sample through the Laboratory's internal mail system, using computer-generated mailing labels and pre-addressed questionnaire return envelopes. Return of the questionnaire was requested within two weeks, and a post card reminder was sent to all subjects in the sample one week into this two-week time period.

III. MEASURES

The questionnaire shown in Appendix A was designed to provide self-reported data on one or more variables from each of the component categories in the newly proposed model of scientists' information behavior. What follows is a discussion of these variables and the way in which they were measured in the present study.

Personal Characteristics

For purposes of consistency with previous empirical research on the topic of scientists' information behavior, the questionnaire used in the present study asked respondents to provide self-reported data as to their age, level of education, organizational tenure, and the nature of their profession. With regard to profession, however, it should be pointed out that the specific dimension of interest in the present study was that of scientists versus engineers. Thus, throughout this study, engineering professions were coded "1," while scientific professions were coded "2."

Task Characteristics

The specific task characteristic of interest in the present study was that of the basic research versus development task dimension. Specifically, subjects were categorized on this bi-polar dimension according to what they reported

as their primary task at the Laboratory. Throughout the present study, involvement in development tasks was coded "1," while primary participation in basic research was coded "2."

Work Group Characteristics

Again, for purposes of consistency with previous empirical research on the topic of the information behavior of scientists, respondents were asked to estimate the size of the work group with which they primarily identify.

Information System Characteristics

Respondents' perceptions of several characteristics of the ORNL Library System were assessed as a part of item 15 in the questionnaire shown in Appendix A. Specifically, subjects were asked to respond to three statements regarding this information system. These statements were: a) "Materials and services of the ORNL Library System are easily accessible to me," b) "Materials and services of the ORNL Library System are easy to use," and c) "Materials and services of the ORNL Library System are high quality in nature." Responses to each of these statements were made on a seven-point scale ranging from 1 ("strongly disagree") to 7 ("strongly agree").

Technological Gatekeeping Activity

The extent to which the respondents play the role of technological gatekeepers within the Laboratory was assessed

through the use of a four-item scale (i.e., items 22 through 25) included in the questionnaire. These items asked the subjects to indicate: a) the number of scientific and technical journals and periodicals which they regularly read, b) the extent to which they recommend technical information to their colleagues, c) the extent to which they seek technical information from members of other organizations, and d) the extent to which members of other organizations seek technical information from them.

These four items represent a slightly modified version of a technological gatekeeping scale developed by Creighton, Jolly, and Demming (1972) which has been utilized in several studies involving gatekeeping activity (Keller and Holland, 1975; Keller, Szilagyi, and Holland, 1976; and Dewhirst and Arvey, 1976). A single gatekeeping score was computed for each respondent by summing their responses to these four items, and the coefficient alpha reliability estimate for this scale was computed to be .70.

Role Orientations

Respondents' professional and bureaucratic role orientations were assessed in the present study through the use of two slightly modified versions of role orientation scales developed by Miller and Wager (1971).

The professional role orientation scale consisted of five items, and these were included in the questionnaire as items 26 through 30. Briefly, these items assessed

respondents' attitudes toward the importance of: a) publishing in professional journals, b) being respected in their particular field, c) being able to pursue their own research ideas, and d) being able to contribute to their profession and to scientific knowledge in general.

The bureaucratic role orientation scale, on the other hand, also consisted of five items, and these are included in the questionnaire as items 31 through 35. In contrast to those items comprising the professional role orientation scale, however, these five items assessed respondents' attitudes toward: a) assuming increased managerial responsibility, b) a career in management, c) the importance of supervisory recognition, and d) their organization in general.

For each statement in these two role orientation scales, subjects indicated their extent of agreement on a five-point scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Scores for each respondent on both of these scales were obtained by summing the responses to the five items in each scale. Finally, the coefficient alpha reliability estimates for the professional and bureaucratic role orientation scales were computed to be .81 and .64, respectively.

Information Behavior

The questionnaire utilized in the present study was designed to provide data on both scientists' self-reported

usage of a variety of technical information channels and systems, as well as their self-reported utilization of a specific technical information system (i.e., a scientific and technical library).

To obtain data regarding scientists' general information behavior, respondents were asked to indicate the extent to which they utilize 20 different information channels and systems in their work. The specific information channels and systems included in the questionnaire were drawn largely from a list of those used in the studies conducted by Rosenbloom and Wolek (1967) and Dewhirst (1970a). These specific channels and system were included as item 21 on the questionnaire, and respondents were asked to indicate the extent to which they utilize each of these channels and systems on a six-point scale ranging from 1 ("very seldom") to 6 ("very often").

Usage of the Laboratory's scientific and technical library system, on the other hand, was assessed by asking subjects to indicate the frequency which best described their usage of the library system. Responses to this question were made on a six-point scale, and the response anchors on this scale were: 1 ("less than once a year"), 2 ("once or twice a year"), 3 ("several times a year"), 4 ("monthly"), 5 ("weekly"), and 6 ("daily").

User Satisfaction

User satisfaction with the ORNL Library System was assessed by asking respondents to express their extent of agreement with three statements regarding this information system. Specifically, these three statements were: a) "My technical information needs have been adequately fulfilled by the ORNL Library System," b) "Given their constraints (e.g., space, budget), the ORNL Library System provides adequate materials and services," and c) "Generally speaking, I am satisfied with the materials and services of the ORNL Library System."

Subjects' responses to these three statements were made along a seven-point scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). An overall user satisfaction score was computed for each respondent by summing the responses to these three items, and the coefficient alpha reliability estimate for this scale was found to be .82.

Subsequent User Behavior

The specific subsequent user behavior to be examined in the present study was that of scientists' complaining behavior with regard to the ORNL Library System. Complaining behavior was assessed in the present study by asking the respondents whether they had ever voiced a complaint regarding the ORNL Library System. In responding to this question, subjects were directed to consider as complaints those dissatisfactions expressed either to their colleagues, Library

System staff members, their supervisors, and Laboratory administrators.

Availability of Alternative Systems

Survey respondents' perceptions regarding the availability of alternative library information systems was assessed by asking subjects to respond to the statement "For all practical purposes, the ORNL Library System is the only library service locally available to me." This specific item was deemed appropriate for the present study since the Laboratory is located near a major university center, and many scientists at the Laboratory claimed to be using the university's library as opposed to the ORNL Library System.

Subjects' responses to this statement were also made along a seven-point scale ranging from 1 ("strongly disagree") to 7 ("strongly agree").

Utility of Subsequent User Behavior

Finally, since the specific subsequent user behavior to be examined in the present study is that of user complaining behavior with regard to the ORNL Library System, the variable measured from this category was users' perceptions concerning the value of expressing complaints concerning the Library System. To measure this variable, subjects were asked to respond to the statement "Complaints/suggestions regarding the Library System will be acted upon in a positive manner."

As with other items in the questionnaire, responses to this item were also made along a seven-point scale ranging from 1 ("strongly disagree") to 7 ("strongly agree").

Descriptive statistics characterizing the entire sample in the present study on each of the variables outlined above are shown in Table 2. Also, an inter-correlation matrix for all the variables being utilized in the present study is included in Appendix B.

IV. DATA ANALYSES

The data analysis phase of the present study consisted of three parts. The first set of analyses was designed to describe the general information behavior of the scientists in the present study. To accomplish this, the 20 information channels and systems included in the questionnaire were rank-ordered according to the usage figures reported by the scientists in the study. Further analyses regarding the general information behavior of these scientists were conducted on these rankings using rank-order correlational analyses.

The second set of analyses was designed to test the seven specific hypotheses regarding scientists' information behavior which were outlined earlier in this paper. The majority of these analyses were correlational in nature and utilized Pearson correlations. However, point-biserial

TABLE 2

DESCRIPTIVE STATISTICS FOR EACH VARIABLE IN THE PRESENT STUDY

Variable	Code	Mean	%	Standard Deviation
Age		42.54		10.65
Tenure		12.55		10.07
Education		4.57		1.52
Work Group Size		11.35		9.66
Perceived Accessibility		5.64		1.12
Perceived Ease of Usage		5.54		.88
Perceived Quality		5.63		.90
Gatekeeping		11.74		3.58
Professional Role Orientation		17.35		4.07
Bureaucratic Role Orientation		14.61		3.04
Library System Usage		4.25		1.24
Library System Satisfaction		16.71		2.61
Perceived Availability of Alternative Library Systems		5.03		1.80
Perceived Utility of Engaging in Complaining Behavior		4.64		.97
Task	Development Tasks		33.2	
	Basic Research		25.0	
	Other		41.8	
Profession	Engineer		43.1	
	Scientist		56.9	
Have Complained about the Library System	Yes		18.7	
	No		81.3	

correlations were utilized when one of the variables in the analysis was dichotomous in nature (e.g., profession, task, complaining behavior). The specific hypotheses which stated the existence of mediating variables in the model were tested using partial correlation techniques, and the hypothesized moderator variables in the model were tested through the use of moderated groups analyses.

Having tested the model of scientists' information behavior as it applies to a library information system in a step-by-step fashion, the final set of analyses in this study was designed to test the model from a more macro perspective. This was accomplished through the use of several multiple linear regression analyses in which each of the dependent variables in the model (i.e., library system usage, library system satisfaction, and complaining behavior with regard to the library system) was regressed on the variables relating to it in the model.

Finally, although the analyses outlined above comprised the primary analyses conducted in this study, several additional analyses were conducted throughout the study for exploratory purposes.

CHAPTER IV

RESULTS

I. GENERAL INFORMATION BEHAVIOR

Rank orderings of the most frequently utilized technical information channels and systems as reported by the respondents in the present study are shown in Table 3 for both the total sample and the scientist--engineer subsample.

As evidenced in this table, the most frequently used information channels and systems reported by these scientists were: a) discussions with members of their work group, b) personal files, c) books, d) journals, periodicals, and technical magazines, and e) the ORNL Library System. On the other hand, the least frequently utilized information channels and systems reported by these scientists were: a) discussions with ERDA personnel, b) computerized SDI systems, c) university and industrial consultants, d) ORNL information centers, and e) discussions with vendor and contractor personnel.

A visual examination of the rank orderings shown in Table 3 also indicates that there were few differences in the information channel/system rank orderings between the scientists and engineer subsamples. Moreover, the rank order correlation between these two subsamples' rank orderings was computed to be .78.

TABLE 3

INFORMATION CHANNEL/SYSTEM USAGE RANKINGS FOR ORNL SCIENTISTS

Information Channel/System	Total Sample	Engineers	Scientists
Discussions with work group members	1	1	2
Journals, periodicals, technical magazines	2	3	1
Own or colleagues' personal files	3	2	3
Books	4	4	5
Internal library system	5	8	4
Discussions with other laboratory employees	6	7	7
External reports and documents	7	6	9
Personal/work group experimentation	8	12	6
Internal reports and documents	9	5	11
Discussions with peers in other organizations	10	10	8
Catalogs/documents supplied by vendors/contractors	11	9	14
Conventions, professional meetings, trade shows, symposia, etc.	12	14	10
Internal meetings, seminars, paper presentations	13	15	12.5
Convention and journal preprints	14	17	12.5
Discussions with vendors/ contractors	15	11	19
Internal information centers	16	13	16
Catalogs/documents supplied by ERDA	17	16	18
Internal SDI system	18	20	15
University/industrial consultants	19	19	17
Discussions with ERDA personnel	20	18	20

Finally, for exploratory purposes only, the rank orderings given 11 specific information channels and systems by the total sample in the present study were compared against the rank orderings given these same channels and systems by a sample of scientists and engineers at a NASA research center (Dewhirst, 1970a). The rankings given these 11 specific information channels and systems by these two samples of research and development scientists are shown in Table 4.

An examination of these data indicates that the reported information behavior of these two samples of research and development scientists appears to be quite similar. This statement is also supported by the fact that the rank order correlation coefficient between these two samples' rankings was found to be .86.

II. HYPOTHESIS 1

The correlations between library system usage and the various antecedent variables measured in the present study are shown in Table 5 for the total sample of scientists and engineers.

As predicted, the majority of these results replicate those reported in previous research studies which have examined the relationships between the antecedent variables and scientists' utilization of external--written information channels. That is, statistically significant positive

TABLE 4

INFORMATION CHANNEL/SYSTEM USAGE RANKINGS
FOR NASA AND ORNL SCIENTISTS

Information Channel/System	NASA Scientists	ORNL Scientists
Discussions with work group members	1	1
Own or colleagues' personal files	2	2
Discussions with other laboratory employees	3	4
Internal library system	4	3
Catalogs/documents supplied by vendors/contractors	5	7
Personal/work group experimentation	6	5
Discussions with vendors/ contractors	7	10
Discussions with peers in other organizations	8	6
Internal meetings, seminars, paper presentations	9	9
University/industrial consultants	10	11
Conventions, professional meetings, trade shows, etc.	11	8

TABLE 5

CORRELATIONS BETWEEN LIBRARY SYSTEM USAGE AND
THE ANTECEDENT VARIABLES

Variable	Correlation
Age	-.04
Tenure	-.11*
Education	.40**
Profession (1 = Engineer) (2 = Scientist)	.27**
Task (1 = Development tasks) (2 = Basic research)	.17**
Work group size	-.15**
Perceived accessibility	.15**
Perceived ease of usage	.13**
Perceived quality	.18**

*P < .05; **P < .01.

correlations were found between library system usage and education, scientific as opposed to engineering professions, basic research as opposed to development tasks, and the perceived accessibility of this information system. As predicted, it was also found that library system usage was negatively related to organizational tenure and work group size, while library system usage was found to be unrelated to the age of the scientist.

Finally, statistically significant correlations were found between library system usage and both the perceived ease of usage and the perceived quality of this technical information system. Thus, these correlational findings are contrary to the expected absence of a relationship between library system usage and these two information system characteristics.

III. HYPOTHESIS 2

To test the second hypothesis in the present study, library system usage was correlated with technological gatekeeping activity and both the professional and bureaucratic role orientation variables for the total sample of scientists and engineers.

As predicted, gatekeeping activity was positively correlated with library system usage ($r = .40$, $p < .01$), and professional role orientation was also found to be positively correlated with library system usage ($r = .40$, $p < .01$).

In contrast to the predicted negative correlation between library system usage and the bureaucratic role orientation, however, utilization of this information system was found to be unrelated to this role orientation ($r = -.04$, n.s.).

Finally, although the analyses discussed above involved the professional and bureaucratic role orientations separately, it has been suggested that these two role orientation variables are not mutually exclusive and should be combined to form four role typologies (Miller and Wager, 1971). Thus, for exploratory purposes, library system usage was examined as a function of these four role typologies. These role typologies were formed by splitting the two role orientation variables at their respective medians, and the four resulting typologies were then used as categories in a one-way analysis of variance with library system usage as the dependent variable.

The results of this analysis are shown in Table 6, and it can be seen that role typology was found to exert a statistically significant effect on library system usage F (3,262) = 12.33, $p < .001$. Further analysis of the four groups' means through the use of Duncan's Multiple Range Test indicated no significant difference in library system usage between the high professional--low bureaucratic typology ($M = 4.83$) and the high professional--high bureaucratic typology ($M = 4.46$). The scientists in these two role typologies, however, reported significantly greater

TABLE 6

ANALYSIS OF VARIANCE SUMMARY TABLE FOR LIBRARY SYSTEM USAGE BY ROLE ORIENTATION TYPOLOGY

Source	D.F.	S.S.	M.S.	F
Between Groups	3	50.66	16.89	12.33*
Within Groups	262	357.80	1.37	
Total	265	408.46		

*P < .001.

library system usage ($p < .05$) than those scientists in both the low professional--high bureaucratic typology ($\underline{M}$ = 3.93) and the low professional--low bureaucratic typology ($\underline{M}$ = 3.69). No significant difference in library system usage, however, was found between these last two role typologies. Thus, it would appear that a high professional role orientation exerts a strong effect on library system usage regardless of one's bureaucratic role orientation.

IV. HYPOTHESIS 3

The third hypothesis in the present study stated that gatekeeping and professional role orientation would mediate the relationships between library system usage and the antecedent variables. That is, it was expected that the

significant correlations found between library system usage and the antecedent variables would disappear once the effects of gatekeeping and professional role orientation were controlled.

To test this hypothesis, two sets of partial correlations were computed between library system usage and the antecedent variables. The first set of these partial correlations was calculated holding gatekeeping constant, while the second set was calculated holding both gatekeeping and professional role orientation constant. These two sets of partial correlation coefficients are shown in comparison with the zero order correlation coefficients between these variables in Table 7.

An inspection of these data indicates that few changes in the relationships between library system usage and the antecedent variables were in evidence when just the effects of technological gatekeeping activity were controlled. However, when both gatekeeping and professional role orientation were held constant, the significant correlations between library system usage and both profession and task disappeared. Furthermore, of the antecedent variables whose correlations with library system usage remained statistically significant after controlling for gatekeeping and professional role orientation, several of these correlations were substantially lower in magnitude than the zero order correlations between these variables. Few changes in the magnitudes of the

TABLE 7

PARTIAL CORRELATIONS BETWEEN LIBRARY SYSTEM USAGE AND THE ANTECEDENT VARIABLES CONTROLLING FOR GATE-KEEPING AND PROFESSIONAL ROLE ORIENTATION

Antecedent Variable	Zero Order Correlation[a]	Gatekeeping Controlled	Gatekeeping and Professional Role Orientation Controlled
Age	-.01	.01	.05
Tenure	-.10	-.08	-.04
Education	.30**	.21**	.14*
Profession	.22**	.22**	.11
Task	.22**	.20**	.05
Work group size	-.13*	-.17*	-.15*
Perceived accessibility	.21**	.19**	.24**
Perceived ease of usage	.18**	.09	.09
Perceived quality	.23**	.15*	.15*

[a]These correlation coefficients differ slightly from those reported earlier due to the fact that the computation of partial correlations requires list-wise, as opposed to pair-wise, deletion of missing data.

*P < .05; **P < .01.

correlations between library system usage and the perceived system characteristics of accessibility and quality, however, were noted when the effects of both gatekeeping and professional role orientation were controlled.

Thus, there appears to be some degree of support for the hypothesized mediating effects of both gatekeeping and professional role orientation, but not gatekeeping itself, on relationships between library system usage and the antecedent variables. Few mediating effects, however, were found for the relationships between library system usage and variables from the category of information system characteristics.

V. HYPOTHESIS 4

To test the fourth hypothesis in the present study, scientists' self-reported usage of the ORNL Library System was correlated with their reported satisfaction as users of this technical information system.

As predicted, no relationship was found between these two variables for the total sample of scientists and engineers ($r = .03$, n.s.). Furthermore, this usage--satisfaction relationship was also tested for the scientist and engineer subsamples separately, and these correlations were also found to be statistically non-significant.

VI. HYPOTHESIS 5

As outlined earlier, it was predicted that scientists' perceptions regarding the availability of alternative library systems would moderate the library system usage--satisfaction relationship. Specifically, it was expected that library system usage and system satisfaction would be positively related for scientists who perceive alternative library systems as being available, but unrelated for scientists who view alternative library systems as being unavailable to them. A moderated groups analysis was used to test this prediction. That is, the total sample of scientists was split at its respective median on the perceived library system availability question, and library system usage was correlated with overall library system satisfaction for each of the resulting subgroups.

For the group of scientists who perceived alternative library systems as being available, library system usage correlated -.01 (n.s.) with overall library system satisfaction. Similarly, for the scientists who perceived alternative library systems as being unavailable, this same correlation was .05 (n.s.). Also the difference between these two correlations was statistically non-significant, and very similar results were obtained when the same analysis was performed on the scientist and engineer subsamples separately.

Thus, no evidence was found in this study for the hypothesized moderating effect of perceived alternative

library system availability on the library system usage--satisfaction relationship.

VII. HYPOTHESIS 6

As in Hypothesis 4, it was also predicted that library system satisfaction would be unrelated to scientists' complaining behavior with regard to this information system. To test this hypothesis, complaining behavior was coded "1" if the scientist reported having never complained about the library system, and "2" if the scientist reported having complained about this information system. This dichotomous complaining behavior variable was correlated with overall library system satisfaction for the total sample of scientists and engineers, and the resulting correlation was found to be -.18 ($p < .01$). Thus, in contrast to the predicted library system satisfaction--complaining behavior relationship, scientists who reported having complained about this information system were less likely to hold favorable attitudes toward this information system.

It is interesting to note, however, that this relationship varied as a function of the scientist's profession. Specifically, the correlation between library system satisfaction and complaining behavior was found to be -.26 ($p < .01$) for the scientists in the sample, but only -.11 (n.s.) for the engineers in the sample.

VIII. HYPOTHESIS 7

Finally, it was predicted that scientists' perceptions regarding the utility of engaging in complaining behavior would moderate the library system satisfaction--complaining behavior relationship. Specifically, it was predicted that library system satisfaction and complaining behavior would be negatively related for scientists who perceived that their library system complaints and suggestions would be acted upon in a positive manner. On the other hand, it was expected that library system satisfaction and complaining behavior would be unrelated for those scientists who believed that their library system complaints and suggestions would not be acted upon positively. This hypothesis was tested using a moderated groups analysis similar to that utilized in testing Hypothesis 5.

The results of this analysis for the total sample of scientists and engineers indicated that library system satisfaction correlated -.07 (n.s.) with complaining behavior for those scientists who believed that their library system complaints and suggestions would be acted upon positively. For the scientists who believed that their complaints and suggestions would not be acted upon positively, however, this same correlation was found to be -.25 ($p < .01$). Finally, although these correlations were in a direction opposite to that hypothesized in this study, the difference

between these two correlations was statistically non-significant. Similar results were also found when the same analysis was performed on the scientist and engineer sub-samples separately.

Thus, no evidence was found in this study for the hypothesized moderating effect of the perceived utility of complaining behavior on the library system satisfaction--complaining behavior relationship.

IX. MACRO ANALYSES OF THE INFORMATION BEHAVIOR MODEL

Having tested the newly proposed model of scientists' information behavior on a step-by-step basis, the final set of analyses in the present paper attempted to analyze the model from a more macro perspective. This was accomplished through the use of several multiple regression analyses in which the dependent variables in the model (i.e., library system usage, library system satisfaction, and library system complaining behavior) were each regressed on the variables which were viewed as relating to it in the model. Given that the major goal of this research investigation is to develop a descriptive model of scientists' information behavior per se, these analyses enabled a determination of which variables in the model were accounting for the most variance in each of the model's dependent variables.

In the first of these regression analyses, library

system usage was regressed on library system satisfaction and the variables preceding library system usage in the model, and the results of this analysis are presented in Table 8. This analysis yielded a multiple R of .65, indicating that approximately 42% of the variance in library system usage could be accounted for by these variables.

However, the most important finding for purposes of understanding scientists' information behavior was the fact that 28% of this library system usage variance was accounted for by the gatekeeping role and professional role orientation variables. None of the antecedent variables accounted for a substantial portion of library system usage variance in comparison to the gatekeeping role and professional role orientation variables, and library system satisfaction did not account for any of the variance in library system usage.

In the second of these analyses, overall library system satisfaction was regressed on each of the variables preceding it in the model, and the results obtained from this regression analysis are shown in Table 9. This analysis yielded a multiple R of .69, indicating that approximately 48% of the variance in overall library system satisfaction could be explained by the variables preceding this construct in the model.

Nearly all of this variance in library system satisfaction, however, was accounted for by the perceived system characteristics of quality and accessibility. None of the

TABLE 8

REGRESSION ANALYSIS RESULTS FOR THE LIBRARY SYSTEM USAGE DEPENDENT VARIABLE

Variable[a]	% of Library Usage Variance Explained	Beta Weight
Age	0	.07
Tenure	0	-.11
Education	3	.18
Engineer	1	-.29
Scientist	0	-.19
Basic research	0	.06
Development tasks	1	.09
Work group size	2	-.15
Perceived accessibility	2	.15
Perceived ease of usage	0	.01
Perceived quality	2	.14
Gatekeeping	9	.28
Professional role orientation	19	.19
Library system satisfaction	0	-.11
	$R = .65$	
	$R^2 = .42$	

[a]The profession and task variables were each "dummy coded" to form two variables for these analyses.

TABLE 9

REGRESSION ANALYSIS RESULTS FOR THE LIBRARY SYSTEM SATISFACTION DEPENDENT VARIABLE

Variable[a]	% of Library Satisfaction Variance Explained	Beta Weight
Age	1	.10
Tenure	0	-.03
Education	0	-.06
Engineer	0	-.16
Scientist	0	-.06
Basic research	0	-.05
Development tasks	0	-.02
Work group size	0	.02
Perceived accessibility	5	.27
Perceived ease of usage	0	-.04
Perceived quality	39	.51
Gatekeeping	2	.05
Professional role orientation	0	.02
Library system usage	0	-.10
	$R = .69$	
	$R^2 = .48$	

[a]The profession and task variables were each "dummy coded" to form two variables for these analyses.

other antecedent variables nor the gatekeeping and professional role orientation variables were able to explain a large percentage of the variance in library system satisfaction. Library system usage also did not account for any of the variance in overall library system satisfaction.

Finally, scientists' complaining behavior with regard to the library system was "dummy coded" and regressed on both library system usage and overall library system satisfaction. This analysis yielded a multiple R of .28, indicating that approximately 8% of the variance in complaining behavior could be explained by these two variables. In addition, it was found that library system usage and satisfaction were able to explain equal percentages of the total complaining behavior variance accounted for by these two variables. The beta weights for these two variables were found to be .21 and -.19, respectively.

CHAPTER V

DISCUSSION

The primary objectives of the present paper were: a) to describe the general information behavior of a sample of research and development scientists, b) to propose a new theoretical model for the purpose of conceptualizing and understanding such behavior, and c) to test the validity of this model as applied to a specific information system commonly used by research and development scientists. Having worked toward the fulfillment of each of these objectives, this final chapter is devoted to a summarization and discussion of the major findings which emerged from this investigation. Also included in this chapter are suggestions for future research on the topic of scientists' information behavior and a revised model of scientists' information behavior.

I. GENERAL INFORMATION BEHAVIOR

Again, one objective of the present study was to describe the general information behavior of a sample of research and development scientists employed at Oak Ridge National Laboratory. On the basis of the analyses conducted in the present study, several points regarding the information behavior of these scientists are noteworthy.

First, it was found that the information behavior reported by the scientists in the present study were very similar to that reported in the literature on scientists' information behavior, and more specifically, to that reported by Dewhirst (1970a) for a sample of NASA scientists. Thus, there appears to be some degree of support for the contention that the information behavior reported by the scientists in the present study is representative of the information behavior of research and development scientists in general.

It should also be noted, however, that a time span of five to twelve years separates the present study from most of the recent empirical research studies on the topic of scientists' information behavior. Nevertheless, the information behavior reported by the scientists in these studies is very similar. Thus, it would also appear that a case could be made for the view that information behavior is a fairly stable phenomenon which occupies an important position in the job of the research and development scientist. Moreover, the information behavior of scientists' would also seem to be relatively immune to changes in both time and technology.

Second, although engineers in the present study tended to report greater utilization of internal information channels than did scientists, these differences were not as great as what previous researchers on this topic have indicated exist. Specifically, it appeared in the present study

that the engineers were more similar to scientists in their information behavior, as opposed to the scientists being more similar to engineers in their information behavior. Of course, one possible explanation for this finding, as originally suggested by Rosenbloom and Wolek (1967), is that the engineer sample in this study simply overrepresented certain types of engineers who tend to be more similar to scientists in their information behavior (e.g., chemical and metallurgical engineers). However, an analysis of the specific subdisciplines in which the engineers in this study held their degrees did not substantiate this explanation.

Another possible explanation for this finding, however, may exist in the fact that many of the engineers at the Laboratory are working on projects which represent the current "state of the art" in their specific fields of engineering. Consequently, it is being suggested here that within any field of engineering, those working in new technological areas will tend to exhibit information behavior which is more characteristic of scientists than engineers. Furthermore, it is also suggested that engineers working in areas of new technology may be more similar to scientists in their information behavior, than scientists working on technologically established projects. In other words, it is being suggested that the degree of innovativeness and/or uncertainty inherent in a scientist's work may provide a

better explanation and understanding of information behavior than profession per se. Unfortunately, this explanation for the information behavior of the engineers in the present study could not be tested since no data were available concerning the innovativeness and/or uncertainty involved in each scientist's work. Nevertheless, the effects of this task dimension on the information behavior of research and development scientists have yet to be studied, and would appear to present a fruitful avenue for future research on the topic of scientists' information behavior.

Finally, it is noteworthy that in this study and in previous studies which have compared scientists' usage of a variety of technical information channels and systems, library information systems were reported to be one of the most frequently used channel or system. In addition, many of the specific information channels which are typically reported as being used more often than library systems are channels which library systems are designed to administer (e.g., books and technical journals). Thus, library information systems appear to occupy an important position in the information behavior of research and development scientists. This contention is also supported by the fact that over 90% of the respondents in the present study disagreed with the statement that "Library materials and services are <u>not</u> important to the success of my work."

Consequently, a library information system serving a research and development organization would appear to provide an appropriate system for use in testing a model of scientists' information behavior.

II. A MODEL OF SCIENTISTS' INFORMATION BEHAVIOR

The primary purpose of the present paper, however, was to propose a general model of scientists' information behavior, and to test the validity of this model as applied to a specific technical information system (i.e., a library information system). Based on the results of both the individual hypothesis tests and the overall regression analyses conducted in the present study, several points appear to be worthy of mention.

First, it should be noted that many of the findings reported in this study of a library information system are consistent with findings in the information behavior literature pertaining to library systems and external--written information channels. Nearly all the variables from the antecedent variable categories of personal, task, work group, and information system characteristics were significantly correlated with scientists' reported utilization of the library system. Also, both the technological gatekeeping and the professional role orientation variables were found to be significantly correlated with reported library system usage in a positive direction.

However, when self-reported library system usage was regressed on all these variables, only gatekeeping and professional role orientation accounted for a substantial portion of the total variance in this specific information behavior. Furthermore, as was predicted in Hypothesis 3, most of the correlations between library system usage and the antecedent variables either disappeared or decreased in magnitude once the effects of technological gatekeeping and professional role orientation were held constant.

Given that this research was designed to increase understanding of scientists' information behavior as an independent phenomenon, it appears appropriate to conclude that antecedent variables such as age, education, task, etc. do not possess the explanatory power which has been attributed to such variables in previous investigations of the information behavior of scientists. Instead, role variables such as gatekeeping activity and role orientation are more efficient in providing an understanding of scientists' information behavior, and the antecedent variables appear to be related to information behavior only through their relationships with these role variables.

Although the antecedent variables appear to be related to information behavior only through their relationships with gatekeeping and role orientation variables, the question remains as to whether these relationships represent spuriousness or a developmental sequence. That is, whether

the various antecedent variables lead to gatekeeping and a specific role orientation, which in turn determine the specific information behavior exhibited by the scientist. Although this question cannot be conclusively answered through a correlational study such as the present investigation, a number of statistically significant correlations were found between the antecedent variables and both the gatekeeping and professional role orientation variables. Since it is difficult to conceive of gatekeeping and role orientation as causing such things as age, education, etc., it is suspected that these relationships are developmental in nature. That is, that the various antecedent variables lead to participation in gatekeeping activity and one's role orientation, which in turn lead to the specific information behavior exhibited by the scientist.

Second, as was predicted in Hypothesis 4, no relationship was found between self-reported library system usage and scientists' overall satisfaction as users of this technical information system. Evidence for this predicted absence of a relationship emerged from both the correlational analyses and the overall regression analyses. Contrary to the prediction stated in Hypothesis 5, however, scientists' perceptions regarding the availability of alternative library information systems did not moderate the library system usage--satisfaction relationship. In fact, library system usage was found to be unrelated to

overall library system satisfaction throughout all the analyses conducted in the present study.

Although it was predicted that self-reported library system usage would be unrelated, or at best weakly related, to overall library system satisfaction, the pervasiveness of this finding throughout this study was a bit surprising. One possible explanation for the pervasiveness of this non-relationship in the present study, however, is purely methodological in nature. Specifically, Ajzen and Fishbein (1977) have argued that the strength of attitude--behavior relationships is primarily a function of the degree of correspondence between the attitudinal and behavioral entities in question. In the present study, library system usage was correlated with scientists' attitude toward a "target" (i.e., the library system itself) as opposed to scientists' attitudes toward an "action" (i.e., library system usage). Thus, in situations of low attitude--behavior correspondence such as the present one, Ajzen and Fishbein (1977) would argue that the absence of a significant correlation is not surprising and should actually be expected.

However, it is also believed that an explanation for the absence of a significant library system usage--satisfaction correlation exists if one subscribes to the position that information behavior is an important part of the research and development scientist's job. Given this viewpoint, such scientists may not be able to change their

information behavior based solely on their satisfaction levels with specific information channels and systems. That is, these scientists' jobs may require continued monitoring and usage of specific information channels and systems regardless of the scientists' attitudes toward these channels and systems.

Regardless of the explanation for these findings, however, the fact remains that the concept of user satisfaction has yet to be related to information behavior in either the present study or previous investigations of scientists' information behavior. Clearly, this is an area of inquiry which deserves further research attention. For example, future researchers should continue the search for "other variables" which may act as moderators of this relationship, as well as examining this relationship under different degrees of attitude--behavior correspondence. However, if such investigations fail to yield significant relationships between information behavior and user satisfaction, then perhaps researchers in this area should consider the development of separate models for each of these concepts.

Third, although no specific hypotheses were proposed and tested with regard to overall library system satisfaction itself, it was found that the greatest portion of overall library system satisfaction was explained by variables from the antecedent variable category of perceived system

characteristics (i.e., quality, accessibility, ease of usage). None of the variables from the other antecedent variable categories nor either of the role variables were found to account for a significant percentage of the variance in overall library system satisfaction.

This finding is of interest in that it suggests that user satisfaction with an information channel or system is primarily determined by factors which are intrinsic to the channel or system itself. Moreover, this finding is also consistent with recent consumer behavior literature which indicates that consumer satisfaction is based on a hierarchy of product or service characteristics in which the product or service must first meet the consumer's expectations in terms of intrinsic characteristics or qualities (Swan and Coombs, 1976).

It should also be recognized, however, that these system characteristics (i.e., quality, accessibility, ease of usage) may simply be dimensions of overall library system satisfaction as opposed to determinants of overall satisfaction. Unfortunately, the self-report nature of the data in the present study does not allow for a crucial test of these two explanations for this study's findings with regard to library system satisfaction. However, this remains an empirical question which deserves attention in future research studies.

Fourth, overall library system satisfaction was found

to be negatively related to the subsequent user behavior of expressing complaints regarding this information system. That is, scientists who indicated lower levels of library system satisfaction were more likely to express complaints concerning this information system. Furthermore, the perceived utility of engaging in complaining behavior was not found to act as a moderator of the user satisfaction--complaining behavior relationship.

As a possible explanation for these findings, which were not predicted in the present study, it should be remembered that these hypotheses were generated on the basis of findings from the general consumer behavior literature. However, one complaint which has been raised regarding consumer research is that the majority of its hypotheses assume high involvement products and services which have important consequences for the consumer (Kassarjian, 1977). Thus, if one accepts the view that the information behavior of scientists represents an important yet low involvement consumer phenomenon, then perhaps the failure to find support in this study for the hypotheses derived from the field of consumer behavior is not surprising.

Of course, this is not to say that the consumer behavior view of technical information as a "product" which is "consumed" by scientists does not provide an appropriate framework for the study of scientists' information behavior. Rather, the predominant models in the field of consumer

behavior, along with the hypotheses generated from such models, may not apply to low involvement products and services such as scientific and technical information.

It should be emphasized, however, that the present investigation of the information behavior of research and development scientists is not without its limitations. Clearly, the greatest limitation exists in the fact that all the data in the present study are self-report in nature which allows for all types of response biases. Nevertheless, it is expected that such biases were not operating to a great extent in the present study. The questionnaire was anonymous, and the scientists in the study appeared to receive the study as an honest attempt to gather data for the purpose of improving an information system which is important to their work. Consequently, it is difficult to think of a specific response bias which would be operating consistently in the present study.

Also it should be recognized that the present study attempted to test a model of scientists' information behavior using a specific technical information system and a sample of scientists from a single research and development organization. On the other hand, it is suspected that a great deal more attention was given in the present study to sample selection than in many of the other studies in this area, and the questionnaire in the study was characterized by a respectable return rate. Nevertheless, future investigations

in this area of research should not only attempt to replicate the present findings but should test the newly proposed information behavior model using other information channels and systems as well as other samples of research and development scientists.

Finally, it should be noted that the present investigation and model of information behavior pertains solely to scientists in research and development organizations. It is not intended to be generalized to scientists working in academic settings. Although a fair amount of research has been conducted on the information behavior of academic scientists, there has yet to be a comprehensive study comparing and contrasting the information behavior of these two types of scientists. Clearly, this represents another fruitful avenue for future research on the topic of scientists' information behavior.

III. A REVISED MODEL OF SCIENTISTS' INFORMATION BEHAVIOR

At this point perhaps the most useful tool for future researchers in this area would be a revised model of scientists' information behavior which incorporates the findings of the present investigation. This model is presented in Figure 4 and illustrates several primary changes in the original information behavior model resulting from the present research study.

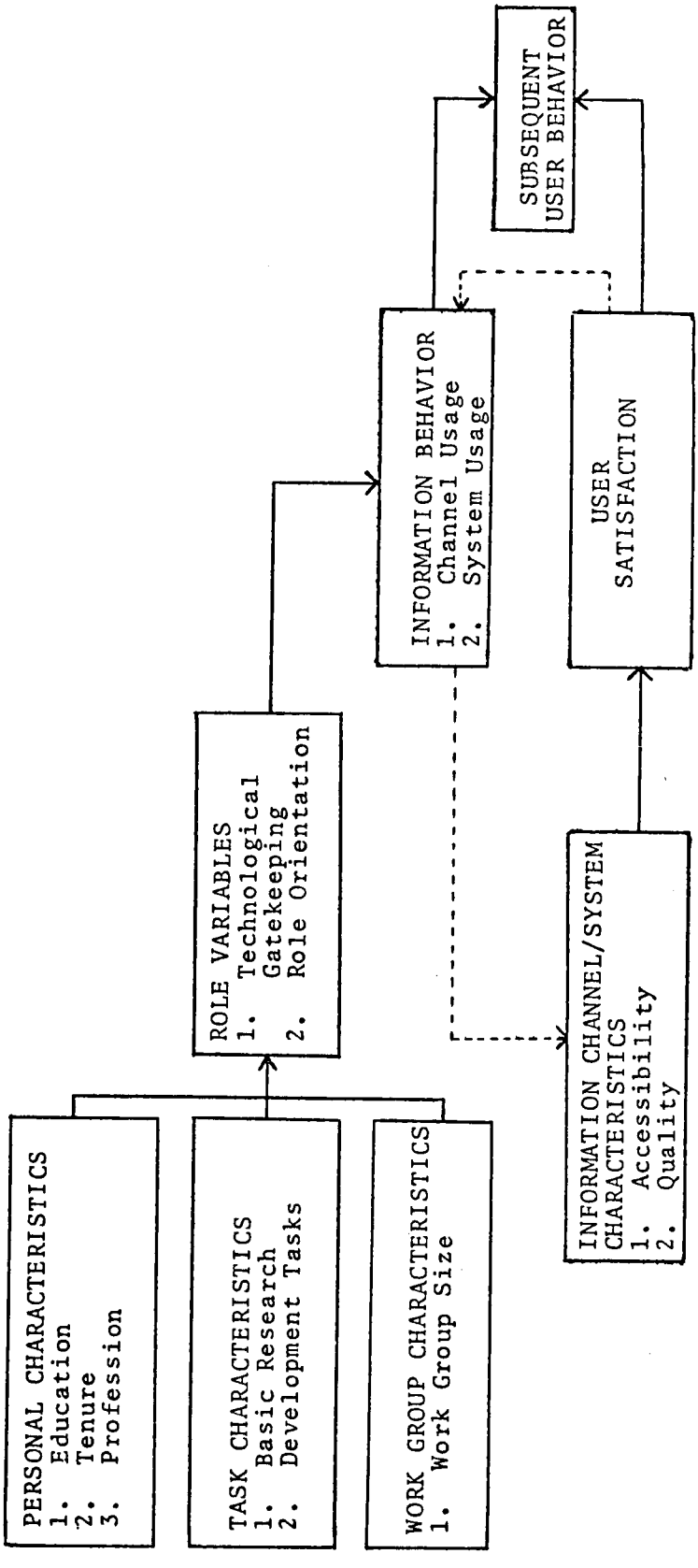


Figure 4. A revised model of scientists' information behavior.

First, it should be recalled that library system usage was found to be unrelated to overall library system satisfaction throughout this study, and that this relationship could not be improved through the use of the perceived availability of alternative systems as a moderator variable. Thus, given the pervasiveness of this non-relationship in the present study and the fact that channel/system usage has yet to be related to user satisfaction in the information behavior literature, it is perhaps best to view these concepts as separate subsystems within the overall information behavior model.

Second, information channel/system usage and user satisfaction appear to be functions of different variables. As predicted in the present study, channel/system usage appears to be primarily determined by the technological gatekeeping and role orientation variables. Furthermore, factors from the antecedent variable categories of personal, task, and work group characteristics appear to be related to information channel/system usage only through their relationships with these role variables. On the other hand, however, there is some evidence from the present study that user satisfaction, and not channel/system usage, may be primarily determined by perceived characteristics of a channel/system such as its accessibility and quality.

Third, although information channel/system usage and user satisfaction appear to be separate subsystems with

separate sets of determinants, it would appear that these two subsystems converge with regard to their outcomes (i.e., subsequent user behavior). Again, it should be remembered that both library system usage and overall library system satisfaction were found to be related to the subsequent user behavior of complaining in the present study.

Finally, it should be pointed out that the channel/system usage and user satisfaction subsystems may also be joined through the feedback loops shown in Figure 4. Unfortunately, this notion could not be tested with the cross-sectional data of the present study, but represents an idea which warrants further research attention in a longitudinal study of scientists' information behavior.

IV. SUMMARY

In summary, some of the results found in the present study (i.e., those pertaining to system usage and the usage--user satisfaction relationship) were supportive of the hypotheses generated from the model of scientists' information behavior outlined in this paper. However, the hypotheses pertaining to the relationship between user satisfaction and complaining behavior along with the predicted moderating effects were not supported in the present investigation. Thus, it would appear that the findings of the present study do not allow for a conclusive statement regarding the validity of the information behavior model

presented in this paper. However, possible explanations for these findings, along with a revised model of information behavior and suggested avenues for future research in this area, were presented and discussed.

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APPENDIXES

APPENDIX A

SURVEY INSTRUMENT USED IN THE PRESENT STUDY

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

August 30, 1977

TO: H7MCD.

cc: F. R. Bruce
File-NoRC

FROM: H. F. McDuffie (3-6777)

SUBJECT: Information Division Customer Satisfaction Study - Library

In keeping with management's concern for customer satisfaction with services, the Information Division is assessing customer attitudes toward the Library services it provides at ORNL.

The objective of our investigation is not only to obtain an index of current satisfaction/dissatisfaction levels with Library services at ORNL, but also to provide an indication of how existing services may be improved so as to better meet the needs of Library users.

Your name has been randomly selected from a list of ORNL employees for inclusion in this study, and we are asking you to help by giving 20-25 minutes of your time to complete the attached questionnaire relating to our Library System. The purpose of this specific questionnaire is to assess customer satisfaction with the Library System at ORNL and the extent to which the ORNL Library System is fulfilling the information needs of ORNL employees.

Your response to the questionnaire will be kept anonymous and will be processed by Walter Zultowski, a consultant from the University of Tennessee. Furthermore, responses from the questionnaire will be analyzed and reported in aggregate statistical terms only.

For your response to be included in our analysis, the attached questionnaire needs to be returned by September 16. Your cooperation in completing the questionnaire in the next two weeks will be greatly appreciated. Completed questionnaires should be returned in the mail envelope provided to:

Walter Zultowski
4500N, Room H-7

HFM:WZ:nrf

ORNL LIBRARY SYSTEM SURVEY

INSTRUCTIONS - Remember that your first reaction to a question is generally the best. If a multiple choice question does not offer a choice which precisely describes your situation or belief, select the choice which comes the closest. Except where otherwise noted, please check only one answer for each question.

Where appropriate, more detailed instructions are given for particular questions. Please read these instructions carefully.

PART I - BACKGROUND QUESTIONS

1. Age:_____

2. Years employed by ORNL:_____

3. Education (Check highest level attained):
   ____High school
   ____Bachelor's degree
   ____Credits toward Master's degree
   ____Master's degree
   ____Credits toward Doctor's degree
   ____Doctor's degree

4. I would consider myself primarily a(n):
   ____Engineer
   ____Scientist
   ____Administrator
   ____Other,_____

5. Supervisory level:
   ____Manager (i.e., division, section, unit, project head)
   ____Nonmanager

6. Academic discipline of highest degree attained (e.g., Chemical Engineering)

   _____

7. The majority of my current work is done as part of an inter-division research team: ____YES ____NO

8. The majority of my current work is involved with the development of impact statements: ____YES ____NO

9. How many professionals are employed in the work group with which you primarily identify? _____

10. My work is primarily:
    ____Basic research
    ____Developmental research
    ____Management
    ____Technical support
    ____Other (please describe briefly)

    _____

11. My work is primarily in the organizational area of:
    ____Administration
    ____Services
    ____Nuclear and Engineering Technology
    ____Physical Sciences
    ____Biomedical and Environmental Sciences
    ____Advanced Energy Systems

PART II - LIBRARY SYSTEM QUESTIONS

12. Which frequency category below best describes the extent to which you utilize the materials and/or services provided by the ORNL Library System. This includes the Central Research Library, the three Branch Libraries, the Translations services, and the Computerized Reference Search services.

____less than once a year
____once or twice a year
____several times a year
____monthly
____weekly
____daily

13. Which library do you primarily use?

____Central Research Library (i.e., located at X-10)
____One of the Branch Libraries
→ Which one? ____Y-12 Technical Library
____Biology Library
____Fusion Energy Library

14. When needing materials and/or services from the ORNL Library System:

____I usually contact the library staff or go to the library myself
____I usually have a clerical staff member contact the library staff or go to the library
____I usually have a research assistant contact the library staff or go to the library
____Other (please describe)

_____

15. Below is a list of statements which may describe your personal experiences with the ORNL Library System. Please circle the one number (i.e. 1-7) which best describes your extent of agreement with each of the following statements regarding the ORNL Library System. Circle "0" (i.e., not applicable) only if you have not used the specific material or service to which the statement refers.

	not applicable	strongly disagree	disagree	tend to disagree	uncertain	tend to agree	agree	strongly agree
Staff members have been courteous in their dealings with me	0	1	2	3	4	5	6	7
When needed, I have received adequate assistance in the use of reference "tools" (e.g., catalogs, indexes, abstracts)	0	1	2	3	4	5	6	7
When needed, staff members have been readily available to answer questions	0	1	2	3	4	5	6	7
I have been adequately informed of newly-acquired library materials through displays, bulletins and acquisition lists	0	1	2	3	4	5	6	7
I have received adequate attention when requesting library materials or services on a "rush" basis	0	1	2	3	4	5	6	7

	not applicable	strongly disagree	disagree	tend to disagree	uncertain	tend to agree	agree	strongly agree
I would like to be asked more often to suggest books/journals to build the library's collection in my area of work	0	1	2	3	4	5	6	7
Journals I use most often should be retained in hard copy as opposed to being microfilmed	0	1	2	3	4	5	6	7
I have had trouble retrieving journal articles that have been microfilmed	0	1	2	3	4	5	6	7
The microfilm and microfiche readers have provided adequate service	0	1	2	3	4	5	6	7
The "down time" of the microfilm and microfiche readers has interfered with my work	0	1	2	3	4	5	6	7
Translations have been provided in time to be useful	0	1	2	3	4	5	6	7
Translations have been precise and accurate	0	1	2	3	4	5	6	7
Available computerized data bases have been adequate for my needs	0	1	2	3	4	5	6	7
Interlibrary loan has been able to locate materials I've requested	0	1	2	3	4	5	6	7
Reimbursements and billings for materials I've ordered have been handled efficiently	0	1	2	3	4	5	6	7
I've been kept informed of special delays, costs, problems, etc. when ordering materials through the library	0	1	2	3	4	5	6	7
I have had difficulty locating issues of journals which are not bound	0	1	2	3	4	5	6	7
The "up-to-dateness" of the library's materials has been adequate for my needs	0	1	2	3	4	5	6	7
The system for circulating new books provides access to these books in time to be useful	0	1	2	3	4	5	6	7
I often go to the Library just to browse through journals, etc.	0	1	2	3	4	5	6	7
I have found useful material while just browsing in one of the ORNL libraries	0	1	2	3	4	5	6	7
Information obtained through the ORNL Library System is not available through other technical information sources	0	1	2	3	4	5	6	7
My technical information needs have been adequately fulfilled by the ORNL Library System	0	1	2	3	4	5	6	7

	not applicable	strongly disagree	disagree	tend to disagree	uncertain	tend to agree	agree	strongly agree
For all practical purposes, the ORNL Library System is the only library service locally available to me	0	1	2	3	4	5	6	7
Library materials and services are not important to the success of my work	0	1	2	3	4	5	6	7
Materials and services of the ORNL Library System are easily accessible to me	0	1	2	3	4	5	6	7
Materials and services of the ORNL Library System are easy to use	0	1	2	3	4	5	6	7
Materials and services of the ORNL Library System are high quality in nature	0	1	2	3	4	5	6	7
I favor the implementation of a circulation system which specifies due dates for books checked out	0	1	2	3	4	5	6	7
Technical library materials and services are difficult to maintain and administer	0	1	2	3	4	5	6	7
The Library is interested in users' complaints/suggestions regarding its services	0	1	2	3	4	5	6	7
Complaints/suggestions regarding the Library will be acted upon in a positive manner	0	1	2	3	4	5	6	7
The physical conditions of the library I use provide an adequate work place	0	1	2	3	4	5	6	7
Given their constraints (e.g., space, budget), the ORNL Library System provides adequate materials and services	0	1	2	3	4	5	6	7
Generally speaking, I am satisfied with the materials and services of the ORNL Library System	0	1	2	3	4	5	6	7

16. What particular aspect of the ORNL Library System's staff, materials, and services have you been most displeased with, if any?

_____

_____

17. What particular aspect of the ORNL Library System's staff, materials, and services have you been most pleased with, if any?

_____

_____

18. Have you ever complained about the ORNL Library System?
___YES ___NO
↓
If YES, to whom?
(Check all that apply)
___my colleagues
___a library staff member
___a library staff supervisor
___the head of the ORNL Library System
___the Director of the Information Division
___my division director
___the Laboratory Director
___Other, (please describe)

_____

19. Have you ever expressed your satisfaction with the ORNL Library System?
___YES ___NO
↓
If YES, to whom?
(Check all that apply)
___my colleagues
___a library staff member
___a library staff supervisor
___the head of the ORNL Library System
___the Director of the Information Division
___my division director
___the Laboratory Director
___Other, (please describe)

_____

20. What specific library materials or services are NOT being provided by the ORNL Library System which would be of use to you? (please describe)

_____

_____

PART III - RELATED TOPIC QUESTIONS

INSTRUCTIONS - Past research studies indicate that usage of technical libraries by R & D professionals is affected by such things as their information channel usage habits, the task they perform, and their career orientation (i.e., research vs. management). In order to further interpret and compare our findings with those of previous research studies, please complete the following items regarding these related topics.

21. Listed below are several possible sources of technical information which you may or may not utilize in your work. Please circle the one number (i.e., 0-7) which best describes the extent to which you utilize <u>each</u> information source in your work.

	never	very seldom	seldom	occasionally	frequently	often	very often
My own or my colleagues' personal files	0	1	2	3	4	5	6
Books	0	1	2	3	4	5	6
Journals, periodicals, or technical magazines	0	1	2	3	4	5	6
Reports and documents generated at ORNL	0	1	2	3	4	5	6
Reports and documents generated outside ORNL	0	1	2	3	4	5	6
Catalogs and documents supplied by vendor/contractors (i.e., suppliers of materials and components)	0	1	2	3	4	5	6
Catalogs and documents supplied by ERDA	0	1	2	3	4	5	6
Discussion with members of my work group	0	1	2	3	4	5	6
Discussion with other ORNL employees	0	1	2	3	4	5	6
Discussion with peers in my fields in other organizations	0	1	2	3	4	5	6
ORNL meetings, seminars, and paper presentations	0	1	2	3	4	5	6
Conventions, professional meetings, trade shows, symposia, etc.	0	1	2	3	4	5	6
Convention and journal preprints	0	1	2	3	4	5	6
Discussion with vendor/contractor personnel	0	1	2	3	4	5	6
Discussion with ERDA personnel	0	1	2	3	4	5	6
Experimentation conducted by me and/or my work group (i.e., with no immediate input of information from any other sources)	0	1	2	3	4	5	6
University and/or industrial consultants	0	1	2	3	4	5	6
The ORNL Library System	0	1	2	3	4	5	6
Technical information centers at ORNL	0	1	2	3	4	5	6
Computerized SDI (selected dissemination of information) lists	0	1	2	3	4	5	6

22. Please indicate the number of scientific or technical journals and periodicals which you read regularly.
____1-2
____3-4
____5-6
____7-8
____9-10
____11-12

23. During a typical month on your job, how often do you recommend specific sources of technical information (e.g., journal articles, knowledgeable colleagues, reports, etc.) to your colleagues?
____Very Seldom
____Seldom
____Occasionally
____Frequently
____Often
____Very Often

24. During a typical month on your job, how often do you seek technical information or advice from members of other organizations (i.e., outside ORNL)?
____Very Seldom
____Seldom
____Occasionally
____Frequently
____Often
____Very Often

25. During a typical month on your job, how often do members of other organizations seek technical information or advice from you?
____Very Seldom
____Seldom
____Occasionally
____Frequently
____Often
____Very Often

26. In the near future, I would rather publish a paper in a leading journal in my profession, as opposed to making a contribution to one of ORNL's projects:
____Strongly Disagree
____Disagree
____Uncertain
____Agree
____Strongly Agree

27. In the long run, I would rather be respected among specialists in my field outside ORNL, as opposed to being respected in ORNL:
____Strongly Disagree
____Disagree
____Uncertain
____Agree
____Strongly Agree

28. It is important to me that I be able to publish the results of my research in professional journals:
____Strongly Disagree
____Disagree
____Uncertain
____Agree
____Strongly Agree

29. Being able to do the kind of research that will contribute to scientific knowledge is very important to me:
____Strongly Disagree
____Disagree
____Uncertain
____Agree
____Strongly Agree

30. It is important to me that I be able to pursue and carry out my own research ideas:
____Strongly Disagree
____Disagree
____Uncertain
____Agree
____Strongly Agree

31. Being able to pursue a career in management is very important to me:
____Strongly Disagree
____Disagree
____Uncertain
____Agree
____Strongly Agree

32. Having a job which permits me to take on progressively more administrative responsibility is important to me:
____Strongly Disagree
____Disagree
____Uncertain
____Agree
____Strongly Agree

33. I would like to assume a position with more managerial responsibility:
____Strongly Disagree
____Disagree
____Uncertain
____Agree
____Strongly Agree

34. Except for economic reasons, I have little interest in ORNL or its future:
____Strongly Disagree
____Disagree
____Uncertain
____Agree
____Strongly Agree

35. Recognition from supervisors for work well done is important to me:
____Strongly Disagree
____Disagree
____Uncertain
____Agree
____Strongly Agree

36. In comparison to your colleagues in similar or related disciplines at ORNL, how would you rate your number of publications in technical periodicals and journals?
____Much Less Than
____Less Than
____Equal To
____Greater Than
____Much Greater Than

37. In comparison to your colleagues in similar or related disciplines at ORNL, how would you rate your number of patents?
____Much Less Than
____Less Than
____Equal To
____Greater Than
____Much Greater Than

38. In comparison to your colleagues in similar or related disciplines at ORNL, how would you rate your overall research performance?
____Much Less Than
____Less Than
____Equal To
____Greater Than
____Much Greater Than

Again, thank you very much for your cooperation. Return this questionnaire to Walter Zultowski, 4500N, Room H-7.

APPENDIX B

INTER-CORRELATION MATRIX FOR ALL VARIABLES IN THE PRESENT STUDY

	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Age (1)	80**	-14**	-01	-02	-05	14**	08	22**	-03	-21**	-24**	-04	25**	-02	06	08
Tenure (2)		-23**	-02	00	-08	09	01	18**	-03	-17**	-23**	-11*	20**	00	05	-04
Education (3)			41**	23**	-01	-09*	-07	-05	22**	50**	-09	40**	-08	22**	21**	-01
Profession (4)				50**	-15**	03	16**	08	06	52**	-14**	27**	09	22**	11*	06
Task (5)					-19**	-03	07	05	10	60**	-21**	17**	-01	14*	-07	-01
Group Size (6)						01	-00	06	04	-19**	22**	-15**	06	-08	-08	-07
Accessibility (7)							57**	49**	04	-07	-08	15**	52**	-10*	14**	24**
Ease of Usage (8)								60**	08	06	-06	13**	46**	-10*	07	33**
Quality (9)									13**	-03	-06	18**	65**	-09	07	38**
Gatekeeping (10)										22**	10*	40**	-01	09	00	17**
Professional Role Orientation (11)											-10*	40**	-07	22**	13*	01
Bureaucratic Role Orientation (12)												-04	-07	-01	-12*	02
Library Use (13)													03	21**	17**	15**
Library Satisfaction (14)														-18**	16**	40**
Complaining (15)															03	-11*
Availability of Alternatives (16)																18**
Utility of Complaining (17)																

Decimal points have been omitted in the above figure.
*P < .05; **P < .01.

Figure 5. Relationships among all the variables in the study.

VITA

Walter Henry Zultowski was born in Newark, New Jersey on December 16, 1951, and was graduated from Delbarton School, Morristown, New Jersey in June 1969. The following September he entered Hartwick College, Oneonta, New York and received a Bachelor of Arts degree in Psychology in June 1973. In the Fall of 1973 he accepted a research assistantship at Wake Forest University, Winston-Salem, North Carolina, and was awarded a Master of Arts degree in General-Experimental Psychology in May 1975.

Mr. Zultowski entered the Graduate School of The University of Tennessee, Knoxville in September 1975 and is a doctoral candidate in the Industrial and Organizational Psychology Program. During his last year at The University of Tennessee, Knoxville he was employed in the Employee Relations Division of Oak Ridge National Laboratory, Oak Ridge, Tennessee. In the Summer of 1978 he will begin employment with the Life Insurance Marketing and Research Association, Hartford, Connecticut.

He is married to the former Linda Bullard of Wethersfield, Connecticut.