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ABSTRACT

There have been hundreds, perhaps thousands, of studies involving scientific and technical information communication performed over the last 25 years. This review attempts to provide a window to these studies for persons interested in studying the results published in technical reports and the formal literature. This review primarily deals with the information-seeking needs and behavior of engineers and, to a lesser degree, scientists or those said to be generally engaged in research and development. The principal focus in on primary communications through interpersonal means and through information found in documents such as books, journal articles, technical reports, etc. Less attention is paid here to the use of secondary services and products such as printed bibliographic indexes and automated bibliographic databases; numeric databases; intermediary organizations such as libraries, information clearinghouses, and information analysis centers (IACs); and technologies used by engineers for communication purpose. The review covers research reported from 1970 forward, although some exceptions are made, particularly when earlier studies begin a sustained series of studies or when they serve as precedents for other subsequent studies. Section 2 provides a brief overview and summary observations concerning: scientific and technical information (STI) communication research approaches and models; STI communication; communication through primary STI media; interpersonal STI communication; STI communication through secondary media and databases; use of libraries, IACs, and clearinghouses; and state-of-the-art literature reviews of engineers' information needs, information-seeking processes, and information use. Section 3 discusses some distinctions made in the literature between engineers' and scientists' information needs, information-seeking processes, and information use. Several extensive and continuous STI communication research efforts are discussed in section 4, including general research themes, brief descriptions of research methods used, and some significant findings. The research review, section 5, consists of a numbered list of 456 references, given in alphabetical order by author. An annotated bibliography of many of the references follows in section 6. A subject index and author index are also provided in section 7. (MAS)

Communication by Engineers: A Literature Review of Engineers' Information Needs, Seeking Processes, and Use

by
Donald W. King
with
Jane Casto
Heather Jones

Center for Information Studies
University of Tennessee

Council on Library Resources, Inc.
August 1994

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Preface

In the summer of 1993 the Council on Library Resources, Inc., contracted with the University of Tennessee, Center for Information Studies, to prepare an annotated bibliography of the information needs and information-seeking habits of scientists and engineers, with emphasis on engineers. Jane Casto and Heather Jones were designated as Student Principal Investigators, and Aaron Dobbs, Margaret Casado, Bart Hollingsworth, and Angela Bozeman served as assistants to help search the literature and to prepare the abstracts presented in this report. Faculty advisors were Professors Gary Purcell and George Sinkankas, who helped design software to facilitate this project.

In addition to the staff mentioned above, I would like to thank José-Marie Griffiths for editing my drafts, and Janet D. Miles for word processing all but the annotated bibliography. Also, I asked Dr. Thomas E. Pinelli if he would edit Section 4.6.2 since the material is so extensive, and he and colleagues did so in a very timely manner.

I would like to apologize to those researchers whose work and/or publications have been excluded because they are not sufficiently engineer-oriented or were overlooked, and, on behalf of the engineering community, I would like to thank all the researchers who have contributed to this extensive body of literature.

Donald W. King
August, 1994

Section 1
Background and Introduction

1.1 Background

In 1990 the Council on Library Resources (CLR) submitted a report (75) to the National Science Foundation entitled "Communications in Support of Science and Engineering," which addressed the objective of learning more about the relationship between information resources and scientific productivity. The report is the outcome of a CLR conference of invited papers and papers commissioned in response to the conference discussion. In addition to a discussion paper by Martin M. Cummings and conference transactions prepared by Eleanor W. Sacks, the two commissioned papers below are presented in the report:

- *The Users and Uses of Scientific Information Resources*, Helen Hofer Gee. This paper explains what might be learned about information needs and information-seeking habits of scientists and engineers. It also suggests some methods that might be used to address these issues.
- *Library Resources and Research Productivity in Science and Engineering*, Nancy A. Van House. Research was performed with 27 large research and academic libraries to determine whether there might be a potential correlation between library resources (e.g., collections acquired and held) and indicators of productivity at the organizations served by them. The pilot study did suggest some positive correlations.

Important issues identified in the report include: the future of scientific publishing, the characteristics of and requirements for scientific communication, and the future form of library services and information systems for science.

In June 1992, another conference, co-sponsored by the Engineering Foundation and CLR, was held on the "Exploration of a National Engineering Information Service (NEIS)." This conference was designed to address weaknesses perceived in gaining access to engineering knowledge (290). In particular, an important aspect of the conference concerned issues dealing with initiating a National Engineering Information Service. To do this, it was concluded that, among other initiatives, there needed to be a "truly comprehensive study of the requirements of the users of engineering information and data to provide a fundamental input to the design considerations. . . . " As a result, the Council of Library Resources asked the University of Tennessee, Center for Information Studies, to prepare a preliminary bibliography of engineers' information needs, information-seeking processes, and information use.

1.2 Introduction

There have been hundreds, perhaps thousands, of studies involving scientific and technical information communication performed over the last 25 years. This review attempts to provide a window to these studies for persons interested in studying the results published in technical reports and the formal literature. This review primarily deals with the information-seeking needs and behavior of engineers and, to a lesser degree, scientists or those said to be generally engaged in research and development. The principal focus of this review is on primary communications through interpersonal means and through information found in documents such as books, journal articles, technical reports, and so on. Less attention is paid here to use of secondary services and products such as printed bibliographic indexes and automated bibliographic databases; numeric databases; intermediary organizations such as libraries, information clearinghouses, and information analysis centers (IACs); and technologies used by engineers for communication purposes. The review covers research reported from 1970 forward (about 25 years), although some exceptions are made, particularly when earlier studies begin a sustained series of studies or when they serve as precedents for other subsequent studies.

Section 2 provides a brief overview and summary observations concerning:

- Scientific and technical information (STI) communication research approaches and models.
- Communication through primary STI media.
- Interpersonal STI communication.
- STI communication through secondary media and databases.
- Use of libraries, info .nation analysis centers (IACs), and clearinghouses.

- State-of-the-art and literature reviews of engineers' information needs, information-seeking processes, and information use.

Section 3 discusses some distinctions made in the literature between engineers' and scientists' information needs, information-seeking processes, and information use. Several extensive and continuous STI communication research efforts have been performed in the last three decades. These research efforts are discussed in Section 4, including general research themes, brief descriptions of research methods used, and some significant findings. The review consists of a numbered list of 456 references, given in alphabetical order by author (Section 5). An annotated bibliography of many of the references follows in Section 6. A detailed subject index and author index are also provided in Section 7.

Section 1.3 Historical Overview

A few excellent studies of communication of scientists and engineers were performed in the 1950s. A review of these and other user studies done prior to 1965 is given by Herner and Herner (152). However, the 1960s yielded a plethora of STI user studies and surveys funded largely by the federal government (National Science Foundation, Department of Defense, and other agencies). Two major one-time STI user studies were sponsored by the Department of Defense (37). Also, several sustained series of studies were begun by Garvey and Griffith at Johns Hopkins University (see Section 4.2), Allen and colleagues at MIT (see Section 4.3), and King and colleagues, first at Westat and then at King Research, Inc. (see Section 4.4). A number of exemplary studies were also performed in the 1960s by Rosenbloom and Wolek (358, 359), Paisley (285), Menzel (261, 262), and others. In the 1970s some of the researchers above continued their research, and their efforts spawned similar or replicated research by others. One such study in particular, which involved a large national survey of engineers, was begun by Shuchman in 1977 (see Section 4.5). The 1980s also produced continued studies by Allen and colleagues, King and colleagues, and, particularly, a series of studies performed by Pinelli, Kennedy, Barclay, and colleagues for NASA/Department of Defense (see Section 4.6). Tushman (see Section 4.3.1) expanded Allen's work, and Kremer (218), Kaufman (184), and others conducted additional surveys with engineers using similar methods. Thus far in the 1990s, studies continue by King and Griffiths (University of Tennessee), and Pinelli, Kennedy, and Barclay. However, the number of very large-scale studies such as those performed in the prior three decades seems to have dwindled considerably.

Communication is narrowly defined by some as sending, transmitting, and receiving messages. However, most of the research reviewed here variously takes into account a broader perspective, including:

- creation of knowledge and its preparation for sending (e.g., writing);
- the many channels used for communicating information, including interpersonal means (e.g., informal discussions, formal presentations) and documented media (e.g., journal articles, books, technical reports, audiovisual) transmitted by direct distribution, colleagues, libraries, etc.; and
- assimilation and use of information received for purposes of research, development, design, management, and so on.

It seems, however, that there is a variety of ways that the terms "information needs," "information seeking," and "information use" are applied in the literature. For example, "information needs" for many authors refers to the sources of information used, such as colleagues and journal articles. For others, "information needs" apply to the information content or messages needed by engineers. Garvey (111) refers to "the nature of information needed," giving 10 examples, including, for example, (1) to aid in perception of definition of problems and (2) to choose a data analysis technique. Some researchers would call such examples "information use" or "purposes of information use." "Information seeking" seems by some to mean identifying, locating, and acquiring needed information. For others, it is all the processes used to apply any of the many available sources of information (called channels by some). The point here is not to resolve these many differences, but rather to point out that such wide differences exist.

This review attempts to finesse this difficulty by focussing first on communication research that identifies sources of information used and then other related aspects. To help, a subject index provides a list of references which present STI communication models; information-seeking processes or sources used; and specific topics concerning gatekeepers, etc. (or generally point-to-point communication) and knowledge diffusion or information transfer (or generally point-to-a-group or mass form of communication). Then primary or secondary communication media are addressed, including detailed indexes of references which discuss published or documented information; interpersonal communication; bibliographic searching (automated and printed products and services) and numeric database use; and intermediary organizations such as libraries, information analysis centers, and clearinghouses. The subject indexes for each of these topics also have sub-topics that address quantitative results dealing with amounts of use, factors affecting use, purposes of use, and consequences of use. Also addressed are communication research methods described in the literature (e.g., surveys, literature reviews, experiments) and special topics discussed such as implications for education, policy, and new technologies, among others. It is hoped that these "slices" of the literature over the past 25 years will provide a means to obtain needed data or information about engineers' communication, with emphasis on their information needs, information seeking, and information use.

Section 2
Summary Observations Concerning Communication by Engineers

2.1 STI Communication Research Approaches and Models

The communication research performed since 1970 seems to be based on five kinds of models or research approaches to examining STI communication. The first approach focusses communication research observations on research and development (R&D) projects and tasks. Engineers and scientists are asked to indicate information sources used by them to perform a recent or particularly important R&D task. With this approach, one can establish the relative importance of various personal, interpersonal, published, and other information sources. Allen, Tushman, Shuchman, Pinelli et al., and others have based some of their research on this approach. Another research approach focusses on the exchange (flow) of information among individual engineers (and scientists). This STI communication research determines the extent to which specific individuals are used as an information source and the extent to which intra-unit, intra-organization, and external information sources (variously called channels) are utilized. Allen, Tushman, and others particularly rely on this approach. This research approach has demonstrated that there are information-intensive individuals in organizations who are extensively used as a source of information by others in their organizations ("information stars"), those who are particularly effective in communicating beyond their units and organizations ("information boundary spanners"), and those who informally or formally enhance a unit's communication capabilities as stars and boundary spanners ("information gatekeepers"). This approach has led to "models" that describe and sometimes illustrate the frequency of point-to-point contacts made between individuals.

Another kind of research has involved what might be referred to as the "life-cycle of information" model. This research approach examines newly created information and follows it through its "life" of use through communication channels such as internal discussions and reporting in an organization, reporting in professional meetings, and on through formal publication of meeting proceedings, journal articles, books, state-of-the-art reviews, and so on. This kind of research is particularly exemplified through studies performed by Garvey and colleagues. The life cycle of information is modelled or portrayed by a time line in which the information appears in various media. Average, median, and frequencies of time spans are also presented in the literature.

A fourth kind of research approach examines the amount of information-related activity and information use which involve either specific communication functions (e.g., authorship, publishing, identification and location, storage for later use, reading, etc.) or the participants/stakeholders who perform the functions (e.g., authors, publishers, libraries, etc.). For this approach, information and data are collected from each type of participant. Garvey, King, Pinelli et al., and their colleagues have employed this research approach. A critical incident of authorship, use of secondary services, or reading is sometimes used as the principal research method. For a critical incident of reading, for example, data are collected concerning such topics as time spent reading, how the item was identified and obtained, purpose for reading, and outcomes of reading (such as time saved, improved decision-making, increased quality of research, and so on).

A related kind of research approach measures the amount and characteristics of flow of information among functions or participants, such as between authors and publishers; publishers and engineers; libraries and vendor databases; libraries and engineers; and so on. Appropriate measures are examined for information input sources, value-added processes, and information output destination for each of the participants/stakeholders. Garvey, King, and colleagues have particularly utilized this form of research and model. This kind of research provides a means of modelling the amount, timeliness, and cost of the flow of information through various channels.

2.2 STI Communication

There is ample evidence of the substantial amount of time spent by engineers in communicating, both as input to their work (reading, listening) and as output resulting from their work (written documents, presentations):

Research	Communicator	Hours or Proportion of Time	
Allen (6)	R&D	Total:	48% of time
Mick, et al. (264)	R&D	Total: Reading: Interpersonal: Other:	40% of time 9.8% of time 23.3% of time 7.0% of time
Griffiths/King (137)	R&D	Total: Input: Output:	1,190 hours; 50% of time 613 hours; 26% of time 577 hours; 24% of time
Pinelli, et al. (339)	Engineers	Total: Input: Output:	66% 31% of 40 hours/week 35% of 40 hours/week

Turoff (407) reports that scientists and engineers at AT&T spend two-thirds of their time communicating.

Although engineers spend a substantial amount of their time communicating, they choose to do so because their performance depends on communicating. Research reported over the years indicates that those who spend more time communicating perform better (e.g., 138, 182) or are high achievers (137, 241). Research also suggests that projects have a better outcome when the project staff communicates more (14). In recent years there has been an interest in designating companies as "learning organizations" that take advantage of what can be learned from outside sources of information.

Another aspect of STI communication is the many forms or media used for communication, including the published literature, and interpersonal conversations and formal presentations. The literature reports a wide difference in findings of the relative importance of various forms of communication.

However, the differences observed in importance of the literature versus interpersonal sources of information may reflect the niche required for all forms of communication. Clearly, most communication researchers have shown that ease of use or time required by users dictates information sources used by engineers. However, the purpose of use (and/or stage of a project) also affects sources used. For example, Gerstenfeld (123) shows that written sources are more commonly used for basic research and interpersonal sources for applied research. Allen and Gerstenberg indicate that experience and engineers' personality are related to literature use; that is, gatekeepers read more than others (e.g., 16).

2.3 Communication Through Primary STI Media

Primary STI media include formal publications such as journal articles, books, published meeting proceedings, technical reports, and patents. They also include engineering and related information recorded in non-paper media, such as audiovisual, CD-ROM, and so on, as well as information obtained through interpersonal means (see Section 2.3). Secondary STI media, on the other hand, are used principally to identify and locate primary STI sources, although sometimes primary data and information may be found in abstracts, etc. Allen, Tushman, Shuchman, Pinelli et al., and others have all observed that personal and interpersonal sources of information are much more likely to be used initially by engineers in addressing a project or problem. Engineers also tend to use internal technical reports more often than externally published materials. For this reason, these communication researchers have downplayed the importance of journal articles, books, and other externally published literature. While Allen and others report that published literature was not greatly utilized and was "mediocre at best in its effect," Shotwell (374) found quite the opposite. He found, in an R&D laboratory which emphasizes bio-sciences, that published scientific literature is reported to be the best source of ideas. Others also seem to find greater use of documents (e.g., 138).

During the 1960s and early 1970s, Garvey and colleagues also reported a small amount of reading of individual journal articles. Their research was performed by sending copies of tables of contents to a random sample of engineers and scientists and asking them if they had read the articles. From the large samples of engineers and scientists an average of about 5 to 10 readings per article title distributed was observed. The researchers gave these numbers in their reports. In some instances (e.g., 117), they reported that the **median** amount of reading per psychology article is about 200, when extrapolated from a 7 percent sample to the entire population. Both the 5-to-10 sample average amount of reading and the 200 median amount of reading findings have been quoted often. To some, these results have suggested that journals are not an effective means of communicating. From a statistical standpoint, however, it is found that the **average** is somewhat higher than the **median** since observations involve a highly skewed distribution of readings. Furthermore, the tables of contents were sent fairly soon after publication, so that amount of reading of articles beyond that time was not included or projected. King and colleagues (201) reviewed the Johns Hopkins data and extrapolated results in both dimensions. The time dimension was taken into account using an aging distribution developed by them. This produced an average amount of reading per article about five times greater than, for example, the reported 200 readings per psychology article. Later, from a 1977 national survey of engineers and scientists, it was estimated that the average reading per psychology article is 858 readings (197). Garvey's method was replicated by King and others, partially to understand it better and confirm the statistical validity of estimates produced by this method (210).

The 1977 national survey and statistical estimates of number of scholarly journal articles published show that all fields of science and technology average about 640 readings per article and engineering articles average about 1,800 readings per article (197). Even though individual engineers at that time read fewer articles (80 articles read per person per year for engineers versus 105 for all sciences), engineers produced even fewer articles per person than the other fields of science (0.03 articles published per person per year for engineers versus 0.14 for all sciences). Thus, the amount of reading by engineers per article published is far greater than for any of the other fields of science. From independent surveys (138) of scientists and engineers in six companies and government laboratories (late 1980s, n≈2,000), the average number of scholarly articles read by engineers is 45 readings per engineer (versus 75 for all sciences). Pinelli, et al.

(338) observed 6.7 average readings of articles in the last month by engineers (or about 80 annually). Amount of time spent reading journal articles is estimated to be about 50 hours per year per engineer. In later studies, Pinelli and colleagues observed averages of 14.8 and 16.9 readings over six months (313).

Other research reported by Meadows (258) indicated that 1.5 papers per week (or about 75 papers per year) are r d by engineers (versus, for example, 7.4 per week by medical professionals) and engineers average about 20 minutes per reading. Hall (144) reports that engineers spend about 5.5 hours per week reading journals. King, et al. (197) report results of communication research by others which indicate engineers spend 5.0, 19.1, and 2.2 to 3.5 hours per month reading journals.

The engineers in the six organizations mentioned above (138) average reading about as many published materials as other scientists (265 total readings per person per year for engineers versus 262 for all sciences), but the type of materials read is very different (see Section 3). The four most frequently read materials are internal reports (73 readings), trade journals (47 readings), scholarly articles (45 readings), and non-business or non-text books such as handbooks, reference books, etc. (26 readings). Extrapolating Pinelli's monthly average to a year, engineers surveyed by him average 50 readings of technical reports and 68 readings of the trade literature.

Griffiths and King (137, 138) show that amount of reading by scientists and engineers is positively correlated to five indicators of productivity; outcomes of readings are found often to be fa rable (savings are achieved and quality and timeliness of work is improved); and achievers tend to read more on the average than non-achievers. Lufkin and Miller (241) made similar observations in the late 1960s.

2.4 Interpersonal STI Communication

Interpersonal communication reviewed here covers meetings and conferences, as well as informal communication and discussions. It also includes a "hybrid" form of communication through teleconferences, e-mail, bulletin boards, and so on (which is interpersonal, but "recorded" and not strictly "oral"). Garvey, et al. (115), perform in-depth research concerning the role of national professional meetings (as part of the life-cycle of scientific and technical information). Griffiths and King (137, 138) present the number of formal presentations made and number attended, as well as amount of time required for both, broken down for internal and external meetings. Pinelli and colleagues (e.g., 328, 339) also discuss the extent of such communication, as well as time spent and consequences of this form of communication.

Allen, Tushman, Rosenbloom and Wolek, and most of the researchers who have used similar methods for observing communication patterns have examined informal interpersonal communications. Graham, et al. (132), performed early (1966) in-depth assessment of this form of communication. Tushman (411) also discusses factors that affect informal communication, purposes of use for this form of communication, and consequences of it. Griffiths and King (137, 138) give estimates of number of informal contacts and time spent in informal discussions. Pinelli, et al. (339), and Shuchman (377) also discuss the importance of informal forms of interpersonal communication.

The literature concerning electronic forms of interpersonal communication is merely touched upon here, hopefully to provide an entry into this extensive literature. Turoff and Scher (407), and Featheringham (100) report on early and extensive research sponsored by the National Science Foundation on computerized conferencing. Braham (55) discusses videoconferencing used by engineers. Electronic mail used in-house is described by Borchardt (47) and Shuchman (377); and Pinelli, et al. (e.g., 328, 339) performed extensive research into use of e-mail. Schaefermeyer and Sewell (365) also discuss communicating by electronic mail and present data on input resources and outcomes of its use.

2.5 STI Communication Through Secondary Media and Databases

2.5.1 Introduction

In this section a brief review is given concerning automated bibliographic searches and databases, printed indexes, and numeric databases. The literature concerning automated bibliographic searching is at least as extensive as th· involving primary communication in STI. A small sample of the literature is given here to provide access to this body of literature for those concerned with this form of STI communication. Less research seems to have been done with automated numeric databases and printed indexes. Much of the latter deals with selective dissemination of information (SDI). Several references discuss methods used to perform research in these areas. In particular, the reader is referred to Lancaster (225).

2.5.2 Automated Bibliographic Database Searches and Databases

During the 1960s a substantial amount of research was performed on information retrieval attributes — particularly regarding "quality" of search output. Measures, models, and methods were developed to observe the "relevance" of retrieved documents, as well as variations of measures of the proportion of relevant documents that are retrieved ("recall") and the proportion of documents retrieved that are relevant ("precision"). In addition, two in-depth test databases were developed in order to examine alternate retrieval methods and different retrieval measures. The first of these was developed by Cleverdon at Cranfield, UK, and the second by Salton at Harvard University and then Cornell University. Only a relatively small portion of this research involved user participation. There are a number of state-of-the-art reviews of this work including, to name a few, King (209) in the 1960s, Saracevic (364) in the 1970s, and, more recently, Kantor (175), Mischo and Lee (266), and Mailloux (244). The in-depth research on relevance, recall, precision, and the like dissipated in the 1970s when automated retrieval systems went online, although there has recently been a renewed interest in the definition and meaning of relevance. In fact, an upcoming chapter has been prepared by Linda Schamber for the 1994 *Annual Review of Information Science and Technology* (Vol. 29) which re-examines the history of this attribute.

Recent research on automated bibliographic database searching tends to be evaluation or research involving system innovation, such as exemplified by Borgman, Case, Cerney, and Meadow (48, 49, 50, 51, 65, 66, 259), King (207), Kuhn and Cotter (222), Posey (345), and Williams (442). Also, a substantial amount of user research deals with "end-user" searching. Such research is typified by Buntrock (62), Dedert and Johnson (85), Lescoheir, Lavin, and Landsberg (231), Richardson (352), and Walton (428).

Another body of research involves end-user surveys to determine the proportion of population that uses automated bibliographic database searches, or amount of searching done. These research projects focus (variously) on factors such as amount and quality of searching, time spent searching (or negotiating searches), purposes for using the service, and estimates of the usefulness, importance, and value of such services. Large-scale national statistical surveys of users are typified by two studies in the 1960s (37), and more recently reported by Griffiths, et al. (137, 138), and by Wanger, Cuadra, and Fishburn (429). These studies examined extent of use and factors affecting use. Other studies are based on user surveys of limited populations including: academic and industrial scientists and engineers, by Bayer, Jahoda, and Needham (32, 33, 170); aeronautics and astronautics engineers and scientists, by Pinelli, Kennedy, Barclay and colleagues (typified by Barclay, et al. (28)); R&D professionals in industrial and government organizations, by Griffiths and King (137, 138); forensic engineers, by Fairbanks (99); small, high-tech firms by King, et al. (194), and energy scientists and engineers by King, et al. (196). Other articles address other aspects of searching, such as reported by Hill (157), Smith (384), and Williams (443).

Williams (441) presents an excellent overview of engineering and scientific databases, including bibliographic databases, full-text databases, and numeric databases. During the 1980s, she also developed a proprietary statistical database which describes the extent of use of specific databases (including engineering-related ones). This service reports these data on a periodic basis (440). Williams (in 138) provides trends on the extent of use of various types of databases from 1978 to 1990. These trends include, among others, total number of searches, connect hours, cost, revenue, and so on.

In addition to the Williams reference above, several other studies have been performed on automated numeric databases. An extensive study of numeric databases used by engineers is reported by Engineering Index, Inc. (423). This study estimates use and discusses factors related to use. Griffiths, et al. (138) report results of a national survey performed in 1984 which estimates amount of use of various types of numeric databases and time spent using each type. Other aspects of numeric database use are discussed by Kröchel (220) and Sterling (388).

A number of studies involve printed indexes and abstracts, including a study by Hurd of their use in an academic library (167). Pinelli, Kennedy, Barclay, and colleagues include printed indexes prepared by NASA and DoD as part of their extensive research (e.g., 328, 338). King, et al. (195), examine the use, usefulness, and value of the Energy Data Base, including online searching as well as Department of Energy printed indexes. Several studies assess selective dissemination of information (SDI) systems and services. These include Hall (145), Mondschein (268), Packer (282), and Sheppard (373).

2.6 Use of Libraries, Information Analysis Centers (IACs), and Clearinghouses

Allen (8), Shuchman (377), and Pinelli, et al. (339) show that library resources and librarians are relatively infrequently used by engineers as a source of information for recent major projects. Pinelli, et al. (339) estimate that aerospace engineers use a library an average of 3.2 times per month (or about 38 times per year). Siess (379) reports data that show that libraries are used by engineers between 28 and 64 times a year depending on the type of research reported. King estimated in 1984 that engineers use a library an average of 54 times per year (in 138). For six organizations surveyed independently in the late 1980s and early 1990s (138), the average is found to be 39 uses per year, which is very close to Pinelli's observation. The 1984 estimate was from a random sample of engineers including academics, which may partially account for the difference between it and the surveys done in organizations in the late 1980s and early 1990s.

King and Griffiths performed independent in-depth studies of the use of libraries in 27 organizations from 1982 to 1993 (137). These studies show that libraries in organizations fill a very special niche in communication processes. For example, most older articles (more than about two years old) that are read by scientists and engineers come from libraries, and these articles are far more useful and valuable than articles read from personal subscriptions (because the latter are read most often for current awareness or continuing education purposes). Libraries are also used by engineers to read journals that are infrequently read by them and/or that are particularly expensive. Engineers and scientists generally act in an economically rational way in considering where they obtain literature by taking into account their time and journal prices. The substantial increase in journal prices over the years has meant that engineers and scientists have decreased their number of personal journal subscriptions (5.7 per person in 1977, 4.0 in 1984, and 3.7 in the late 1980s/1990s). The proportion of all readings that are from library-provided journals has correspondingly increased (18 percent in 1977, 27 percent in 1984, and 32 percent in the late 1980s/1990s). Even so, the number of personal subscriptions (about half of which are paid for by companies) far exceeds the number of library subscriptions in companies, typically by a ratio of 5 to 1. Griffiths and King (137) have demonstrated the usefulness and value of organization libraries and their services and they cite a number of similar results reported b others.

Several in-depth studies have been performed to assess IACs. A Coastal Engineering IAC was described by Weggel in 1973 (431). Mason (249) conducted a cost benefit analysis in 1977. At about that time Corridiodore (72) studied Department of Defense IACs, and Engineering Index, Inc., performed a study of IACs and numeric data provided by them (423). In the early 1980s, Roderer and King (in 195), examined the use, usefulness, and value of two IACs (Network Energy Software Center and the Radiation Shielding Information Center). Extensive studies have also been performed on federal clearinghouses, including a study by McClure, et al., on the National Technical Information Service (253), and studies by Pinelli, et al., concerning other federal centers (e.g., 299).

2.7 State-of-the-Art and Literature Reviews of Engineers' Information Needs, Information-Seeking Processes, and Information Use

There has been a large number of reviews of engineering communication and related literature. Many useful reviews can be found in the *Annual Review of Information Science and Technology (ARIST)*, published annually since 1966 by the American Society for Information Science. In particular there is a series of chapters in *ARIST* on Information Needs and Uses, authored by most of the exemplary researchers in this subject over the past four decades: Menzel in Volume 1 (260), Herner and Herner in Volume 2 (152), Paisley in Volume 3 (285), Allen in Volume 4 (11), Lipetz in Volume 5 (236), Crane in Volume 6 (78), Lin and Garvey in Volume 7 (235), Martyn in Volume 9 (248), Crawford in Volume 13 (79), Dervin and Nilan in Volume 21 (88) and Hewins in Volume 25 (156). In addition, just about every related information and communication topic is covered by *Annual Review of Information Science and Technology* over the years, including engineering information systems (Mailloux (244)), bibliometrics (White and McCain (435)), technical utilization (Thompson (402)), gatekeepers (Metayer-Duran (263)), information marketing (Tucci (404)), information retrieval (Kantor (175)), cognitive research information science (Allen (2)), and end-user searching of bibliographic databases (Mischo and Lee (266)), to name just a few examples.

Apart from the *Annual Review of Information Science and Technology* volumes, there are several books that serve as a literature review or that have a useful range of information needs and use chapters prepared by knowledgeable researchers. Examples of such books include *Key Papers in Information Science*, edited by Griffith (135); *Encyclopedia of Library and Information Science*, edited by Kent (190); *Communication Among Scientists and Engineers*, edited by Nelson and Pollock (278); *Scientific Communications and Information*, translated from Russian by Burger (265); *TechnologyTransfer: A Communication Perspective*, edited by Williams and Gibson (439); *The Future of the Printed Word*, edited by Hills (158); and *Managing Professionals in Innovative Organizations*, edited by Katz (180). Many of the articles and other materials covered in this bibliography are found in one form or another in these books. Certainly the scope of topics found here is also covered in these books. Some journal articles also serve as reviews of information use or communication-related issues. One excellent recent review of electronic publishing of journal articles is authored by Schauder (367). In addition to providing some of his primary research results concerning electronic-related issues and potential acceptance of electronic formats, Schauder covers most aspects of electronic publishing from copyright to economics to technical feasibility. Unfortunately, few of the references cited in his article are found to present hard data, and for many of those that do, the data are now out of date. In 1991 Pinelli (327) provides a useful review of the literature dealing specifically with information-seeking processes of engineers. Part of this review deals with the nature of science and technology, differences between engineers and scientists (see Section 3), and factors that affect use of information and information sources. He also specifically discusses the research of Herner (153), Rosenbloom and Wolek (359), Allen (8), Kremer (218), Shuchman (377), and Kaufman (184). Pinelli (314) also reviews the research literature and comments on a research agenda for scientific and technical information with a focus on users. Poland (343) reviews the literature concerning information communication among scientists and engineers. Aloni (17) discusses literature dealing primarily with informal and formal communication among engineers in R&D-like organizations. This extensive analytical review is useful to those interested in information-seeking processes, gatekeepers, boundary spanning, and related issues. Gupta (140) does a good job of showing comparative data from studies performed prior to 1981 — particularly regarding types of information, sources (e.g. internal or external), and factors related to sources used. In 1974, King and Palmour (206) provide an early review of user behavior; Wood (449) covers user studies from 1966 to 1970; and in 1966 Lufkin and Miller (241) give an early review of the literature on reading habits of engineers and provide some revealing survey data of their own.

Several relevant literature reviews are given in the technical report literature or the reviews are a part of major reports. For example, Broadbent and Lofgren (60) in 1991 review the literature concerning library and information center use, usefulness and value. In 1989, Chang (68) provides an analytic review of the literature from the perspective of three information needs and use models. Earlier in 1979, Lowery (240) reviewed a number of user studies from the perspective of factors that affect information-seeking behavior of scientists and engineers. Hensley and Nelson (151) discuss the literature concerning information users and uses, and in 1972 Havelock (147) compiled a bibliography on knowledge utilization and dissemination.

Section 3
Distinguishing Engineers from Scientists

3.1 Introduction

The kind of work performed by engineers tends to be considerably different from that done by scientists. Thus, information needs and information-seeking processes vary considerably between engineers and scientists in order for these two groups to accommodate their work objectives. Unfortunately, a substantial amount of research concerning STI communication does not make a distinction between engineers and scientists. In this section, several articles and technical reports are reviewed which present differences between engineers and scientists. These materials are briefly discussed in Section 3.2. In Section 3.3 some specific data are presented concerning the extent of use of the literature and other information services by engineers and by scientists. The overall review of the literature discussed below attempts to determine whether or not the research reported made a determination as to whether survey respondents (or the focus of the research) specifically involved engineers. A listing of citation numbers for communication research specifically involving engineers is given in Section 7.1.

3.2 Literature Which Distinguishes Engineers and Scientists

An assessment of information needs of seven specific fields of science (physics, chemistry, biology, geosciences, astronomy, mathematics, and computer science) and engineering is made by Gould and Pearce (131). This assessment is based on in-depth interviews and consultations with 131 individuals who teach, conduct research, or who are clearly connected with scientific research. Each field of science and engineering is discussed regarding:

- The nature of research performed,
- The nature of information,

- The future for information in the field, and
- The use of engineering information, including:

  (1) the use of primary literature (serials, patents, technical reports, standards),

  (2) major indexing and abstracting services (print and electronic)

  (3) current awareness services and products (current research, electronic networks, conference proceedings, letters journals, newsletters, technical reports, preprints, databases),

  (4) other electronic sources, and

  (5) future needs and directions (of the literature, electronic resources, interpersonal information environment, education, and data).

Regarding engineering information, Gould and Pearce conclude that:

- Quick access to all types of literature will continue to be a fundamental need, use of document delivery systems will grow, and major indexes need to be improved regarding grants and certain proceedings and technical reports.
- Engineers will seek and use a more integrated information environment, including electronic full-text, graphics, materials property data, and gateways to commercial databases and software collections.
- Formal education needs to emphasize current and emerging information tools and sources of information.
- Growth and emerging capabilities open up opportunities for networked and shared evaluated physical property and other data.

The results demonstrate that not only are engineering and science information needs different, but all individual fields of science are unique in themselves.

Early reviews also point out differences between engineers and scientists. For example, Blade (44) in 1963 discusses the nature of engineering, including aspects of creativity, research, and education. In 1967, Rosenbloom and Wolek (359) present examples of differences observed regarding engineers' and scientists' sources of information (see Section 3.3). In 1988, Allen (6) explores some of the principal differences observed in some of his and other research projects (see Section 3.3). He also discusses the relation between science and technology, and how knowledge diffuses over time from science to technology and finally into products. He shows how information flows among these phases of research and development, and gives some data from citation analysis to demonstrate his model of this flow. Pinelli (327) provides a very useful summary of the literature concerning these distinctions. In particular, he surveys most of the significant literature regarding information-seeking processes and the factors that explain these differences.

3.3 Some Quantitative Observations of Engineers' and Scientists' Information Sources Used

Rosenbloom and Wolek (359) surveyed more than 3,000 engineers and scientists in large corporations and from a sample of members of the Institute of Electrical and Electronic Engineers. One principal focus of the data collection was to determine information sources used by engineers and scientists to perform their work. Respondents were asked to report their most recent instance in which an item of information proved to be useful in their work (excluding someone in their immediate circle of colleagues). Sources used are summarized as follows:

	Proportion of Instances (%)	
	Engineers	Scientists
Sources within own company		
Interpersonal		
Local source (within establishment)	25	18
Other corporate	26	9
Written media (documents)	12	6
Sources outside company		
Interpersonal (anyone outside company)	11	16
Written media		
Professional (books, articles, conference papers)	15	42
Trade (trade magazines, catalogs, technical reports)	11	9
	100	100

Clearly, these engineers in the 1960s relied much more on sources found in their own organization than on external sources (63 percent versus 33 percent), and they relied more on interpersonal sources than on written materials (62 percent versus 43 percent). Scientists' most important source was the published literature (43 percent of instances).

Allen (6) reports comparisons observed in the early 1980s between information sources used in performing technological projects and scientific research projects. Sources (or channels) used in these projects are summarized below:

	Proportion of Instances (%)	
	17 Technological Projects	2 Scientific Research Projects
Literature	8	51
Vendors	14	0
Customer	19	0
Other external sources	9	14
Lab. technical staff	6	3
Company research programs	5	3
Analysis and experimentation	31	9
Previous personal experience	8	20
	100	100

These results suggest that engineers are more dependent on colleagues and scientists use the literature more than engineers do. Allen points out that engineers also need different kinds of journals and they use the literature for entirely different purposes. Engineers spend 7.9 percent of their time using the literature versus 18.2 percent by scientists (or 48 percent and 64 percent of total time spent communicating).

Griffiths, et al. (138), report results of nearly 10,000 survey responses from scientists and engineers studied across a six-year period. To simplify the comparisons, scientists are grouped into natural science (physics, chemistry, mathematical, environmental, life) and other sciences (computer, psychology, social science). Some comparisons are given below:

Type of Document	Average Annual Number of Readings*		
	Engineers	Natural Scientists	Other Scientists
Scholarly journals	45	125	70
Trade journals	47	45	47
Scholarly books	14	19	12
Other books	26	28	31
Internal reports	73	37	60
External reports	8	9	7
Patent documents	6	3	1
Other documents	46	52	25
	265	318	253

*"Reading" means going beyond the title, abstract, etc., to the body of the text. Surveys conducted in late 1980s and early 1990s.

Total reading by engineers is somewhat less than by natural scientists, but about the same as other scientists. Engineers read far fewer scholarly journals, but more internal reports. Otherwise, amount of reading of the other types of documents is not appreciably different.

Griffiths, et al. (138), also report that the use of libraries for work-related purposes (late 1980s) is far less by engineers than by scientists: 39 times per year per person by engineers; 96 times by natural scientists; and 80 times by other scientists. A national survey reported by them in 1984 shows 54, 60, and 68 times per year, respectively. The late 1980s results are largely from companies and government agencies, whereas the 1984 national statistical survey included academic engineers and scientists as well. It is believed that academic engineers use libraries more frequently than do other engineers. In the 1984 survey, engineers were observed to use automated bibliographic searching far less than scientists: 0.8 average times per year engineer; 5.8 times by natural scientists; and 1.7 times by other scientists. The 1984 survey showed that the proportion of engineers who use computers is about the same as scientists (85 percent of engineers), but engineers averaged fewer hours using the computers.

Section 4
Some Sustained and Exemplary STI Communication Research

4.1 Introduction

Several organizations have conducted sustained STI communication research involving engineers and scientists over a lengthy time. Also, some exemplary studies have been performed over the past 25 years which deal exclusively or largely with information-seeking processes of engineers. This section describes the historical progression of these research efforts. The first of these research efforts, headed by William D. Garvey at The Johns Hopkins University, began in the early 1960s. The second series of seminal studies of communication patterns in R&D laboratories was begun by Thomas J. Allen at the Massachusetts Institute of Technology and then by Michael Tushman and others. A third study effort, involving statistical descriptions and indicators of STI communication, was begun in the 1970s by Donald W. King and colleagues at King Research, Inc. From 1977 through 1980, Hedvah L. Shuchman of The Futures Group performed surveys of engineers in the U.S. to determine their information-seeking behavior. Beginning in the early 1980s, Thomas E. Pinelli and colleagues performed communication research at NASA Langley Research Center. Later he was joined by John M. Kennedy and Rebecca O. Barclay to perform a long series of studies of communication patterns of engineers and scientists located in a number of countries. All of these studies involved extensive data collection from statistical surveys performed nationally using lists from engineering and professional societies, or surveys conducted in companies and other organizations. These survey approaches are also briefly described.

4.2 Research Studies in Patterns of Scientific Communication by William D. Garvey and Colleagues at The Johns Hopkins University

In the 1960s, the National Science Foundation sponsored William D. Garvey and Belver C. Griffith to perform a series of communications studies involving psychology. These studies expanded to other fields of science and continued into the 1970s. The studies had two particularly valuable thrusts. The first thrust concerned the "flow" of scientific information through various communication channels such as internal reports, professional meetings, journal articles, and so on. The research established a timeline as to when, following creation, the information appears in each of the channel sources, and it also shows that information giving research results can appear in multiple publications, such as in several journal articles. The second research thrust dealt with the extent to which information is used, particularly in the journal literature.

A useful summary of this work is found in *Communication: the Essence of Science* (111), published in 1979. The first five chapters, authored by Garvey, provide a philosophical discussion of the role of communication in its many forms in the conduct of research and creation of scientific knowledge. Particular emphasis is given to journal articles. Following that are ten principal papers co-authored by Garvey and his colleagues over the years (in totality Griffith, Lin, Nelson, Tomita, Gottfredson, Goodnow, and Woolf). This research provides substantial detail about the creation and forms of communication of scientific knowledge, particularly giving a time span on the many forms of STI communications. They discuss in detail the many informal and formal interactions among scientists and show that a relatively small portion of scientists write journal articles in a given year. Thus, publications, such as journal articles, are found to be much more diffusion mechanisms than the point-to-point interpersonal forms of communications.

In order to trace the various channels used to transfer information, the researchers designed an elaborate longitudinal study which they classified as study Series A through G. The longitudinal studies included engineering scientists (chosen from engineering societies — American Society of Heating, Refrigerating and Air-Conditioning Engineers; American Institute of Aeronautics and Astronautics; American Institute of Mining, Metallurgy and Petroleum Engineers; and Optical Society of America), physical sciences, and social sciences. Series A involved national professional meeting presentations, with survey samples of 1,715 authors, 14,873 attendees, and 1,344 paper requestors. The major purpose of this series was to develop a time base from inception of research, through pre-meeting dissemination phases, to post-meeting publication. Series B and C involved follow-up of presenters one and two years following the meeting (1,784 and 405 presenters respectively) to determine journal publication status of information presented and related information. Series D included a survey follow-up of persons who requested copies of the original presentation to compare the usefulness of the information found in the copy of the presentation and the journal article (313 requestors). This also provided a means to determine awareness of the journal article. Series E was a study of authors of journal articles (3,676 articles/authored) to determine the communication processes associated with journal publication and subsequent appearance in abstracting journals and as citation in subsequent articles. This also provided evidence of time sequence. Series F was a study of the information-exchange activity among workers in the same subject-matter area (1,937 persons). This research helped establish the extent of informal networks (i.e., including invisible colleges). Finally, Series G involved a follow-up of Series E articles/authors to examine further or subsquent work in the same subject-matter area (2,023 articles/authors).

Research also examined information use in great detail. The researchers determined "the nature of information needed" and related such needs to stages of scientific work and source of obtained information needed for the most recently completed activity. Of seven sources used, journals were reported by a higher proportion of scientists successfully using sources to obtain needed information. Other sources in decreasing proportions are local colleagues (nearly as high as journals), books, technical reports, non-local colleagues, meeting presentations, and preprints.

4.3 Studies of Communication Networks in R&D Organizations by Thomas J. Allen and Colleagues at Massachusetts Institute of Technology

In the mid-1960s, Thomas J. Allen began a series of studies which have continued to the present. Much of this effort was performed at the Massachusetts Institute of Technology under grant from the National Science Foundation. One of the studies involved "record analysis" (like a diary) and a self-administered questionnaire, with responses from 1,153 engineers and scientists. Some of the studies involved in-depth recordkeeping over an extended period of time by a relatively small number of engineers and scientists (probably less than 50). The stage or phase of research or development was recorded, as were instances of use of specific information channels. These studies spawned a series of studies by others that have continued into the 1990s. Many such studies have adapted or semi-adapted the principal method used by Allen, which was to observe sources or the channels used to support a specific research or development project.

One of the approaches used by Allen and colleagues was to observe exchanges or flow of information between individuals working in an R&D organization. They discovered that there tended to be individuals, referred to as "stars" or "gatekeepers", whom others depend heavily upon for internal, as well as external, sources of informatior These stars are particularly familiar with not only internal technical reports and the published literature, but they are also aware of knowledgeable internal and external interpersonal sources of information. Allen also made a point of distinguishing the differences in information-seeking behavior of scientists and engineers. As a result of these findings, Allen and colleagues made a number of suggestions as to how R&D organizations should be organized and structured to optimize communication processes, particularly involving engineers.

Allen and colleagues identified nine basic information channels:

- Literature: Books, professional, technical, and trade journals and other publicly accessible written material.
- Vendors: Representatives of, or documentation generated by, suppliers or potential suppliers of design components.
- Customer: Representatives of, or documentation generated by, the government agency for which the project is performed.
- External sources: Sources outside the laboratory or organization which do not fall into any of the above three categories. These include paid and unpaid consultants and representatives of government agencies other than the customer agency.
- Technical staff: Engineers and scientists in the laboratory who are not assigned directly to the project under consideration.

- Company research: Any other project performed previously or simultaneously in the laboratory or organization regardless of its source of funding. This includes any unpublished documentation not publicly available, and summarizing past research and development activities.

- Group discussion: Ideas which are formulated as the result of discussion among the **immediate** project group.

- Experimentation: Ideas which are the result of test or experiment or mathematical simulation with no immediate input of information from any other source.

- Other division: Information obtained from another division of the same company.

In-depth research by Allen and colleagues determined the extent to which these channels are used and which appear to be most useful, and also identified the factors leading to their use.

Some basic conclusions of the studies are:

- Performance of R&D organizations and individual engineers and scientists depends to a great degree on the extent of communication practiced. For example, evidence suggests that the proportion of time spent gathering information is related to the quality of the solution produced and that those considered to be high performers communicate much more extensively than low performers.

- Engineers and scientists tend to rely on specific individuals for information. Such "information stars" tend to have high status/prestige in the organization. Persons with high status tend to communicate among themselves, or those with "low" status come to them (but not the other way). Such information stars are much more exposed to the literature and outside sources of knowledge.

- The gatekeeper's function involves a two-step process which first absorbs information from various sources outside the organization, and then transfers and disseminates relevant information to individuals inside the organization.

- Engineers tend to use interpersonal communication extensively, and they rely on internal technical reports more than on the formal published literature.

- Communication, and thereby performance, in organizations can be improved by structuring R&D organizations and projects to facilitate communication practices and to enhance gatekeepers' communication abilities and participation.

- Factors leading to channel use include accessibility as the most important determinant of the overall extent to which an information channel is used. Accessibility and perceived technical quality both influence the choice of the first source of information used. Experience with channels determines the perception of accessibility.

- Specific information sources/channels used are a function of both the design function being performed and the phase in which the project happens to be. Research requires much more use of the formal literature than development does. Extent of literature use is cyclical throughout the project phases.

These studies have served as the underpinnings of studies by Tushman, Shuchman, and Pinelli, Kennedy, Barclay, et al. described below.

4.3.1 Expansion of Allen's Work by Tushman and Colleagues

Tushman began a series of studies of communication in organizations as part of his doctoral thesis under Allen's supervision. His most extensive research involved a survey of professionals in an R&D facility of a large corporation. In this survey he relied on a "personal contacts record" for 15 weeks, in which data were recorded one day a week on specified days. All together, more than 400 professionals were surveyed. Communication was studied in terms of several dimensions: the type of work being performed (i.e., basic and applied research, development, and technical service), level of dependence on information (intra-project, intra-firm, and extra-firm), environment in which task is performed (i.e., stable or turbulent), and perception (by others) of the projects as being high- or low-performing. He also examined the relevance of (1) information "stars" who are approached as an information source with high frequency by colleagues, (2) "boundary spanners" who span communication boundaries between units in an organization or between projects in the organization and the outside, and (3) "gatekeepers" who are information stars and boundary spanners.

4.4 Statistical Description of STI Communication by Donald W. King and Colleagues at King Research, Inc.

This work has spanned more than three decades. Its principal contribution from the perspective of this review has been to provide a broad statistical description of the scientific and technical information and communication environment. Prior to 1970 most of this research involved evaluation and economic analyses of information systems and services performed for the U.S. Patent Office, National Technical Information

Center (and its predecessors), American Psychological Association, the U.S. Air Force, and others. In 1972, as a result of work under an NSF contract, King and Edward C. Bryant authored a book (208) on evaluation of secondary and primary information services. The evaluation addressed each of six principal functions of information transfer: composition, reproduction, acquisition and storage, identification and location, presentation and assimilation (use). For each function, examples were given for cost variables on the one hand and, on the other hand, service attributes related to service demand, use of information, and ultimately to value of the services.

In 1973, for the 10th Annual National Information Retrieval Colloquium, King and Vernon E. Palmour prepared a state-of-the-art review on user behavior (206). They modified a model presented by Lin and Garvey (235) by imposing user behavior on three basic aspects of the scientific information system: information needs, information seeking and exchange, and information uses. "Information needs" is defined as the information messages needed, and "information uses" as the purposes for which information is used (e.g., conducting research, education, writing, etc.). Also added are information requirements, which are user specifications of information and service attributes (e.g., accuracy of information, timeliness of service provision) involved in information seeking and exchange (and information organization and management). The latter two aspects include the six functions of information transfer discussed above.

In 1972, King and colleagues were awarded an NSF contract to develop the concept of editorial processing centers (EPCs). The basis for this work was to examine the economic and technical feasibility of centers which could obtain and process article manuscripts in electronic form. Such electronic media could be aggregated into one or more databases of articles which might serve as a means to disseminate separate copies of journal articles in electronic form. This work led to two additional areas of inquiry by King and his colleagues.

The first area of inquiry, beginning in 1974, was a series of studies under NSF contract to develop Statistical Indicators of Scientific and Technical Communication. This research provided a series of trends (1960 to 1974) and projections (1975 to 1980) for STI literature (books, journals, technical reports, etc.), library and secondary services, authorship and information use activities of scientists and engineers, and total STI expenditures in the U.S. The six information transfer functions mentioned before were expanded to ten: (1) research and information generation (new), (2) composition, (3) recording (new), (4) reproduction, (5) distribution (part of presentation), (6) acquisition and storage, (7) organization and control (new), (8) identification and location, (9) physical access (part of presentation), and (10) assimilation by user. Each function was examined in detail to determine amount of STI activity and total STI expenditures. Among other findings, the results showed that the "information explosion" merely reflected growth in number of scientists and engineers. For example, the number of articles published per scientist or engineer was nearly constant over a 15-year period (1960 to 1974). Another major finding was the careful estimates of the very large amount of S&T communication resource expenditures ($8.5 billion in 1974).

A second area of inquiry, started in 1976, involved the feasibility of electronic publishing of journal articles (199). The study concluded that current and near-future (to 1988) economics and technologies pointed to a two-tier system of dissemination of articles in both traditional paper form **and** electronic form. As an extreme example, if an engineer or scientist reads all articles in a journal, the journal and acquisition cost per reading is very low (in fact, much lower than could be expected at that time by electronic distribution). If an engineer or scientist reads only one article from the journal, the cost per reading is very high if the reader is sent the entire set of journal issues (or even one). Thus, the cost per reading of electronic distribution is much less than paperform for this instance. At some amount of reading there is a break-even point for those two options. Taking into account the frequency distribution of such readership as well as all available channels of distribution (i.e., personal subscriptions, libraries, person-to-person, etc.), ages of articles read, and sources of costs (e.g., pre-run, run-off, database, etc.), a two-tier system involving both electronic and paper forms was clearly best at that time and for the foreseeable future.

Results from all the journal studies were published in 1981 (197). In this book, fourteen basic channels of flow of information found in articles are described in detail. Estimates of amounts and costs are made for the flow of information among scientists (as authors), publishers, secondary organizations, libraries, scientists (colleagues), and scientists (as end-users). Much of this information is based on a statistical survey of scientists and engineers (2,350 usable survey responses) in which a critical incident of reading established time spent reading, how the article was identified, where it was obtained, purpose of reading, consequences of reading, and so on. An author survey was also conducted. One finding is that the average amount of reading of individual articles (and journals) is far greater than previously thought by many (including the researchers).

In 1981 King and colleagues began a series of studies to examine the use, usefulness, and value of scientific and technical information and the contribution that STI services make to these outcomes. The initial study (funded by the Department of Energy) focussed on products from the Energy Data Base (196). Previous studies and surveys done by King, et al., were complemented with surveys of users of energy-related journals, technical reports, printed indexes, and online searches. "Value" is estimated by the "price" paid by engineers in terms of the time the spend identifying, acquiring, and using information, and by self-reported "savings" achieved from information obtained from the services and publications. A follow-up study further examined the usefulness and value of libraries and information analysis centers (195). Again, much of the analysis was based on user surveys.

In 1984 the National Science Foundation sponsored follow-up surveys of scientists and engineers to determine journal article authorship and reading, as well as use of libraries, technical report reading, and use of automated bibliographies and numeric databases. Another study was sponsored by the Small Business Administration to determine information needs and sources of information used by scientists and engineers found in small, high-tech firms (194).

From the 1980s to the present, King, Griffiths, and colleagues have performed a series of 31 proprietary studies in companies, government agencies, and universities to determine communication activities of professionals (including scientists and engineers). All together, more than 10,000 survey responses have provided estimates of quantities and effort (time) required for information inputs (using documents and by interpersonal means), information outputs (writing and interpersonal means), channels used, and consequences of using information and information services. Results of the communication practices of scientists and engineers (culled from surveys done in the late 1980s) are presented in a report to NSF (138) and in a forthcoming book. Results aggregated by those engaged in R&D are also presented in a book (137) prepared under grant from the Special Libraries Association. This book presents data on the amount of reading of various materials and the consequences of information read on productivity and other measures of performance of readers. Results of these studies show that scientists and engineers spend a majority of their time communicating through formal publications and interpersonal means. A great deal of time is spent reading (337 hours per year), but those who read more tend, on the average, to be more productive and achieve more (see also 241). Scientists and engineers use a variety of information sources and utilize multiple channels (e.g., libraries, etc.), but do so in an economically rational way. The "price" paid in time spent by engineers and scientists in reading is appreciably greater than the cost of services and products used to obtain the documented information. These studies also demonstrate considerable use and value of organization libraries and individual services provided by these libraries (137).

4.5 *Information Transfer in Engineering*, a Major Study by Hedvah L. Shuchman and Colleagues at The Futures Group

From 1977 through 1981, Hedvah L. Shuchman (The Futures Group) performed an in-depth study, sponsored by the National Science Foundation, based on a national survey of engineers (only). This two-stage survey, conducted in 1979, consisted of choosing 89 firms employing 14,797 engineers and sub-sampling 3,371 engineers from these firms. A self-administered questionnaire was distributed to these engineers, with 1,315 engineers responding. Among other topics, the survey dealt with steps taken in looking for information thought to be needed to work out a solution for the most important technical project or task currently being worked on. The most frequently reported steps include: personal store of technical information (93 percent of cases), informal discussions with colleagues (87 percent), and discussions with supervisors (61 percent). Library sources (technical journals, conference reports) were sixth among steps (35 percent), and databases were eighth (20 percent).

There is some discrepancy in information reported to be needed by engineers and that reported to be produced by them. For example, basic S&T knowledge (ranked first of sources of information needed) was said to be needed by 82 percent of engineers, but only 34 percent said they produced this type of information. The next four sources of information needed included in-house technical data (72 percent), physical data (57 percent), product characteristics (49 percent), and design methods (48 percent). Information produced by engineers included in-house technical data (59 percent), new methods (41 percent), design methods (40 percent), and physical data (38 percent). When engineers read magazines or journals, they mostly read industry information, engineering society journals, and general news magazines, mainly to keep current in their field. Internal sources of information are considered much more important to engineers than external sources.

Data are also provided on use of technology by engineers. Most frequently reported technologies used at that time (late 1970s) include keyboards (62 percent of engineers), line printers (56 percent), computers (54 percent), microform (54 percent), slides (52 percent), audio calls (58 percent), facsimile (49 percent), and video display (44 percent). At that time, technologies considered potentially useful were graphics recognition (46 percent), video tape deck (43 percent), and computer-aided instruction (42 percent).

4.6 Studies of Aerospace Engineers and Scientists Performed by Thomas E. Pinelli, John M. Kennedy, Rebecca O. Barclay, and Colleagues for NASA and the Department of Defense

4.6.1 Early Research

From the early 1980s until the present, Thomas E. Pinelli and colleagues first from NASA Langley Research Center and then from elsewhere have performed a series of remarkable studies of technical communications in the aerospace field. These results have been extensively reported in NASA Technical

Memoranda and published papers. In 1980, a user needs study was conducted by Pinelli and colleagues to determine if Langley's STI program met those needs (342). The study was limited to formal STI documents processed at or by the Langley STI program, and included a review of previous studies done there; an audit of documents and information processes; a statistical, in-depth survey of 55 engineers and scientists; and a self-administered survey (n=647 valid responses). Surveys dealt in particular with user perceptions of attributes (e.g., quality, timeliness, etc.) of internal report processes, and extent to which scientists and engineers used STI services and products such as publications, conferences, bibliographic services, etc. They also asked how important publishing is to the respondent's professional advancement (60 percent said very important).

4.6.2 Studies of Aerospace Engineers and Scientists

The diffusion of knowledge, including its production, transfer, and use, is an essential part of aerospace research and development (R&D) and is of paramount importance to the process of innovation within the U.S. aerospace industry. To learn more about this process, researchers at the NASA Langley Research Center, the Indiana University Center for Survey Research, and Rensselaer Polytechnic Institute organized a research project to study knowledge diffusion in aerospace. Sponsored by NASA and the DoD, the *NASA/DoD Aerospace Knowledge Diffusion Research Project* was conducted by Dr. Thomas E. Pinelli, Dr. John M. Kennedy, and Rebecca O. Barclay.

Endorsed by aerospace professional societies and sanctioned by certain groups and panels, the *NASA/DoD Aerospace Knowledge Diffusion Research Project* was begun in 1989 as a five-year project "to provide descriptive and analytical data regarding the flow of scientific and technical information (STI) at the individual, organizational, national, and international levels and to examine both the channels used to communicate STI and the social system of the aerospace knowledge diffusion process." The Project, in four phases, focused on technology rather than science and on engineers rather than scientists and takes the position that STI that results from federally funded aerospace R&D is an economic asset or resource rather than a component of national security.

The research results of the Project could be used to understand the information environment in which U.S. aerospace engineers and scientists work (that is, the academic, government, and industrial sectors), the information-seeking behavior of U.S. aerospace engineers and scientists, and the factors that influence their use of STI. Such an understanding could (1) lead to the development of practical theory, (2) contribute to the design and development of systems for diffusing aerospace information, and (3) have practical implications for transferring the results of federally funded R&D to the U.S. aerospace community. To date, 28 Project reports and 42 Project papers have been published. All Project publications are available from the National Technical Information Service (NTIS). A brief description and summary of the four Project phases follows.

Phase I

Phase I concentrated on describing and explaining the information environment in which U.S. aerospace engineers and scientists work (that is, the academic, government, and industrial sectors), the information-seeking behavior of U.S. aerospace engineers and scientists, and the factors that influence their use of STI. Survey research, in the form of self-reported mail questionnaires and telephone surveys, was used for data collection because of the capability of this methodology to gather data on a population that is too large and geographically dispersed to observe directly. Questionnaires permitted large amounts of data to be collected and manipulated in a uniform manner using statistical tests and methods. The members of the American Institute of Aeronautics and Astronautics (AIAA), the Society of Automotive Engineers (SAE), the Society of Manufacturing Engineers (SME), and engineers and scientists at five NASA field centers served as the sample populations. A summary table of the Phase I surveys follows.

	Survey Number and Year Survey Was Conducted	Sample Population and Survey Method	Sample Size	Adjusted Response Rate (%)	Report (R) Paper (P) Number
1.	1988	AIAA Mail Survey	2000	606 (30%)	Reports 1,2,3
2.	1989	AIAA Mail Survey	2894	2,016 (70%)	Reports 4,5,6
3.	1989-1990	AIAA Mail Survey	1553	975 (63%)	Report 20
4.	1989-1990	AIAA Mail Survey	1462	955 (65%)	Report 20
5.	1991	NASA Telephone	5008	550 (92%)	Report 12
6.	1991-1992	SAE Telephone	2000	407 (74%)	Report 13
7.	1991	SAE Telephone	2000	430 (75%)	Report 14
8.	1991	SAE Mail	2000	946 (67%)	Reports 15,24
9.	1993	AIAA Mail	2000	1,006 (55%)	Paper 38
10.	1993	SAE Mail	2000	950 (48%)	Paper 39
11.	1994	SME Mail	1500	In Progress	

Survey 1 was an exploratory (pilot) study conducted for the purposes of investigating the technical communications practices of U.S. aerospace engineers and scienti. s. The importance of technical communications, the amount of time spent preparing and working with technical communications received from others, the appropriate content of an undergraduate course in technical communications for aerospace engineering majors, the use of libraries and electronic data bases, and the use and importance of computer and information technology were among the topics investigated. The factors that influence the use of U.S. government technical reports by U.S. aerospace engineers and scientists was the focus of Survey 2. Respondents were also asked to indicate their use of selected information products, their use of libraries and computer and information technology, the steps used to locate information, and the sources used to obtain U.S. government technical reports. A significant finding of Survey 2 was that relevance, technical quality, and comprehensiveness have a much greater influence on the use of U.S. government technical reports than do accessibility, ease of use, and expense.

Surveys 3 and 4 looked at how U.S. aerospace engineers and scientists find out about and obtain certain information products such as DoD and NASA technical reports, why these products are not used, the use of announcement and current awareness tools, and the use of foreign language technical reports. DoD and NASA technical reports were used by and were considered to be important to U.S. aerospace engineers and scientists in the performance of their professional duties. Libraries played a very small role in helping survey respondents find out about the existence of NASA and DoD technical reports; the role of libraries in physically obtaining copies of these reports was greater. The survey respondents made little use of announcement and current awareness tools such as *STAR* and foreign language technical reports. "Not relevant to my research" was the reason given most often by survey respondents for not using DoD and NASA technical reports. "Accessibility" was the reason given most often for not using the announcement and current awareness tools. A large percentage of the respondents was unaware that these tools existed. "Not relevant to my research" and "can't read the language" were the reasons given most frequently for not using foreign language technical reports. The purpose of Survey 5 was to obtain feedback from NASA engineers and scientists regarding the NASA STI program. About 83 percent of the respondents rated the NASA STI system either "good" or "excellent."

Surveys 6, 7, and 8 investigated the technical communications practices of U.S. aerospace engineers and scientists working in design and development and the influence of technical uncertainty on information use. Technical uncertainty and project complexity were strongly (positively) correlated. Further, as technical uncertainty increased, so did the use of information. As technical uncertainty increased, information use become more formal (written as opposed to oral) and more external (originating and residing outside of the organization). As technical uncertainty increased, so too did the use of the results of federally funded STI and the use of DoD and NASA technical reports.

Survey 9 investigated computer-mediated communication (CMC) and the communication of technical information in aerospace. While the results indicate that CMC is an important function in communication patterns, the research indicated that CMC is used less often and is deemed less valuable than other more conventional media such as paper documents, group meetings, and face-to-face conversations. Survey 10 explored the use of computer networks in aerospace. In general, the results paint a picture of widespread use of electronic networks in aerospace engineering. Survey 11 (in progress) investigated the technical communications practices of U.S. aerospace engineers and scientists working in manufacturing and production and the influence of technical uncertainty on information use.

Phase 2

Phase 2 focused on industry-affiliated information intermediaries (e.g., libraries and librarians) and their role in the aerospace knowledge diffusion process. The NASA and DoD STI systems are intermediary-based systems that rely on librarians and technical information specialists to complete the knowledge transfer process. To date, empirical findings on the effectiveness of information intermediaries and the role(s) they play in knowledge transfer are sparse and inconclusive.

A list of U.S. and Canadian aerospace libraries served as the population for the Phase 2 survey. This list was compiled from several sources, including the *Directory of Special Libraries and Information Centers* and the Special Libraries Association. To be eligible for participation in the study, each industry library had to hold aerospace, aeronautical, or related collections. The completed list consisted of 336 libraries; all 336 libraries were surveyed. With an adjusted sample of 271 and 182 completed questionnaires, the adjusted response rate was 67 percent. The survey was conducted between May and August 1990.

A group of special librarians worked with the project team to compile the list of survey questions. The questions were pretested before distribution. The questionnaire was organized around the following topical objectives: library demographics, NASA technical reports, bibliographic tools and electronic data bases, information technology, NASA information products and services, end user-intermediary interface, library outreach, and producer-intermediary interface.

The results of the Phase 2 survey (see Project Report 21) confirm that NASA technical reports are used by and are important to U.S. aerospace engineers and scientists. The results also confirm the essentially passive nature of the system used to transfer the results of federally funded aerospace R&D. The findings also appear to confirm the essentially passive role of U.S. aerospace industry information intermediaries in the STI production, transfer, and use process. On the industry (user) side, the passivity is due in large part to a lack of corporate support (funding). On the NASA (producer) side, the passivity is due for the most part to the lack of effort by NASA in involving U.S. aerospace industry information intermediaries in the producer to user process or to giving this group of individuals a specific role or responsibilities for completing the STI production, transfer, and use process.

U.S. aerospace industry librarians and technical information specialists do play an important role in completing the STI production, transfer, and use process. However, their impact does appear to be strongly conditional and limited to a specific context. Their role in completing the process could be enhanced by increasing their involvement (proactivity) and responsibility in the process. Increased involvement in the STI production, transfer, and use process requires greater recognition, responsibility, and support from U.S. aerospace industry management and NASA.

Phase 3

Phase 3 focused on investigating the information-seeking behaviors of U.S. aerospace engineering faculty and students and the role of academically-affiliated information intermediaries in the aerospace knowledge diffusion process. The U.S. faculty sample was obtained primarily from four-year institutions that participated in the 1990 NASA/USRA (University Space Research Association) capstone design program. Also included were some institutions with aerospace programs accredited by the Accreditation Board for Engineering and Technology (ABET). The student sample included those students enrolled in a NASA/USRA-funded undergraduate capstone course in the spring of 1990. U.S. academic libraries in four-year Accreditation Board for Engineering Education (ABET) accredited colleges and universities served as the population for the Phase 3 survey. The sample consisted of the 75 libraries in those colleges and universities participating in the 1990 NASA/USRA (University Space Research Association) capstone design programs plus others with aerospace engineering programs. Four additional student surveys were conducted. One survey population was student members of the AIAA; another was engineering and science students at the University of Illinois at Urbana-Champaign (UI-UC); a third was aerospace engineering students at Texas A&M; and a fourth was technology students at Bowling Green State University (BGSU). The UI-UC student survey was distributed through the mail. A single mailing was used with both the AIAA and the UI-UC student surveys. The BGSU and the Texas A&M surveys were distributed in the classroom. A summary table of the Phase 3 surveys follows.

Survey Number and Year Survey Was Conducted		Sample Population and Survey Method	Sample Size	Adjusted Response Rate (%)	Report (R) Paper (P) Number
1.	1990	NASA/USRA Faculty Mail Survey	501	275 (55%)	Report 23 and Paper 20
2.	1990	NASA/USRA Student Mail Survey	unknown	640	Report 23 and Paper 20
3.	1990	NASA/USRA Intermediary Mail Survey	70	68 (97%)	Report 22
4.	1993	AIAA Student Member Mail Survey	4000	1,673 (42%)	Report 26 and Paper 40
5.	1993	Univ. of IL Student Mail Survey	4223	1,132 (27%)	Report 27
6.	1993	Texas A&M Student Survey	unknown	54	Report 27
7.	1993	Bowling Green State University Student Survey	unknown	68	Report 27

Surveys 1 and 2 were organized around the following topical objectives: the use and importance of selected information sources and products, the use of specific print sources and electronic data bases, the use of computer and information technology, and instruction in using information materials and resources.

Survey 3 was organized around the following topical objectives: librarian and library demographics, NASA technical reports, bibliographic tools and electronic data bases, information technology, NASA information products and services, the end user-intermediary interface, library outreach, and the producer-intermediary interface. Surveys 4 through 7 were organized around the following topical objectives: career goals, communications skills training, and the use of STI.

Faculty and students display similar patterns of use for both information sources and products. Faculty and students made limited use of announcement, current awareness, and bibliographic tools. Both groups made limited use of electronic (bibliographic) data bases. Faculty and students use computer and information technology, but faculty use generally outstrips student use. Between half and three-quarters of the students indicated that they had received instruction in the use of engineering information resources, library resources, and technical writing and oral presentations. Only one-third had received instruction in searching electronic (bibliographic) data bases.

The results of the Phase 3 intermediary survey indicate that NASA technical reports are used by and are important to U.S. engineering faculty and students. The results also confirm those of Phase 2 of this Project about the essentially passive nature of the system used to transfer the results of federally funded aerospace R&D to the academic community as well as the essentially passive role of U.S. academic libraries and librarians in aerospace knowledge diffusion process. On the academic (user) side, the passive nature is due, in large part, to philosophy and a lack of support (funding). On the NASA (producer) side, the passive nature is due, for the most part, to the lack of effort devoted by NASA to involving U.S. academic librarians and information intermediaries in the producer-to-user transfer process or to giving this group of individuals a specific role or responsibilities for completing the aerospace STI production, transfer, and use process.

Phase 4

Phase 4 concentrated on describing and explaining the information environment in which non-U.S. aerospace engineers and scientists work (that is, the academic, government, and industrial sectors), the information-seeking behavior of non-U.S. aerospace engineers and scientists and aerospace engineering students, and the factors that influence their use of STI. Site specific surveys of aerospace engineers were conducted in India, Israel, Japan, the Netherlands, and Russia after an exploratory (pilot) study was conducted. Members of the Royal Aeronautical Society (RAeS) were the sample population for the United Kingdom. A summary table of the Phase 4 practitioner surveys follows.

	Survey Number and Year Survey Was Conducted	Sample Population Surveyed By Mail	Adjusted Response Rate (%)	Report (R) Paper (P) Number
1.	1990	Western Europe	101	Paper 4
2.	1991	Israel	97	Paper 14
3.	1991	Japan	96	Paper 25
4.	1992	United Kingdom	1,102 (75%)	Report 25
5.	1992	Russia	209 (64%)	Report 16
6.	1992	The Netherlands	109 (55%)	Report 17
7.	1993	India	72 (48%)	Report 18
8.	1994	Japan	In Progress	

A comparison of U.S. and non-U.S. aerospace engineers and scientists shows that both groups consider the ability to communicate technical information effectively essential (important) to professional success. Although the actual number of hours spent communicating differs between the two groups, survey respondents agree that (1) as their years of professional work experience increase, so does the time they spend communicating and (2) as they advance professionally, they spend more time communicating technical information. U.S. and non-U.S. aerospace engineers and scientists exhibit some slight differences in the types of information products that they produce and use; overall, the U.S. group appears to produce and use greater numbers of information products.

When faced with obtaining information needed to solve a technical problem, both groups display markedly similar information search patterns. They first consult their personal stores of information; then, they seek out co-workers inside their organizations; next, they consult colleagues outside of their organization. If these strategies do not yield the necessary information, both groups of respondents use the literature resources found in a library. Only as a last resort do they consult a librarian. However, the non-U.S. group reports greater use of a library in performing their present professional duties than the U.S. group reports.

U.S. aerospace engineers and scientists make greater use of computer and information technology and electronic networks than do their non-U.S. counterparts, although the non-U.S. group does anticipate increasing use of these technologies. The non-U.S. group makes greater use of "foreign" language technical reports than does the U.S. group, a factor that may be attributable to their considerable fluency in at least one or more foreign languages. Constraints such as political control of information and linguistic and cultural attitudes toward communication play a significant role in the diffusion of knowledge through the aerospace community.

Student surveys were conducted in India, Japan, Russia, and the United Kingdom at the following institutions: Indian Institute of Science, University of Tokyo, Moscow Institute of Technology, Cranfield University, and Southampton University. A summary table of the Phase 4 student surveys follows.

	Survey Number and Year Survey Was Conducted	Sample Population Surveyed	Number of Responses	Report (R) Paper (P) Number
1.	1992	Russia	117	Report 28
2.	1993	India	40	Report 28
3.	1993	Japan	77	Report 28
4.	1994	United Kingdom	93/34	Report 28

A comparison of U.S. students with Indian, Japanese, Russian, and U.K. students reveals similarities and differences in their information-seeking behaviors. Indian, Japanese, and U.K. students believe that it is important to professional success to communicate effectively in writing and orally, as do U.S. students. Russian students are less likely to see the relevance of technical communication skills to professional success. In general, students from the four countries use their personal stores of technical information and consult other students when they need information to solve technical problems. The Indian, Japanese, Russian, and U.K. students report greater use of a library than do U.S. students when they need information to solve a technical problem.

The results of the *NASA/DoD Aerospace Knowledge Diffusion Research Project* should prove useful for understanding the information environment in which U.S. aerospace engineers and scientists work (that is, the academic, government, and industrial sectors) and the factors that influence their use of information. This ongoing research has provided a tremendous amount of data and resultant insights about the information-seeking behaviors and communications patterns and the system used to disseminate the results of federally funded aerospace research and development.

Section 5
Listing of References

5.1 Introduction

Below are 456 references of material covering engineers' information needs and information-seeking behavior. The listing is alphabetic by first author; when an author has multiple listings, they are given from most to least current. Each item cited has a unique number which is referenced in all other sections, including the author and subject indexes in Section 7. Citations include some information to help locate and obtain materials if desired. An affiliation is provided for many first authors; if the affiliation remains the same for an author across references it is not included beyond the first such reference. However, if a change has been identified, it should also appear. Many citations of technical reports indicate where the reports can be obtained (e.g., National Technical Information Service (NTIS) or Education Research Information Service (ERIC)), and the citations give an accession number, if known. Some citations give the number of references cited in the work.

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448* Wolek, Francis W. "The Engineer: His Work and Needs for Information." *Proceedings of the American Society for Information Science* 6 (1969): 471-476. 25 references.

449 Wood, D.N. "User Studies: Review 1966-1970." *ASLIB Proceedings* 21 (1971): 11-23.

450* Wooster, Harold (Air Force Office of Scientific Research, Arlington, VA, USA). "Policy Planning for Technical Information in Industry." In *Documentation Planning in Developing Countries, International Federation for Documentation (FID/DC) Symposium, Bad Godesberg, Federal Republic of Germany, 29 November 1967*. 16 pages.

451* Workshop Steering Group (Cross-Disciplinary Engineering Research Committee, Commission on Engineering and Technical Systems, National Research Council, Washington, D.C.). *Report of a Workshop held in Washington, D.C., June 11, 1985*. Washington, D.C.: National Academy Press, 1985. 52 pages.

452* Zielstorff, Rita D. (Massachusetts General Hospital), Christopher Cimino, G. Octo Barnett, Laurie Hassan, and Dyan Ryan Blewett. "Representation of Nursing Terminology In The UMLS Metathesaurus: A Pilot Study." *Proceedings: Fifteenth Annual Symposium on Computer Applications in Medical Care: Assessing the Value of Medical Informatics*. (1993): 392-396.

453* Zinn, Karl (Center for Research on Learning and Teaching, Ann Arbor, MI). "A Computer-based System to Enhance Sharing of Technical Information in a System of Scientific Communities." *Current Research on Scientific and Technical Information Transfer*, Micropapers Edition. New York: Jeffrey Norton Publishers, (1976):15-24.

454* Zipperer, Lorri (American Medical Association). "The Creative Professional and Knowledge." *Special Libraries* 84, no. 2 (Spring, 1993): 69-78. 15 references.

455 Ziman, J.M. "Information, Communication, Knowledge." *Nature* 224 (1969). 8 pages. 11 references.

456* "Canada: Saskatoon Engineers Get Serious." *Engineering Digest* (April 1987): 4. vol. 33.

Section 6
Annotated Bibliography

3 Allen, Robert S. (Purdue University. "Physics Information and Scientific Communication: Information Sources and Communication Patterns." *Science and Technology Libraries* 11, no. 3 (1991): 27-38.

The communication patterns of physicists and all scientists are undergoing change due to introduction of new technology, especially electronic communication. Traditional information sources of physics, as well as developing electronic information sources are defined. Also examined are the effects overlap and replacement of traditional information sources by new sources have on the communication patterns of scientists and the scholarly communication cycle. Study findings can be applied to many other fields, including engineering. 22 references.

5 Allen, Thomas J., and Kumar S. Nochur. "Do Nominated Boundary Spanners Become Effective Technological Gatekeepers?" *IEEE Transactions on Engineering Management* 39, no. 3 (1992): 265-269.

The article examines the effectiveness of formally designated gatekeepers in transferring technologies. A gatekeeper's role is to integrate different functional departments within an organization and to maintain connections with sources outside that organization. Traditionally this has been developed as an informal position, but recently firms have created an actual job description: Gatekeeper. There is some question whether such a formal assignment enables these individuals to perform the role expectations effectively. A study was performed to determine the relative effectiveness of and attitude towards these gatekeepers. The research used The Geophysics Department of the Corporate Research Center. This center has 77 scientists and engineers, but within the entire region there are 405 geophysics professionals. A questionnaire was developed to collect data from the entire regional staff. The following categories were outlined: demographic and job-related information; communication partners; attitudes towards the Research Center; and adoption of technologies. The results indicate that the designated gatekeepers only partially fulfill the expectations of their assigned boundary spanning function. Although they communicate well within their given organization, they are perceived as failing to disseminate the new technologies among the regional colleagues. As this is primary to their role, they are not viewed as being effective. The author suggests that the findings indicate that instead of nominating individuals to be gatekeepers, administrators ought to select individuals who may already be known as gatekeepers--if only informally--and assign them to these positions. 10 references.

8 Allen, Thomas J. *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the R & D Organization.* Cambridge, MA: MIT Press, 1977.

This text is the culmination of an extensive ten year study which: distinguishes the types of informational needs that scientists have and determines in what respects they remain unsatisfied; examines the means and occasions of scientific information exchange in order to single out the features that make them more or less able to meet the scientists' several needs; and analyzes characteristics of the scientists' specialties, institutions, and outlooks as possible conditions that may influence their needs for information, their opportunities for satisfying them, and, hence, their information-gathering habits and satisfactions, thereby producing a more complete systemic understanding of the communication process in science or technology. Particular attention is paid in exploring the technical information arena as a separate entity from the purely scientific information arena. The text distinguishes engineers from scientists, differentiates the patterns in Science communication from those in Technology communications, exposes the relationship between science and technology, and details the nature of technical literature with particular attention paid to the formal engineering literature. Provides data, tables, figures, and copies of the instruments used in data collection.

9 Allen, Thomas J., and Alfred P. Sloan. "Communication Networks in R&D Laboratories." *R&D Management* 1 (1970): 14-21.

Communications networks in R&D laboratories are shown to have structural characteristics, which when understood can be used to effectively keep the personnel of the laboratory abreast of technological advances. Informal relations and physical location are shown to be important determinants of this structure. These relations can be developed through the formation of project teams and intergroup transfers and loans. The effect of physical location on communications is especially strong and should be given serious consideration when designing research facilities. 13 references.

12 Allen, Thomas J. and Stephen I. Cohen. "Information Flow in Research and Development Laboratories." *Administrative Science Quarterly* 4 (March 1969): 12-19.

Technical communication patterns in two research and development laboratories were examined using modified sociometric techniques. The structure of technical communication network in both laboratories results from the interaction of both social relations and work structure. The primary communication facilitators in each laboratory had more oral contact with extra-organizational colleagues and read more of the current literature. Recognition and reward are suggested to encourage technological gatekeepers to continue in their roles. Encouraging extra-organizational contacts through paid attendance to conventions and a liberal travel budget is also suggested. 19 references.

17 Aloni, Michaela (Ministry of Defence, Israel). "Patterns of Information Transfer Among Engineers and Applied Scientists in Complex Organizations." *Scientometrics* 8, no. 5-6 (1985): 279-300.

The article reviews major studies of information transfer published in American Management Science journals from 1976-1982. The review is broken into four parts. It begins with an historical and conceptual background, followed by an introduction to Organizational Psychology. The bulk of the article discusses studies of information transfer. The conclusion includes a discussion of implications of the insights gained for library and information scientists. In the 1960s Allen studied identical R&D Projects to determined how information enters and flows through an organization. He named those individuals that were most frequently contacted for information: Gatekeepers. Tushman extended Allen's findings and asserted that research projects, having the highest degree of uncertainty, were found to have a decentralized communication structure and tended to engage in a great deal of intra-project communication. Gatekeepers span communication boundaries, therefore they play a vital role in the working of both the division in which they work and the organization as a whole. Katz & Allen studied the link between communication and production and discovered that in those teams whose composition remained constant, productivity increased to a peak after 1 1/2 years but declined thereafter, reaching very low levels after 5 years. In her dissertation Kreiner studied the phenomena of gatekeepers. Sixty of the seventy-three engineers responded to her questionnaire. She determined that of those individuals identified by their peers as gatekeepers, 50% held managerial positions, nine held graduate degrees and all had been with the firm for more than five years. However, taken as a group, these individuals had no more contacts with other scientists than their peers. Persson questions the whole gatekeeper idea, claiming that the notion of a gatekeeper promotes an "elitist pattern of information dissemination." Shuchman's study revealed engineers prefer informal to formal sources of information and need far more information than they generate. The author of this review recognizes that Tushman's model is limited but asserts that Tushman has had a lasting impact on all work done in the discipline. 69 references.

18 Arechavala-Vargas, Ricardo (School of Education, Stanford University). *The Communication Network Structures of Research and Development Units*. Ph.D. Dissertation, August 1985. Stanford, California: Stanford University, 1985. 254 pages.

This study on the communication networks among scientists working in industrial research and development settings expands the definition of communication to include interpersonal relationships as well as the flow of technical information. It focuses more on performance measures than communication and may have some implications in the realm of internal and informal information seeking behavior of engineers working in R&D units in private industry. The research instrument used is a questionnaire administered to 932 scientists in 101 R&D units. Twelve companies from the oil, chemical, manufacturing and pharmaceutical industries are included. R&D activity is differentiated from basic research as more structured, containing more diversity, and as constrained by the goals of the larger organization. The basic assumption is that scientific activity and individual professional success depend on communication networks. A basic communication network encompasses three types of networks defined in terms of the types of exchanges involved 1) technical assistance-communication of technical information in aid of specific problem solving; 2) communication of information-less structured communication that includes organizational and technical information; and 3) 'sounding board'-communication with other scientists in the context of new idea development. Basic elements of communication networks are defined as reciprocal links between two individuals in an R&D unit, and triads, links between three individuals. Aggregates of links and triads form the core structure within a unit's communication network. The researcher concluded that the presence of a strong core structure (composed of many links and triads) within technical assistance networks correlated positively with improved unit performance, irregardless of the total amount of information flowing in the network. The presence of more reciprocal links was more important in 'sounding board' networks. The presence of a strong core structure in information networks did not influence unit performance. In addition, the researcher found that the clarity of network structure (i.e. a high level of agreement among unit members as to the level and nature of information exchanges) had a positive effect on unit performance for both 'sounding board' and technical assistance networks. Questionnaire.

19 Arthur, Richard H. (University of Wisconsin). "Developing a Broad Based Communication Course for Engineers." *66th Annual Meeting of the Speech Communication Association, New York, NY, November 13-16, 1980.* (November 1980): 25 pages. (Available from ERIC ED 197392.)

Noting the increased attention being given to the communication needs of specific professional groups, this paper concentrates upon the needs of engineers and engineering students. The first section provides a general discussion of the communication needs of practicing engineers and technicians and of the ways in which these needs have traditionally been met. It serves as a rationale for the development of courses for engineers that concentrate on spoken communication. The second section describes the development of one course, which includes both oral and written communication, that was specifically structured for students in an engineering curriculum. The final section reports on a limited survey of 65 speech communications to the area of technical communication in the discipline. 22 references.

22 Baltatu, Monica E. "Online Information." *Chemical Engineering* (January 9, 1984): 69-72.

This article focuses on online databases that provide access to technical literature and numerical data. It identifies specific databases from various vendors that are of interest to chemical engineers. The capabilities of 12 bibliographic databases and 23 numeric databases are described and discussed. Additionally it discusses the Chemical Information System (CIS), a set of online databased containing bibliographic and descriptive information and numeric data on over 192,000 chemcial substances and some of the issues users face with numerical databases. 8 references.

28 Barclay, Rebecca O., Thomas E. Pinelli, David Elazar, and John M. Kennedy. *An Analysis of the Technical Communications Practices Reported by Israeli and U.S. Aerospace Engineers and Scientists.* Paper 14. Paper presented at the International Professional Communication Conference (IPCC), November 1, 1991, Orlando, FL. (Available from NTIS 92N28183.)

Reports the results of two pilot studies conducted as part of phase 4 of the NASA/DoD Diffusion Project. These two studies investigated the communication practices of Israeli and US aerospace engineers and scientists. Objectives of both studies were to determine 1) the importance of technical communications; 2) use and production of technical communications; 3) views of course content of an undergraduate course on technical communications; 4) use of libraries, technical information centers and on-line databases; and 5) use and importance of computer and information technologies. The research instrument used was a mailed self-administered questionnaire. The US population (N=100) consisted of randomly selected aerospace engineers and scientists working in cryogenics, adaptive walls, and magnetic suspension. A slightly modified version of the questionnaire was sent to Israeli engineers and scientists working at the IA/Tashan Engineering Center (N=300). Major findings include 1) Israeli respondents devoted 38% of working time to technical communication, while US respondents devoted 50%, with total time spent in communication increasing with years of experience for both groups; 2) Israeli respondents use more technical information products and report more use of journal articles, drawings/specifications, technical manuals and promotional literature. US respondents reported more use of conference papers and technical presentations; 3) Both groups report greater use of US technical reports than AGARD technical reports; 4) both groups report that informal discussions with colleagues, followed by discussions with subject experts as the most frequently used information sources; and 5) 97% of Israeli respondents and 93% of US respondents report use of computer and information technologies. The results for US respondents are replicated from the initial Phase I study of the Diffusion Project. 7 references.

29 Barclay, Rebecca O., Thomas E. Pinelli, Michael L. Keene, John M. Kennedy, and Myron Glassman. "Technical Communications in the International Workplace: Some Implications for Curriculum Development." Paper 15. Reprinted from *Technical Communication*, vol. 38, no. 3 (Third Quarter, August 1991): 324-335. (Available from NTIS 92N28116.)

The rapid increase in the number of academic programs in technical communication illuminates a big gap between what is taught and what is actually practiced. This article reports the results of a survey of U. S. and European aerospace engineers concerning the kinds of communication products the engineers actually use, the kinds they produce, and the recommendations they would offer designers of academic courses (N=164). Specific means to bridge the gap between classroom and workplace include: relevant faculty work and educational background, advisory boards, professional contacts, research, and feedback. Lists of information gathering products preferred by U.S. engineers and the amount of time they spend on average with each product are included. Provides information to compare the most popular communication Includes data and methodology. 15 references.

30 Barczak, Gloria (Northeastern University), and David Wilemon. "Communication Patterns of New Product Development Team Leaders." *IEEE Transactions on Engineering Management* 38, no. 2 (May 1991): 101-109.

This study focuses on two types of new product development team leaders, operating and innovating, and explores their communication patterns with team members and external groups. The results indicate that the communication patterns of the team leaders are dependent on the type of team. Further findings indicate that degree of success differentiates the communication patterns of the team leaders within the operating types of teams. 114 team leaders, in companies in the electrical and electronics industry with over $25 million in sales annually, were the subjects. The more effective operating leaders discussed technical issues significantly more often than their less successful colleagues. The successful innovating team leaders were more likely to discuss customer needs. 48 references.

31 Batson, Robert G. "Characteristics of R&D Management Which Influence Information Needs." *IEEE Transactions on Engineering Management* EM-34, no. 3 (August 1987): 178-83.

Using an information systems perspective, information needs of mid- and upper-level R&D managers are identified. This is based on a review of their environment, functions, and communication patterns. The information problems in R&D, such as the inability to respond rapidly and failure of analytical support methods, are seen as symptoms of the mismatch of information needs and information systems employed. The new technology of decision support systems is discussed as the ideal solution approach to R&D information management and decision making. A comprehensive list of candidate databases is included. 35 references.

32 Bayer, Alan E. (Boys Town, NE), and Gerald Jahoda. "Effects of Online Bibliographic Searching on Scientists' Information Style." *Online Review* 5, no. 4 (1981): 323-333.

To determine the impact of online bibliographic searching on researching styles, 262 industrial scientists and 70 academic chemists were offered a free, formal introduction to online search services. They were given a pre-test survey that included questions about the average time they spent gathering information, their general attitude about selected aspects of the process of gathering information, and the relative utility of different methods of gathering information. Thirteen months later they were given a post-test survey. This is a longitudinal study; however, after the first year, 41% of the industrial scientists "frequently" used online searches as compared to 71% of the chemists who used those searches. It was determined that those industrial scientists who were the more frequent users of online searching increased their contacts with persons outside their immediate environment. This was not borne out in the academic setting. As well, it was determined that those industrial scientists who characterized themselves as frequent users (of online searching) spent more time than before writing and preparing research reports. While in general the users suggested that the capability of online bibliographic search were valuable to their work, it was determined that the introduction of online searching has not impacted the use of traditional information retrieval strategies. There is strong evidence that frequent users increased their reliance on librarians. The article includes five tables that display various correlations between the amount of online use in academic and industrial settings, the amount of online use and the change in assessment of other information sources etc. 15 references.

34 Beardsley, Charles W. "Keeping on Top of Your Field." *IEEE Spectrum* (December 1972): 68-71.

With the rapid changes in technology, engineers have a need to keep up with developments in their fields. The author contacted engineers and engineering managers to question them on their sources of information and their information gathering techniques. The author mentions nine contacts specifically. The author also cites information from studies by the Hewlett-Packard Company of its customers. The use of journals, catalogs, and sales literature are the most popular ways to keep up with changes. Due to time lost in travel and away from work, attendance at conferences and trade shows are not as popular as they have been in the past. Convenience and ease of access appear to account for which information sources are ranked the highest. Much information is gained first-hand from colleagues and subordinates. The age and size of the company can influence the flow of information and can influence an employee's reading and educational habits. A survey conducted by the McDonnell Douglas Company of its engineers in the late sixties is cited to support the idea that short courses, seminars, and college courses are not preferred methods of keeping updated. Engineers tend to prefer informal, unstructured methods of staying abreast, such as reading technical literature and interacting with peers. The author concludes with a note to anyone who has information to convey to engineers: ease of access is the key to communication. Three charts are included showing preferences for literature over other forms of information gathering and reasons for attendance at trade shows. The information in the charts comes from the surveys conducted by Hewlett-Packard and McDonnell Douglas. 3 references.

35 Beckert, Beverly A. "The Technical Office." *Computer-Aided Engineering: CAE* 7, no. 12 (December 1988): 76-80.

Technical office automation (TOA) is presented as the best way to improve productivity and efficiency beyond computer-aided design. Subjects discussed include TOA's communication support through various types of e-mail, presentation graphics software, and electronic publishing capabilities. Project management tools to enhance scheduling, track resources and costs, and define employee responsibilities are also mentioned. Five information management tools are described: document management systems, electronic file systems, database management systems, configuration management systems, and hybrid information management systems.

36 Bermar, Amy. "Babel In Design Land: "Can We Talk?" Marketing and Design Don't Speak the Same Language; In Fact, They Often Don't Even Speak. (Second of a three-part series on how engineers related to other members of a design team)" *EDN* 35, no. 18A (September 6, 1990): 57-58.

Open, frequent and clear communications are required to optimize the productive relationship between engineering and marketing operations in a concurrent product development process. This involves the execution of tasks to bring a product to market in a minimum amount of time, and an assessment of potential market wants and needs. Marketing assesses potential demand and engineering must determine if the requirements can result in an economical, manufacturable product. Discusses examples of the use of communication to resolve problems.

38 Bichteler, Julie (University of Texas at Austin). "Geologists and Gray Literature: Access, Use, and Problems." *Science and Technology Libraries* 11, no. 3 (1991): 39-49.

Geoscientists use large quantities of gray literature in the form of national, state, and local publications from societies and government agencies; dissertations and theses; maps; field trip guidebooks; and newsletters. Gray literature provides unique information on local and regional geology, oil and gas, soil, ground water, and mineral resources and is often produced more rapidly than traditional sources. Problems of physical quality, access, bibliographic control, and acquisition arise from inadequate coverage in bibliographies and databases, producers' lack of knowledge and concern for user needs, poor service from vendors, and university library cataloging and interlibrary loan policies. Recent improvements achieved by the American Geological Institute, geological surveys, and professional societies are encouraging. The results of this study will be useful to designers of any subject specialty database, by offering suggestions on how to effectively deal with that subject specialty's gray literature.

39 Bichteler, Julie, and Dederick Ward. "Information-Seeking Behavior of Geoscientists." *Special Libraries* 79, no. 3 (Summer 1989): 169-178.

Authors investigated problems encountered by geoscientists retrieving and processing information. Through interviews and questionnaires, geologists judged the importance of information sources and described their continuous and "on-demand" modes of information seeking (N=56). Journals and personal contacts rank highest. Geologists show little interest in end-user searching and need additional training in information services, sources, and procedures. Results also illustrate opinions of foreign language literature, variations in patterns of information seeking which depend on professional position and time available, and problems resulting from constraints set by employers. Implications of the study's findings can be expanded to incorporate other applied sciences. This study is often cited by other scientific and technical information use studies. 4 references.

47 Borchardt, John K. (Shell Development Corp.). "Improve In-House Communications." *Chemical Engineering* 97, no. 3 (March 1990): 135-138.

Better in-house technical communications can mean more sharing of ideas, in a more stimulating environment, with less duplication of effort, which leads to increased productivity. Five actions are discussed that managers can capitalize upon to improve informational flow within the work place: 1) set aside a regular time to talk to coworkers to find out who is conducting similar research; 2) establish a regular in-house seminar program as a way for staff to communicate results, describe problems, and receive useful input from peers; 3) use bulletin board announcements of papers being presented at meetings, abstracts of recent company patent work to describe new technology, and encourage creativity; 4) utilize internal corporate trade fairs in very large firms to transfer information and technology between personnel in scattered locations; and 5) employ the latest communications media, including electronic mail, laptop personal computers, and facsimile machines.

49 Borgman, Christine L., Donald O. Case, and Charles T. Meadow. "The Design and Evaluation of a Front-End User Interface for Energy Researchers." *Journal of the American Society for Information Science* 40, no. 2 (March 1989): 99-109.

This research project was conducted in six steps over a two-year period. Interviews were conducted with 33 individuals involved in energy research. The sample is comprised of 23 search intermediaries knowledgeable about information retrieval (IR) systems; five indirect end users with little or no IR system expertise, who used the services of intermediaries; and five direct end users who were competent in using IR systems, but unsure that they were getting everything they could. Based on interview results, the researchers designed three prototype 15-minute training programs and one prototype assistance program to run on an IBM-PC using DOS. These were evaluated by 28 subjects who were different from the population of the original interviews, but still involved in energy research. Several areas were critiqued for improvement, the programs redesigned, and the improved software evaluated again. No correlation was found between satisfaction with the program and the number of records retrieved and examined. Even taking into account problems with the research methodology, this software seems to improve end-user search results with less time invested in learning the processes.

50 Borgman, Christine L., Donald Case, and Charles T. Meadow. "Evaluation of a System to Provide Online Instruction and Assistance in the Use of Energy Databases: the DOE/OAK Project." *Proceedings of the 49th ASIS Annual Meeting* 23 (1986): 32-38.

Updates the authors' 1985 report to the ASIS meeting about the design and evaluation of a front end software package for the U.S. Department of Energy RECON system. The user population (energy researchers) was studied and three programs were completed and evaluated: a general introduction to the DOE RECON system and databases and two parallel programs to teach searching concepts. Evaluation subjects came from four populations: eight search intermediaries who were familiar with DOE RECON; six search intermediaries who were familiar only with other retrieval systems; eight graduate students who were studying energy-related topics; and six graduate students who were studying library science. Discussion follows of the subjects' evaluations and criticisms of specific points of the various programs. Based on these evaluations, the software was redesigned and is in the process of being evaluated again. The goal is to design software that energy researchers will use to facilitate online searching. Sample screens from the tutorial and the assistance software are included. 12 references.

51 Borgman, Christine L., Donald Case, and Charles T. Meadow. "Incorporating Users' Information Seeking Styles Into the Design of an Information Retrieval Interface." *Proceedings of the 48th ASIS Annual Meeting* 22 (1985): 324-330.

This article is the preliminary status report of the development of a front-end interface to train and assist online information retrieval system users. Five direct end users, five indirect end users, and 23 search intermediaries of the U.S. Department of Energy RECON system were interviewed regarding their information searches in an effort to determine the characteristics necessary for a front-end interface. The data show that interface needs vary with system experience; an interface for infrequent or inexperienced users will focus on vocabulary and basic search technique. A prototype was developed that contained computer-assisted instruction (CAI) modules and user assistance modules. CAI modules teach basic concepts of online searching. User assistance programs can be used independently. Together, they serve as a "search intermediary." The prototype was evaluated by a group of skilled search intermediaries and two groups of graduate students, one with subject knowledge but no information retrieval experience, and one with information retrieval knowledge but no subject background. After evaluation, the prototype will be modified. The authors state that specific needs and characteristics of energy researchers can be incorporated into an interface design that makes the system accessible to new users, and enhances the system for current ones. 14 references.

54 Brady, Edward L., ed. "U.S. Access to Japanese Technical Literature: Electronics and Electrical Engineering" (NBS Special Publication 710). *Proceedings of a Seminar held at the National Bureau of Standards, Gaithersburg, Maryland, USA, June 24-25 1985.* Washington, D.C.: U.S. Department of Commerce, National Bureau of Standards, 1986. 159 pages.

U.S. Access to Japanese Technical Literature: Electronics and Electrical Engineering. Contains the text of a round-table discussion of Japanese and American representatives from academia, government and private industry. Also included in part II are the visuals from selected seminar presentations. The text of these presentations is not included. Major observations of the round-table discussions include: 1) as of the seminar date, there is no comprehensive compilation of Japanese engineering information sources published in English; 2) there is a lack of USA engineers who are seriously studying technical Japanese; 3) engineering information currently available in English is not fully exploited by USA engineers; 4) there is an increasing amount of Japanese scientific and technical information available in English; 5) there is no real demonstrated demand for Japanese STI; and 6) English language publications may be particularly useful to academic engineers. Also discussed is an effort by Japan Information Center for Scientific and Technology (JICST) to provide its on-line database in an English language format in the United States. This document identifies both gaps in the provision of Japanese STI to engineers and barriers to the use of Japanese STI.

55 Braham, James. "Captains of Video: Through the Marvels of Videoconferencing, Engineers Are Slicing Development Time as Well as Travel Expense." *Machine Design* 63, no. 9 (May 9, 1991): 71-75.

A descriptive advocation of videoconferencing, this article provides information on advantages of videoconferencing through interviews with employees of Hewlett-Packard and Ford Motor Company. Videoconferencing enables quicker decision time, and is easy to use. There has been a rapid growth in use of these systems. Due to use of the technology, the pricing of this service has been decreasing steadily.

61 Brown, James William (University of Minnesota). "The Technological Gatekeeper: Evidence in Three Industries." *Journal of Technology Transfer* 3, no. 2 (1979): 23-36.

Previous studies have developed the concept of the 'technological gatekeeper' as one who is integral to the diffusion of scientific and technical information from the environment to the R&D firm. Gatekeepers have been found in industries that have rapidly expanding technology. Using data from six firms in three industries, the present study found the gatekeeper phenomenon extends to firms with less rapidly changing environments. The gatekeeper construct becomes important to any company that has an R&D mission. Many of the sociometric and demographic characteristics of gatekeepers were validated in new research settings. 24 references.

62 Buntrock, Robert E., and Aldona K. Valicenti (Amoco Corp.). "End-Users and Chemical Information." *Journal of Chemical Information and Computer Science* 25 (1985): 203-207.

Discusses the education and training of end-users to search the chemical literature. The "end-user" is usually defined as a processor of information (or generator of knowledge) who uses information sources directly, especially computerized sources. Chemists and chemical engineers can perform good, cost-effective searches if they are appropriately motivated and trained. Information groups and professionals should assist with and provide end-user training as a cost-effective way to reinforce and extend their own service. From the point of view of the chemical information specialist, online searching became readily available in 1973 and widespread by 1976. As systems improved, many scientists became interested in the new technology and wanted to be directly involved. Experiment and pilot-unit automation became more common, and many chemists and chemical engineers foresaw their microcomputers also being used for end-user searching. In 1981, an experiment at Amoco with user-friendly intermediaries indicated that end-user self-motivation and perceived need are very important; that both trainers and trainees profit by the experience; and that interest in online searching will be maintained through integration of office automation technologies. 16 references.

64 Burte, Harris M. (Air Force Materials Laboratory). "Some Experiences in Generating and Maintaining Communication Within Interdisciplinary R&D Teams." *Joint Engineering Management Conference, October 9-10 1975*. 71-73.

Describes a study that was conducted to verify some of the factors found to be important in establishing and maintaining interdisciplinary R&D teams. A distinction is made between horizontal and vertical interdisciplinary activities. Horizontal activities involve the classical scientific disciplines; whereas vertical interdisciplinary activities covers the spectrum from fundamental research through lab development, etc. In the study presented here, most of the projects involved primarily Air Force personnel, but the teams cut across a variety of organizational lines. In developing these teams the first barrier to overcome was the long standing antipathies between lab and field engineering personnel. To address this problem, special attention was paid to identification of "part-act" goals which the team could successfully attain. The researchers quickly discovered that it was necessary for at least one individual to possess leadership skills. As it was fundamental to the project that the highest number of ideas and opinions be recognized, the leader had to develop a sense of awareness of and respect for differences in opinion. This requires a sensitivity to the nuances of communication (e.g. body language or use of specialized jargon etc.) These more subtle modes of communication require a greater patience to interpret and often served to slow the process down. However, only that leader who recognized true differences in points of view defined the issues and was than able to encourage the growth of new approaches to problem solving. A number of ways were found to maximizes the development of new ideas and perspectives. Researchers found that frequent use of "off site" meeting places seemed to encourage participants to voice opinion. In addition, it was determined that recording and posting all suggestions would validate people's ideas. Most importantly however, was that early definition and establishment of specific, credible goals served to focus everyone's attention. It was found that a great deal of time was needed to set up the teams and negotiate the power structures implicit in any group structure.

65 Case, Donald (University of California, Los Angeles), Christine Borgman, and Charles Meadow. "End-User Information-Seeking in the Energy Field: Implications for End-User Access to DOE/RECON Databases." *Information Processing & Management* 22, no. 4 (1986): 299-308.

A software research and development project for the U.S. Department of Energy provided an opportunity to explore the information-seeking behavior of energy researchers. The DOE project, entitled "Online Access to Knowledge," or "OAK," is developing a microcomputer interface for improving end-user access to energy databases. Interviews with 18 researchers and 34 search intermediaries in energy-related fields indicate a reliance on databases as sources of information. The interview data suggest a migration of searchers toward commercial systems that offer the widest choice of database coverage. Despite previous efforts to encourage direct use of RECON databases, most energy researchers interviewed preferred that others do their searching for them. Librarians and technical information specialists, although recognizing the potential for researchers to use databases directly, doubted that such use would be common in the near future. However, this and other studies suggest a trend towards first-hand use of databases by end-users in the energy field, particularly younger researchers. Preliminary testing of the OAK software indicates that end-users *will* search, if provided with adequate tools. These findings are discussed in the light of previous research on the information gathering habits of scientists and engineers. 37 references.

66 Case, Donald, Christine Borgman, and Charles T. Meadow. "Information-seeking in the Energy Research Field: the DOE/OAK Project." *Proceedings of the 48th ASIS Annual Meeting* 22 (1985): 331-336.

This article is of interest to people who study sources of information used in the energy industry. The authors conducted interviews with ten energy researchers and twenty-three search intermediaries who use the Department of Energy's RECON online information system. The data from these interviews, gathered for the Department of Energy Online Access to Knowledge (OAK) project on improving access to energy databases, indicate a heavy reliance on databases as sources of information and suggest a migration of searches toward commercial systems that offer the widest choice of database coverage (Dialog, Orbit, or BRS). End users of the database information - energy researchers - still prefer that others do their searching for them. Those who conducted their own searches were generally satisfied with the results; but they indicated they were uncomfortable with the search process, terminology, or strategy; they did not have time to do the search carefully; and/or they were afraid of missing important citations in the course of limiting the search. The authors are working on a front end interface that will lessen the effort needed to conduct an online search. They also hope to incorporate into the interface software a "back door" that will allow connection to other computers and other database systems. Future research will tell under what circumstances the interface will be adopted and if its availability will change the ratio of direct to indirect users of RECON. While there is a modest trend toward first-hand use of databases by end users, printed and interpersonal sources are still the preferred channels for obtaining energy information. 20 references.

67 Chakrabarti, Alok K. (Drexel University), Stephen Feinman, and William Fuentevilla. "Characteristics of Sources, Channels, and Contents for Scientific and Technical Information Systems in Industrial R&D." *IEEE Transactions on Engineering Management* EM-30, no. 2 (May 1983).

This is a report on the use of scientific and technical information sources by scientists, engineers, and managers. Using a Thurstone scaling technique, the frequency of use of the sources, channels and contents were correlated with various characteristics. For the scientific and technical information the following characteristics were of interest: the skill necessary to use effectively, utility of information, source availability, ease and cost of use. For the content, these characteristics were examined: the skills necessary to use effectively, utility of information, coherence of information, and ease of use. Finally, for the channels, the skills necessary to use effectively, dependability, availability, physical distance, and cost were compared. The data from a large number of respondents from a large corporation showed that source availability and ease of use determine the usage rates of a given source. Availability, cost and physical distance are most important for usage of a specific channel of information. Utility and coherence of the information are the only factors that are related to usage. 13 references.

69 Cho. Yong-Ja (University of Manitoba). "Information Requirements of Engineers in an Academic Institution." *11th ASIS Midyear Meeting, Knoxville, Tennessee, June 13-16, 1982.* (1982).

The study reports the group characteristics of engineers in an academic institution, their information needs and perception of information, the sources and values of their information, the factors affecting their information-gathering activities, and how a library or information center fits into their information activities. The study specifically investigates the information-gathering activities at three stages: (1) current awareness and/or general information gathering, (2) formulating the new research project, and (3) conducting the research. Finally, the role of a library or information center at each stage of the information-gathering activities is examined. 5 references.

70 Clayton, Audrey (Forecasting International, Ltd., Arlington, VA). *The Potential Influence of Social, Economic, Regulatory and Technological Factors on Scientific and Technological Communication Through 2000 AD. Final Report.* Washington, DC: Division of Information Science and Technology, National Science Foundation, 1981. 282 pages.

This 3-volume document reports on the future of scientific and technical communication and the factors that may influence its evolution. The report scope includes scientists and engineers in the United States from all sectors of the economy. Volume I presents the principle study findings, Volume II contains the project history, and Volume III contains a bibliography. The study traces the current status of scientific and technical communication and highlights existing trends. The affects of potentially disturbing factors are traced in case studies of bibliographic retrieval services and computer conferencing. The focus of the report is the "user", defined as the individual who either initiates or receives STI. Major conclusions include: 1) continued increasing use and cost of on-line searching; 2) technological advances that will blur the distinction between written and oral, formal and informal communication; 3) STC (scientific and technical communication) will become indistinguishable from general information flows in terms of dissemination. Consequently, information systems and services must become either increasingly simplified to allow end-user use or the use of skilled intermediaries will become mandatory. The report recommends setting national objectives for information resource management.

71 Collins, H. M. (University of Bath. U.K.) "The TEA Set: Tacit Knowledge and Scientific Networks." *Science Studies* 4, no. 2 (April 1974): 165-186.

This article will be useful in the study of information transfer among people. The nature of much scientific knowledge makes it difficult to investigate accurately with conventional sociological techniques of information gathering and diffusion. Studies indicate that scientists are not aware of gaining information from other than formal channels. Scientists may not know how much they know or where they learned it. The author discusses how real, useable knowledge was transferred among a group of scientists. Members of seven British and five North American laboratories were working on the same problem. building a transversely excited atmospheric pressure CO_2 laser, also known as a TEA laser. Interviews with these scientists revealed the uncertainties and complexities involved in information transmission from one scientist to another. The original project relied on trial and error rather than theory. Personal visits, telephone calls, and personnel transfers proved to be more important to the diffusion of knowledge than journal articles or conferences. In this situation, information transfer took place through informal networks of contacts among laboratories. These informal transfers are crucial to the growth of scientific knowledge. 43 references.

74 Council on Library Resources. Inc. *Thirty-Fourth Annual Report.* Washington, D.C.: Council on Library Resources, Inc., 1990. 64 pages.

Reviews the activities of Council on Library Resources (CLR) for 1989/1990, and provides a status report on the four dominate projects. Of relevance here is the third project contained in, "Communications in Support of Science and Engineering." This examines the relationship between information resources and scientific productivity. Highlighted is a conference sponsored by CLR that enabled scientists and academic leaders to consider the topic of scientific and engineering communication. Noted, also, are three additional special conference papers, two of which were completed in time for this report. The first of these, by Helen Gee, considers options for future research into the information needs and seeking behavior of scientists and engineers. The second, by Nancy Van House, explores the relationship between the extent of library resources and the quality of scientific research in academic settings. This report briefly discusses three basic aspects of scientific communication that warrant further attention: 1) future form of scientific publishing; 2) characteristics of and requirements for scientific communication; and 3) future forms of library services and information systems. Due to the brief nature of the treatment of these subjects, this document may primarily be useful as background reading that identifies both trends in scientific communication and areas for future research.

75 Council on Library Resources. *A Report to the National Science Foundation from the Council on Library Resources, August 1990.* Washington, D.C.: Council on Library Resources, 1990.

Communications in Support of Science and Engineering. Explores aspects of scientific and engineering communication with the objective of learning more about the relationships between information resources and scientific productivity. This report presents CLR's efforts to identify important trends and problems in scientific and engineering communication. Major observations include: 1) computer networks play an increasing role in transferring scientific and technical data; 2) the rapid expansion of electronic mail use will have a significant impart of communication practices; and 3) end-user searching of on-line databases will increase. An additional trend noted is new alternatives in scientific publishing, especially desk-top publishing and the emergence of electronic journals. Potential problems associated with electronic publishing are also discussed, including loss of bibliographic control, and a lack of adequate quality controls with electronic journals. Of some interest may also be the additional special papers published within this report. These include "The Users and Uses of Scientific Information Resources: Recommendations for Study" by Helen Gee, in which the author suggests that a new knowledge base about scientific communication is needed.

81 Cumming, Denise (Honeywell Technology Strategy Center). "But I Need it Today: Information Transfer in an Applied Research Environment." *Proceedings of the Technology Transfer Society International Symposium: Indianapolis, Indiana: The Society Meeting June 14-17, 1981.* Washington, D.C. p. 6.21-6.22

The author asserts that an unexpected result of recent technical advances, has been that as more information becomes available, users have, in fact, begun to demand the material itself and not just a reference to that material. Not all materials are suited to the more sophisticated electronic formats. Therefore an information professional might be expected to rely on more traditional, if more expensive, ways of transferring information. This may require some innovative procedures for transferring documents. Because many engineers are involved in a variety of projects simultaneously, some of which are short term while others are long term, they are constantly shifting focus; their information needs are "acute." Often a single piece of information can mean the potential for continued or discontinued financial backing of the project. Speed and accuracy are essential. The author asserts that all information generators and distributors need to apply a systems analysis to their present methods for channeling information. The best method for transferring information materials may not necessarily be the most technologically or economically sound. The users can be expected to pay for their materials.

83 Davis, Peter, and Marcia Wikof. "Scientific and Technical Information Transfer for High Technology: Keeping the Figure in its Ground." *R&D Management* 18, no. 1 (January 1988): 45-58.

This paper presents some 13 choices for effective organization to increase productivity. The organizational structure and processes suggested for implementation will have a major effect on how scientific and technical information (STI) is transferred as well as the quality of the STI that is disseminated and used. Hence changing the context in which STI is transferred may be much more effective than improving the efficiency of existing transfer procedures. 26 references.

85 Dedert, Patricia L., and David K. Johnson. "Promoting and Supporting End-User Online Searching in an Industrial Research Environment: a Survey of Experiences at Exxon Research and Engineering Company." *Science and Technology Libraries* 10, no. 1 (Fall 1989): 25-45.

Scientists at Exxon's basic research facility in Clinton, NJ, have been offered the opportunity to learn the basics of online searching of STN databases. A growing number of scientists have their own IDs and search for themselves in their offices. Scientists also have access to menu-driven searching using SearchMaster scripts and the Guided Search feature of STN Express software on a public terminal. End-user searching (of STN, DIALOG, and ORBIT databases) has been slowly increasing. Still, the population of active end-users represents 11% of the potential end-user population. The information specialists at Exxon offered a tutorial session on fundamental searching skills emphasizing basic search commands. The article includes the topics covered in the 1-1/2 hour course. Participants were offered a 30-minute practice search session guided by an instructor. Some end-users prefer search menus, some want to use a command language; some want to search at the public terminal, some want to work in their offices; some want to attend training courses, others want to read a manual and teach themselves. Some people prefer using the print indexes, and some take all search requests to professional searchers. The searching staff has increased visibility and enhanced their reputation for willingness to help. They will continue to search for products, services, and teaching methods that will solve the problems of mastering search commands, database designs, and search strategies. Tables and graphs are included that show the numbers of people who conducted searches on which databases and total amounts of connect time. 9 references.

86 DeFanti, Thomas A. (University of Illinois at Chicago), and Maxine D. Brown. "Scientific Animation Workstations: Creating an Environment for Remote Research, Education, and Communication." *Academic Computing* 3, no. 6 (February 1989): 10-12, 56-57.

This article addresses the need for televisual communication. Visualization is a form of communication which uses computer graphics and image processing. A scientific animation workstation is a computer system with visualization capabilities. The application of networks to visualization is televisualization. The Electronic Visualization Laboratory (EVL) at the University of Illinois at Chicago received a grant from AT&T to develop a scientific animation workstation and a televisualization network. Low-cost computer systems capable of scientific animation must be developed for researchers to use easily in their offices. This system will improve people-to-people information transfer, especially in engineering and computational science. Images provide a necessary alternative to numbers. Much of modern science can no longer be communicated in print, such as DNA sequences, molecular models, medical imaging scans, and simulations of fluid flows. Some concepts need to be expressed and taught visually. It is necessary for scientists to be able to visualize complex computations and simulations in order to understand, study, discuss, test, evaluate information. Scientists can examine visual data for anomalies or errors in data. They need to be able to receive and/or transmit visual information and record it on videotape. Visualization can be for personal analysis, information sharing among peers, or presentation in formal surroundings. The quality of the graphics can depend on the use for which the graphics are intended. The EVL faculty will combine affordable equipment with specially designed graphics software to make visualization a reality for computational scientists.

89 Dixon, John R. (Mechanical Design Automation Laboratory, University of Massachusetts). "Information Infusion is Strategic Management." *Information Strategy: The Executive's Journal* 8, no. 1 (Fall 1991): 16-21.

Described are the results of a study conducted to evaluate those companies with "serious competitive problems." The research supports the theory that only those companies that use gatekeepers -- employees assigned to stay informed in selected areas and then direct the flow of information to other employees -- will successfully manage the "information infusion." A primary reason many companies have lost a competitive edge is that those companies employ executives and engineers who are ignorant of, or resistant to, new product and process methods and technologies. Information infusion would enable these companies to correct this weakness. There are eight steps necessary for successful integration of new development methods and technologies. However, this article focuses on only the two fundamental steps: A) staff members must research and identify current technologies, and B) any information received must be evaluated and distributed immediately. These are the primary functions of a "gatekeeper." Although any company's gatekeeper performs functions specific to that company, and they should be flexible within their individual assignments, a gatekeeper would be required to subscribe to relevant journals, attend conferences and meetings, contact vendors and maintain a library of papers and articles. Described are three possible problems inherent to gatekeeper programs: 1) failure to include preexisting natural gatekeepers in the new formal system; 2) allowing the program to become a bureaucracy with only a limited connection to the business it is supposed to support; and 3) confusion of training and information gatekeeping. 1 reference and a recommended reading list of 10 titles.

90 Doty, Philip (University of Texas). "Electronic Networks and Social Change in Science," *Proceedings of the 55th Annual Meeting of the American Society for Information Science* 29 (1992): 185-192.

Science has developed a large and sophisticated social and technological infrastructure to support scientific and technical communication and to define the role that communication plays in the scientific process. The scientific community has relied for many decades upon the print medium for its communication system. The elements of the infrastructure are identified and discussed. There are many opportunities and challenges facing the scientific community as the emphasis on electronic networking grows. Many assumptions about the effects of networking need to be evaluated and analyzed. While there are many benefits to be had from the increased use of electronic networks, some of the issues which will affect the scientific community are mentioned here and should be examined and discussed carefully. Items for discussion include but are not limited to authorship, rights for editing, repackaging, and selling information, privacy, liability, reliability of information, accessibility, information overload, and intellectual property rights. As policies are developed, these issues and others need to be considered. Caution is urged in expectations for the benefits of networks in science, and costs and limitations of these networks must be examined. Suggestions are made for additional research to determine how scientists use networks, what tasks scientists do not use networks for, and how they decide the issue. Are networks really helpful in completion of scientific tasks? Research will help identify the effects of reliance on networks and its implications for the social infrastructure of scientific research and communication. 30 references.

91 Eckerson, Wayne. "DEC's Net Makes the World One Big Office." *Network World* 7, no. 27 (July 20, 1990): 17-18.

Digital Equipment Corporation's network technologies enable it to link disparate locations to allow its engineers to work together on similar or the same projects. Lists 12 technologies.

92 Ellis, Richard A. (Tennessee Valley Authority). "Information Acquisition and Processing by the Technical Person: Seance, Science, Synthesis." In *11th ASIS Midyear Meeting, Knoxville, Tennessee, June 13-16, 1982.* (1982).

The environmental or energy technologist often is confronted with urgent demands from the organizational "on high" for interpretation of technical fact by which corporate policy on energy and environment may be formulated (the seance). At other times, the technical person working on long-term projects in energy or environmental areas follows classic research methodology which demands a thorough investigation of the work of fellow professionals working worldwide (the science). Perhaps most importantly, however, the technical person must access diverse information that can be sorted and integrated into alternative problem solutions. These tools for problem solving must be fashioned so as to be usable by the consumers that require them, be they agency decision makers or concerned and impacted publics (the synthesis). Provides a unique view of the technical information seeker's environment as a diverse universe with various levels of synthesis required.

95 Estabrook, Leigh Stewart (University of Illinois at Urbana-Champaign) "Valuing a Document Delivery System." *RQ* 26, no. 1 (Fall 1986): 58-62.

This article is relevant to determining the value of information and library services. This study investigated ways users can estimate the value of information provided by a system. Valdez, a large engineering firm, has an information center which supports engineering research through bibliographic and reference service. A six-item questionnaire was sent to engineers who had used the center's document delivery service asking them to evaluate the amount and relevance of information it provided. They were asked to estimate the time they saved and to put a dollar on the usefulness of the information. Other questions asked the number of employees who saw or used the information and the extent to which it improved the company's competitive position. Cost and cost savings were calculated from Valdez Corporation's salary figures for engineering and library staff and occupancy costs of the library. The evaluation of the relevance and impact of the information was highly favorable. In a worst-case estimate, two dollars were saved for every one spent. In the best-case estimate, $47.64 was saved for each dollar invested in the information center. The author mentions some flaws in the study, but emphasizes that studies such as these can help convince funders that the information libraries provide makes a significant difference to their users. 16 references.

100 Featheringham, Tom R. (New Jersey Institute of Technology). "Computerized Conferencing and Human Communication." *IEEE Transactions on Professional Communication* PC-20, no. 4 (December 1977): 207-213.

This article is of interest to one who is studying the history of the development of electronic communications systems. It describes the Electronic Information Exchange System (EIES) which pioneered in application of new electronic technology to the act of communication. The Computerized Conferencing and Communications Center at the New Jersey Institute of Technology (Newark), sponsored by the National Science Foundation, built a computerized conferencing system. It was designed as a test facility to support information exchange among small groups of research scientists and engineers. Contained in the system were four main subsystems: message, conference, notebook, and bulletin. In the message mode, the user could send a message to one or more other users. In the conference mode, one person was designated moderator and participants sent messages which could be stored for days, weeks, or months. The notebook was a word-processing facility in which one had the ability to draft lengthy documents and modify them. In the bulletin mode, items were submitted to an editor who entered the item into the publicly available bulletin for anyone to read. Advantages of this system included: saving time, saving money, having a complete record of conferences, and being able to make anonymous comments. Disadvantages included: information overload, non-use by some individuals, and lack of visual and non-verbal cues. A diagram of the menu choices and the subsystems available is included in the article. There is a table of reasons listed by individuals for non-use of the equipment during the experimental phase. 11 references.

104 Franke, Earnest A. "The Value of the Retrievable Technical Memorandum System to an Engineering Company." *IEEE Transactions on Professional Communication* 32, no. 1 (March 1989): 12-16.

The introduction of the structured, retrievable technical memorandum system into a mid- to large- sized engineering company stimulates thought and action by enabling the exchange of ideas, knowledge, experience, and achievements. The technical memo serves as a training aid for junior engineers, thereby reducing the time constraints on senior designers. It provides introductory and background information for work in unfamiliar fields, records design, trade studies, and serves as a basis of estimate for cost proposals. Also, the technical memo promotes continuous awareness of developments, not only in an individual's special fields, but in neighboring disciplines as well. The memo is the most popular format for reports since its printed headings make it easy to identify the writer and subject. Four reasons why engineers write memos are: 1) to influence decisions; 2) to incorporate a project and its result into a reference source; 3) to impart an impression of industriousness; and 4) to display professional skills. 4 references.

105 Fraser, Emily Jean (Hewlett Packard, Santa Clara, CA), and William H. Fisher. "Use of Federal Government Documents by Science and Engineering Faculty. *Government Publications Review* 14 (1987): 33-44.

The use of United States federal government publications by the science and engineering faculty of UCLA is examined (N=137). Replicating a study performed by Peter Hernon in 1979, this study describes and analyzes information-seeking behavior. It further tests Hernon's hypothesis that the use of documents by faculty does not differ significantly from one discipline to another. The results of this study support previous findings, indicating that federal government documents are under utilized, especially by scientists, engineers, and faculty. Results also suggest that when using federal government documents, scientists and engineers exhibit atypical information-seeking behavior. Includes tables, data, and methodology. 12 references.

106 Fraser, Jay. "Plug Yourself into a Network." *EDN* 37 (July 20, 1992): 221-224.

Networking is not always easy for engineers, but the results are worth the effort. Networking is an informal arrangement of people sharing information and helping each other on a continuing basis. Some strategies are broadly mentioned for starting or developing a network with people both in and out of an individual's field.

107 Freeman, James E. (University of Denver) and Albert H. Rubenstein (Northwestern University). *The Users and Uses of Scientific and Technical Information: Critical Research Needs.* Washington D.C.: National Science Foundation, 1974. (Available NTIS PB237941.)

The text outlines issues in the use of scientific and technical information (STI), including how to incorporate user needs and requirements in the development and evaluation of STI services. The principle objective is to identify a set of critical research needs and experimental possibilities related to users and uses of STI. This document is focused towards those responsible for proposing that particular research be undertaken; those responsible for supporting and initiating research on and development of STI related services; and those concerned with scientific and technical information policy. Issues were outlined and evaluated by a group of academic, industrial and government STI involved workers. Areas identified as important include: more effective means of familiarizing potential users with STI services (marketing) and improving the use of information concerning users in the design and management of STI services. Freeman and Rubenstein assert that there is a need for user manuals and online tutorials to prepare engineers and others for successful use of STI services. Other topics discussed include: the effect of user perception on the design and use of high-speed/high-density STI interfaces, the use of file overviews and lists of terms that indicate the entry points of the file, suggestions for maintaining user use and interest, proactive systems, and structuring files to the cognitive style of the user group. Various STI service management issues are briefly discussed. Includes survey tools used to identify and prioritize issues and a list of organizations which have created STI user manuals directed at specific user groups.

108 Fries, James R. "Database Searching in Chemical Engineering." *Chemical Engineering* (December 28, 1981): 71-74.

Discusses computer databases covering the chemical process industries and the private and commercial search services currently available. Indicated the advantages of database searching are flexibility, timeliness, comprehensiveness, and cost-effectiveness. Lists 16 commercial databases and 3 vendors with addresses. 4 references.

109 Frost, Penelope A., and Richard Whitley (Manchester Business School). "Communication Patterns in a Research Laboratory." *R&D Management* 1 (1971): 71-79.

The article describes the effect of communication liaisons -- or Gatekeepers -- on communication patterns and the relations between communication habits. The researchers use methods similar to those developed by Allen in the United States, but here they were interested in how the role of gatekeeper technology had impacted a British research laboratory. Two types of data were collected: details concerning the scientists' past experiences/activities and the record of their present communication behavior. The return rate was high, over 90%. Because the measurement of individuals performance was of crucial important, the management committee of the lab was asked to rank each participating scientist on technical performance on a 5 points scale. Analysis of data was concentrated in three areas: communication networks, factors affecting communication patterns, and factors, including communication behavior, related to performance. Those scientists who received more than 93 contacts over the 21 days of the study were termed "stars." Contrary to Allen's studies, in this laboratory, there was no significant relation between being a "star" and level of education. However, five of these "stars" were section leaders. It was determined that the actual physical distance between people does not impact their communication patterns as much as the geographical arrangement of work groups. Those sections in which scientists worked together appeared to have more "original" scientists than sections in which scientists worked alone. High performers have a higher proportion of out of division contacts than low performers. The author characterizes the role of a gatekeeper as a by-product of the official status of a given researcher rather than being independent of it. Section leaders are perceived as possessing the important technical information; it is they who have the largest number of discussion contacts both inside and outside the facility. 25 references.

111 Garvey, William (Johns Hopkins University). *Communication: The Essence of Science.* New York: Pergamon Press, 1979.

This text explores the facilitation of information exchange among librarians, scientists, engineers, and students. Particular attention is paid to information retrieval system design variables such as: how do scientists seek information; why do they seek information; why do they fail to seek information; do different types of people seek information in different ways and if so, how can information systems be designed to suit different types of clientele; and lastly, how do people process information. The text also discusses the need for scientific communication services, the importance of knowing the status of the information seeker, the drivers to information seeking, the similarities and dissimilarities in the formal and informal communication domains, the media which best suit scientific communication, and the relationship between science (pure) and technology (applied). The source provides data, tables, and extensive exposition of methodology.

113 Garvey, William; Nan Lin; Carnot E. Nelson; and Kazuo Tomita. "Research Studies in Patterns of Scientific Communication: I, General Description of Research Program," in *Communication: The Essence of Science.* New York: Pergamon Press, 1979: 165-183.

This paper is the first in a series which describes the general procedures and some findings of over 70 studies which were conducted from 1966 to 1971 on the information-exchange activities of over 12,000 scientists and engineers in a sample of nine physical, and social and engineering sciences. The studies were designed that (1) the full spectrum of scientific communication media could be explored, (2) the various studies were coupled in order that data obtained from other studies could be compared, (3) the scheduling of the studies was conducted in real time in order that the same body of information could be followed from its inception to its final integration into the general body of scientific knowledge, and (4) the same studies were conducted for all nine disciplines being studied in order that genuine comparisons could be made among them. The data are stored on machine-readable magnetic tapes and are available for all interested scholars.

114 Garvey, William and S.D. Gottfredson. "Changing the System: Innovations in the Interactive Social System of Scientific Communication," in *Communication: The Essence of Science.* New York: Pergamon Press, 1979: 300-324.

Science is described as a social system of which interactive communication is the salient feature. Implications of this view of scientific communication are considered for the planning of innovations in the system. It is suggested that (a) innovation itself be seen as a process, (b) the dual role of the active research scientist (who is at once producer/disseminator and consumer/user of scientific information) be considered and (c) innovators take cognizance of the fact that alterations of the system may not always affect the desired changes in scientists' behavior unless the goals of the innovation are compatible with the individual and aggregate goals of the scientific community. Finally, a demonstration of the approach suggested is simulated, and its effect on the system of scientific communication is examined. Based on this simulation, a supplemental innovation is designed which overcomes faults in the major innovation while retaining the original goal.

115 Garvey, William, Nan Lin, Carnot E. Nelson and Kazuo Tomita. *The Role of the National Meeting in Scientific and Technical Communication.* Baltimore: Johns Hopkins University Press, 1978.

The text contains the results of a comprehensive study of scientific/technical communication associated with eleven national meetings which were sponsored by nine physical, social, and engineering science disciplines. Three groups of meeting participants were studied: authors (persons who presented papers), attendants (sample of persons who were present at these paper presentations), and requestors (sample of persons who requested copies of these papers). The results showed that the national meeting is the first public announcement of a large portion of current research findings in any discipline and much of the information-exchange behavior encountered at the meeting is intrinsically exploratory. The meeting presentation itself usually constitutes an interim report since most material presented there ultimately finds its way into the journal literature. Some discussion is presented of the relationship of the information exchange activities to characteristics of meeting participants. Particular attention is given to how information seeking behavior by participants at the engineering meetings differs from participants in other disciplines.

116 Garvey, William, Nan Lin, and Kazuo Tomita. "Research Studies in Patterns of Scientific Communication: III. Information-Exchange Processes Associated With the Production of Journal Articles." *Information Storage and Retrieval* 8 (1972): 207-221.

The two studies described in this article focus on information-exchange associated with material published in journal articles. The first study concentrated on the prepublication information-exchange activities of article authors, from the time their work first reached a report stage until it was published (N=3,676). The results of the second study, related directly to the articles studied in the first one, and the results of the first study wer combined to discuss how scientists assimilate and use information contained in these articles when this information is also disseminated via informal media prior to its appearance in journal articles (N=1,935). The findings are discussed in light of questions they raise about the function of current journal articles. The article provides database designers with a picture of the scientific and technical communication community.

122 Gerstberger, Peter G. (Massachusetts Institute of Technology, Sloan School of Management), and Thomas J. Allen. "Criteria Used by Research and Development Engineers in the Selection of an Information Source." *Journal of Applied Psychology* 52, no. 4 (August 1968): 272-279.

This article is of interest to research and development department managers, professional engineering society administrators, and librarians. This study followed 19 engineers for 15 weeks and questioned them using a modified version of the Solution Development Record (included in the article), supplemented by periodic questionnaires. Each subject was asked to report on the type of information sought, the order in which information channels were approached, and the success, of two searches each week. Nine information channels were ranked on the basis of accessibility, ease of use, technical quality, and degree of experience with each channel. Terms were clarified for subjects as necessary. Tables are included that compare frequency of use to perceived accessibility, perceived ease of use, and perceived technical quality. Results show a strong relationship between accessibility and frequency of use. Data also show a strong positive relationship between the degree of experience with a channel and both perceived accessibility and ease of use. Accessibility is the single most important determinant of use of an information channel; however, perception of accessibility is influenced by experience. Therefore, managers need to provide opportunities for use of various high quality information channels. Other suggestions include: control information access quality by hiring competent staff, encourage engineers to use them as consultants, make information services more available, and make professional publications less technical and more readable. Data collection instrument included. 7 references.

123 Gerstenfeld, Arthur (Worcester Polytechnic Institute), and Paul Berger. "An Analysis of Utilization Differences for Scientific and Technical Information." *Management Science* 26, no. 2 (February 1980): 165-179.

A study of science and information transfer processes, based on data from scientists and engineers at five major U.S. corporations garnered over two years (N=about 300). The issues investigated were differences between basic and applied research, and between the use of oral and written information, the timing of use and the time lag between receipt and use of information. The analysis shows that important information transfer, in applied research, takes place toward the beginning of a gi project by way of oral dissemination. Basic research utilizes information transfer late in the time frame of the proj .t, from the written form. Some beneficial examples of this are peer review systems and non-in-house conference proceedings. Managers should encourage applied researchers to attend technical seminars in-house. 39 references.

124 Gilchrist, Alan (Institution of Civil Engineers, London, Great Britain). "Information Provision for Civil Engineers: A Pilot Study." *British Library R&D Report* 5761 (April 1983): 83 pages.

Reports the findings of a study of civil engineers in Great Britain from both the private and public sectors. The study population (N 75) consisted of representatives from upper management, practicing engineers and information intermediaries. The research instrument used is an interview proceeded by discussions with key personnel at the

Institute of Civil Engineers. The study concluded that civil engineers are not information conscious and are not well served by either the secondary literature or national information services. The study further concludes that civil engineers prefer to seek information from other engineers. These sources include both personal contacts and formal consultations with professional organizations. The second preferred information seeking behavior is the scanning of current journals. Other information sources noted by the study include standards and codes of practice, trade literature, and personal files of journal articles. When asked to rank information seeking activities used to solve specific problems, personal files ranked first, with 93% reporting use, informal discussions with colleagues ranked second, with 87% reporting use, and librarians ranked last, with only 14% reporting use. Additional study findings confirm the low ranking of librarian or information intermediary use. Civil engineers regard libraries as sources of materials rather then as sources of information.

130 Glueck, William F. (University of Missouri), and Lawrence R. Jauch. "Sources of Research Ideas Among Productive Scholars." *Journal of Higher Education* 46, no. 1 (January/February 1975): 103-114.

This paper describes a study that was conducted to determine the sources that researchers use to acquire the ideas that guide their research. One-hundred and sixty "hard science" researchers from forty-six departments were interviewed. The interview questions were drawn from an hypothesis that outlined four sources of research ideas. This sources are rank ordered from most often to least often utilized: the researcher her/himself, local colleagues, literature, and peers elsewhere. As was predicted, more productive researchers relied on their own ideas and past work as the primary source of research ideas. While the literature was another valued source, of less value were ideas contributed by colleagues elsewhere. The least influential were ideas supplied by local colleagues. The article contains the following four tables: outline of composition of the sample by department; the most frequently mentioned sources; the relative importance of each of these sources; and correlation of productivity levels with respective information sources. 28 references.

131 Gould, Constance C., and Karla Pearce. *Information Needs in the Sciences: An Assessment.* Mountain View, Calif.: The Research Libraries Group, Inc., 1991.

Contains an assessment of information needs in eight science disciplines, including engineering. The scope of each chapter is to identify the dominate concerns and trends in each discipline and to relate these to information requirements in each discipline. Concerning engineering, information needs are characterized as encompassing data from all scientific disciplines. The authors predict that the demand for electronic information will continue to grow. Additionally the demand for access to US engineering research from other industrialized countries will grow. The report further notes that engineers use all forms of published materials. The chapter on engineering contains a profile of these forms, including brief descriptions of the major indexing and abstracting services in engineering. The profile of engineering concludes with an assessment of future needs, noting that, while academic libraries will remain the chief source of research information, access to information note included in the major indexes, such as grant information and technical reports, needs to be improved. This report presents a superficial overview of the discipline.

132 Graham, Warren R. (American Institutes for Research, Washington DC), Clinton B. Wagner, William P. Gloege, and Albert Zavala. *Exploration of Oral/Informal Technical Communications Behavior. Final Report.* Washington, D.C. : Advanced Research Projects Agency, Defense Research and Engineering, 1966.

Reports the findings of a study that explored the informal communications behavior of scientists and engineers in academia, government, and industry. The study's objective was to determine the kinds of management decisions needed to enhance research productivity by improving informal research communication. The research methodology used included informal discussions with 107 research directors and chairs of university science departments and a series of formal interviews, questionnaires, and communications incidents memoranda taken from 326 project directors engaged in research. Copies of the interview questions and the communication incidents memoranda are included in the appendices of this report. The report includes 1) discussions of how informal and formal technical communications are interrelated; 2) how difficult-to-obtain information is located; 3) the value of informal research communications; 4) the effects on research motivation and innovation; 5) the role of newsletters; 6) intra-organizational communications; 7) inter-disciplinary communication; 8) use of communications technology; 9) restrictions on information transfer; and

10) the function of informal communications in the research process. The report concludes that researchers in a wide variety of disciplines use informal research communications. Engineers use informal communications, especially, to develop methods and techniques for carrying out research plans and place less emphasis on informal communications for current awareness needs. Information technology discussions are dated, but the analysis of the communication incidents memoranda documents active communication activities, rather then impressions recorded in a questionnaire.

134 Griffin, Abbie (University of Chicago), and John R. Hauser. "Patterns of Communication Among Marketing, Engineering and Manufacturing—a Comparison Between Two New Product Teams." *Management Science* 38, no. 3 (March 1992): 360-373.

Two product development teams working on automobile component projects were compared to see if the communications patterns would be affected by one teams use of the Quality Function Development (QFD) approach when the other used the phase-review method. The results show that the QFD approach yielded a higher effective communication rate than did the traditional phase-review method. As success in product development is closely related to effective communication between the different components of the development team, it can be concluded that the QFD approach is significantly more effective than the phase-review method. 27 references.

137 Griffiths, José-Marie (University of Tennessee, Knoxville) and Donald W. King. *Special Libraries: Increasing the Information Edge.* Washington, D.C.: Special Libraries Association. 1993.

This book provides data from more than 10,000 survey responses dealing with communication patterns of scientists and other professionals, particularly but not exclusively those found in companies, laboratories, and government agencies. Data are presented concerning amounts and time spent writing and reading, and in interpersonal communication. Data are also given for communication patterns and costs involving journals, books, and technical reports. Estimates are provided concerning the dollar value of information provided in documents and by value-added services (e.g., libraries) found in organizations.

138 Griffiths, J-M, B.C. Carroll, D.W. King, M.E. Williams, and C.M. Sheetz. *Description of Scientific and Technical Information in the U.S.: Current Status and Trends* (vol. 1). (Available from the University of Tennessee, School of Information Sciences, 1991.) 188 pages.

This report summarizes a research effort funded under contract from the National Science Foundation to describe the current status and trends, and opportunities and problems of STI dissemination in the U.S. The description of STI is based on a model of four basic communication functions: scientists' and engineers' primary work (e.g., research, education, management, etc.), information input (e.g., interpersonal, reading, numeric data, imagery, etc.), information output (e.g., presentations, writing, numeric data, software, etc.), and communication processes (e.g., publishing, library services, bibliographic services, etc.). Each function is described in terms of quantities (e.g., number of articles written and read), resources required to perform the functions (e.g., time spent writing and reading, cost of publishing, etc.), and trends observed. When possible, interfaces between functions are described (e.g., price and demand of journals). Information and data are reported from a number of studies, including special analysis of data from surveys (conducted by the project staff) of information-seeking behavior of scientists and engineers. Special chapters address technological developments, international issues, and other issues.

143 Hall, Angela M. *INSPEC User Preference in Printed Indexes.* London: The Institution of Electrical Engineers, 1972.

This study describes users' preference for particular printed indexes in the field of science and technology and an assessment of the characteristics of these indexes. The design of a suitable questionnaire and the choice of a representative sample of users are detailed. The figures and comments extracted from the questionnaires returned are then presented and discussed. The importance of the role of the user in the performance of the indexes was accepted and the reactions of the users to various characteristics in the indexes were sought. Results include a list of attractive and useful index characteristics, relationships between frequency of use and ease of use, relationship between use of highly structured vocabulary and the frequency of use, a list of user suggestions for additional information in the subject indexes, and user suggestions for additional index fields (acronym, report no., patent concordance, etc.). Although dealing with paper indexes, the information obtained here could readily be applied to the creation of an electronic index.

144 Hall, Angela, P. Clague and T.M. Aitchison. *The Effect of the Use of an SDI Service on the Information-Gathering Habits of Scientists and Technologists.* London: The Institution of Electrical Engineers, 1972.

This survey forms an integral part of an Investigation of the performance, economics and acceptability to users of an SDI service. The survey examined the methods used by the scientist and technologist to keep informed of recently-published information and the effect which the SDI service had on these information-gathering habits. A questionnaire was sent to recipients of the service in universities, industry and government departments, both before it commenced and again after up to two years. A control group also answered the same questionnaire in order that the effects of the service might be isolated. The survey showed that use of the service significantly increased the recipients' confidence that they were keeping up-to-date with newly-published literature and many reduced the number of periodicals which they scanned regularly. This left them with more time in which they could read and assimilate useful articles if they wished to do so. The industrial scientists benefitted most from the service because they had previously attempted to cover a wider field and scan more periodicals.

146 Harris Jr., William J. "Creative Dissemination of Technical Information." In *The Engineering Manager: Survival in the Seventies, 17th Joint Engineering Management Conference, The Engineering Institute of Canada, Montreal, 1969.* 61-70.

In a study by Auerbach Corporation of 1373 of the Defense Department's professional personnel and a study by North American Aviation Corporation of 1500 professional personnel, it was concluded that there is no such thing as a typical information user; and that in any business, there are only a few individuals who work with information transfer. Tables are included that show the first choice for information by DoD users and industrial users and media through which DoD employees receive information. The varieties of information requirements for each engineering position are explored. The transfer of information from the generator to the user by way of oral communication to recorded transfer (journals, photographs, etc.) to information analysis center is illustrated. Battelle Memorial Institute studied over 400 information analysis centers for the National Science Foundation. A model of a typical information analysis center is illustrated in a chart. These centers are determined to be the most creative dissemination techniques yet devised, but expensive. General Electric is presented as an example of a company that is investing in information, and a program it has initiated is discussed. The costs and benefits of improved engineering information services are not known. No one knows how much is spent on information services at this time, or how much it is worth, or how much information deficiencies cost a company. Creative dissemination of information and effective utilization of information resources will be important challenges to a manager of the 70's. 8 references.

155 Heroux, Ronald G. "Issues of Computer Conferencing." *Proceedings of the Technological Transfer Society International Symposium, June, 1981.* 6.3-1-6.3-3.

This article deals with computer conferencing as a linking mechanism in the technology transfer process. The mechanics and uses of electronic mail and computer conferencing are discussed. The author mentions such systems as EIES (Electronic Information Exchange System), LOGON by Control Data Corporation, and POLITECHS (an inquirer response system by Participation Systems). Advantages of computer conferencing that are discussed include money saved in travel and telephone costs, speed with which information is transferred, and convenience. People with problems are able to cut across political and geographic boundaries to connect with people who have information to help solve those problems. Some disadvantages cited are the training time for learning to use the equipment, follow-up sessions to stay in practice, unreliability of the equipment, and the need to organize large groups of people who want to communicate and exchange information with each other.

157 Hill, R. John. "Using Personal Bibliographic Data Bases to Keep Up with the Engineering Literature." *IEEE Transactions on Professional Communication (IPC)* 32, no. 3 (September 1989): 189-193.

Retrieval of bibliographic information from literature searches is moving from tne large central databases to specialized remote personal computer (PC)-mounted databases. The advantages to the PC-mounted database include the potential for tailoring the database contents to reflect individual interests, rapid and convenient access, and flexibility in carrying out a literature search because of the personalization of literature retrieval criteria and report formats. A personal database for engineers must be comprehensive, informative, versatile, quick, and convenient to use. The following issues also need to be addressed: purpose, technical scope, available time for compilation, size of completed data file, and support files. A software package's record form, data entry, selection of records, report compilation, and versatility features need to be examined next. To be effective, a personal database must take into account the structure of the literature it contains, as well as provide easy access for record entry and searching. 7 references.

160 Holland, Maurita P., Thomas E. Pinelli, Rebecca O. Barclay, and John M. Kennedy. "Engineers as Information Processors: A Survey of U.S. Aerospace Engineering Faculty and Students." Paper 20. Reprinted from *European Journal of Engineering Education*, vol. 16, no. 4 (1991): 317-336. (Available from NTIS 92N28155.)

(note: also available as a reprint in *European Journal of Engineering Education* vol. 16, no. 4, 1991 p317-336). US aerospace engineering faculty and students were surveyed as part of the NASA/DOD Diffusion Project. Self-administered questionnaires were received from 275 faculty members and 640 students. Objectives of the survey were to determine: 1) use and importance of information sources; 2) use of specific print and electronic sources; 3) use of information technology; and 4) influence of instruction on use of information sources. The researchers concluded that both faculty and students are 'information naive', seek out information alone or with the help of colleagues, tend not to use the information products and services oriented towards them, make limited use of librarians, and make considerable use of computer and information technologies. Little evidence was found to support the belief that instruction in library use has had a significant impact on broadening either the frequency or the range of information sources used by students. Additionally the authors conclude that future information-seeking behavior of engineers is well-established while in school, and that students tend to emulate the behavior of faculty. This document focuses on engineers working in academic settings. 28 references.

162 Holmfeld, John D. (Department of Special Interdisciplinary Studies, Case Western Reserve University) *Communication Behavior of Scientists and Engineers* Ph.D. Dissertation. Cleveland, Ohio: Case Western University, 1970. 301 pages.

Examines the communication behavior of scientists and engineers working in the field of liquid propellant rocket engines. (N=70). The researcher notes differences in the types of knowledge exchanged by scientists and engineers. Engineers communicate knowledge that relates to specific engineering problems or systems. A detailed understanding of scientific theory is less important than obtaining a workable solution. The researcher observes that engineers tend to deal with complexity by using intuition, which is composed of past experience and familiarity with past design solutions by others. Another aspect noted is the often proprietary nature of technical information, which can hamper the exchange of technical knowledge in private industry. Also stressed as of value to engineers i the reliability of technical information. The researcher analyzed oral and written technical communications and observed that engineers rarely initiate written reports. Few engineers publish in journals, but engineers working in academic and government settings may commonly write technical reports. Concerning oral communication, the researcher has emphasized formal oral communication in the form of professional meetings and conferences. The researcher noted that few general design engineers in the field of liquid propellant rocket engines attended meetings, relying, instead, on reports from specialized engineers who did attend. Those attending meetings stressed the importance of hearing papers read, which allowed them to assess the reliability of the information presented. Engineers, along with scientists, strongly valued the importance of informal communication with papers at meetings and identified as most valuable information obtained about grants and funding. This document provides both an overview of the nature of engineering knowledge and for the observations concerning the value of meetings and conferences. Such observations have implications for future trends and features of electronic conferences.

165 Hoyt, J.W. "Periodical Readership of Scientists and Engineers in Research and Development Laboratories." *IRE Transactions on Engineering Management* EM-9, no. 2 (June 1962): 71-75.

The reading habits of scientists and engineers engaged in research and development are shown to be readily differentiated by academic attainment and field of academic discipline. Eight tables demonstrate this finding (n=2,387). Other less important influences on readership appear to be pay level and general type of work (research, test, or development.) From these data, advertising programs can be developed toward categories of research and development personnel. The usefulness of journal advertising as a source for employment opportunity has been shown to be helpful. Junior scientists and engineers seem to rely on employment advertising to a somewhat greater extent than senior level positions.

167 Hurd, Julie M. (University of Illinois at Chicago), Ann C. Weller, and Karen L. Curtis. "Information Seeking Behavior of Faculty: Use of Indexes and Abstracts by Scientists and Engineers." *Proceedings of the American Society for Information Science* 29 (1992): 136-143.

This research project investigates information seeking behavior by science and engineering faculty and explores their use of major access tools such as *Current Contents* and *Science Citation Index* as a timely means of identifying research literature. The paper describes a survey of faculty in the pure and applied sciences carried out during autumn 1991 to establish a baseline for a subsequent survey to assess the impact of availability of locally mounted databases (N=559). Results included the discovery that many faculty fail to use indexes accessed by electronic means and prefer manually accessed information tools. Suggestions for convincing non-users of technology benefits are given. Peer education is advocated. The paper provides solid data insights into user reaction to electronic information access and retrieval. 8 references.

168 Hutchinson, Robert A. (Battelle Northwest Laboratory), Jack E. Eisenhauer, Gerald J. Hane, and Donna C. Debrodt. "Information Flow from Japan to U.S. Researchers in Applied and Basic Energy Fields." *Journal of Technology Transfer* 10, no. 1 (1985): 1-7.

This study, by Pacific Northwest Laboratory (PNL), evaluates technical information transfer from Japan to the United States. U.S. researchers in each of ten selected technical fields were identified and interviewed to obtain their perceptions of information transfer from Japan. Results show that although there are major differences between technical fields, U.S. researchers generally consider information transfer from Japan to the U.S. to be inadequate. Researchers noted, in particular, the difficulties they have attending conferences in Japan or visiting Japanese research facilities. In contrast, Japanese researchers attend all major conferences and frequent research facilities in the U.S. There were several suggestions to improve information transfer from Japan, including improving the screening and translation of technical material published in Japan, promoting binational seminars and workshops, and encouraging laboratory visits and exchange of research personnel.

170 Jahoda, Gerald (Florida State University), Alan Bayer, and William L. Needham. "A Comparison of On-Line Bibliographic Searches in One Academic and One Industrial Organization." *RQ* (Fall 1978): 42-49.

The authors have conducted a comparative study of the use of online searches by persons in one academic and one industrial organization so that librarians may better understand the needs of users. Fifty participants in the study were faculty members, research associates, and graduate students from the Chemistry Department at Florida State University in Tallahassee, Florida. Chemists also participated from Monsanto Textiles in Pensacola, Florida, with some searching also conducted at the Monsanto facility in Durham, North Carolina. Selected results of 353 searches conducted at FSU and 345 searches conducted at Monsanto are summarized under the following headings: purpose of the search request, sources checked by the user prior to the search request, search characteristics, technical problems encountered, users' opinions of search results, and typical search profiles. Percentages are of all searches at each institution separately. Questions asked of users and responses are included in tables in the article and in appendices. This study concludes that computer online bibliographic searching is used and appreciated by both academic and industrial chemists. Academic chemists tended to interact directly with the system more often than industrial chemists, but both groups expressed the same opinions concerning the number, currency, and utility of the citations located.

Query negotiation for such specific search requests tended to take less time than reported in other studies for social sciences and humanities. Online bibliographic searching is a suitable reference technique for both academic and industrial environments, and librarians and information specialists can expect continued interest in and use of such services. Data collection instrument included. 4 references.

172 Johnson, Alan W. (USAF, Air Force Institute of Technology, Air University). *Perceived Barriers and Opportunities to Engineering Technical Communication in Selected Air Force Organizations*. Master's Thesis, September 1989. 62 pages.

Reports the results of a master's thesis study to identify technical communication barriers and opportunities perceived by selected Air Force Systems Command (AFSC) and Logistics Command (AFLC) engineers that affect the diffusion of technologies within their organizations. The author surveyed 86 engineers, with a response rate of 73.2% A copy of the survey questionnaire is included in Appendix B. The study addressed three investigative questions: 1) what is the frequency of use and perceived importance of information sources and channels; 2) what communication barriers are perceived to impede access to external sources of technical information; and 3) what communication opportunities do Air Force engineers perceive that would enhance the diffusion of technologies in their organizations. Major findings of the study are that informal internal sources are the most frequently used by respondents and all internal information sources were perceived as having more value than external sources; the two most significant perceived barriers impeding technical communications with external sources were lack of time and organizational priorities that discourage innovation; the most frequently mentioned suggestion for improving the flow of technical information was to improve access to external information sources. Suggestions included improving on-line database access, procurement of technical literature and establishing/improving technical libraries at air logistics centers.

174 Kant, Raj (Honeywell Systems and Research Center, Minneapolis, MN), and Jon Krueger. *Engineering Information System (EIS). Final Report for Period September 1987-July 1991*. Wright-Patterson Air Force Base, Ohio: Manufacturing Technology Directorate, Wright Laboratory, Air Force Systems Command, 1992. 73 pages. (Available from NTIS AD-A254013.)

Describes the Engineering Information System Program (EIS) created by the U.S. Department of Defense in 1987 in response to increasing concerns about the exchange of engineering information between contractors and the government. An EIS is defined as containing two components: 1) an Engineering Information Model (EIM); and 2) the EIS framework which includes the automated services embedded in software used to support an EIS. The focus of this described DoD EIS program was to create, not an existing EIS, but EIS standards as a means of ensuring uniformity between EIS's. Although not directly connected to the information seeking/acquiring behavior of engineers, this report discusses creating a national engineering information database.

177 Kasperson, Conrad J. (Franklin & Marshall College). "Psychology of the Scientist: XXXVII. Scientific Creativity: A Relationship with Information Channels." *Psychological Reports* 42, no. 3 (1978): 691-694.

Using peer nominations, 65 physical scientists were classified as either creative and productive, productive but not creative, or non-creative and non-productive. Each scientist was then interviewed to determine his information-receiving behaviors and attitudes. Results indicate that creative scientists are distinguished from other scientists in their use of people as sources of information and that they receive information from a wider range of disciplinary fields. 4 references.

178 Kasperson, Conrad J. "An Analysis of the Relationship between Information Sources and Creativity in Scientists and Engineers." *Human-Communication Research* 4, no. 2 (Winter 1978): 113-119.

Those scientists characterized as "creative" tend to utilize informal information gathering techniques, notably through peer associations, as much, or more, than traditional resources. The study described here is based on Mednick's (1962) associationist position, that information use patterns play a key role in an individual's process of creativity. To test this idea, 29 academic and 36 industrial physical scientists and engineers were categorized as one of these three ty~~ creative and productive; productive, but not creative; or noncreative and nonproductive on the basis of peer evaluation. Two sets of questions were asked: how do "creative scientists" access and use information differently than "noncreative scientists" and, by determining the information gathering habits of a given scientist, can one predict into which of the above categories that individual would fall? Prior to the study the researchers developed six hypotheses about the correlation between information gathering habits and productivity. The article describes the degree to which each hypothesis was challenged or affirmed. The participant's information seeking and receiving behavior and attitudes were measured and related to the criterion group membership. The following results emerged. Consistent with the associationist position, variety of exposure to information content, in terms of scientific disciplines from which the information was received, was significantly different for the three groups, with the creative group having the greatest variety. Second, group membership can, with a fairly high probability, be predicted based on information seeking behavior and attitudes. Included are the outline of the methodologies used, and a statement concerning the selection of subjects. 24 references.

183 Katzen, May. "The Changing Appearance of Research Journals in Science and Technology: an Analysis and a Case Study." In: *Development of Science Publishing in Europe*, ed. A.J. Meadows. Amsterdam: Elsevier Science Publishers, 1980.

The article describes a study conducted to determine the impact of different modes of communication between scientists and their colleagues. The researchers have distinguished between internal communication linkages -- those involving different task areas or projects, and those linkages that involve administrative or organizational communication, in a given research setting. The following hypothesis was developed: "Role specification in external communication will be positively related to performance for development and technical service projects but will be negatively related to performance for research projects." This study involved 61 projects in an industrial R&D laboratory for a total of 350 scientists. Each of these scientists were asked to note (on provided forms) all those individuals with whom they had communicated on a particular day. Respondents were asked to characterize each of these communications as either "problem solving" or "administrative" transactions. While there were no differences in the relative patterns of these two types of communication, overall patterns of communication were influenced by the nature of the projects' work. It was determined that research projects had the most communications within their own projects, while development and technical service projects tended to communicate with outside sources. The article contains five tables that display various correlations between project performance and communication types, the correlations between project type and content of message etc. The research reinforces the importance of managing communication patterns in organizations and further recognizes the value of those individuals who communicate with others outside their immediate environment. 53 references.

186 Keller, Robert T., and Winford E. Holland. "Boundary-Spanning Roles in a Research and Development Organization: An Empirical Investigation." *Academy of Management Journal* 18, no. 2 (June 1975): 388-393.

Boundary-spanning roles are vital to the transfer of technology and information across organizational boundaries. This study was conducted to test the hypothesis that boundary-spanning activity (BSA) would be positively related to levels of role conflict and ambiguity and negatively related to levels of job satisfaction. It was also hypothesized that BSA would be positively related to marginality and to political and economic value orientations and negatively to aesthetic and religious value orientations. This study was conducted in the applied science department of a government research and development organization that interacts with more than 20 universities, private contractors, and other government agencies. Anonymous questionnaires were mailed and interviews were conducted to corroborate the questionnaire data. A four-item scale was used to measure the BSA by asking the following questions: the total number of periodicals read regularly, the number of times the individual recommended specific information sources to a colleague last month; the number of times information was sought from outside of the organization last month; and the number of times people from outside the organization sought information from the individual last month. Role conflict, ambiguity, job satisfaction, marginality (a self-orientation related to "belonging" to a group), and six personality related values were also measured. Tables in the article report correlational analysis results. BSA was negatively related to role ambiguity and positively related to job satisfaction. BSA was not related to marginality or any personality-related values. None of the hypotheses were supported. These findings show that boundary-spanning roles appear to attract those with theoretical value orientation who are seeking the discovery of "truth," rather than those with political values oriented toward power. 23 references.

192 King, Donald W. (King Research, Inc.), and José Marie Griffiths. "Indicators of the Use, Usefulness and Value of Scientific and Technical Information." In *Online Information 91: 15th International Online Information Meeting Proceedings, London, UK, Dec 10-12 1991*. New Jersey: Learned Information, 1991. pp. 361-377.

Reviews several studies of the consequences and amount of time spent by scientists and engineers in reading, books, periodicals, and other information sources. The report uses this data to derive indicators of the effect of reading on scientists's and engineers' use of information in their work and on relationships between reading and productivity and professional achievement. The authors observe that two major events, the evolution of information technologies and proposed large science projects, may significantly alter the balance of the amount of time devoted to the four STI communication functions: primary work, information input, information output, and communication processes. Major findings of the study include: 1) information found in documents was rated as highly valuable as an aid in performing primary work, rating only behind use of equipment in value. Information found in documents rated highest in value for background research, professional development and education and training; 2) most reading is done to address specific work activities with the remainder connected to professional development, current awareness and communication; 3) those scientists and engineers who reported the highest annual rates of readings also reported higher productivity in terms of proposal preparation, high consultation and advice-giving activity, and numbers of records written per hour of R&D activity; and 4) those scientists and engineers who read heavily also attained higher professional levels of achievement as measured by awards, patents recognition, etc. This report provides an overview, not only of the information seeking process, but measurable evidence of the value of information sources to scientists and engineers. 13 references.

195 King, Donald W., José-Marie Griffiths, Nancy K. Roderer, and Robert R.V. Wiederkehr. *A Study of the Value of Information and the Effect on Value of Intermediary Organization, Timeliness of Service & Products, and Comprehensiveness of the EDB*. Vol. 1, *The Value of Libraries as an Intermediary Information Service*. Vol. 2, *The Value of the Network Energy Software Center and the Radiation Shielding Information Center*. Vol. 3, *The Effects of Timeliness and Comprehensiveness on Value*. (September, 1984). 131 pages. (Available from NTIS.)

This document reports in three volumes the results of a series of surveys designed to determine what contribution intermediary information transfer organizations such as libraries and information analysts centers make to the value of information and to assess the value of two somewhat different software information analysis centers and the value of their products and services and to investigate the importance of timeliness and comprehensiveness to the value of information found in technical reports and journal articles. Data were collected from six surveys. The first was a study of the population of scientists and engineers from nine fields of science conducted as part of a National Science Foundation study. It involved estimating many variables related to authorship, journal use, library use, numeric database searching, and bibliographic database searching. Demographic information identifies scientists and engineers funded by the Department of Energy (DOE) (N=664). The second, a survey of managers, administrators, operational professionals, and scientists and engineers engaged in research and development at Rocky Flats, Rockwell Energy Systems Group, and Oak Ridge National Laboratory (ORNL), obtained information about general reading library use, awareness of services, and satisfaction with services (N=195). In addition, four surveys were conducted at the three library locations to obtain detailed information about recent uses of specific library materials and services. Detailed analyses including numerous tables and figures present the findings of these studies. Excellent background on a wide variety of issues central to scientific and technical communication behavior.

196 King, Donald W., José-Marie Griffiths, Nancy K. Roderer, Ellen A. Sweet, and Robert R.V. Wiederkehr. *The Value of the Energy Data Base*. King Research Inc. (March 1982). 82 pages. (Available from NTIS DE82-014250.)

A study was conducted to assess the value of the Energy Data Base (EDB), which is produced by the Technical Information Center (TIC) of the Department of Energy (DOE) in order to provide a means of identifying primary energy information sources, particularly journal articles and technical reports. The volume of energy information distributed to and used by the DOE-funded research community was identified, and value was determined in terms of user willingness to pay for information, the effect of information obtained on work, and the effect of the work performed on organizations and society. Two types of value were computed, apparent value or the amount paid for information in terms of time and money, and consequential value, or the savings achieved by the application of the information. Data used came from TIC records and a previous survey of scientists and engineers which identified the value associated with the reading of journal articles and technical reports in terms of both dollars and time saved. It was found that savings of equipment resulted from the use of EDB products and services, and benefit-to-cost ratios for EDB searching and reading were identified as 5.9 to 1 or 31 to 1 respectively. This report contains an executive summary and technical documentation of the study. Sample questionnaires and a 47-item bibliography are provided. 76 references.

197 King, Dona' ! W., Dennis D. McDonald, and Nancy K. Roderer. *Scientific Journals in the United States: Their Production, Use, and Economics*. New York: Academic Press, 1981.

This book describes a model of communication among authors, publishers, seconaary database producers and vendors, libraries, and scientists as intermediary communicators and end-users. Data are provided for amount of communication among these participants. Data and trends (1960-1975) are given for number of articles written and resources used (time of authors and editors, and cost); size, growth, resources used, and prices of STI publishing; number, growth, and resources used in libraries and secondary organizations used for STI communication; and amount of reading and resources used for obtaining and reading scientific articles. One chapter is devoted to a discussion of the future of scientific journals, including electronic distribution of articles. Data are provided from a national survey of scientists and engineers, surveys of libraries, cost analyses from publishers, and results from other studies. The book primarily summarizes results of a series of studies performed under contract to the National Science Foundation. 204 references.

199 King, Donald W., and Nancy K. Roderer. *Systems Analysis of Scientific and Technical Communication in the U.S.: The Electronic Alternative to Communication through Paper-based Journals*. King Research, Inc., report to the National Science Foundation. 1978. (Available from NTIS PB-281847.)

This is a study of the economic and technical feasibility of electronic publishing. The project examined economic and technical aspects of authorship, publishing, bibliographic services, libraries, and end-use of journal articles. The study concluded that the optimum system in the near future would involve two tiers: journals which are frequently read by individual scientists should continue to be distributed in paper form; however, journals that are infrequently read should have separate copies of articles orderd and distributed electronically. The report points out some limitations of technology at the time, including input quality and costs, problems with graphics and photographs, availability and costs of receiving stations, and so on.

200 King, D.W., F.W. Lancaster, D.D. McDonald, N.K. Roderer, and B.L. Wood. *Statistical Indicators of Scientific and Technical Communication. Volume I: A Summary Report*. 1976. (Available from GPO 083-000-00295-3.)

201 King, D.W., D.D. McDonald, N.K. Roderer, and B.L. Wood. *Statistical Indicators of Scientific and Technical Communication. Volume II: A Research Report*. 1976. (Available from NTIS PB-254060.)

202 King, D.W., D.D. McDonald, N.K. Roderer, C.G. Schell, C.G. Schuller, and B.L. Wood. *Statistical Indicators of Scientific and Technical Communication. 1977 Edition*. 1977. (Available from NTIS PB-278279.)

This series of annual and special reports presents trends from 1960 to 1976 and projections to 1980. The reports are based on national surveys of scientists and engineers, and secondary research. The statistical indicators are based on a model of 10 basic functions involved in information transfer, beginning with research and information creation, and ending with assimilation by scientists. The statistics deal largely with documented information (books, journals, and technical reports). Trends are given for number of articles, books, and technical reports produced, processed by various intermediary organizations, and read. Overall costs and prices are also presented. Total expenditures for STI communication are estimated.

203 King, D.W., C.G. Schuller, and B.L. Wood. *A Chart Book of Indicators of Scientific and Technical Communication in the United States.* 1977. 29 pages. (Available from GPO 038-000-0360-7.)

A total of 27 figures is used to display information about a scientific and technical (S&T) information transfer model, United States S&T communication costs, and U.S. S&T literature items. Figures dealing with communication costs include such variables as function, number of scientists or engineers, literature media, current and constant dollars, and process and control share of S&T communication costs. Figures dealing with S&T literature items give information on such variables as number of literature media types, prices in current and constant dollars, distribution, and number of subscriptions. Provides a comprehensive historical picture of the scope of S&T information.

206 King, Donald W. and Vernon E. Palmour. "User Behavior." In *Changing Patterns in Information Retrieval*, ed. Carol Fenichel. Philadelphia: ASIS, 1974.

This state-of-the-art paper is prepared around a communication model of Lin and Garvey (235), consisting of information needs, information seeking and exchange, information organization and management, and information uses. The model is applied to primary, secondary, and tertiary channels. Information needs are defined by various types of messages (e.g., ideas, research results, numeric data, etc.), and uses are defined by the purposes for which the information is used (e.g., research, writing, professional development, proposal preparation, etc.). Information seeking and exchange has two components: the media (e.g., articles, conferences, etc., for primary media) and requirements or attributes of informaiotn and medium or service (e.g., accuracy, timeliness, accessibility, etc.) Six principal functions of printed media are also discussed: composition, reproduction, acquisition and storage, identification and location, presentation, and assimiliation. p. 7-334. 98 references.

212 Kleinman, Larry. "The Engineer and His Future with the Computer." *Specifying Engineer* 50 (September 1983): 37-39, 202-203.

Discusses the impact computers have had and will continue to have on the transformation of the engineering workplace. Three major computer enhancements can be expected in the next 25 years: better communication, improved information access, and computer control of our environment and our businesses. Networking will grow; all computers will communicate with all others. Four basic types of computers will develop: a "library" computer and network controller; a "personal workstation" for personal and business transactions; a specialized personal workstation; and a hand-held computer which will replace our calculators, currency, and credit cards. Computer size and access speed will be much less important in the future because very small computers will be able to handle what we now consider enormous amounts of data. Prices will fall to the point where the great majority of households will own computers. Using computers will become easier as we develop voice-activation and more sophisticated programming languages. In the engineering field, word processing, calculating and drafting will be handled by one integrated system. Database accessing will be a large part of the engineer's workday. Journals and advertisements will be electronic, and dynamic in the sense that they will be largely interactive.

216 Krall, George F. (Krall Management Incorporated, Paoli, PA), and Sandra L. Burgoon. "Electronic Storage and Delivery of Handbook-Type Information: An Emerging New Tool for Engineers." *Current Research on Scientific and Technical Information Transfer*, Micropapers Edition. New York: Jeffrey Norton Publishers, 1976 (September, 1976) 24 pages.

A re-examination of data used in a study of informal communication among sleep researchers raises some interesting questions on the definition of communication and its relationship to research productivity. This paper presents results of this re-examination and suggests directions for future investigations. It describes five different ways of defining the communications links between scientists. This article expands the work of Crawford and De Solla Price (also included in this database). *See also*: Crawford and De Solla Price. Includes: data (taken from previous studies, see the other articles noted under the *See also* reference). 5 references.

216 Krall, George F. (Krall Management Incorporated, Paoli, PA), and Sandra L. Burgoon. "Electronic Storage and Delivery of Handbook-Type Information: An Emerging New Tool for Engineers." *Current Research on Scientific and Technical Information Transfer*, Micropapers Edition. New York: Jeffrey Norton Publishers, 1976 (September, 1976) 24 pages.

An in-depth look at the information requirements, information use and work patterns of design engineers, the primary users of handbook-type information. Design engineers are receptive to new ways of enhancing productivity through more effective storage and delivery of handbook-type information. The computer technology required to deliver the information design engineers need is available and is already in use within large corporations in several major industries. Properly implemented, electronic delivery would improve the efficiency of information use by facilitating retrieval, data reduction, mathematical and statistical manipulation of data, and interaction between private and public data sources. Since it appears to foster favorable changes in work patterns, we expect this emerging tool to improve engineering work quality and productivity.

217 Kranzberg, Melvin (Georgia Institute of Technology). "Formal Versus Informal Communication Among Researchers," in *Current Research on Scientific and Technical Information Transfer*. Micropapers Edition, NY: Jeffrey Norton Publishers: 1976.

In the innovation process, the flow patterns of scientific and technical information indicate that the formal and informal communication systems are not competing with one another. They complement one another, and the problem is to get the formal and the informal systems working together most effectively for transmitting the many different kinds of information which are essential at different points within the innovation process. Formal information systems within the science and technology disciplines, while theoretically providing quick storage and retrieval of information, do not receive full use. Instead, informal communication networks have grown up: "invisible colleges" among those at the forefront of research; the movement of people from firm to firm, from government to academia to industrial laboratory; and "technological gatekeepers" within R&D laboratories. These gatekeepers usually refer the information recipient to elements in the formal system - articles, handbooks, or sometimes individuals who know where the published information can be found. The gatekeeper is thus part of the interface between the information user and the storage and retrieval element of the formal information system. The formal STI systems seem to work better then the informal systems. However, because of the symbiotic relationship between the formal and informal systems, the full advantages of an efficient formal system cannot be realized unless the informal system makes proper use of it. Hence further attention might be directed toward improving the interface between the formal and informal systems, in order to make full use of the innovative ability and capacities of American scientists and engineers. 1 reference.

218 Kremer, Jeanette Marguerite (University of Illinois). *Information Flow Among Engineers in a Design Company* Ph.D. Thesis, University of Illinois, Urbana-Champaign, IL, USA, 1980.

Reports the results of a study of engineers' use of informal and formal communication channels in a US design company (N=73). The research instrument used was a self-administered questionnaire with a response rate of 82%. A copy of the instrument is included in the report. Major report findings include the observation that formal and informal channels follow specific patterns and complement each other in the information acquisition process. Respondents revealed a preference for internal communication channels, both informal and formal. The use of external channels was found to be equally small among identified gatekeepers and other engineers, with gatekeepers characterized as among the most experienced engineers, and also including engineering managers. The choice of an information channel was determined by accessibility, ease of use, technical quality and previous experience with the channel. Additionally, subject specialization of the engineer also affected channel choice. When asked to rate information sources, respondents rated manuals to be the best sources, and respondents preferred formal to informal information sources. The author found that most information searches were undertaken to find solutions to a specific problem and that information located by chance was deemed an important part of the process. This study is one of the earlier, classic studies of engineer's information seeking acquiring habits.

222 Kuhn, Allan D. (Defense Technical Information Center, Alexandria, VA.) and Gladys A. Cotter. "The DoD Gateway Information System (DGIS): User Interface Design." *Proceedings of the 49th ASIS Annual Meeting* 23 (1986): 150-157.

This paper discusses the development of a tool to provide rapid, easy access to scientific and technical information for research scientists and researchers from a variety of databases from the federal and commercial sectors. The objective is to provide researchers with a single, easy-to-use interface for accessing, interrogating, and post-processing information from numerous databases. The Defense Technical Information Center (DTIC) is the program manager for the design, development, and implementation of the DGIS. Site visits and user surveys showed six critical areas to incorporate into a DoD gateway system: 1) a gateway user interface; 2) a directory of databases; 3) remote database connection routines; 4) common data retrieval routines; 5) simultaneous search capabilities; and 6) data analysis and post-processing routines. The menu was the first item to be designed. With this menu, the user can, at any time, enter any menu number, any command, backup to higher level menu, go back to the DGIS top menu, or quit the session. Illustrations of menu pages and the selections available on each page of the menu are given and accompanied by textual explanation. The purpose of the system is to allow the user to process information and to process knowledge which has accumulated throughout the wide range of resources in his/her domain of expertise. After getting their information, researchers may then use the wide range of processing routines in DGIS to tailor their own information aggregations into forms that are useful to them. 7 references.

223 Lacy, William B. (University of Kentucky), and Lawrence Busch. "Informal Scientific Communication in the Agricultural Sciences." *Information Processing & Management* 19, no. 4 (1983): 193-202.

This analysis of informal scientific communication emphasizes the communication which occurs among public sector agricultural researchers. While the formal channels and the informal channels constitute the two mutually dependent elements of this communication, the importance of the informal channels is often ignored. The informal communication network is examined utilizing a survey of randomly sampled U. S. agricultural scientists listed in the Current Research Information System (N=1431). Particular individuals in the informal communication network are viewed as important sources of influence for a variety of research decisions such as choice of problem, methods, key concepts and theoretical orientation. However, informal scientific communication appears to occur infrequently, and to be primarily limited to one's own discipline. Scientists report communication with scientists outside their department, clients and extension staff is limited to less than once a month. In addition, the nature and frequency of the informal scientific communication is highly related to the criteria utilized in establishing research agendas and the publication products. However, the use of and reliance on particular channels of communication may affect scientists and their research in different and sometimes contradictory ways. Consequently, it is important to view the informal scientific communication and the processes and products of science as inextricably bound together in a mutually interdependent social system. The article should prove helpful in establishing background information on the mechanics of informal technical communication, which may influence database design. 31 references.

227 Landendorf, Janice M. (North Star Research and Development Institute, Minneapolis, MN). "Information Flow in Science, Technology and Commerce: A Review of the Concepts of the Sixties." *Special Libraries* 61, no. 5 (May-June 1970): 215-222.

Information on user characteristics is of crucial importance in the design of information systems. Unfortunately, many scientists and engineers will not necessarily use information even when it is readily available to them. Characteristic communication behavior is established for two basic types of users: the successful research scientist and the average industrial technologist. Communication activities do not represent an isolated behavior pattern. They are deeply tied to social, professional, and institutional relationships. There are limits on the extent to which these behavior patterns can be modified to increase the use of information. Applications of the study's conclusions for information system designers is discussed. 30 references.

229 Leibson, David E. "How Corning Designed a 'Talking' Building to Spur Productivity.' *Management Review* 70 (September 1981): 8-13.

Research showed that engineers would move no more than 35 meters to obtain information. Corning Glass Works had a building designed and built to promote more communication and creative ideas. Some features are high ceilings, glass walls with curtains for privacy, and an open design.

231 Lescoheir, R. S., M. A. Lavin, and M.K. Landsberg. "Database Development and End-User Searching: Exxon Research and Engineering Company." *Science and Technology Libraries* 5, no. 1 (1984): 1-15.

Description of REIS (Research and Engineering Information Services) experiences with enhancing local access to proprietary information for the end user from a two-phased project. Phase One defined the user needs, organized a customized database and trained engineers to use the indexes. First REIS evaluated the then present system, made recommendations for resolving the situation. A user's manual was written to describe the collection and instruct engineers in the use of KWIC (Key word in Context) indexing. After completing Phase One the divisions corresponding database contained 7,000 records with an expected 2,000 more records to be added each year. A preliminary review projected a possible savings of 2.5% of an engineer's work week due to improved access. Phase Two involved developing an on-the-job training session, designed to introduce the engineers to the process of online searching. Although the sections were identical in structure, subject emphasis depended on the backgrounds of attendees. The classes were designed to help the engineers minimize the time they spend away from their work. The entire division was given an opportunity to attend classes; over 90% participated. A random survey done nine months after the training period found that 63% of the engineers performed successful individual searches, with most searches lasting only 5-10 minutes. 3 references.

232 Levinson, Nanette S. (American University), and David D. Moran. "R&D Management and Organizational Coupling." *IEEE Transactions on Engineering Management* EM-34, no. 1 (February 1987): 28-35.

Studies of research and development (R&D) management have emphasized the management of change and continuity. This review, of an R&D laboratory, was derived from 29 interviews with research performers and managers. The strategic approach for enhancement of research management focuses on five coupling patterns: 1) links of the elements within the R&D cycle; 2) links across organizational levels; 3) links with organizations in a laboratory environment; 4) links within specific stages of the R&D cycle; and 5) links between R&D mentors and performers. These are the major links constituting the connections in which information travels. Managing this information transfer and maintaining a balance between loose and tight coupling is one of the most significant activities of research management. The preferred strategy has been careful and creative attention to existing and needed levels of intensity, rigidity, and freedom throughout the stages of the R&D process. 22 references.

234 Lievrouw, Leigh A. (University of Alabama), and Kathleen Carley. "Changing Patterns of Communication Among Scientists in an Era of 'Telescience'." *Technology in Society* 12, no. 4 (1990): 457-477.

In the new technologically driven work environment, scientists engage in new modes of communication. The effects of telescience on research communication and research is outlined. The article describes three types of communication processes and structures that inform a scientists' work. Conceptualization is characterized by relatively small, informal discussions. Typically the scientists within such a group shares concerns or methodologies. In the Documentation stages, scientists communicate in a more formal, structured way. The documents produces in this states follow stylistic conventions. When scientific ideas become part of public discourse, they enter the Popularization stages. Scientists increase their "sphere of influence" as they move through these cycles. As telecommunication technologies become more common, these communication patterns will change. By their very nature telecommunication channels enlarge an individuals sphere of influence forcing the nature of scientific inquiry itself to develop; therefore, the distinctions between the above outlined stages of scientific communication will become less pronounced. Telescience will increase the size of its informal network, thus allowing for cross-disciplinary research. The conventional channels for publication will be replaced by, or challenged by, less formal on-line newsletters and electronic bulletin boards. It is supposed that fields may experience different degrees of exposure to popular media. 61 references.

238 Llull, Harry (Cent nial Science and Engineering Library, University of New Mexico). "Meeting the Academic and Research Information Needs of Scientists and Engineers in the University Environment." *Science and Technology Libraries* 11, no. 3 (1991): 83-99.

Today's research-intensive universities require science and engineering librarians to address both the academic and research information needs of various members of the university community. This paper defines some of the differences between information needs of the traditional academic patron and those of the researcher. It proposes that horizontal organizational structures, emphasis on the team concept, and the electronic library environment come together in a synergetic way to assist librarians in providing informational services in an environment of conflicting priorities. 17 references.

239 Lorenz, Patricia. "Searches Conducted for Engineers." (Paper presented at the National Online Information Meeting, New York, March 25-27, 1980). Arlington, VA: ERIC Document Reproduction Service (Computer Microfilm International Corporation)

This paper surveys the databases searched for engineers by an industrial information specialist. There are three categories of engineers who are seeking information: (1.) engineers who recognize the value of on-line searches; (2.) referrals by colleagues; and (3.) engineers who do not seek help. The last category declines as the amount of successful searches for colleagues are completed. Searches for engineers require patience, cost consciousness, and the ability to meet short deadlines for critical information needs. The databases used most often at Exxon Research and Engineering Company are Compendix, APLIT, CA Search, and NTIS. Rationale for use, professional experience and desirable features are provided in short notations. Similar information is provided for ten lesser used systems as well. Patent searches are explored through the World Patents Index, APITAT, Chemical Abstracts, and IFI claims. Copies of the eleven transparencies used in the presentation are included.

240 Lowry, Glenn R. *Information Use and Transfer Studies: An Appraisal.* (1979) 37 p. (Available from ERIC ED-211085.)

This paper discusses underlying assumptions of user studies and approaches to information systems design, and reviews key issues in the design of information systems in three major areas: 1) factors affecting information seeking and use; 2) formal and informal channels of information transfer; and 3) discipline oriented transfer patterns. Factors discussed include the membership of scientists in social groups served by different information systems, user preference in channel selection, and the effect of the anticipated use of information on information seeking behavior. Discussion of the formal and informal channels of information transfer reviews the role of scientific communication in research and creating knowledge, the patterns of information transfer and use of information as affected by organizational structure, the journal as a standard channel for information transfer, meetings and conferences as informal communication channels, and the roles of the "invisible college" and informal groups in communication. Discipline oriented transfer patterns are discussed in terms of the differences in development between scientific and technical fields and between physical and social sciences. A summary of user studies as of 1979 concludes the paper. 19 references.

244 Mailloux, Elizabeth N. "Engineering Information Systems." In *Annual Review of Information Science and Technology (24).* New York: Elsevier Science Publishers, 1989. pp. 239-266.

The chapter reviews the current status of engineering information systems and products. Because today's engineers are often engaged in applied, rather than mechanical research, they have altogether different kinds of information needs than their predecessors. The article notes a study that found that 93% of engineers work with their own inventory of technical skills and information. Only 20% of an engineer's time is spent engaged in the intellectual activities of engineering; the remaining 80% is spent gathering and manipulating information. It is estimated that engineering productivity would be improved by a minimum of 15% through increased use of new information systems. A 1983 study found that availability and the ease of use were the two most important factors determining the frequency that an individual would access a source for information gathering. Together with burgeoning information systems and products, there are emerging information-user communities.

Information-user communities are characterized by individuals that believe in individual decision and action, but are committed to working within specific task groups. However, current information systems and communities continue to be divided between those that are primarily discipline related and those that are mission related. Discipline related systems are those concerned with the services and products that pertain to technical literature. The author defines an information system as any "combination of data and equipment that has been coherently designed, integrated and implemented to perform specific information functions." Mission related systems are those that reflect the planning, design etc., that comprise the overall engineering task. Within a mission related system there are production systems - the first to be automated, - and management systems. Computer-integrated manufacturing technologies (CIM), a system developed by WEATHERALL, combines manufacturing management systems with the computers operating on the "shop floor"; it has been found that this integration has saved packaging time, manufacturing time and distribution time. It is estimated that (CAM) can represent a reduction costs by 25%. Finally, within mission related systems there are archival systems; these provide health and safety records or any data needed for the daily operations of the Plant.

Any change of the information-transfer patterns will affect both management and staff. With increased use of engineering information systems and products and user communities, there will be a "flattening" of the traditional hierarchy and may bring about a loss of autonomy of the engineers. 118 references.

246 Martino, Al (Stone and Webster Engineering Corporation). "Stone and Webster Engineers Phone System to Bridge Continents." *Communication News* 30, no. 4 (April 1993): 32 (1).

This article is of interest to individuals who are in charge of information transfer within a system that involves several physical locations. It is a description of Stone and Webster Engineering Corporation's telecommunications system. They use AT&T's Definity Communications System Generic PBX system to link its field engineers with experts from around the world. This company uses Generic 1, Generic 2, and Generic 3 switches and AT&T fiber-optic T1 circuits with local area network configuration to link its U.S. and European offices. Video, voice, and data can be received and transmitted around the world via these dedicated circuits, and the system enables engineers to meet through videoconferences and voice mail instead of having to fly to one physical meeting place. Stone and Webster plans to use ISDN within the next year, as soon as their local networks are made ISDN-compatible.

256 Meadows, A.J. (Loughborough University), and P. Buckle. "Changing Communication Activities in the British Scientific Community." *Journal of Documentation* 48, no. 3 (September 1993): 276-290.

The last detailed study of trends in science communication in the UK was carried out a decade ago. A new study has therefore been made (via interview and questionnaire surveys) to investigate how the handling of information by scientists in the UK has developed during the 1980s. The most obvious changes have occurred in informal communication between scientists, reflecting the rapid expansion of electronic networking in recent years. Automation has also led to an increasing emphasis on the information role of the end-user. At the same time, the formal communication system has posed an increasing number of problems (e.g. information overload, rapid increases in costs). There was a fair degree of consensus amongst respondents concerning likely communication trends in the immediate future. Interestingly, it was the opportunities, as much as the problems, that were stressed. 42 senior personnel in academic research institutions and libraries were interviewed. The second survey was of 42 working scientists in four university departments and two industrial research laboratories. The third survey was of 23 Aslib member institutions. 7 references.

258 Meadows, A.J. (Department of Astronomy and History of Science, University of Leicester). "How the Scientist Acquires and Uses Information." in *Communication in Science*. Meadows, A.J. London: The Butterworth Group, 1974, 91-125.

Meadows asserts that scientists and technical professionals prefer to avoid acquiring information. The psychology of potential user groups must be taken into account when assessing information systems. Extensive discussion is provided on the factors which attract engineers and applied scientists to an information source. Findings show that engineers read less than do other groups and they prefer easily browsable items where facts and figures are readily pulled out (tables, charts, graphs, etc.); they subscribe to fewer journals than do pure or theoretical scientists and most do not read journals outside of their discipline. Furthermore, 65-70% of engineers will only read journals published in the United States or the United Kingdom, despite readily available English translations of foreign journals. 80% of engineers' reading matter will consist of material published in the last 12 months. 70% of all applied science/engineering reading was in journals, although engineers make more use of textbooks than their pure science counterparts. Engineers are more likely to be interested in patent information and prefer full text sources to the abstract journals more popular with theoretical scientists. Includes data and tables.

264 Meadows, A.J. (Department of Astronomy and History of Science, University of Leicester). "How the Scientist Acquires and Uses Information," in *Communication in Science*. Meadows, A.J. London: The Butterworth Group, 1974, 91-125.

A secondary analysis of data describing the information-related attitudes and behaviors of scientists and engineers. The data set includes the responses of 560 scientists and engineers to a 600+ item questionnaire, which is included in Appendix I of the report. The results of the analysis were used to develop a meta-level model to provide a policy-level approach to information users studies. The author argues that user studies should be evaluated, not on how well they describe individual behavior, but on policy relevance and impact. The focus of the report is the development and testing of models to describe individual information-related attitudes and behaviors and the impact on those behaviors of organizational setting, job type, functions, and tasks. The meta-level model identifies various levels of variables that affect information behavior. An operational version of the model was developed to test relationships between these identified variables. Tests of the operational model indicate that external variables (e.g. environments, job type, functions, and tasks) are significant predictors of information-related behaviors and attitudes. The author concludes that interventions aimed at changing information behavior should be aimed at variables that can be controlled, such as organizational settings, job types and tasks. This report provides an overview of the information-behavior model development process as opposed to the individual behavior emphasis of the majority of user studies conducted.

268 Mondschein, Lawrence G. (Johnson & Johnson). "Selective Dissemination of Information (SDI) Use and Productivity in the Corporate Research Environment." *Special Libraries Association* 81, no. 4 (Fall 1990): 265-279.

This article focuses on providing information to scientists in R&D facilities. One hundred fifty-six scientists who were involved in basic research and were employed in centers that had libraries with SDI (Selective Dissemination of Information) were selected to participate in a study comparing use of SDI and productivity. Productivity was measured by the number of papers authored or coauthored by the scientist. Information use was analyzed for each of fourteen information sources. A list of information sources is provided in the article. Also included is a copy of the questionnaire used in the survey. Descriptive statistics of use of information sources as compared to the number of papers published are included. Four information sources were found to be related to productivity: review of SDI printouts, reading books and texts, informal meetings with colleagues, and attending conferences. The other ten information sources were not found to be statistically significant in explaining variability in productivity. Scientists who use SDI on a regular basis are the most productive. Suggestions are made to librarians who work in the scientific environment about making information services in general and SDI specifically more attuned to the needs of the scientists. New developments in information technology will change the way current awareness information is provided. Librarians in R&D facilities need to educate research personnel on the benefits of SDI and other information sources. Questionnaire included. 11 references.

269 Mondschein, Lawrence G. "Selective Dissemination of Information (SDI): Relationship to Productivity in the Corporate Environment." *Journal of Documentation* 46, no. 2 (June 1990): 137-145.

Selective dissemination of information (SDI) is an information alerting service designed to keep individuals informed of new developments in a particular field. This study evaluates the use of SDI by basic research scientists in a corporate environment. The following concepts are examined to develop the best model of SDI use and productivity: (1.) background of subjects; (2.) work environment; (3.) need to keep abreast of new research developments; (4.) use of information sources; and (5.) productivity or number of papers published. One hundred fifty six (156) scientists met the entrance criteria and were analyzed using both descriptive and inferential statistics. Multivariate models revealed interesting patterns. Frequency of SDI use was found to be related to work environment, need to keep abreast of new research developments, and use of primary and secondary information sources, including patents. Productivity was found to be related to background characteristics of the scientist, the work environment, need to keep abreast of new research developments, and the use of a variety of information sources. Based on these findings, scientists who use SDI on a regular basis appear to be more productive than their colleagues who are infrequent users, or who do not subscribe to the service. 7 references.

277 Neale, Michael (Michael Neale & Associates Ltd., Farnham, Surrey, Great Britain). "A Study of the Potential Contribution of the British Library to the Information Needs of Engineers." *Report* TRB 293 (October 1982) 30 pages.

This paper identifies information needs of engineers and relates needs to available information sources. The primary objective is to make recommendations to the British Library for improvements in the supply of engineering information. The study includes a review of the nature of engineering work and an overview of information sources, such as textbooks, journals, patents, manuals and bibliographic databases. Cited as most directly useful to engineers are design guides, manuals, and handbooks. The study notes that engineers prefer people to documentation as a primary information source. Engineering information needs are characterized as tightly connected to the design and development of specific products or artifacts. The study identifies gaps in engineering information provision and makes recommendations including: (1) specification of new product development needs in terms that state basic requirements and do not prejudice solutions in favor of existing products; (2) textbooks that describe potentially useful scientific phenomenon that are written for practicing engineers; (3) handbooks on alternative engineering mechanisms/tools that give comparative information on performance, economy, efficiency; (4) surveys on the performance of similar products, systems, techniques, tools, etc.; and ( ) handbooks on component production techniques that give comparative information on sizes, shapes, operating costs, and tolerances. The study further observes that information provided by bibliographic databases is not in a format that permits effective use or retrieval. The study recommends improvements in indexing, abstracting, subject access, and keyword access. Recommendations to the British Library include improvement of keywording and other retrieval mechanisms, cooperation with the Patent Office to distill relevant engineering information from patents, and cooperation with the British Standards Institution to include more useful information in engineering standards. This document is a useful overview of engineering information sources in Great Britain, and their relation to the engineering product design and development cycle.

278 Nelson, Carnot E. and Donald K. Pollock. *Communication Among Scientists and Engineers.* Lexington, Massachusetts: Health Lexington Books, 1970.

Assimilation and dissemination of information by scientists and engineers is an integral part of their research and development activities. The process by which scientists and engineers disseminate and assimilate information has been studied for a number of years in a number of specialized fields. This volume is a collection of the most important papers to date which deal with the communication structure of science and the production of scientific information, the utilization of scientific information, and the development of scientific information systems. Price discusses the use of citations in studying the structure of science. Lin, et al. discuss the information flow process in science, while differences in this process are discussed in the papers of Garvey, et al. and Hagstrom. Informal communication networks are dealt with in Griffith's paper. Orr begins the section on the utilization of information with a conceptual model of the process. This is followed by a discussion in the Allen and Rubenstein, et al. papers of the utilization of information by scientists and engineers. Wolek then examines the effect of message complexity on communication. Whittenberg presents guidelines for a task oriented information system, while the papers of Parker, Roberts, and Herschman deal with the actual development of such systems for both universities and disciplines.

279 Newell, Sue (Aston University, UK), and Peter Clark. "The Importance of Extra-Organizational Networks in the Diffusion and Appropriation of New Technologies: The Role of Professional Associations in the United States and Britain." *Knowledge: Creation, Diffusion, Utilization* 12, no. 2 (December 1990): 199-212.

It is argued that the national manufacturing industries depend on the ability to acquire and adopt the best of new technologies and methodologies. Therefore companies should recruit "boundary spanners" or employees who : e active in professional, technical or scientific networks and can acquire the latest information within their fields. Comparative analysis of data obtained from members of the American Production and Inventory Control Society and their counterpart in Great Britain suggests that British firms have been less successful in appropriating relevant technological innovations due to less access to important extra-organizational networks. Data presented demonstrate the relationship between professional society involvement and innovativeness. 18 references.

281 Oen, Carol (Oak Ridge National Laboratory), and Helen A. Pfuderer. "Scientific and Technical Information for Research and Development." *Proceedings of the 11th ASIS Midyear Meeting, Knoxville, Tennessee*, June 13-16, 1982.

Collaborating with and providing information support to research and development teams is the cornerstone of information work at Oak Ridge National Laboratory (ORNL). This paper discusses some of the factors that portend success or failure in such a collaboration and future opportunities and challenges. The spectrum of interactions of ORNL research and information staff members in providing information to research and development is also reported. ORNL is a large, multidisciplinary institution involving people with scientific and technical backgrounds in basic sciences, engineering, advanced energy technologies, and biomedical and environmental science. The Laboratory has always recognized the importance of information. Specialized technical information analysis centers appeared at the Laboratory in 1962. In these centers researchers devoted a portion of their time to assure that the results of their work were available in a readily usable form to their colleagues and others. In addition to the information analysis centers that offer great depth in relatively narrow subject areas, the complex, multidisciplinary project teams include information specialists in a matrix organizational form. At ORNL, most persons involved in information have a "double discipline" background (i.e., they have educational and research experience in a technical area and have expertise in information science as well). Presently there are between 150 and 200 persons identified as information professionals (not including library personnel) at ORNL. The specific challenges and opportunities for these people in working in this R&D environment are discussed.

286 Palmer, Judith (Rothansted Experimental Station, England), and Simon Harding. "Research Reports: Can Information Users Be Classified Like Books?" *Library and Information Research News* 15, no. 54 (1992): 12-16.

Scientists from three departments in an agricultural research institute were interviewed using a 44-item questionnaire to determine if information searching behavior is influenced by discipline, personality, or organizational idiosyncracies. The scientists were then asked to complete three tests -- the Kirton Adaptation-Innovation Inventory, the Learning Styles Questionnaire (LSQ), and the Whitley test. They were grouped into five clusters according to their information seeking behaviors. The Kirton test measures adaptors and innovators, those who want to do things better and those who want to do things differently. The LSQ measures activists who want to involve themselves fully in new experiences, reflectors who stand back and observe, theorists who like to analyze and synthesize, and pragmatists who look for new ideas and like to get on with things and solve problems. Learning style and creative style were identified as important aspects of cognitive style related to information seeking behavior. The active-reflector scale correlated highly and significantly with the Kirton Adaptor-Innovator Inventory, with the active pole corresponding to the innovator and the reflective pole corresponding to the adaptor. This correlation shows that there is a link between cognitive style and learning style. Scientists can be classified by information behavior, but the most important delineating feature in information behaviors is the area of discipline. This research shows that subject area is important, suggesting that information services and products should be targeted more specifically toward disciplines. This research also established a holistic concept of information behavior and showed that cognitive style can be considered as a factor in information behavior. Because of the high percentages of women in certain groups, this study raises the question of whether men and women seek information in different ways. 10 references.

287 Palmer, Judith (Agricultural and Food Research Council, UK). "Scientists and Information: II. Personal Factors in Information Behaviour." *Journal of Documentation* 47, no. 3 (September 1991): 254-275.

The Kirton Adaption-Innovation Inventory and the Learning Styles Questionnaire were used as part of a wider investigation, reported in an earlier paper, to explore the influence of personality, discipline and organizational structure on the information behaviour of biochemists, entomologists and statisticians working at an agricultural research station (n=67). Results from the psychometric tests were assessed in terms of the groups obtained from a cluster analysis. Groups identified by the KAI as Innovators and by the LSQ as Activists sought information more widely, more enthusiastically and from more diverse sources than other groups. Groups identified as Adaptors by the KAI and Reflectors by the LSQ, were more controlled, methodical and systematic in their information behaviour. The article examines the technical information searcher as a whole person and as a branch of their specific discipline. The first part of this research project, less relevant to this bibliography, was published in *Journal of Documentation* 47, no. 2 (June 1991): 105-129. 59 references.

288 Passman, Sidney (United States Arms Control and Disarmament Agency). *Scientific and Technological Communication*. Oxford, England: Pergamon Press, 1969. 151 pages.

Provides an overview of the various components of scientific and technical literature. Includes chapters on primary scientific literature, technical report literature, and a short overview of information exchange. Of particular relevance is chapter two, "The Research and Engineering Process and Technical Information," in which the author presents a survey of the literature on scientific communication. Also noted are traditional differences between scientists and 'technologists,' i.e. engineers. Pure scientists are characterized as literature dependent while technologists depend on colleagues. The author also notes that technologists lack the scientist's strong motivation to publish. Further observed is the growing importance of informal communication channels in the advance communication of research findings. This document is a useful piece of background material. 179 references.

291 Peterson, Ivars. "The Electronic Grapevine: Computer Networks and Fax Machines Accelerate the Pace of Scientific Communication—For Good or Ill." *Science News* 138, no. 8 (August 11, 1990): 90-91.

A basic overview of the effects of computer networks on the speed of research and development. Relates pros and cons of rapidity and ease of access and dissemination of research findings.

311 Pinelli, Thomas E., Rebecca O. Barclay, Ann P. Bishop, and John M. Kennedy. "Information Technology and Aerospace Knowledge Diffusion: Exploring the Intermediary-End User Interface in a Policy Framework." Paper 23. Reprinted from *Electronic Networking: Research, Applications and Policy*, vol. 2, no. 2 (Summer 1992): 31-49. (AIAA pending.)

(note: also available as a reprint in *Electronic Networking* vol. 2, no 2, Summer 1992 p31-49). This paper asserts that federal attempts to stimulate technological innovations have been unsuccessful because of the application of an inappropriate policy framework that lacks understanding of the process of technological innovation and fails to acknowledge knowledge production, transfer, and use as equally important components in knowledge diffusion. This report argues that the potential contributions of high-speed computing and networking systems will be diminished unless knowledge about the information-seeking behavior of users is incorporated into a new policy framework. This report presents survey findings from the NASA/DoD Diffusion Project to support this argument. Of particular interest is the presentation of data from three mailed surveys, the first focused on members of the AIAA, the second on US and Canadian aerospace libraries. and the third on US academic engineering libraries, faculty members and students enrolled in engineering programs. The third survey is more extensively discussed in NASA Technical Memo 107928, *Paper 20: Engineers as Information Processors: A Survey of US Aerospace Engineering Faculty and Students*. NASA/DoD survey findings are more extensively discussed in other Diffusion Project reports included in this bibliography. 55 references.

312 Pinelli, Thomas E., John M. Kennedy, and Terry F. White. *Engineering Work and Information Use in Aerospace: Results of a Telephone Survey*. Report 14. Washington, DC: National Aeronautics and Space Administration. NASA TM-107673. October 1992. 25 pages. (NTIS pending.)

Reports the results of a survey concerning the daily work activities of aerospace engineers and scientists, measurement of various practices used to obtain information and use of electronic networks. Data was collected using a telephone survey of the Aerospace division of the Society of Automobile Engineers (SAE) (N=430/response rate

75%). A copy of the questionnaire is included in appendix C. Major findings were that all respondents preferred co-workers as an information source above all others, with aerospace engineers exhibiting a slightly stronger preference then non-aerospace engineers; all respondents agreed that the technical uncertainty of a project increased the need for information; and there is a wide-spread use of electronic networks within aerospace. 87% of respondents reported that networks were accessible and 71% reported network use to contact co-workers at remote sites. Overall researchers observed that engineers are more intensive network users than managers. Engineers were the most likely to use networks to communicate with work group members and least likely to use networks to communicate with people outside the organization. The researchers note that computer networks play an increasingly heavy role in engineering, because they link design and analysis tasks with other resources to create integrated engineering information systems. This report may be of particular interest, as it offers a recent and extensive discussion of technology use by engineers.

314 Pinelli, Thomas E. *Establishing A Research Agenda for Scientific and Technical Information (STI): Focus on the User*. Paper 22. Paper presented at the "Research Agenda in Information Science" workshop sponsored by the Advisory Group for Aerospace Research and Development (AGARD), April 7-9, 1992, Lisbon, Portugal. (Available from NTIS 92N28117.)

Presents a short discussion of STI provision in the US and identifies library and information science as the discipline most closely associated with the provision of scientific and technical information. The author discusses the need for setting research priorities concerning the investigation of STI and presents an analysis of the present US system of STI dissemination. The author characterizes the current situation as passive, fragmented and unfocused and argues that a focus on the information seeking behavior of STI users is central to establishing an effective STI dissemination system. The author concludes with a brief discussion of the nature of science and technology, highlighting the differences between engineers and scientists. A more extensive discussion of the nature of science and technology and the differences between engineers and scientists is provided by Thomas J. Allen in "Distinguishing Between Engineers and Scientists," which is included in this bibliography. 61 references.

315 Pinelli, Thomas E., John M. Kennedy, Rebecca O. Barclay, and Ann P. Bishop. *Computer and Information Technology and Aerospace Knowledge Diffusion*. Paper 19. Paper presented at the Annual Meeting of the American Association for the Advancement of Science (AAAS), February 8, 1992, Chicago, IL. (Available from NTIS 92N28211.)

Reports the use of computer and information technology by US aerospace engineers and scientists working in academia, government, and industry. The researchers note that the literature on engineers' technology use tends to focus on financial, technical or management aspects of use, while neglecting the problems and issues encountered by individual users. The study presents data collected from three surveys: two mailed self-administered questionnaires to the members of the American Institute of Aeronautics and Astronautics (AIAA) and a telephone survey of the members of the Society of Automotive Engineers (SAE). The SAE survey is more extensively discussed in *Report 14: Engineers Work and Information Use in Aerospace: Results of a Telephone Survey*. Respondents of the first AIAA questionnaire (N=1839) were asked about computer and information technology use. Respondents reported almost universal use of mature technologies, and 2/3 reported use of emerging technologies. The researchers found few distinguishing characteristics between users and non users. The respondents of the second AIAA survey (N=975) were asked about use of NASA scientific and technical information in specified electronic formats. The majority of respondents were likely to use data tables/mathematical presentations and computer programs. Over 50% would consider using on-line versions of NASA technical reports. 54 references.

317 Pinelli, Thomas E. "The Information-Seeking Habits and Practices of Engineers." Paper 13. Reprinted from *Science & Technology Libraries*, vol. 11, no. 3 (Spring, 1991): 5-25. (Available from NTIS 92N28114.)

This article serves as a contribution to thematic issue on the information seeking and communication behavior of scientists and engineers. Discusses information seeking habits and practices of engineers as instinct from scientists. Findings show that traditional information services and products may not meet the information needs of U.S. engineers. The reason for this deficiency is that the specific information needs of engineers are neither well known nor understood. What is known about the information seeking habits and practices has not been applied to existing engineering information services and information professionals continue to overemphasize technology instead of concentrating on the quality of the information itself and the ability of the information to meet the needs of the user.

Although information professionals have assumed certain similarities between science and technology and scientists and engineers, the two user groups are not the same. The difference in work environment and personal/professional goals between the engineer and the scientist proves to be an important factor in determining their information-seeking habits and practices. The article is a review paper which explores the science/technology and scientist/engineer dichotomy and focuses on the information-seeking habits and practices of the engineer. Engineers look for sources which are highly accessible (the single most important factor) and are perceived to be of high technical quality. Engineers, in selecting among information channels, act in a manner which is intended not to maximize gain, but rather to minimize loss. Findings indicate that: 1) Engineers tend to make substantially greater use of information sources within the organization than do scientists; 2) Scientists make considerably greater use of the professional (formal) literature than do engineers; and 3) Scientists are more likely than engineers to acquire information as a consequence of activities directed toward general competence rather than a specific task. Pinelli asserts that the specific information needs of engineers are neither well known nor well understood and that what is known has not been applied to existing engineering information services. The article functions as an excellent locator of pertinent articles. 39 references.

318 Pinelli, Thomas E., Rebecca O. Barclay, Maurita P. Holland, Michael L. Keene, and John M. Kennedy. "Technological Innovation and Technical Communications: Their Place in Aerospace Engineering Curricula. A Survey of European, Japanese and U.S. Aerospace Engineers and Scientists." Paper 21. Reprinted from the *European Journal of Engineering Education*, vol. 16, no. 4 (1991): 337-351. (Available from NTIS 92N28184.)

This survey of approximately 125 Western European, 50 US, and over 100 Japanese aerospace engineers and scientists is part of the NASA/DoD Aerospace Knowledge Diffusion Research Project. Questionnaires solicited opinions regarding the importance of technical communications to their profession; the use and production of technical communications; and views about the appropriate content of an undergraduate course in technical communications. 101 responses were received from Western Europe, 63 from the USA, and 96 from Japan. About 94% of the European, 97% of the Japanese and 95% of the US respondents indicated that effective technical communication was very important. Respondents from all three groups indicated that a large proportion of their working week is spent communicating technical information. European respondents use more technical information than their American and Japanese counterparts. Aerospace engineers and scientists in this study used considerably more information than they produced, and the type of technical communications product both used and produced seems to be related to the respondents' professional duties. European and US respondents thought that aerospace engineering and science majors should take an undergraduate course in technical communication, but only 12% of the Japanese respondents agreed. The majority of Japanese and US respondents favoring such a course believed it should be taken for credit, but only 34% of the Europeans concurred. European and US respondents favored a required course; the Japanese believed it should be an elective. Most European and US aerospace engineers and scientists believed that technical communications should be taught as part of an engineering course, while the Japanese were largely divided over its place in the curriculum. Recommendations on principles to be taught in an undergraduate technical communications course seemed consistent with the types of communications respondents use and produce. Respondents stressed defining the communication's purpose, developing paragraphs and choosing words. Approximately 70% of all three groups wanted to include references, symbols, and punctuation in such a course, and about 50% also wanted to include abbreviations. There was general agreement that abstracts, technical reports, technical instructions, and journal articles be included in such a course as appropriate on-the-job communications. 23 references.

319 Pinelli, Thomas E., John M. Kennedy, Rebecca O. Barclay, Nanci A. Glassman, and Loren Demerath. *The Relationship Between Seven Variables and the Use of U.S. Government Technical Reports by U.S. Aerospace Engineers and Scientists*. Paper 17. Paper presented at the 54th Annual Meeting of the American Society for Information Science (ASIS), October 30, 1991, Washington, DC. (Available from NTIS 92N28115.)

Highlights the findings of a study undertaken to investigate the relationship between the use of US government technical reports by US aerospace engineers and scientists and selected variables. Data was collected via a self-administered questionnaire mailed to a randomly selected sample of the members of AIAA (American Institute of Aeronautics and Astronautics) (N=3298/response rate 70%). The questionnaire focused on use of conference meeting papers, journal articles, in-house technical reports, and US government technical reports during a six month period. The variables examined included accessibility, ease of use, expense, familiarity, experience with the source, technical quality or reliability, and comprehensiveness and relevance. Major findings are that government-affiliated respondents reported the most frequent use of US government reports but, overall, in-house technical reports were the most frequently used item. Government-affiliated respondents ranked US government technical reports as more important than did academic or industry-affiliated respondents. In-house reports ranked as most important overall and US government technical reports as least important. Of all variables examined, relevance had the greatest influence on the use of US government reports, followed by reliability and accessibility. They are the three variables that influence the use of all four technical information products examined in the study. 18 references.

320 Pinelli, Thomas E., John M. Kennedy, Rebecca O. Barclay, and Terry F. White. "Aerospace Knowledge Diffusion Research." Paper 16. Reprinted from *World Aerospace Technology '91: The International Review of Aerospace Design and Development*, vol. 1 (1991): 31-34. (Available from NTIS 92N28220.)

Presents a brief overview of the NASA/DoD Diffusion Project. Summarizes major findings of the project. Detailed descriptions of the NASA/DoD Diffusion Project are available in related documents included in this bibliography.

328 Pinelli, Thomas E., John M. Kennedy, and Terry F. White. *Summary Report to Phase I Respondents Including Frequency Distributions*. Report 5. Washington, D.C.: National Aeronautics and Space Administration. NASA TM-102773. January 1991. 53 pages. (Available from NTIS 91N20988.)

Presents a brief overview of Phase 1 of the NASA/DoD Knowledge Diffusion Project. The report contains three sections. Section 1 introduces the Project. Section 2 describes the survey and the questionnaires administered. Section 3 summarizes the results of Phase 1. The bulk of the document is comprised of an appendix which contains the tabulated results by question of the answers to the questionnaire. The analysis of the results of Phase 1 are fully discussed in *Technical Communication in Aerospace: Results of an Exploratory Study*. The value of this document is that it contains not only a copy of the questionnaire but frequency information too. 44 references, 14 reports, 23 papers, authors and titles listed.

331 Pinelli, Thomas E., John M. Kennedy, and Rebecca O. Barclay. "The Role of the Information Intermediary in the Diffusion of Aerospace Knowledge." Paper 8. Reprinted from *Science and Technology Libraries*, Vol. 11, No. 2 (Winter, 1990): 59-76. (Available from NTIS 92N28113.)

This report presents a conceptual framework for understanding the diffusion of aerospace knowledge. The primary focus is on the information channels and members of the social system associated with the knowledge diffusion process, placing emphasis on aerospace librarians as information intermediaries. This paper includes a brief overview of the federal aerospace knowledge diffusion process and identifies librarians and technical information specialists as 'gatekeepers' who enhance the information transfer process. Additionally it discusses problems with the US federal STI system, noting that it is hindered by the fact that there is no systematically designed approach to the transfer of federally funded R&D knowledge to potential users. The formal part of this process heavily depends on information intermediaries to complete the transfer process. The authors assert that, while such intermediaries are assumed to play a significant role in the formal transfer process, their role in the knowledge diffusion infrastructure is poorly understood.

This paper provides an overview of the major findings of the NASA Information Diffusion Project, but only presents a superficial discussion of the role of librarians as information intermediaries. 39 references.

333 Pinelli, Thomas E., Rebecca O. Barclay, John M. Kennedy, and Myron Glassman. *Technical Communications in Aerospace: An Analysis of the Practices Reported by U.S. and European Aerospace Engineers and Scientists.* Paper 4. Paper presented at the International Professional Communication Conference (IPCC), September 14, 1990, Guilford, England. (Available from NTIS 91N14079, and AIAA 91A19799.)

Reports the results of two pilot studies conducted as part of the NASA/DoD Diffusion Project. The pilot studies were concerned with the technical communications practices of European and U.S. aerospace engineers and scientists. Objectives of the study were to determine the importance of technical communication, the use and production of technical communications, views of the content for an undergraduate class on technical communication, use of libraries, technical information centers, and on-line databases, and use of computer and information technologies. The research instrument used was a self-administered questionnaire mailed to members of the American Institute of Aeronautics and Astronautics (N=2000/response rate of 30.3%), and to a group of European aerospace engineers and scientists in the NATO AGARD countries (N=125/response rate 26.1%). Major findings were that (1) European respondents spent an average of 11.04 hours per week in technical communication vs 13.95 for US respondents; (2) memos, letters and audio visual materials are the information products most frequently produced by both groups; 3) memos, letters, and drawings/specifications are the information products most frequently used by US respondents, while letters, memos, and journal articles are most frequently used by European respondents. Both groups use a variety of information sources to solve technical problems, with informal discussions with colleagues being the most frequently used. Least used are on-line databases. 91% of US and 86% of European respondents reported use of computer and information technologies. These findings are discussed more extensively in NASA Technical Memo 101534, *Technical Communications in Aeronautics: Results of An Exploratory Study*. However, this report focuses on the contrast of engineers in the US and Europe. 4 references.

337 Pinelli, Thomas, E., Myron Glassman, Walter E. Oliu, and Rebecca O. Barclay. *Technical Communications in Aerospace: Results of Phase 1 Pilot Study -- An Analysis of Profit Managers' and Nonprofit Managers' Responses*. Report 3. Washington, D.C.: National Aeronautics and Space Administration. NASA TM-101626. October 1989. 71 pages. (Available from NTIS 90N15848.)

This is an analysis of data collected from a study concerning the technical communications practices of aerospace engineers and scientists. The basic assumption of this study is that profit and nonprofit managers in the aerospace field have different communication practices. Profit and nonprofit managers were compared in five areas: 1) importance of communicating technical information effectively; 2) use and production of technical information and technical information products; 3) content for an undergraduate course in technical communications; 4) use of libraries, technical information centers and on-line databases; and 5) use and importance of computer and information technology. Results revealed that profit and nonprofit managers have different communication practices for only the second of the five areas addressed in the study. The research instrument used was a mailed self-administered questionnaire, and the survey population comprised a random sample (N=2000) of the members of the American Institute of Aeronautics and Astronautics. The response rate was 30.3%. A copy of the instrument is included in the appendix along with twenty seven tables of statistical data. 14 references.

338 Pinelli, Thomas, E., Myron Glassman, Rebecca O. Barclay, and Walter E. Oliu. *Technical Communication in Aerospace: Results of a Phase 1 Pilot Study -- An Analysis of Managers' and Nonmanagers' Responses*. Report 2. Washington, D.C.: National Aeronautics and Space Administration. NASA TM-101625. August 1989. 58 pages. (Available from NTIS 90N11647.)

An analysis of data collected from an exploratory study concerned with the technical communication practices of aerospace engineers and scientists. The researchers' primary assumption is that aerospace managers and nonmanagers have different communication practices. Five secondary assumptions were established for the study: 1) that the importance of communicating technical information effectively is equally significant to aerospace managers and nonmanagers; 2) that the use and production of technical information and technical information products are different for managers and nonmanagers; 3) that the content for an undergraduate course in technical communications should be viewed differently by both groups; 4) that the use of libraries, technical information centers and on-line databases differs for managers and nonmanagers; and 5) that the use and importance of computer and information technology differs for aerospace managers and nonmanagers. Study results indicated that managers and nonmanagers were found to have different communication practices for the second, fourth and fifth assumptions. However the evidence was neither conclusive nor compelling that the perceived differences could be attributed to the different duties performed by managers and nonmanagers. The research instrument used was a self-administered mailed questionnaire (N=2000), and the population surveyed was comprised of members of the American Institute of Aeronautics and Astronautics working in academia, government and private industry. The survey had a 30.3% response rate. A copy of the instrument is included in the appendix with 27 tables of statistical data. 5 references.

339 Pinelli, Thomas E., Myron Glassman, Walter E. Oliu, and Rebecca O. Barclay. *Technical Communications in Aeronautics: Results of Phase 1 Pilot Study*. Report 1 (Parts 1 and 2). Washington, D.C.: National Aeronautics and Space Administration. NASA TM-101534. February 1989. (Part 1, 106 pages., available from NTIS 89N26772; Part 2, 83 pages., available from NTIS 89N26773.)

Reports the results of an exploratory study of the technical communications practices of USA aeronautic engineers and scientists (90% engineers 10% scientists) working in private industry, government and university settings. The research instrument used is a mailed self-administered questionnaire (N=2000) with a response rate of 30%. A copy of the questionnaire is included in Part 2 of this technical memo, along with tables of tabulated statistical survey results. The study had a two-fold purpose to gather baseline data on technical communications and to formulate research questions for a future study on the use of technical reposts in aeronautics. The five specific objectives of the present study are to solicit opinions on the importance of technical communications, to determine use and production of technical communications, to solicit opinions on content for an undergraduate course in technical communications, to determine library, information center, and on-line database use and to determine use and importance of computer and information technology.

Major findings are that 90% of respondents rate ability to communicate important. The study estimates that 50% of work-time for both engineers and scientists is spent in either receiving or giving technical communication. The most frequently produced technical communications are internal memos, letters, and A/V materials while the most frequently used technical information products are memos, letters, journal articles and drawings/specifications. The least used are technical reports and conference papers. The most frequently used types of technical information used in the course of current projects are scientific and technical information and internal technical data. The least used are patent and economic information. To solve specific problems, 88.7% of respondents reported use of personal information and 77.2% reported use of informal discussions with colleagues. These respondents revealed infrequent library use. Although 94% indicated library use, only 36% reported library use of more then once per month. 44.1% reported on-line database use with 23% performing their own searches and 45% using intermediaries. Scientists and engineers working in universities were more likely to use on-line databases. 91% reported computer technology use with 46% also reporting use of electronic mail and 55.8% reporting use of teleconferencing. NASA scientists and engineers were more likely to use both electronic mail (72.6%) and teleconferencing (71.8%) 42 references.

343 Poland, Jean (Purdue University). "Informal Communication Among Scientists and Engineers: A Review of the Literature." *Science and Technology Libraries* 11, no. 3 (1991): 61-73.

The literature dealing with informal communication behavior among scientists and engineers is reviewed. The effects new communications technology may have on that behavior are considered, along with implications for librarians. The article provides a substantial overview and integration of the research in the field of science and technology information systems design and user behavior from the 1960s through the 1980s. Discusses several articles cited in this bibliography in their historical perspective. *See also* Garvey, Wolek, Griffith, De Solla Price, Crane, Allen, Menzel, and Ladendorf. 44 references.

345 Posey, Edwin D., and Charlotte A. Erdman. "An Online UNIX®-Based Engineering Catalog: Purdue University Engineering Library," In *Role of Computers in Sci-Tech Libraries*, 31-43. New York: Haworth Press, 1986.

This article describes the Engineering Information System at Purdue University's Engineering Library. The menu-driven front end allows the user to choose from several files: books, journals, technical reports, reserve materials, and the reference collection. Full Boolean search capabilities are implemented. All of Purdue's acquisitions are added to the OCLC database. Archival tapes are returned each week and records are loaded into the system. Staff members enter the tables of contents into the file which is reloaded weekly and thus is current. Most patrons prefer using the computer catalogs to using the microform catalogs, but the microform catalogs remain the definitive record of the library's holdings. The Books file contains over 20,000 monographs, mainly additions to the collection since 1970. Tables of contents greatly increase the possibility of finding specific information. Patrons can enter terms in the language of the engineer, the number of search terms is increased dramatically, and the patron can find items of specific interest. Results are immediate. Display of the table of contents allows for accurate assessment of the type of book involved. There are some areas for improvement, but overall the system has been very successful. This system is easily accessible, the items described are available locally, and the terms used in searching are simpler than the Library of Congress subject headings. A sample search is illustrated with diagrams of the computer screen at different stages of the search.

348 Quinn, John J. "Information and the Industrial Chemist." *Chemistry in Britain* 21, no. 8 (August 1985): 738-739.

More effort is being put into improving interactions between academia and industry. This survey, by the Science and Industry Council of Great Britain, carried out from November 1983 to March 1984, (N=345 of 500) gives demographic background and characteristics of members and their sources of information. 6 tables. 2 references.

351 Report of the Comptroller General of the United States. *Observations on Collection and Dissemination of Scientific, Technical, and Engineering Information*. Washington, DC: National Technical Information Service, US General Accounting Office, 1976. 24 pages.

Reviews the information collection and dissemination practices of the National Technical Information Service. The report focuses on the services' collection process and the adequacy of information received from other government agencies and the private sector. While this document is not directly concerned with the information seeking/acquiring practices of engineers, it may be of some interest as background reading. However, due to the publication date, it cannot be taken to reflect conditions at this time.

352 Richardson, Robert J. (Raytheon Company). "End-User Online Searching in a High-Technology Engineering Environment." *Online* 5, no. 4 (October 1981): 44-57.

Raytheon Company Submarine Signal Division and DIALOG Information Services, Inc. conducted a one-year program to determine the extent to which scientists and engineers will use direct online searching in support of their daily work. Twenty scientists and engineers with a variety of experience levels and academic backgrounds were selected to participate in this program. Four databases were selected as most relevant to Raytheon's technical interests, and special financial arrangements were made between the two organizations. The twenty participants were trained, and log sheets (copy included in article) were distributed for recording search activity, results, and evaluations. System usage was surprisingly low. The author stresses that generalizations should not be developed based on this study due to the very small sample size. However, some inferences were outlined as follows: the possession of a new tool does not change the engineer's information gathering and utilization patterns; there are many effective alternative information channels already in place; some people just do not like online searching; a new dynamic will develop between scientists and information professionals to facilitate the transfer and use of information. A graph is included that shows hours of connect time by month by database. Tables show overall usage by database (connect time and offline prints) and usage by technical discipline. Data collection forms included. Bibliography of 9 items.

353 Rickards, Janice (Queensland University of Technology, Australia), Peter Linn, and Diana Best. "Information Needs and Resources of Engineering Firms: Survey of Brisbane and the Gold Coast of Queensland." *Australasian College Libraries* 7, no. 2 (June 1989): 63-72.

Discusses the information needs and resource use of engineering firms in the Brisbane and Gold Coast regions of Australia. Two recent studies had been reported by the end of 1987. These were the basis of the 1988 study reported in this article. Questionnaires were administered by telephone interview to the managing director or a senior manager of each firm contacted. 72% of 294 contacted firms responded. Manufacturing was the major activity of over one-third, followed by consultancies and services. The average total number of employees was 103, with an average of 43 on site. The firms most often sought technical information, followed by government regulations and legislation. In three-fourths of the organizations, locating information was the responsibility of the person who needed it. Information sources used included reference works, standards, trade publications and journals, and suppliers (as an outside source). Nearly two-thirds of the organizations surveyed had a library or other organized information resource, though with only an average of 1.5 full-time employees involved in maintaining these facilities. Consultancies, organizations with over 100 employees, and organizations with a library were more likely to have access to online databases. Consultants were the biggest users of information. On average, organizations considered current information services to be "just adequate." 36% of the organizations surveyed believed that they should pay an outside group to provide information, while 32% considered that it should be provided in-house, and nearly one-fourth specified a combination of inside and outside provision. As a result of this survey, the library at Queensland University of Technology has begun placing more emphasis on availability of technical information; strong in-house collections of reference materials, standards and periodicals; and online services. Different promotional strategies are being used to reach different market segments. 3 references.

354 Roderer, Nancy K. (King Research, Inc), and Donald W. King *Information Dissemination and Technology Transfer in Telecommunications*. (November, 1982): 66 pages. (Available from ERIC ED 239582.)

Using a model of scientific and technical information transfer as a framework, this document focuses on four types of activities: the generation or authorship of telecommunications information and its publication, distribution, and use. Different forms of publication are considered in each functional area, though primary emphasis is on the scholarly journal. An introduction presents a brief discussion of telecommunications and telecommunications information and a model of the formal communications process. Section 2, an examination of information generation, touches on research funding, authors of scholarly communications articles, and costs of authorship, while types of products and service, publishers, and publication costs are covered in Section 3. Distribution of information products and services is discussed in Section 4, which looks at distribution channels, volume, costs, and secondary products and services. The last three sections examine information use, including amount of journal reading, use of other materials, use costs, and total system costs and the value of telecommunications information; the role of industry, government, and academia in information and exchange of information among United States and foreign scientists and engineers; and issues in telecommunications area information. This article provides interesting associated information on the Scientific and Technical Information international community. 8 references.

357 Rosenberg, Victor. "Factors Affecting the Preferences of Industrial Personnel for Information Gathering Methods." *Information Storage and Retrieval* 3 (1967): 119-127.

This article is for those who are concerned with information sources for and information gathering activities of professional personnel. A structured questionnaire was administered to professional personnel in industrial and government organizations, asking the subjects to rank eight information gathering methods according to their preference in given hypothetical situations. The subjects were then asked to rate the methods on a seven point scale according to ease of use and amount of information expected. The subjects were divided into two groups determined by their time spent in research or research related activities. The groups were designated "research" and "nonresearch." A statistical analysis of the data from 96 subjects (52 in research, 44 in nonresearch) showed that no statistically significant differences were present in either the rankings or the ratings between research and nonresearch personnel. A highly significant correlation was found, however, between the preference ranking and the ease of use ratings in both groups, whereas no significant correlation was found between the preference ranking and the amount of information ratings.

The results of the study imply that the ease of use of an information source is more important than the amount of information expected for information gathering methods in industrial and government environments, regardless of the research orientation of the users. 10 references.

358 Rosenbloom, Richard S. (Harvard University), and Francis W. Wolek. *Technology and Information Transfer: A Survey of Practice in Industrial Organizations*. Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1970. 174 pages.

Reports the results of a study of the communication and use of technical information. The study focuses on the flow of information across organizational lines in the research and development operations of large USA industrial corporations. The research instrument used is a series of self-administered questionnaires. The survey population consists of a group of engineers and scientists working in private industry (N=1900) and a random sample of the members of the Institute of Electric and Electronics Engineers (IEEE) (N=1200). The researchers define transfer of technical information as the process by which information originating in one organizational setting is acquired and used by engineers and scientists in another part of the organization. The study's central finding is that scientists and engineers will use alternative sources depending on the motivating forces driving the information seeking behavior. Those with a high expectation of making a contribution to a developing body of knowledge, termed a professional focus, will use mainly formal and external information sources. Scientists and engineers who focus on making contributions to ongoing projects, termed an operational focus, will use mainly informal and internal information sources. Scientists and engineers with a professional focus value precision, simplicity, and analytical rigor in a source. Those with an operational focus value communication with colleagues involved in the same type of work.

The researchers also noted differences in the sources used by IEEE survey respondents and corporate survey respondents. IEEE respondents more frequently used a wide variety of external information sources and were characterized as more highly educated, more active professionally and obtaining more seniority. The researchers theorize that these characteristics may have resulted in the different information source use pattern of IEEE survey respondents.

359 Rosenbloom, Richard S., and Francis W. Wolek. *Technology, Information, & Organization: Information Transfer in Industrial R&D*. Boston: Harvard University, 1967. 134 pages.

Reports the findings of a 1967 study of information transfer in the R&D operations of large industrial corporations. This study explores the association of variations in a number of specific personal, organizational, and technological factors in the use of information sources. The research methodology used was a survey questionnaire of 2000 US engineers and scientists working in 13 industrial organizations and 1200 members of the Institute of Electrical & Electronics Engineers. A copy of the survey questionnaire is included in the appendix. The authors conclude that their findings are consistent with earlier, similar studies. Generally the authors observe that, when the focus of technical work is on internal operational goals, local and internal information sources account for most instances of information transfer. When the focus is on contributions to a body of knowledge, i.e. professional goals, formal and external sources account for most instances of information transfer. These findings are similar to those reported in a later study by the same authors, *Technology and Information Transfer*. This report includes a substantial description and analysis of the structure of the information transfer process in Chapter 3. The authors analyze differences in the transfer process of scientists and engineers, and between different sub-disciplines within both the sciences and engineering. The authors conclude that the information networks of the various professionals interact within the organization's network of goals and purposes, yielding a new matrix of interconnections. This report is one of the early, classic studies of the information seeking/acquiring habits of scientists and engineers.

362 Rubenstein, Albert H. (Northwestern University), C. W. N. Thompson, and Robert D. O'Keefe, "Critical Field Experiments on Uses of Scientific and Technical Information." *Current Research on Scienctific and Technological Information Transfer*, Micropapers Edition, New York: Jeffery Norton Publishers, 1976.

This is a report on a two year project, designed to identify critical field experiments involving behavior of users of Scientific and Technical Information (STI). The expected audiences for the output include: researchers on the STI process, designers and managers of STI systems and services (STI/SS), and users of STI/SS (e.g., scientists, engineers, and their managers). This project starts with a literature analysis. Then surveys were conducted for all three target audiences. This supports the development of a propositional inventory and an overall framework and delineates researchable questions and specific experimental designs. The output includes field experimental designs on these subjects: the effects of accessibility, ease of use, and quality, on preference for and use of STI/SS; the roles of key communicators; group cohesiveness as a factor in adoption of new STI/SS; marketing strategies for STI in LDCs; the role of face-to-face communication; non-standard search strategies; and the integrated nature of Technology Exchange Transactions (TET). Bibliography of working papers.

367 Schauder, Don. "Electronic Publishing of Professional Articles: Attitudes of Academics and Implications for the Scholarly Communications Industry." *Journal of the American Society for Information Science* vol. 45, no. 2 (March 1994): 73-100.

This article reports on a study done to determine the contribution that publishing professional articles in electronic form can make to scholarly and research communication. The article presents an excellent up-to-date state-of-the-art review and history concerning journal publishing and electronic methods of communicating primary and secondary publications. The article also presents results of a survey of scientists, engineers, and other professionals in Australia, the UK, and the US (n=743 senior academics). The survey examined reasons authors select journals to which they submit manuscripts (prestige and readership most important; speed of acceptance less important), length of publishing period (respondents report that they think it should take less time than it does), opinions concerning eight common criticisms made of journals (agreement is greatest concerning high price, and lowest concerning journals being too selective), university and library support concerning subscriptions and access to journals, and attitudes concerning attributues of electronic form. 206 references.

368 Schrage, Michael, and Alun Anderson. "Computer Tools for Thinking in Tandem: `Groupware' Can Erase Geography; It May Supplant Printed Journals and Link Researchers in `Virtual Laboratories'." *Science* 253, no. 5019 (August 2, 1991): 505-507.

This article praises groupware, software that permits real-time communication between researchers at different locations. Groupware enables several researchers to simultaneously edit, see changes made on the other end(s) of the collaboration and talk with each other onscreen.

369 Scott, Christopher. "The Use of Technical Literature by Industrial Technologists." *IRE Transactions on Engineering Management* EM-9, no. 2 (June 1962): 76-86.

A study of the role of scientific information in the work of a sample of technologists in the British electrical and electronics industry. The sample consisted of 1,082 people in 127 establishments, who were interviewed for approximately one hour each. "Technologist" covers all those who engage in research, those with technical qualifications, and those who are responsible for planning and development work. A primary finding is that the principal role of the literature to the people studied is to supply useful information which is not deliberately sought by the reader. Its role as a reference source is less significant. A copy of the questions used for the interviews is included in the appendix.

374 Shotwell, Thomas K. (Salsbury Laboratories). "Information Flow in an Industrial Research Laboratory - A Case Study." *IEEE Transactions On Engineering Management* 18, no. 1 (1971): 26-33.

Two questionnaires were designed to study the flow of information to and within an industrial bioscience lab. The first asked the staff to characterize the frequency, direction of flow and perceived usefulness of oral vs. written communication. The second questionnaire was designed to determine the scope of existing communication mechanisms. The study revealed that formal communication lines were not used between individuals, but rather for administrative decisions. High frequency communicators tend to be those who read more of the literature. However, those who read scientific journals tend to participate less in the information flow than those who read technical journals. The sources of new ideas for products and research were also studied. Twenty out of the twenty-nine staff stated that published scientific literature was the most valuable information source followed by professional meetings, collegues and consultants. With regard to the best sources of ideas for procedural innovations, twenty-one out of the twenty-nine rated professional literature as the most valuable, then colleagues and finally consultants. Seventy-three percent of the time devoted to communication was dedicated to communication within the laboratory itself. The majority of Doctorate holders were in involved in from sixty to eighty different contacts while most of the bachelors and masters were involved in thirty-one to sixty contacts. 15 references.

376 Shuchman, Hedvah L. "Information Technology and the Technologist: A Report on a National Study of American Engineers." *International Federation for Documentation* 7, no. 1 (1982): 3-8.

This study was conducted to examine the engineer's role in the flow of technical information, identify the methods of communication and patterns of information used by engineers in different technical disciplines and diverse industrial settings, and to forecast the potential impact of new information technologies on individual engineers and their professions. A survey instrument was developed and sent to 3,371 engineers, with a response from 1,315 engineers representing industrial sectors, engineering disciplines, engineering job activities, educational levels, dates of engineering training, and ages. Tables are included that show responses to questions asked in the survey regarding information use, information needs, information produced, and technology used. Hypotheses developed during initial interviews about information needs, information sources, and information output were confirmed by data received from the survey. Engineers prefer informal sources of information such as colleagues, supervisors, and internal technical reports for the first steps in problem solving, regardless of job activity or industry. Engineers do not regard information technology as an important adjunct to the process of communicating technical information. Most engineers do not have ready access to sophisticated information technologies. Engineers in management lack hands-on experience with much information technology. Policy recommendations based on the gathering and analyzing of this information are to involve engineers in the formulation, dissemination, and implementation of government regulations and to include members of minority groups in the informal communication networks that provide participants with such a large percentage of their information. Internal reporting is an important method of transferring technical information, and much information is locked into private corporate networks, and at present there are no methods for indicating the nature and volume of this information. Engineering education should focus on the uses of technology, the economics of the issues, and the potential for information transfer using the technology.

377 Shuchman, Hedvah L. *Information Transfer in Engineering*. Glastonbury, Connecticut: The Futures Group, 1981. 265 pages.

Reports the findings of a research project funded by the National Science Foundation to study the process by which engineers receive and communicate technical information. The principle objectives are to produce a profile of the information used by engineers, to identify communication methods and patterns, and to describe new information technologies and forecast the potential impacts on engineers and the profession. The research methodology included extensive personal interviews with 39 engineers and a self-administered questionnaire (N=3371/response rate 39%). The survey population included engineers from 89 US companies representing six engineering disciplines: civil, electrical, mechanical, industrial, chemical and environmental, and aerospace. The report includes extensive tables highlighting information needs and information outputs broken down by type of knowledge, industry, job activity, and discipline. Major findings include: 1) engineers rarely find all information needed to solve a problem in one source; 2) engineering is distinguished from other professions by the high value place on information immediately 'to hand'; 3) the major difficulty in finding information is to identify a specific piece of missing data and then learning its location; 4) the information search process involves talking to other engineers; 5) preferred sources ranked by order of preference are personal files, colleagues and internal technical reports; and 6) libraries, technical information directors and on-line databases are considered only as a last resort. The study revealed that engineers are a fairly homogeneous profession regarding use and value of information sources. Additional observations include the importance of proprietary information. The author suggests that proprietary information represents an important sub-system within the larger scientific and technical information system. This is a highly relevant document, as it is one of the basic studies often cited in other studies included in this bibliography.

378 Shuchman, Hedvah L. "Informal Information Networks and Women in Engineering." *43rd ASIS Annual Meeting, Anaheim, CA, October 5-10, 1980* 17 (1980): 242-245.

A recent study indicates that informal sources of information are of great importance to engineers employed in industry. Engineers, to a greater extent than scientists and other professionals, share in informal networks to gain access to the established knowledge of their profession and for the acquisition of new knowledge. Increasing the opportunities for informal communication of technical information with special attention to those not now part of the network could have a direct impact on the advancement of women in technical careers. This article provides further analysis of several other articles included in this bibliography. *See also:* Shuchman, Hedvah. *Information Transfer in Engineering*; Allen, Thomas. *Managing the Flow of Technology*; Glock, C. Y. *The Flow of Information Among Scientists*. 11 references.

379 Siess, Judith A. (University of Illinois at Urbana-Champaign). "Information Needs and Information-Gathering Behavior of Research Engineers." *Proceedings of the 11th ASIS Midyear Meeting, Knoxville, Tennessee, June 13-16, 1982*. (1982).

A study conducted at two research institutions, the U.S. Army Corps of Engineers Construction Engineering Research Laboratory and the Department of Civil Engineering, University of Illinois at Urbana-Champaign, was designed to discover the information needs of engineers engaged in research and development and the means they choose to fulfill these needs. What implications do information needs have for libraries, information centers, and information specialists? A questionnaire survey was conducted at both institutions, with response rates of 80% and 50%. The survey included questions on the types of information needs, sources of information, types of materials in personal or office collections, experience with online searching, frequency and mode of library use, and perceptions of the adequacy of the libraries available to the respondents. Two quiet distinct library situations were present: one group has an aggressive technical information center while the other relies on a college-wide academic library and a departmental reference room. Striking differences in library use were seen between the two groups. A first step in the research was the distinction between information needs, wants, and demands. Unfortunately needs are not readily discernible, especially by means of a questionnaire, and undemonstrated needs, or wants, were substituted. Demands are those wants made known to those who can fulfill them, and these wants are to what information specialists usually respond. However, the problems of perception, identification, and satisfaction of users' unexpressed needs remain a primary concern for future research. Types of information needed could be divided into three groups: previously published and new information in one's own field, information in related fields, and known item or specific fact questions. Sources of information included journals, texts, colleagues, personal collections, technical reports, handbooks, patents, card catalog, abstracting and indexing journals, bibliographies, and the library staff. The size of the sample did not allow for detailed analysis of need and use patterns by such factors as age, experience, rank, or subject, but some differences that appeared will be noted in the analysis. Results will be reported on differences in sources used between the two user populations, which are related to the differences in expressed wants for types of information. The nature and frequency of use of the library will be presented, as will user evaluation of the collections and services of the various libraries available to them. In addition, these results will be compared with results from other user surveys dealing with engineers and similar occupations. Finally, the implications of the findings for information centers, information delivery systems, and future research will be discussed. 19 references.

380 Sieving, Pamela C. (University of Michigan). "The Information Quest as Resolution of Uncertainty: Some Approaches to the Problem." *Science and Technology Libraries* 11, no. 3 (1991): 75-81.

Several techniques can be observed among scientists seeking to meet specific information needs or coping with the excess of information presented to them. A taxonomy is applied to these techniques, and some suggestions are made for meeting perceived needs. The article provides good background information on various types of scientist-information seekers. The knowledge of various styles of searching may allow database designers to build in flexible searching capabilities into the system in order to accommodate searching styles prevalent in the target audience. 9 references.

384 Smith, Elaine Davis (University of the West Indies). "A Comparison of the Effects of New Technology on Searching Habits in Industrial and Academic Institutions." *Journal of Information Science* 19 (1993): 57-66.

This article is based mainly upon the findings of three surveys on the effects of new technology on searching habits in industrial and academic institutions, conducted in Autumn 1988 and Autumn 1990. It is appreciated that this two-year time gap between the two sets of surveys must be taken into account, as should more recent advances in the technology and services available, in that they have an influence on the findings. These are investigated, and conclusions drawn as to the overall differences, similarities and changes in searching in industrial and academic institutions. In particular, the effects of new technology on information personnel and end-users with regard to their searching are reviewed and compared, and changes in the roles of the various players in the field considered. Specific concentrations surveyed included: chemical companies (N=21); engineering institutions (N=23); and academic institutions (N=33). Comparisons are drawn between the three different types of searching atmospheres. This should allow designers to isolate those design features and searching issues which are particularly inherent in the arena of engineering and its associated technical information. 29 references.

385 Spilka, Rachel (University of Maine). "Orality and Literacy in the Workplace: Process- and Text-Based Strategies for Multiple-Audience Adaptation." *Journal of Business and Technical Communication: JBIC* 4, no. 1 (January 1990): 44-67.

Reports the findings of a qualitative study of the writing habits of seven engineers in two divisions of a large US corporation. The focus is on the role of interpersonal, oral interaction, termed orality, in the production of corporate documents. The researcher identifies at least four significant roles played by orality in the successful production of documents: 1) a central means of analyzing the intended document audience; 2) a means of adapting writing style and content to audience needs and perceptions; 3) means of fulfilling writing goals and resolving differences between writer and reader needs; 4) means of fulfilling social goals and sustaining corporate culture. The engineers were able to use orality to achieve corporate consensus concerning documents purposes, content and style. The researcher found that those engineers who planned and composed documents in social isolation tended to have inaccurate perceptions about their readers and the social and political constraints operating in the corporate culture. The researcher concludes that corporate writers play a significant role in creating and transmitting corporate knowledge. The writing process shapes the meaning and direction of corporate knowledge. This study provides insight into the information transmitting behavior of engineers, which is related to information seeking/acquiring behavior. 10 references.

389 Stern, Arnold. "Information Transfer Between an Academic Research Center and Its Member Firms." *Journal of Technology Transfer* 14, no. 314 (Summer/Fall 1989): 19-24. [Supported in part by the Sandoz Foundation.]

A study of information transfer methods between an engineering research center conducting biochemical and biochemical-engineering research at a major academic institution and its member engineering firms. Telephone interviews with 47 member firms explored the origin, type and use of information from the center, followup after obtaining it, problems encountered, why the firms maintained relations with the center, and how relations could be improved. Of the firms surveyed, 46% were chemical-pharmaceutical, 23% engineering, 21% biotechnology, 6% software, and 4% government laboratory. 57% of the firms used center information. Of these, 19% used the information to develop a new process or product, 13% for modification of a process or product, 11% for marketing purposes, 4% for system design, and 42% for no specific use other than to keep abreast of developments. In 53% of the cases, information obtained was of a specific technical and scientific nature. 45% of the firms wanted general technical and scientific information. 2% wanted information about their products for marketing purposes. 21% of the firms reported that other business priorities prevented use of the information, 15% that they had internal problems, and 64% that they had no problems putting the information to use. 53% reported that they used the center primarily for keeping abreast of developments; 15% mentioned an appreciation of the center's director; 12% mentioned contact with the scientists; 9% wanted an extension of R&D; 7% cited the center as a source of future personnel; and 4% saw the center as a way of obtaining feedback on a product or process the firm had developed. 47% saw no need to change their relationship with the center. 15% wanted the center to be more sensitive to their problems, while another 15% felt the center understood their challenges. 17% wanted more direct contact with the center, and 6% desired more detailed information. These statistics, and follow-up interviews, indicate that relationships between the university research center and its industrial partners can be mutually beneficial. 19 references.

395 Taylor, Robert L. (Dept. of the Air Force.) "A Longitudinal Analysis of Technical Communication in Research and Development." *Journal of Technology Transfer* 1, no. 2 (1977): 17-31.

A longitudinal study of the technical communication patterns of 184 engineers in high technology research and development laboratory centers on the activities of technology gatekeepers. The two-step flow of information follows the literature as well as the results of prior studies. Gatekeepers span the boundaries of the organization in transfer of technology from outside the laboratory, while facilitating the distribution of technical information to colleagues in the organization. Data is analyzed over a five year period with respect to changing organizational structures, new technical assignments and alterations in group composition. In spite of these types of dynamic changes, the data consistently shows the gatekeeper identification and technical information flows. 9 references.

396 Taylor, Robert L. "The Technological Gatekeeper." *R&D Management* 5, no. 3 (1975): 239-242.

This study identifies a two-step communication process, mediated by technological gatekeepers for scientific and technical fields. The existence of the gatekeeper phenomenon can be shown through both peer evaluation and supervisory recognition. The 'gatekeepers' are the people usually chosen as the best sources for technical information, and are also most often identified as sources for the best technical ideas. On examination, the outside communications habits of the gatekeepers show a significantly larger number of extra-organizational contacts. Seven descriptive variables are provided for identifying gatekeepers. 9 references.

397 Taylor, Robert L., and James M. Utterback. "A Longitudinal Study of Communication in Research: Technical and Managerial Influences." *IEEE Transactions on Engineering Management*, EM-22, no. 2 (May 1975): 80-87.

Examines several variables affecting technical communication patterns in an R&D laboratory. Personal interviews gathered information from 184 engineers. Of these 24 were identified as technological gatekeepers. People chosen both as sources of information and ideas, and as having a high frequency of contact with external information sources. Changes in technical assignment and administrative control were observed in three of the groups studied. Frequency of both internal and external technical communication was somewhat less for the changed groups in contrast to a comparable stable group. Regular use of professional periodical literature was also considerably less among members of the changed group. The general response of the engineers to administrative change was to retain their previous communication patterns. Observation of 31 engineers with changed technical assignments showed that changed technical missions resulted in less communication for a change group than for stable groups, especially in the number of contacts outside the lab. The technical change group reported an average of 29% above the laboratory median in regard to outside contacts; the stable group, 61.4%. Project teams depended upon links with the functional groups to which the engineers were previously assigned.

A second study, conducted eighteen months later, provides important data regarding the effects of change on technical communication patterns. The time lapse was sufficient for the administrative change groups to restructure their technical information patterns into self-contained entities. Key individuals in the new groups were also the most important communication links in the parent group. Change in technical emphasis had no effect on the existing network although the intensity of communication increased. Finally, newly formed project groups reflected the same functional ties which the older project groups evidenced. These findings suggest that factors other than structural or technical variables account for the communication "gatekeeper" role prevalent in this and other studies of technical communication patterns in research and development organizations. 23 references.

400 Thomas, Rick (Evenview Corp.) and Robert Drury. "Team Communication in Complex Projects." *Engineering Management International* 4 (1988): 287-297.

Engineering managers, facing ever greater system integration challenges, must actively improve team communications. As a conceptual tool, the activity of a system development team may be described as a group of coupled conversations. Based in this approach, a model is outlined which offers a graphic representation of resources and a metaphor for interactive communications. Use of this model encourages consideration of the total requirements for a given conversation and helps to explicitly document successful interaction patterns. Models including these features are expected to lead to broader use of computer workstations for managing system development. Until this happens, the concepts are valuable to managers to help organize and clarify their team's work. 12 references.

401 Thompson, Benna (Science and Education Administration, U.S. Department of Agriculture). "Future Direct Users of Sci-Tech Electronic Bases.' *Proceedings of the 11th ASIS Midyear Meeting, Knoxville, Tennessee, June 13-16, 1982.* (1982).

Sci-tech database producers and vendors eye the end user as their potentially largest direct market. Discusses implications of this for the sci-tech library or information center. Scientists were expected to be interested in accessing the bases themselves, especially when the base was a unique, highly specialized file, e.g., MYCOTOX, Environmental Mutagens, Chemical Abstract Service, or Questel substructure searching; however, they did not want to allocate time, a scarce resource, or effort, to learn how to effectively access relevant electronic databases. Various databases which might be suitable for direct user access are discussed. Theories on future direct user access of sci-tech electronic bases are presented. Includes ideas about marketing sci-tech databases to potentially reluctant users.

403 Tombaugh, Jo W. (Carleton University). "Evaluation of an International Scientific Computer-Based Conference." *Journal of Social Issues* 40, no. 3 (1984): 129-144.

In order to ascertain the value and potential endorsement of computer-based networks and online seminars the researchers sponsored a bioconversion conference. To initiate this study, letters were sent to 541 scientists inviting them to participate. Twenty-two percent of those from industrialized countries and thirty-one percent from developing countries accepted the invitation. Following the seven month conference, surveys were distributed to those who participated. They were asked to comment not only on the technology itself but also the scientific value of the exercise. Seventy-seven percent of the scientists indicated that they would participate in other computer-based conferences. However, 77% indicated that they had problems with the technological links. In addition, a survey was sent to 178 of the scientists who refused to participate. Seventy-six percent of these scientists indicated that "other scientific activities took higher priority" while 83% cited cost problems. Although the article contains no tables or graphs, there is extensive quantitative data reporting and analyzing responses to specific questions. The concerns of those participants from industrialized and developing countries are discussed in terms of social psychology (e.g., equity, leadership, and communication networks.). 13 references.

407 Turoff, Murray, and Julian Scher (New Jersey Institute of Technology). "Computerized Conferencing and its Impact of Engineering Management." *Joint Engineering Management Conference, October 9-10 1975.* 59-70.

The article describes the then-new technology of computerized conferencing. Computer technology has provided the framework for a communication mechanism which allows participants to be separated in time as well as space. As most "formal studies" indicate, anywhere from 50-90% of managers' time is spent engaged in some sort of communication. In the computerized model, the computer as an intermediary between those involved; it allows people to choose the time where they may wish to send or receive messages. Furthermore, computerized conferencing allows for both formal and informal contacts. Using engineering management as a model for the scenario, the authors outline four areas of possible enhancement: crisis management, project planning, adaptive simulation modeling, and project coordination. A conferencing system would help minimize the time and information lost in a period of crisis. In addition to crisis management these systems allow for increased project planning and forecasting. That participants can remain anonymous increases the possibility that they will participate more fully in the process of developing new projects. The article uses project DELPHI to exemplify such a conferencing system. DELPHI is described as a structured communication process with feed back and successive questionnaires. A figure portrays the operating conditions in a communication network where information is needed from both within and between the organization. The continuous communication and feed back by such conferencing systems can smooth that process. The author suggests that using computer conferencing to simulate crisis situations will help to analyze individuals react in pressure situations. This will provide insight into the underlying structure of the organization. Finally, these systems can aid in project coordination and proposal generation. The article notes that most prevalent explanation for failures in R&D environments is the lack of meaningful communication between market and R&D groups. Thus communication capitalizes on both the vertical and lateral planes, and results in a "cross-fertilization of ideas and mixtures of specialization," and this will give companies a competitive edge in the market place. 12 references.

408 Tushman, Michael L. (Columbia University), and Ralph Katz. "External Communication and Project Performance: An Investigation into the Role Of Gatekeepers." *Management Science* 26, no. 11 (1990): 1071-1085.

The article describes a study that investigated the role of gatekeepers in the transfer of information in a single R&D setting. The researchers compared the performance of two project groups: one that utilized gatekeepers and one that did not. The study assumes that there is an important relationship between the level of technical (or localized) language used by a project group and the relative utility of a gatekeepers function. If, for example, a subunit's work is universally defined then organizational factors are less of an impediment to external communication; therefore gatekeepers may not be required. The study was carried out in an R&D facility and focused on 345 professionals. The lab was organized into seven departments and these departments were involved in sixty-one separate projects. Two sets of data were collected. Each lab manager was asked to rate his/her own project using a set of criteria. Then each project was independently rated, using the same criteria, by a group of managers. These results were inter-correlated. To collect the information each professional was asked to list all those individuals with woman she/he had communicated on a given day. This data was collected one day a week for fifteen weeks. The study classified gatekeepers as those individuals who were in the top 1/5th of their department communication distribution as well as in the top 1/5th of the extra-organizational communication distribution. The research investigated two basic questions with regard to information flow: A) under what conditions will gatekeepers be a more effective linking mechanism than direct contact; and B) what role do gatekeepers play in mediating the flow of external information. The results indicate that locally defined development projects that use gatekeepers are more effective than those development projects. However, for more universally oriented research projects, the more effective projects relied on direct contact with external sources of information. With regard to the role that gatekeepers, it was discovered that they project supervisors cannot substitute for gatekeepers in linking locally oriented units to external areas. Gatekeepers, therefore play a key role in communication networks, but this role is different than, if complementary to, the supervisory role. The paper includes four tables that display different correlations between project performance and any external communications with regard to project type, gatekeeper presence, and supervisory functions. 65 references.

409 Tushman, Michael L., and Thomas J. Scanlan "Boundary Spanning Individuals: Their Role in Information Transfer and Their Antecedents." *Academy of Management Journal* 24, no. 2 (1981): 289-305.

As organizations develop and evolve, their internal units will become increasingly specialized. This specialization can create obstacles to effective information processing as units and subunits attend to their own particular work requirements. This phenomena may require that individuals be assigned the task of mediating the flow of information between subunits as well as mediating the flow of information from outside. The research investigated two questions: how do new ideas/information enter organizations and what are the antecedents of those individuals who provide this informational linkage. The researchers make an important distinction between the internal and external communication "stars," and those who function in both capacities - "boundary spanning individuals." The study was conducted in an R&D division of an American high technology medical instrument corporation. The lab is divided into four departments and employs 210 people. The department was designated as the unit of analysis; individuals were asked to report their actual, work-related communication. The data was collected once a week for five weeks. In addition to the above survey, each individual was given a questionnaire in which they were asked a number of specific questions. Individuals were asked to identify those were considered most "technically competent," those who were considered "valuable contacts" (for external information) and finally everyone was asked to indicate how she/he developed contacts with external sources. Boundary spanning individuals have twice the number of nominations as do internal "stars" and three times the number of nominations as external "stars." Further, it was determined that boundary spanning is not a function of status; of those characterized as boundary spanning individuals, thirty-two percent were supervisors and sixty-eight percent were bench-level scientists or engineers. With regard to antecedents, it was discovered that internal communication "stars" were seen as technically competent independent of the degree of their external linkages. However, there was no association between being an external "star" and perceived competence. The authors suggest distinguishing between informational and representational boundary spanning roles. Internal and external "stars" are trained for specific, formal roles; they perform a more routine transacting/representational function. Informational boundary spanning, although an informal function represents a critical resource for the organization. Future research ought to explore the possibility of expanding the role of boundary spanning individuals to include organization decision making. The article includes five tables that display various methods used for communication, demographic variables with regard to stars vs. non-stars, methods of establishing links with other areas, and specific statistical information. 54 references.

410 Tushman, Michael. "Managing Communication Networks in R&D Laboratories." *Sloan Management Review* 20 (Winter 1979): 37-49.

The article describes some of the problems involved in establishing and maintaining communication networks in R&D environments. Studies indicate that engineers and applied scientists spend between 50-75% of their time communicating with others. Task interdependence and the nature of the projects' environment play a role in influencing the degree of communication between groups. The article describes a study that was conducted in the R&D facility of a large American corporation. The researchers asked personnel to report all work related verbal communication on certain days over a four month period. The study involved three types of personnel: research staff, development staff and those involved with technical services. Each of these groups displayed its own patterns of communication. The more effective research projects include diverse and extensive communication only with those areas that provide technical input. Further, for communication outside the firm, research staff utilized some form of gatekeeper. Those individuals involved with technical services were more strongly connected to areas outside the laboratory (exhibiting more than three times the number of communication ties than those involved in research projects) and they did not utilize gatekeepers. However, they did depend on supervisors for facilitating communication networks more than either of the two other groups. Those involved in development projects, required intra-project communication between decentralized groups and their extra-organization communication was usually mediated by gatekeepers. There are no set patterns however, and the function of the group will ultimately determine how the network will operate. The results are synthesized into a contingency model for managing communication in R&D settings. Two assumptions support this model: a) the primary function of a projects network is the transmission of information, and b) effective projects will require difference types of networks. 21 references.

418 United States. House. Committee on Science. Task Force on Science Policy. "Science Policy Study: Background Report no. 5, The Impact of Information Technology on Science." *Transmittal to the Ninety-ninth Congress, Second Session, September 1986.* Prepared by Congressional Research Service, Library of Congress, 1986 51 pages.

Provides a comprehensive review of the impact of information technology on science. Of particular relevance here is section III, "Impact of Information Technology on Dissemination and Use of Research Results." Major areas discussed include the current status of electronic information dissemination. This section notes the increasing amount of numeric data available and the corresponding strain on traditional, printed information sources. Further noted are the relatively few publicly available on-line numeric databases. Cited as examples of the Chemical Information System and databases provided by the Office of Standard Reference Data. The report observes the development of all types of databases as reflecting several major trends: 1) technological advances that allow better end-user searching; 2) wide-band communications that permit high speed data transmission; 3) optical and video disk storage mediums that offer high-density secondary storage of data; and 4) creation of databases as a by-product of individual research. Also reviewed are computer networks, which are cited as providing increased access to information and colleagues on a global basis. The report also highlights electronic mail as an increasingly valuable communication mode. Also discussed is computer conferencing and electronic publishing. Identified as major concerns with electronic publishing are limitations on providing graphic information, copyright issues, reluctance of scientists to accept non-peer reviewed data.

419 Utterback, James M. (University of Indiana). "The Process of Innovation: A Study of the Origination and Development of Ideas for New Scientific Instruments." *IEEE Transactions on Engineering Management* EM-18, no. 4 (November 1971): 124-131.

The problem of technical innovation is treated as occurring in three phases: idea generation, problem solving, and implementation and diffusion. Two questions are addressed in a study of 32 new scientific instruments: What information led to the origination of ideas for these new products, and how was information acquired and used in the development of these ideas? Idea generation is assumed to require a synthesis of several pieces of information. Innovators rely on oral communications outside of their firm in generating ideas. Conversely, they relied on sources inside their firm and first used local sources of information (both literature and experience), then secondary sources (discussion) and finally they used primary sources (analysis and experiment) in problem solving. Generation of an idea was generally found in the recognition of a seed or problem. However, in the minority of the cases when generation of an idea was stimulated by technical information, more recent technology was used in the innovation and literature and outside consultants were used more often as sources of information during problem solving. 23 references.

423 Veyette Jr., John H. (Engineering Index, Inc.), Robert Bezilla, and Y.S. Touloukian. "Alternatives for Accessing Engineering Numerical Data." New York: Engineering Information, Inc., 1978. (Available from NTIS PB 282609.)

Summarizes the results of a study conducted to determine which, if any, new information products and services, including online interactive access, based on the Center for Information and Numerical Data Analysis and Synthesis (CINDAS) data collections, would be accepted and used by the engineering community. Surveys investigated potential user reaction to alternative modes of accessing evaluated numerical data. The text example was the evaluated numerical database of CINDAS. Focus group sessions with "bench engineers" were conducted in Philadelphia, Chicago, and Los Angeles. Generally, the engineers' information sources and procedures seemed to be confined largely to the use of handbooks and departmental data, and personal contact with co-workers, in-house specialists, sub-contractors, and vendors. Most respondents appeared to use traditional library research methods almost as a last resort. Engineers for the most part seem more oriented toward application than toward the generation of new concepts and theories. They tended to expect secondary sources to have made systematic reviews of the state-of-the-art findings upon which the data are founded. Focus group conclusions were translated into a mail questionnaire which was administered to two groups of practicing engineers. Again, the results indicate that engineers are not satisfied with present methods for acquiring reliable numerical data and would utilize new methodology if offered. During the research phase, CINDAS generated a computer-readable numerical database of evaluated data. Procedures were developed to assure that data were properly interpreted, accurately translated into machine-readable form, and to assure file integrity. A comprehensive set of conversion factors, and a materials directory were established as the two main related elements. Software for updating, maintaining and displaying these elements was also developed.

425 Vincenti, Walter G. *What Engineers Know and How They Know It*. Baltimore, MD: Johns Hopkins University Press, 1990. 326 pages.

An overview of the intellectual content of engineering which focuses on the engineering design process as the central activity in the creation of engineering knowledge. The design function is described as evolving from initial project definition to successive divisions into highly specific sub-problems that are eventually solved in semi-isolation from each other. Design activities are divided into higher level activities, which are characterized as unstructured and conceptual, and lower level activities, which are characterized as highly structured. The author notes that the majority of engineering design activities are lower-level. The author presents a summary of six knowledge categories and associated activities that are derived from five case studies of aircraft engineering design. These studies date from the first half of the twentieth century. Knowledge categories are defined as: fundamental design concepts-basic engineering theory, criteria and specifications- concepts are translated into concrete technical terms, theoretical tools- includes general scientific and mathematical constructs, quantitative data- which is obtained through observation, practical considerations- which are formed through past experience, and design instrumentation-which is composed of procedures and judgement skills needed to seek design solutions. The author concludes with a model of the growth of engineering knowledge in which he asserts that new engineering knowledge is that which extends past the predicted or foreseen. New knowledge is selected and retained for inclusion in the body of accepted engineering knowledge on the basis of trial and error experienced in the design process, i.e. that which 'works' will be retained. The author argues that this practical focus of engineering knowledge formation distinguishes it from scientific knowledge. This work may be primarily useful for describing the context in which engineers seek and acquire information.

426 Wagner, Michael M. (University of Pittsburgh), and Gregory F. Cooper. "Evaluation of Meta-1 Based Automatic Indexing Method for Medical Documents." *Computers and Biomedical Research* 25 (1992): 336-350.

The paper describes an experiment that was conducted in order to determine the effectiveness of MetaIndex. MetaIndex is an automatic indexing program designed to create symbolic representations of documents for the purpose of document delivery. MetaIndex therefore, operates like a thesaurus. The authors describe a hierarchy of three figures in the organization of information in the MetaIndex program. At the most fundamental level, the database is a large set of strings of medical language phrases. This set of string phrases is clustered in "conceptual equivalence classes" differentiated by one of two types of semantic relationships: "lexical variant" or "synonymy links." At the highest epistemological level are the sets of "interconcept" links. This final level is referred to as the "domain model." The study was conducted to evaluate the cost effectiveness and effectiveness of the MetaIndex method of indexing relative to manual indexing. The document collection used for this work was the Slice of Life (SOL) medical image collection. SOL is a collection of more than 31,000 medical images on video disk. A study set of 126 of these images was selected at random from the SOL database. These images were processed and transfigured as input for the MetaIndex program. Five physicians were recruited to judge the MetaIndex index records for accuracy and completeness. On average a SOL image was described by eight words of text. MetaIndex generated 407 indexing terms for the 126 image samples (or 3.3 terms/image). Ninety-one percent of these terms were judged acceptable. However, to the set of 372 MetaIndex terms, the judges added 207 additional terms for a total of 579 terms. Thus the MetaIndex program identified 64% of the total set of indexes that were acceptable to the judges. As the evaluation of MetaIndex was based on physician-generated indexes and because physicians tend to use the same terms for indexing as other physicians, it was judged that the programs are relatively accurate, but incomplete indexing for the SOL database. The article contains two tables that display, respectively, the causes of inaccurate indexing and the causes of missed indexes. 28 references.

428 Walton, Kenneth R. (Exxon Research and Engineering Company) "SearchMaster—Programmed for the End-User." *Online* (September 1986): 70-79.

After a study revealed a strong interest in online searching among personnel at Exxon Research and Engineering in Annandale, NJ, the searching staff began to use SDC's SearchMaster package as a front-end system for training scientists and engineers to do their own online searches. SearchMaster has made searching easier and thus more accessible to occasional searchers, freeing searching staff for more sophisticated information problems. SearchMaster is quick and easy to learn to use. They search CA and INSPEC databases for routine searches--author search, reference verification, and simple subject searches using keywords for browsing. Tables and charts included in the article show a sequence of menu screens depicting a typical BROWSE search; usage during six months of 1985 in connect hours; number of repeat and first-time users in six months of 1985; number of sessions per user; usage by type of search activity; number of end-user sessions compared to the number of requests for searches by professional intermediaries. The introduction of SearchMaster has brought the first significant sustained use of online searching by large numbers of end-users at Exxon. While not the final answer to problems of end-user searching, SearchMaster has been popular and easy to use. 2 references.

433 Weinschel, Bruno O. (Weinschel Engineering Co., USA), Russel C. Jones, principal investigators. *Toward the More Effective Utilization of American Engineers: The National Engineering Utilization Survey.* Washington, D.C.: American Association of Engineering Societies, 1986. 204 pages.

Reports the results of a two year study of the use of engineering talent in selected USA industries with a high demand for engineers. The study involved two questionnaires, one aimed at individual engineers and the second designed for engineering managers. The individual engineer survey is included in the report's appendix and is of particular relevance here. The individual engineer population consisted of members of major U.S. engineering societies (N=16,169) and engineers randomly selected from participating companies (N=1,375). The response rates were 62.7% and 75%, respectively. This study concluded that U.S. engineers are highly under-utilized and identified contributing factors: 1) management interactions; 2) extent of support services available; 3) amount of continuing professional development; and 4) information sources available. In management interactions, 92% of respondents rated good management/technical personnel communications essential but only 43% indicated the presence of good communications. For information sources, 80% of the most highly utilized engineers indicated ready access to new technical information, while only 30% of the least utilized engineers reported ready access. The questionnaire also included a section on information sources used in both current projects and for continuing professional current awareness. For current projects, respondents ranked personal information files first, informal contacts with co-workers second, and published technical articles third. For continuing awareness, respondents ranked technical articles first, informal co-worker contacts second, and catalogs and trade literature third. When asked to indicate frequency of use for sources, personal files were reported as most frequently used for both current projects and continuing awareness. Informal contacts were reported second most frequently used for current projects and external technical reports were second most used for continuing awareness. Overall, survey results indicated secondary literature, especially, is not well utilized by engineers. One third of respondents indicated that they never use computerized literature sources, indexing or abstracting sources, or electronic databases. Another one third utilize these sources less then once a year. Two factors were identified that inhibit use of secondary literature 1) engineers regard information systems as awkward and hard to use, thus relying on mediated searches and 2) most of these sources are subject oriented while most engineering information needs are problem oriented.

434 Welborn, Victoria (University of California at Santa Cruz). "The Cold Fusion Story: A Case Study Illustrating the Communication and Information Seeking Behavior of Scientists." *Science and Technology Libraries* 11, no. 3 (1991): 51-58.

On March 23, 1989 a research team from the University of Utah announced at a press conference that they had achieved cold fusion in the laboratory. The events that ensued offer an opportunity to re-examine the information seeking and communicating process of scientists, with particular reference to peer review and the role of the scientific journal. Provides useful background knowledge of modern scientific communication. 4 references.

436 Whitley, Richard (Manchester Business School) and Penelope Frost. "Task Type and Information Transfer in a Government Research Laboratory." *Human Relations* 25, no. 4 (August 1973): 537-550.

This article is of interest to people who study task analysis and information flow within an organization, particularly a scientific research organization. Forty-eight scientists were each interviewed and assigned to one of four task categories. Groups were for scientists who performed research tasks, formulating and testing theories and concepts; new development tasks, developing new technologies for the facility; extension tasks, improving the performance, utility, and applications of existing facilities; and responsibility tasks, tending to the operation of the facility, troubleshooting, making adjustments to equipment. The flow of information was studied by means of questionnaires on fifteen days over a period of three months. Subjects were asked to indicate which of a list of information sources had proven useful and relevant in their work. There are three tables showing the results of the data analysis. Task type was compared to educational background, organizational authority, information source utilization, and participation in the scientific community. Conclusions show that task type is related to a scientist's use of external information. It is at least as influential as educational background in overcoming organizational boundaries. Task type mediates relations between educational level, authority, and use of extraorganizational sources for obtaining and disseminating information. The impact of task type boundaries on restricting information flow is also shown, especially when boundaries are identical with formal organizational boundaries. Differences in task type form communication barriers due to differing concerns and areas of expertise. Task type boundaries restrict the flow of information. Barriers in the flow of communication can be overcome by scientists who are engaged in different types of tasks. 11 references.

439 Williams, Frederick and David V. Gibson, eds. *Technology Transfer: A Communication Perspective*, Sage Publications, London, UK, 1990.

Contains two relevant sections: "The Intraorganizational Environment: Point-to-Point Versus Diffusion," by Dorothy Leonard-Bardon (p43-61), and "Transfer via Telecommunication," by Frederick Williams and Eloise Brackenridge (p171-191). The first selection defines two distinct technology transfer situations, point-to-point and diffusion, that have different implications for both intraorganizational communication and management practices. Technology transfer is defined as the process by which specialized technical skills are transferred from the source of the technology to a target group of receivers. Point-to-point transfer involves transfer from a singe group of experts to a single targeted group and usually involves simple, face to face negotiation. Diffusion, which is more commonly found in large organizations, involves dissemination of technical skills to various organizational groups. Negotiation is replaced by a marketing approach that involves use of more formal communication mechanisms, such as newsletters, memos, etc. These different models of technology transfer may have implications, primarily, for engineers involved in team projects in large R&D settings. 19 references. The second selection highlights computer networks as enhancing the rate of technology transfer by: 1) supporting collaboration between research scientists; 2) supplying access to a wide variety of information and computing resources; and 3) forging links between government and commercial groups. Both selections are primarily useful as background reading material. 38 references.

446 Winsor, Dorothy A. (Dept. of Management, GMI Engineering and Management Institute, Flint, MI) "How Companies Affect the Writing of Young Engineers: Two Case Studies." *IEEE Transactions on Professional Communication* 33, no. 3 (September 1990): 124-129.

This article is of interest to people who are involved in the training of new workers whose job responsibilities involve writing. The study interviews two co-operative engineering students, one with three months of school and one with twenty-one months of school and work experience. They selected documents they had written and discussed them in taped interviews. A list of questions was used to guide the interview. The students' supervisors were asked the same questions concerning the work of the students. Answers were compared to analyze the degree to which each student had assimilated the rules and competencies for writing acceptably for the company. The student with more experience on the job showed more agreement with her supervisor on views of her work, reflecting more assimilation into the work environment. The student with less experience followed a model to write while the more experienced wrote without any guidelines. The less experienced worker was uncertain about the audience of the work, the format the work should be in, the purpose of the work, and was lacking any historical context of the work. His writing was edited extensively by his supervisor. This study demonstrates that people develop writing skills by exposure to competent language users and their texts. Beginners will need help becoming accustomed to the full context of their positions, but guidance does facilitate the acquisition of skills. 18 references.

448 Wolek, Francis W. "The Engineer: His Work and Needs for Information." *Proceedings of the American Society for Information Science* 6 (1969): 471-476.

The article describes the different ways in which a full understanding of the work that an engineer performs can be helpful in interpreting and anticipating her/his information needs. As a methodology, engineering can be broken down into two components: design and development. This article focuses primarily on the engineering development process. This process can itself be understood as a progression from defining the problem to building and testing possible solutions. Because the estimates of time allocation run at 5-10% for the definition and 90-95% for building and testing, the assumption is that engineers obtain most of their critical information in the process of building models. However, in this respect, they depend primarily on the empirical data collected as well as any informal discussions conducted at the time of the experiment. If much of the significant information is gathered in this local context, what then is the role of the information scientist. Primarily an engineer will be interested in any historical information about the performance of similar technologies, and this should be provided when he/she is still only defining the problem.

Only by understanding the degrees to which engineers will necessarily limit the information processing they must accomplish can the information scientist play a significantly supportive role. This has come to be known as technological forecasting. 25 references.

450 Wooster, Harold (Air Force Office of Scientific Research, Arlington, VA, USA). "Policy Planning for Technical Information in Industry." In *Documentation Planning in Developing Countries, International Federation for Documentation (FID/DC) Symposium, Bad Godesberg, Federal Republic of Germany, 29 November 1967.* 16 pages.

This paper summarizes a talk delivered at the 1967 Symposium of the FID/DC. It is divided into three sections: 1) management of research and development in industry; 2) information transfer in industrial R&D; and 3) responsibilities of the documentalists. Section 2 is of interest as it summarizes the findings of Rosenbloom and Woleck's 1967 study *Technology Information and Organization: Information Transfer in Industrial R&D.*

451 Workshop Steering Group (Cross-Disciplinary Engineering Research Committee, Commission on Engineering and Technical Systems, National Research Council, Washington, D.C.). *Report of a Workshop held in Washington, D.C., June 11, 1985.* Washington, D.C.: National Academy Press, 1985. 52 pages.

Information and Technology Exchange Among Engineering Research Centers and Industry reports the recommendations of a workshop held to advise the National Science Foundation on means of encouraging information exchange among cross-disciplinary Engineering Research Centers, which were established by NSF in 1985. The workshop concluded that NSF should not moderate communication programs but should allow individual ERC's to establish information exchange networks. Specific options for information exchange were identified, including electronic mail, newsletters, and professional meetings. Also discussed were potential linkages with foreign firms and small USA companies and means for monitoring ongoing research. This document recommends building communication networks between private industry, government, and academic engineering activities and institutions.

452 Zielstorff, Rita D. (Massachusetts General Hospital), Christopher Cimino, G. Octo Barnett, Laurie Hassan, and Dyan Ryan Blewett. "Representation of Nursing Terminology In The UMLS Metathesaurus: A Pilot Study." *Proceedings: Fifteenth Annual Symposium on Computer Applications in Medical Care: Assessing the Value of Medical Informatics.* (1993): 392-396.

To see whether the National Library of Medicine's Metathesaurus includes terminology relevant to clinical nursing practice, two widely used nursing vocabularies were matched against the NLM's Metathesaurus. The two nursing vocabularies were the North American Nursing Diagnosis List of Approved Diagnoses (NANDA) and the Omaha system, a vocabulary of problems and interventions developed by the Omaha Visiting Nurses Association. First, the terms were scanned against META in their "native" form, with phrases and combinations intact. This produced a relatively low percentage of exact matches (12%). Next the terms were separated in "core concepts" and "modifiers" and the analysis was repeated. The percentages of exact matches to terms in META increased to 32%. However, the semantic types of the split terms often were not equivalent to the semantic types of the phrases from which the split terms were derived. In some cases, terms returned as exact matches but had different meanings in META. It was determined that automatic scanning for lexical matches is a helpful first step in searching for vocabulary representation in META, but term-by-term search for context, semantic type and definition is essential. However, it seems clear that representation of nursing terminology in the Metathesaurus needs to be expanded. There is one table that displays a sample of terms from NANDA and the Omaha system lists, and four tables which display the percentage of "matches" in META with phrases intact, the matches for NANDA diagnosis, OMAHA problems and for Omaha Intervention terms. 7 references.

453 Zinn, Karl (Center for Research on Learning and Teaching, Ann Arbor, MI). "A Computer-based System to Enhance Sharing of Technical Information in a System of Scientific Communities." *Current Research on Scientific and Technical Information Transfer*, Micropapers Edition. New York: Jeffrey Norton Publishers, (1976):15-24.

The purpose of this project was to develop and test the feasibility of a technique for facilitating and motivating sharing of scientific and technical information among individuals in a scientific community. The information to be shared was for the most part acquired by and stored in a generally-accessible computer system. Computer-based communication was arranged to allow one who originated information to disseminate it to a wide audience of potential users without the delay, expense or editorial constraint of conventional publication. The pilot implementation is being tested with communities sharing information about computing and information processing resources. Data are being taken on the effectiveness, utility, and usability of the service. Most of the participants are users of the computers of three Michigan universities which are connected by the MERIT Computer Network. Some of the communities include persons from universities outside the state or from government and industry. The pilot implementation will be extended to other types of scientific and technical information, and other kinds of scientific communities. Includes sample interaction with on-line component of directory. 16 references.

454 Zipperer, Lorri (American Medical Association). "The Creative Professional and Knowledge." *Special Libraries* 84, no. 2 (Spring, 1993): 69-78.

A case study was used to define information needs of professionals in an active exhibit design firm. Structured, open-ended interviews served as the data collection instrument. Information as to how users gather and use needed information was compiled. Information was often collected through similar actions by different users. Personal experiences of colleagues served as commonly used sources. Text sources were used when available, but reliance on them was minimal. The main conclusion is that this firm would benefit from the use of centralized information sources. Although this conclusion is applicable to the exhibit design and the design field in general, the technical nature of this environment and its subject matter may not provide a suitable career alternative for the art librarian. This article provides an excellent practical example of technical information use and use styles in modern American industry. 15 references.

456 "Canada: Saskatoon Engineers Get Serious." *Engineering Digest* (April 1987): 4. vol. 33.

Engineers Toastmasters Club No. 5280 of Saskatoon is composed entirely of professional engineers, and is devoted to helping members build and market engineering communication skills. Membership in the Association of Professional Engineers of Saskatchewan is required for admission. The club was formed because it was felt that other local toastmasters clubs were not meeting engineers' specific communication and leadership skill needs. 20 members were needed to start the club which has grown to 24 members today. Meeting format is the same as that followed by all toastmasters clubs. This is being improved to allow more time for technical questions. Members receive feedback on their presentations to the club in order to help them with their final presentations.

Section 7
Subject and Author Indexes

7.1 Subject Index

7.1.1 Introduction

Each reference is reviewed and identified from the perspective of various topics that are discussed or presented. These topics are given below, and item (or reference) numbers are listed for each topic. General topics are:

- Topics related to general STI communication patterns (12 sub-topics)
- STI communication involving primary/published media (16 sub-topics)
- Interpersonal STI communication (8 sub-topics)
- STI communication involving secondary media, systems, databases (11 sub-topics)
- STI communication through intermediary organizations, libraries, information analysis centers, clearinghouses (11 sub-topics)

Sub-topics in the areas above generally establish the kinds of communication discussed or observed in the reference. The sub-topics also establish the kinds of information or data provided, such as extent or amount of communication done; factors affecting information use, services or sources; purposes for which information is used; and outcomes of use, such as improved productivity, creativity, performance, etc.

- Other aspects of STI communication, information presented (8 sub-topics)

These sub-topics include such aspects as distinguishing between engineers and scientists, comparisons among countries, STI policies, and so on.

- Study methods used (6 sub-topics)
- Communicator characteristics discussed or observed (4 sub-topics)
- Employment sector or affiliation of communicators discussed or observed (3 sub-topics)
- State-of-the-art reviews, articles, chapters, book reviews

7.1.2 Topics Related to General STI Communication Patterns

STI Communication Models

17 Aloni, Michaela
21 Auster, Ellen
28 Barclay, Rebecca O. (Paper 14)
29 Barclay, Rebecca O. (Paper 15)
45 Blados, Walter R. (Paper 2)
60 Broadbent, Marianne
68 Chang, Shan-Ju
69 Cho, Yong-Ja
76 Coyne, J.G.
77 Crane, Diana (1972)
111 Garvey, William (*Communication: The Essence of Science*, 1979)
116 Garvey, William (1972)
117 Garvey, William (1971)
118 Garvey, William (1970)
119 Garvey, William (1968)
120 Garvey, William (1967)
121 Gellman, Aaron J.
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
140 Gupta, B.M.
146 Harris Jr., William J.
169 Irwin, Harry
171 Johns Hopkins University
174 Kant, Raj
197 King, Donald W. (1981)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. I*, 1976)
201 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. II*, 1976)
202 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, 1977 Edition*, 1977)
203 King, D.W. (*A Chart Book of Indicators of Scientific and Technical Communication in the United States*, 1977)
204 King, D.W. (1979)
205 King, Donald W. ("Systemic and Economic Interdependencies in Journal Publication", 1977)
206 King, Donald W. (1974)
208 King, Donald W. (1971)
224 Lancaster, F.W. (1993)
226 Landau, Herbert B.
232 Levinson, Nanette S.
233 Leivrouw, L.A.
234 Leivrouw, Leigh A.
241 Lufkin, J.M.
264 Mick, Colin K.
265 Mikhailov, A.I.
269 Mondschein, Lawrence G. ("SDI: Relationship to Productivity in the Corporate Environment", 1990)
272 Morris, Ruth C.T.
284 Paisley, William (1980)
315 Pinelli, Thomas E. (Paper 19)
324 Pinelli, Thomas E. (Paper 12)
327 Pinelli, Thomas E. (Report 6)
342 Pinelli, Thomas E. (1981)
354 Roderer, Nancy K.
355 Rogers, Everett M. (1983)

358 Rosenbloom, Richard S. (1970)
360 Rothwell, Roy
369 Scott, Christopher
378 Shuchman, Hedvah L. (1980)
385 Spilka, Rachel
400 Thomas, Rick
410 Tushman, Michael ("Managing Communication Networks in R&D Laboratories", 1979)
425 Vincenti, Walter G.
449 Wood, D.N.
453 Zinn, Karl

Models of information flow, channels

17 Aloni, Michaela
21 Auster, Ellen
28 Barclay, Rebecca O. (Paper 14)
109 Frost, Penelope A.
146 Harris Jr., William J.
197 King, Donald W. (1981)
204 King, D.W. (1979)
205 King, Donald W. ("Systemic and Economic Interdependencies in Journal Publication", 1977)
233 Leivrouw, L.A.
234 Leivrouw, Leigh A.
264 Mick, Colin K.
342 Pinelli, Thomas E. (1981)
355 Rogers, Everett M. (1983)
369 Scott, Christopher
385 Spilka, Rachel
410 Tushman, Michael ("Managing Communication Networks in R&D Laboratories", 1979)

Models of communication functions and/or participants/stakeholders

29 Barclay, Rebecca O. (Paper 15)
45 Blados, Walter R. (Paper 2)
76 Coyne, J.G.
116 Garvey, William (1972)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
146 Harris Jr., William J.
174 Kant, Raj
184 Kaufman, Harold G.
197 King, Donald W. (1981)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. I*, 1976)
201 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. II*, 1976)
202 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, 1977 Edition*, 1977)
204 King, D.W. (1979)
206 King, Donald W. (1974)
208 King, Donald W. (1971)
315 Pinelli, Thomas E. (Paper 19)
324 Pinelli, Thomas E. (Paper 12)
327 Pinelli, Thomas E. (Report 6)
354 Roderer, Nancy K.
400 Thomas, Rick

Models of information life cycle, flow among media

111 Garvey, William (*Communication: The Essence of Science*, 1979)
116 Garvey, William (1972)
117 Garvey, William (1971)
118 Garvey, William (1970)
119 Garvey, William (1968)
120 Garvey, William (1967)
171 Johns Hopkins University
234 Leivrouw, Leigh A.
355 Rogers, Everett M. (1983)

Models of communication as a component of science, technology, work

45 Blados, Walter R. (Paper 2)
60 Broadbent, Marianne
69 Cho, Yong-Ja
76 Coyne, J.G.
121 Gellman, Aaron J.
137 Griffiths, José-Marie (1993)
140 Gupta, B.M.
269 Mondschein, Lawrence G. ("SDI: Relationship to Productivity in the Corporate Environment", 1990)
327 Pinelli, Thomas E. (Report 6)
355 Rogers, Everett M. (1983)
360 Rothwell, Roy
400 Thomas, Rick
410 Tushman, Michae' ("Managing Communication Networks in R&D Laboratories", 1979)
447 Wolek, Frances W. (1970)
453 Zinn, Karl

Other Models

1 Ackoff, R.L.
358 Rosenbloom, Richard S. (1970)
370 Senders, J.W.
378 Shuchman, Hedvah L. (1980)
399 Taylor, Robert S. (1986)
425 Vincenti, Walter G.

Information-Seeking Processes, Information Sources Used

3 Allen, Robert S.
7 Allen, Thomas J. (1983)
8 Allen, Thomas J. (1977)
10 Allen, Thomas J. ("Roles in Technical Communication Networks", 1970)
12 Allen, Thomas J. ("Information Flow in Research and Development Laboratories", 1969)
13 Allen, Thomas J. (1968)
14 Allen, Thomas J. ("Studies of the Problem Solving Process in Engineering Design", 1966)
15 Allen, Thomas J. (*Managing the Flow of Scientific and Technical Information*, 1966)
16 Allen, Thomas J. (1964)
17 Aloni, Michaela
22 Baltatu, Monica E.
24 Barclay, Rebecca O. (Paper 41)
25 Barclay, Rebecca O. (Paper 37)
26 Barclay, Rebecca O. (Paper 33)
27 Barclay, Rebecca O. (Report 17)

28 Barclay, Rebecca O., Paper 14
30 Barczak, Gloria
31 Batson, Robert G.
34 Beardsley, Charles W.
45 Blados, Walter R. (Paper 2)
46 Blaxter, K.L.
59 Brittain, J.M.
61 Brown, James William
67 Chakrabarti, Alok K.
101 Fine, Sara
103 Ford, G.
109 Frost, Penelope A.
110 Gaffney, Inez M.
111 Garvey, William (*Communication: The Essence of Science*, 1979)121 Gellman, Aaron J.
122 Gerstberger, Peter G.
123 Gerstenfeld, Arthur
124 Gilchrist, Alan
128 Glassman, Nanci A. (Report 12)
129 Glock, C.Y.
130 Glueck, William F.
133 Gralewska-Vickery, A.
137 Griffiths, José-Marie (1993)
140 Gupta, B.M.
142 Hall, Angela M. ("Comparative Use and Value of INSPEC Services", 1972)
143 Hall, Angela M. (*INSPEC: User Preference in Printed Indexes*, 1972)
144 Hall, Angela (*The Effect and Use of an SDI Service on the Information-Gathering Habits of Scientists and Technologists*, 1972)
146 Harris Jr., William J.
148 Hecht, Laura M. (Report 28)
149 Hecht, Laura M. (Report 27)
150 Hecht, Laura M. (Report 26)
153 Herner, Saul (1954)
160 Holland, Maurita P. (Paper 20)
162 Holmfeld, John D.
166 Hunter, J.F.
168 Hutchinson, Robert A.
172 Johnson, Alan W.
173 Johnston, Ron
177 Kasperson, Conrad J. ("Psychology of the Scientist: XXXVII.", 1978)
179 Kasperson, C.J. (1976)
187 Kennedy, John M. (Paper 42)
188 Kennedy, John M. (Paper 40)
214 Kohl, John R. (Paper 25)
215 Korfhage, Robert R.
217 Kranzberg, Melvin
218 Kremer, Jeanette Marguerite
219 Krikelas, James
223 Lacy, William B.
225 Lancaster, F.W. (1974)
227 Landendorf, Janice M.
229 Leibson, David E.
241 Lufkin, J.M.
254 McCullough, Robert A.

261 Menzel, Herbert ("Scientific Communication: Five Themes from Social Science Research", 1966)
262 Menzel, Herbert (1962)
264 Mick, Colin K.
265 Mikhailov, A.I.
272 Newell, Sue
277 Neale, Michael
286 Palmer, Judith (1992)
293 Pinelli, Thomas E. (Report 25)
293 Pinelli, Thomas E. (Report 24)
294 Pinelli, Thomas E. (Report 23)
297 Pinelli, Thomas E. (Report 20)
298 Pinelli, Thomas E. (Paper 36)
302 Pinelli, Thomas E. (Report 18)
303 Pinelli, Thomas E. (Report 15)
304 Pinelli, Thomas E. (Report 16)
305 Pinelli, Thomas E. (Paper 31)
306 Pinelli, Thomas E. (Paper 29)
308 Pinelli, Thomas E. (Paper 26)
317 Pinelli, Thomas E. (Paper 13)
318 Pinelli, Thomas E. (Paper 21)
322 Pinelli, Thomas E. (Report 9)
323 Pinelli, Thomas E. (Report 8)
324 Pinelli, Thomas E. (Paper 12)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
333 Pinelli, Thomas E. (Paper 4)
334 Pinelli, Thomas E. (Paper 6)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
348 Quinn, John J.
349 Raitt, David I.
353 Rickards, Janice
357 Rosenberg, Victor
358 Rosenbloom, Richard S. (1970)
359 Rosenbloom, Richard S. (1967)
362 Rubenstein, Albert H.
369 Scott, Christopher
371 Shapero, Albert
374 Shotwell, Thomas K.
376 Shuchman, Hedvah L. (1982)
377 Shuchman, Hedvah L. (1981)
379 Seiss, Judith A.
382 Skelton, Barbara
383 Smith, Clagett G.
386 Spretnak, Charles M.
392 Subramanyam, K.
395 Taylor, Robert L. (1977)
397 Taylor, Robert L. ("A Longitudinal Study of Communication in Research: Technical and Managerial Influences", 1975)
398 Taylor, Robert S. (1991)
412 Tushman, Michael L. ("Technical Communication in R&D Laboratories: The Impact of Project Work Characteristics", 1978)

413 Tushman, Michael L. ("Information Processing as an Integrating Concept in Organizational Design", 1978)
414 Tushman, Michael L. (1977)
419 Utterback, James M.
427 Waldhart, Thomas J.
433 Weinschel, Bruno O.
447 Wolek, Francis W. (1970)
454 Zipperer, Lorri

Information Sources Are Ranked

16 Allen, Thomas J. (1964)
67 Chakrabarti, Alok K.
106 Fraser, Jay
111 Garvey, William (*Communication: The Essence of Science*, 1979)
122 Gerstberger, Peter G.
123 Gerstenfeld, Arthur
130 Glueck, William F.
146 Harris Jr., William J.
177 Kasperson, Conrad J. ("Psychology of the Scientist: XXXVII.", 1978)
179 Kasperson, C.J. (1976)
184 Kaufman, Harold G.
218 Kremer, Jeanette Marguerite
328 Pinelli, Thomas E. (Report 5)
338 Pinelli, Thomas E. (Report 4)
339 Pinelli, Thomas E. (Report 1)
352 Richardson, Robert J.
357 Rosenberg, Victor
359 Rosenbloom, Richard S. (1967)
376 Shuchman, Hedvah L. (1982)
427 Waldhart, Thomas J.
447 Wolek, Francis W. (1970)

Gatekeepers, Information Stars, Boundary Spanning, Information Networks (Point-to-Point)

3 Allen, Robert S.
5 Allen, Thomas J. (1992)
9 Allen, Thomas J. ("Communication Networks in R&D Laboratories", 1970)
10 Allen, Thomas J. ("Roles in Technical Communication Networks", 1970)
12 Allen, Thomas J. ("Information Flow in Research and Development Laboratories", 1969)
15 Allen, Thomas J. (*Managing the Flow of Scientific and Technical Information*, 1966)
17 Aloni, Michaela
18 Arechavala-Vargas, Ricardo
21 Auster, Ellen
61 Brown, James William
64 Burte, Harris M.
83 Davis, Peter
89 Dixon, John R.
105 Fraser, Emily Jean
109 Frost, Penelope A.
129 Glock, C.Y.
134 Griffin, Abbie
140 Gupta, B.M.
169 Irwin, Harry
185 Kaula, P.N.
186 Keller, Robert T.

217 Kranzberg, Melvin
218 Kremer, Jeanette Marguerite
274 Myers, L.A.
280 Nochur, K.S.
395 Taylor, Robert L. (1977)
396 Taylor, Robert L. ("The Technological Gatekeeper", 1975)
397 Taylor, Robert L. ("A Longitudinal Study of Communication in Research: Technical and Managerial Influences", 1975)
400 Thomas, Rick
408 Tushman, Michael L. (1990)
409 Tushman, Michael L. (1981)
410 Tushman, Michael ("Managing Communication Networks in R&D Laboratories", 1979)
411 Tushman, Michael L. ("Impacts of Perceived Environmental Variability on Patterns of Work Related Communication", 1979)

Information Transfer (non-Point-to-Point), Knowledge Diffusion, Networks (General)

71 Collins, H.M.
77 Crane, Diana (1972)
111 Garvey, William (*Communication: The Essence of Science*, 1979)
140 Gupta, B.M.
159 Hoch, Paul K.
169 Irwin, Harry
194 King, D.W. (1985)
211 King, William R.
230 Leonard-Barton, Dorothy
232 Levinson, Nanette S.
267 Moenaert, Rudy K.
355 Rogers, Everett M. (1983)
356 Rogers, Everett M. (1982)
382 Skelton, Barbara
389 Stern, Arnold
407 Turoff, Murray
438 Williams, Frederick ("Transfer via Telecommunications: Networking Scientists and Industry", 1990)

Information Needs (Content, Purposes of Use, Sources) and Information Requirements (Information or Service Attributes) Specified

10 Allen, Thomas J. ("Roles in Technical Communication Networks", 1970)
30 Barczak, Gloria
37 Berul, Lawrence H.
67 Chakrabarti, Alok K.
68 Chang, Shan-Ju
72 Corridiodore, Michael C.
87 Derr, Richard L.
89 Dixon, John R.
98 Faibisoff, Sylvia G.
109 Frost, Penelope A.
111 Garvey, William (*Communication: The Essence of Science*, 1979)
123 Gerstenfeld, Arthur
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
153 Herner, Saul (1954)
168 Hutchinson, Robert A.

194 King, D.W. (1985)
231 Lescoheir, R.S.
242 Machlup, Fritz
256 Meadows, A.J. (1993)
265 Mikhailov, A.I.
272 Morris, Ruth C.T.
353 Rickards, Janice
376 Shuchman, Hedvah L. (1982)
377 Shuchman, Hedvah L. (1981)
399 Taylor, Robert S. (1986)
447 Wolek, Francis W. (1970)
448 Wolek, Francis W. (1969)
454 Zipperer, Lorri

Factors that Affect or Are Related to Information or Source Use, Such as Distance, Ease of Use, Awareness, Quality, User Characteristics, User Environmental Characteristics

3 Allen, Robert S.
5 Allen, Thomas J. (1992)
7 Allen, Thomas J. (1983)
9 Allen, Thomas J. ("Communication Networks in R&D Laboratories", 1970)
10 Allen, Thomas J. ("Roles in Technical Communication Networks", 1970)
12 Allen, Thomas J. ("Information Flow in Research and Development Laboratories", 1969)
14 Allen, Thomas J. ("Studies of the Problem Solving Process in Engineering Design", 1966)
18 Arechavala-Vargas, Ricardo
21 Auster, Ellen
24 Barclay, Rebecca O. (Paper 41)
25 Barclay, Rebecca O. (Paper 37)
26 Barclay, Rebecca O. (Paper 33)
27 Barclay, Rebecca O. (Report 17)
28 Barclay, Rebecca O. (Paper 14)
31 Batson, Robert G.
43 Bishop, Ethelyn
61 Brown, James William
67 Chakrabarti, Alok K.
71 Collins, H.M.
83 Davis, Peter
89 Dixon, John R.
101 Fine, Sara
103 Ford, G.
106 Fraser, Jay
109 Frost, Penelope A.
111 Garvey, William (*Communication: The Essence of Science*, 1979)
123 Gerstenfeld, Arthur
124 Gilchrist, Alan
128 Glassman, Nanci A. (Report 12)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
162 Holmfeld, John D.
172 Johnson, Alan W.
173 Johnston, Ron
177 Kasperson, Conrad J. ("Psychology of the Scientist: XXXVII.", 1978)
179 Kasperson, C.J. (1976)
184 Kaufman, Harold G.

186 Keller, Robert T.
214 Kohl, John R. (Paper 25)
218 Kremer, Jeanette Marguerite
225 Lancaster, F.W. (1974)
229 Leibson, David E.
230 Leonard-Barton, Dorothy
232 Levinson, Nanette S.
233 Leivrouw, L.A.
234 Leivrouw, Leigh A.
264 Mick, Colin K.
267 Moenaert, Rudy K.
272 Morris, Ruth C.T.
280 Nochur, K.S.
286 Palmer, Judith (1992)
293 Pinelli, Thomas E. (Report 25)
293 Pinelli, Thomas E. (Report 24)
294 Pinelli, Thomas E. (Report 23)
295 Pinelli, Thomas E. (Report 22)
298 Pinelli, Thomas E. (Paper 36)
302 Pinelli, Thomas E. (Report 18)
303 Pinelli, Thomas E. (Report 15)
304 Pinelli, Thomas E. (Report 16)
305 Pinelli, Thomas E. (Paper 31)
306 Pinelli, Thomas E. (Paper 29)
308 Pinelli, Thomas E. (Paper 26)
317 Pinelli, Thomas E. (Paper 13)
322 Pinelli, Thomas E. (Report 9)
323 Pinelli, Thomas E. (Report 8)
328 Pinelli, Thomas E. (Report 5)
333 Pinelli, Thomas E. (Paper 4)
334 Pinelli, Thomas E. (Paper 6)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
342 Pinelli, Thomas E. (1981)
349 Raitt, David I.
355 Rogers, Everett M. (1983)
357 Rosenberg, Victor
358 Rosenbloom, Richard S. (1970)
359 Rosenbloom, Richard S. (1967)
371 Shapero, Albert
377 Shuchman, Hedvah L. (1981)
382 Skelton, Barbara
383 Smith, Clagett G.
395 Taylor, Robert L. (1977)
396 Taylor, Robert L. ("The Technological Gatekeeper", 1975)
397 Taylor, Robert L. ("A Longitudinal Study of Communication in Research: Technical and Managerial Influences", 1975)
398 Taylor, Robert S. (1991)
399 Taylor, Robert S. (1986)
412 Tushman, Michael L. ("Technical Communication in R&D Laboratories: The Impact of Project Work Characteristics", 1978)
413 Tushman, Michael L. ("Information Processing as an Integrating Concept in Organizational Design", 1978)

414 Tushman, Michael L. (1977)
433 Weinschel, Bruno O.
447 Wolek, Francis W. (1970)
450 Wooster, Harold

Time Spent Communicating

6 Allen, Thomas J. (1988)
29 Barclay, Rebecca E (Paper 15)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
264 Mick, Colin K.
339 Pinelli, Thomas E. (Paper 15)
407 Turoff, Murray

Outcomes of Information Use, Such as Improved Productivity, Performance, Promotion, Achievements Recognized, Quality of Research, Creativity

9 Allen, Thomas J. ("Communication Networks in R&D Laboratories", 1970)
12 Allen, Thomas J. ("Information Flow in Research and Development Laboratories", 1969)
14 Allen, Thomas J. ("Studies of the Problem Solving Process in Engineering Design", 1966)
30 Barczak, Gloria
58 Brinberg, Herbert R. (Paper 24)
61 Brown, James William
67 Chakrabarti, Alok K.
109 Frost, Penelope A.
125 Glaser, Edward M.
129 Glock, C.Y.
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
177 Kasperson, Conrad J. ("Psychology of the Scientist: XXXVII.", 1978)
179 Kasperson, C.J. (1976)
242 Machlup, Fritz
336 Pinelli, Thomas E. (Paper 1)
382 Skelton, Barbara
383 Smith, Clagett G.
433 Weinschel, Bruno O.

7.1.3 STI Communication Involving Primary/Published Media

33 Bayer, Alan E. (1979)
53 Boulgarides, J.D.
84 Davis, Richard M.
114 Garvey, William ("Changing the System: Innovations in the Interactive Social System of Scientific Communication", 1979)
171 Johns Hopkins University
192 King, Donald W. (1991)
193 King, Donald W. (1989)
213 Kochen, F.
258 Meadows, A.J. (1974)
264 Mick, Colin K.
265 Mikhailov, A.I.
277 Neale, Michael
359 Rosenbloom, Richard S. (1967)
385 Spilka, Rachel

432 Weil, Ben H.
446 Winsor, Dorothy A. (1990)

Journals, Journal Articles

28 Barclay, Rebecca O., Paper 14
29 Barclay, Rebecca O. (Paper 15)
111 Garvey, William (*Communication: The Essence of Science*, 1979)
116 Garvey, William (1972)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
142 Hall, Angela M. ("Comparative Use and Value of INSPEC Services", 1972)
143 Hall, Angela M. (*INSPEC: User Preference in Printed Indexes*, 1972)
144 Hall, Angela (*The Effect and Use of an SDI Service on the Information-Gathering Habits of Scientists and Technologists*, 1972)
158 Hills, Phillip
164 Houghton, Bernard
165 Hoyt, J.W.
183 Katzen, May
195 King, Donald W. (1984)
196 King, Donald W. (1982)
197 King, Donald W. (1981)
198 King, Donald W. (1980)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. I*, 1976)
201 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. II*, 1976)
202 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, 1977 Edition*, 1977)
203 King, D.W. (*A Chart Book of Indicators of Scientific and Technical Communication in the United States*, 1977)
204 King, D.W. (1979)
205 King, Donald W. ("Systemic and Economic Interdependencies in Journal Publication", 1977)
210 King, Donald W. (1978)
241 Lufkin, J.M.
257 Meadows, A.J. (1979)
271 Mooney, C.J.
283 Page, Gillian
288 Passman, Sidney
313 Pinelli, Thomas E. (Report 13)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
329 Pinelli, Thomas E. (Report 4)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
340 Pinelli, Thomas E. (1989)
341 Pinelli, Thomas E. (1982)
342 Pinelli, Thomas E. (1981)
354 Roderer, Nancy K.
367 Schauder, Don
369 Scott, Christopher
377 Shuchman, Hedvah L. (1981)
378 Shuchman, Hedvah L. (1980)
408 Tushman, Michael L. (1990)
422 Van Styvendale, B.J.H. (1977)

Books, Monographs

137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
192 King, Donald W. (1991)
195 King, Donald W. (1984)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. I*, 1976)
201 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. II*, 1976)
202 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, 1977 Edition*, 1977)
203 King, D.W. (*A Chart Book of Indicators of Scientific and Technical Communication in the United States*, 1977)
228 Leggett, Robert G.
241 Lufkin, J.M.
271 Mooney, C.J.
354 Roderer, Nancy K.
421 Van Styvendale, B.J.H. (1981)

Technical Reports, Gray Literature

19 Arthur, Richard H.
28 Barclay, Rebecca O., Paper 14
29 Barclay, Rebecca O. (Paper 15)
37 Berul, Lawrence H.
38 Bichteler, Julie (1991)
39 Bichteler, Julie (1989)
45 Blados, Walter R. (Paper 2)
104 Franke, Earnest A.
105 Fraser, Emily Jean
126 Glassman, Myron (no date)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
157 Hill, R. John
195 King, Donald W. (1984)
196 King, Donald W. (1982)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. I*, 1976)
201 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. II*, 1976)
202 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, 1977 Edition*, 1977)
203 King, D.W. (*A Chart Book of Indicators of Scientific and Technical Communication in the United States*, 1977)
216 Krall, George F.
252 McClure, Charles R. (1937)
253 McClure, Charles R. (1986)
254 McCullough, Robert A.
270 Monge, Peter R.
288 Passman, Sidney
299 Pinelli, Thomas E. (Report 19)
300 Pinelli, Thomas E. (Paper 35)
301 Pinelli, Thomas E. (Paper 34)
306 Pinelli, Thomas E. (Paper 29)
309 Pinelli, Thomas E. (Paper 17)
313 Pinelli, Thomas E. (Report 13)
324 Pinelli, Thomas E. (Paper 12)
325 Pinelli, Thomas E. (Paper 11)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
329 Pinelli, Thomas E. (Report 4)
337 Pinelli, Thomas E. (Report 3)

338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
341 Pinelli, Thomas E. (1982)
342 Pinelli, Thomas E. (1981)
354 Roderer, Nancy K.
377 Shuchman, Hedvah L. (1981)

Conference Papers, Patent Documents, Other Documents

28 Barclay, Rebecca O., Paper 14
137 Griffiths, José-Marie (1993)
313 Pinelli, Thomas E. (Report 13)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
375 Shuchman, Hedvah L. (1983)

Authorship, Writing

19 Arthur, Richard H.
29 Barclay, Rebecca O. (Paper 15)
84 Davis, Richard M.
104 Franke, Earnest A.
111 Garvey, William (*Communication: The Essence of Science*, 1979)
116 Garvey, William (1972)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
183 Katzen. May
197 King, Donald W. (1981)
271 Mooney, C.J.
327 Pinelli, Thomas E. (Report 6)
339 Pinelli, Thomas E. (Report 1)
377 Shuchman, Hedvah L. (1981)
385 Spilka, Rachel
386 Spretnak, Charles M.
446 Winsor, Dorothy A. (1990)

Amount written

29 Barclay, Rebecca O. (Paper 15)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
197 King, Donald W. (1981)
198 King, Donald W. (1980)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. 1*, 1976)
204 King, D.W. (1979)
210 King, Donald W. (1978)
271 Mooney, C.J.
327 Pinelli, Thomas E. (Report 6)
339 Pinelli, Thomas E. (Report 1)

Time spent writing, cost of writing

29 Barclay, Rebecca O. (Paper 15)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
197 King, Donald W. (1981)
198 King, Donald W. (1980)
204 King, D.W. (1979)
205 King, Donald W. ("Systemic and Economic Interdependencies in Journal Publication", 1977)
207 King, Donald W. (1972)
327 Pinelli, Thomas E. (Report 6)
339 Pinelli, Thomas E. (Report 1)
367 Schauder, Don

Consequences of writing, importance of writing, effects of writing on careers

29 Barclay, Rebecca O. (Paper 15)
84 Davis, Richard M.
104 Franke, Earnest A.
327 Pinelli, Thomas E. (Report 6)
339 Pinelli, Thomas E. (Report 1)
341 Pinelli, Thomas E. (1982)
385 Spilka, Rachel

Measures Related to Reading

Amount of reading

29 Barclay, Rebecca O. (Paper 15)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
165 Hoyt, J.W.
197 King, Donald W. (1981)
192 King, Donald W. (1991)
193 King, Donald W. (1989)
196 King, Donald W. (1982)
198 King, Donald W. (1980)
204 King, D.W. (1979)
206 King, Donald W. 1972
241 Lufkin, J.M.
288 Passman, Sidney
301 Pinelli, Thomas E. (Paper 34)
306 Pinelli, Thomas E. (Paper 29)
309 Pinelli, Thomas E. (Paper 17)
313 Pinelli, Thomas E. (Report 13)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
339 Pinelli, Thomas E. (Report 1)
354 Roderer, Nancy K.
369 Scott, Christopher

Time spent reading, cost of reading

29 Barclay, Rebecca O. (Paper 15)
33 Bayer, Alan E. (1979)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)

192 King, Donald W. (1991)
193 King, Donald W. (1989)
196 King, Donald W. (1982)
197 King, Donald W. (1981)
198 King, Donald W. (1980)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. 1*, 1976)
204 King, D.W. (1979)
205 King, Donald W. ("Systemic and Economic Interdependencies in Journal Publication", 1977)
206 King, Donald W. 1972
241 Lufkin, J.M.
264 Mick, Colin K.
327 Pinelli, Thomas E. (Report 6)
339 Pinelli, Thomas E. (Report 1)
354 Roderer, Nancy K.
378 Shuchman, Hedvah L. (1980)

How read materials are identified and located, such as automated research, citation elsewhere, recommended

39 Bichteler, Julie (1989)
45 Blados, Walter R. (Paper 2)
105 Fraser, Emily Jean
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
196 King, Donald W. (1982)
197 King, Donald W. (1981)
198 King, Donald W. (1980)
204 King, D.W. (1979)
206 King, Donald W. 1972
258 Meadows, A.J. (1974)
324 Pinelli, Thomas E. (Paper 12)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
341 Pinelli, Thomas E. (1982)
369 Scott, Christopher

Where read materials are obtained, such as personal file, library, colleague, unit collection

45 Blados, Walter R. (Paper 2)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
196 King, Donald W. (1982)
197 King, Donald W. (1981)
204 King, D.W. (1979)
206 King, Donald W. 1972
324 Pinelli, Thomas E. (Paper 12)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
341 Pinelli, Thomas E. (1982)

Factors affecting use of materials and reading, such as availability, price, refereed, age

28 Barclay, Rebecca O., Paper 14
45 Blados, Walter R. (Paper 2)
105 Fraser, Emily Jean

111 Garvey, William (*Communication: The Essence of Science*, 1979)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
197 King, Donald W. (1981)
206 King, Donald W. (1972)
300 Pinelli, Thomas E. (Paper 35)
301 Pinelli, Thomas E. (Paper 34)
309 Pinelli, Thomas E. (Paper 17)
313 Pinelli, Thomas E. (Report 13)
325 Pinelli, Thomas E. (Paper 11)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
341 Pinelli, Thomas E. (1982)
342 Pinelli, Thomas E. (1981)

Purpose of reading and information use, such as research, stage of research, product development, education, keeping current

111 Garvey, William (*Communication: The Essence of Science*, 1979)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
196 King, Donald W. (1982)
197 King, Donald W. (1981)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
339 Pinelli, Thomas E. (Report 1)
341 Pinelli, Thomas E. (1982)
377 Shuchman, Hedvah L. (1981)
432 Weil, Ben H.

Effects of information use on creativity, performance, achievement, productivity, decisions, career

137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
192 King, Donald W. (1991)
193 King, Donald W. (1989)
196 King, Donald W. (1982)
197 King, Donald W. (1981)
241 Lufkin, J.M.
327 Pinelli, Thomas E. (Report 6)
432 Weil, Ben H.

Usefulness, utility, importance, value of information read

28 Barclay, Rebecca O., Paper 14
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
192 King, Donald W. (1991)
193 King, Donald W. (1989)
196 King, Donald W. (1982)
197 King, Donald W. (1981)
313 Pinelli, Thomas E. (Report 13)
327 Pinelli, Thomas E. (Report 6)

328 Pinelli, Thomas E. (Report 5)
369 Scott, Christopher
432 Weil, Ben H.

7.1.4 Interpersonal STI Communications

19 Arthur, Richard H.
136 Griffith, Belver C. (1992)
264 Mick, Colin K.
265 Mikhailov, A.I.

Communication Through Meetings, Conferences

47 Borchardt, John K.
53 Boulgarides, J.D.
115 Garvey, William (1978)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
272 Newell, Sue
329 Pinelli, Thomas E. (Report 4)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
342 Pinelli, Thomas E. (1981)
369 Scott. Christopher
377 Shuchman, Hedvah L. (1981)
456 --, *Engineering Digest*

Informal Communication, Discussions

30 Barczak, Gloria
36 Bermar, Amy
47 Borchardt, John K.
132 Graham, Warren R.
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
176 Karon, Paul
182 Katz, Ralph (1979)
223 Lacy, William B.
267 Moenaert, Rudy K.
279 Newell, Sue
312 Pinelli, Thomas E. (Report 14)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
329 Pinelli, Thomas E. (Report 4)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
377 Shuchman, Hedvah L. (1981)
378 Shuchman, Hedvah L. (1980)
387 Stenzler-Centonze, Marjorie
400 Thomas, Rick
408 Tushman, Michael L. (1990)
409 Tushman, Michael L. (1981)

411 Tushman, Michael L. ("Impacts of Perceived Environmental Variability on Patterns of Work Related Communication", 1979)
412 Tushman, Michael L. ("Technical Communication in R&D Laboratories: The Impact of Project Work Characteristics", 1978)
413 Tushman, Michael L. ("Information Processing as an Integrating Concept in Organizational Design", 1978)
414 Tushman, Michael L. (1977)

Electronic Conferencing, E-mail, Bulletin Boards

42 Bishop, Ann P. (Paper 39)
47 Borchardt, John K.
55 Braham, James
100 Featheringham, Tom R.
155 Heroux, Ronald G.
256 Meadows, A.J. (1993)
263 Metayer-Duran, Cheryl
312 Pinelli, Thomas E. (Report 14)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
368 Schrage, Michael 1967
377 Shuchman, Hedvah L. (1981)
384 Smith, Elaine Davis
403 Tombaugh, Jo W.
405 Tuck, Bill
406 Turoff, M. (1982)
407 Turoff, Murray

Non-Verbal Communication, Body Language

82 Dalton, Marie

Measures Related to Interpersonal Communication

Amount, extent of communication

137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
223 Lacy, William B.
328 Pinelli, Thomas E. (Report 5)
339 Pinelli, Thomas E. (Report 1)
342 Pinelli, Thomas E. (1981)

Time spent communicating, cost of communicating

100 Featheringham, Tom R.
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
264 Mick, Colin K.
267 Moenaert, Rudy K.
365 Schaefermeyer, Mark J.

Factors affecting interpersonal communication, such as distance, availability, user characteristics

82 Dalton, Marie
182 Katz, Ralph (1979)

403 Tombaugh, Jo W.
408 Tushman, Michael L. (1990)
409 Tushman, Michael L. (1981)
411 Tushman, Michael L. ("Impacts of Perceived Environmental Variability on Patterns of Work Related Communication", 1979)

Purposes of interpersonal communication, such as research, stage of research, career enhancement

182 Katz, Ralph (1979)
408 Tushman, Michael L. (1990)

Outcomes of communication

30 Barczak, Gloria
182 Katz, Ralph (1979)
365 Schaefermeyer, Mark J.
369 Scott, Christopher
378 Shuchman, Hedvah L. (1980)
408 Tushman, Michael L. (1990)

7.1.5 STI Communication Involving Secondary Media, Systems, Databases

108 Fries, James R.
128 Glassman, Nanci A. (Report 12)
135 Griffith, Belver C. (1980)
277 Neale, Michael
421 Van Styvendale, B.J.H. (1981)
422 Van Styvendale, B.J.H. (1977)
443 Williams, Martha E. (1975)

Automated Bibliographic Databases, Searching

22 Baltatu, Monica E.
32 Bayer, Alan E. (1981)
33 Bayer, Alan E. (1979)
37 Berul, Lawrence H.
49 Borgman, Christine L. ("The Design and Evaluation of a Front-End User Interface for Energy Researchers", 1989)
50 Borgman, Christine L. (1986)
51 Borgman, Christine L. (1985)
62 Buntrock, Robert E.
65 Case, Donald (1986)
66 Case, Donald (1985)
85 Dedert, Patricia L.
99 Fairbanks, Aline M.
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
139 Griffiths, José-Marie (1991)
157 Hill, R. John
161 Holmes, P.L.
163 Hosono, Kimio
170 Jahoda, Gerald
175 Kantor, Paul B.
194 King, D.W. (1985)
196 King, Donald W. (1982)
207 King, Donald W. (1972)

208 King, Donald W. (1971)
221 Kuhlthau, Carol Collier
222 Kuhn, Allan D.
224 Lancaster, F.W. (1993)
231 Lescoheir, R.S.
239 Lorenz, Patricia
244 Mailloux, Elizabeth N.
245 Marshall, Doris B.
247 Martyn, John (1987)
259 Meadows, Charles T.
266 Mischo, William H.
270 Monge, Peter R.
295 Pinelli, Thomas E. (Report 22)
296 Pinelli, Thomas E. (Report 21)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
329 Pinelli, Thomas E. (Report 4)
335 Pinelli, Thomas E. (Paper 5)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
342 Pinelli, Thomas E. (1981)
343 Poland, Jean
345 Posey, Edwin D.
346 Pryor, Harold E. ("An Evaluation of the NASA Scientific and Technical Information System", 1976)
352 Richardson, Robert J.
361 Rowley, J.E.
364 Saracevik, Tefko (1970)
372 Sharp, E.T.
384 Smith, Elaine Davis
401 Thompson, Benna
418 United States. House. Committee on Science
426 Wagner, Michael M.
428 Walton, Kenneth R.
429 Wanger, Judith
433 Weinschel, Bruno O.
437 Williams, F.W.
440 Williams, M.E. (annual since 1982)
441 Williams, M.E. (1985)
442 Williams, Martha E. (1994)
443 Williams, Martha E. (1975)
452 Zielstorff, Rita D.

Printed Indexes, Current Awareness, Selective Dissemination of Information (SDI), Current Contents

33 Bayer, Alan E. (1979)
80 Cronin, Blaise
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
142 Hall, Angela M. ("Comparative Use and Value of INSPEC Services", 1972)
143 Hall, Angela M. (*INSPEC: User Preference in Printed Indexes*, 1972)
144 Hall, Angela (*The Effect and Use of an SDI Service on the Information-Gathering Habits of Scientists and Technologists*, 1972)

164 Hoyt, J.W.
196 King, Donald W. (1982)
224 Lancaster, F.W. (1993)
256 Meadows, A.J. (1993)
268 Mondschein, Lawrence G. ("Selective Dissemination of Information (SDI) Use and Productivity in the Corporate Research Environment", 1990)
269 Mondschein, Lawrence G. ("SDI: Relationship to Productivity in the Corporate Environment", 1990)
270 Monge, Peter R.
282 Packer, K.H.
288 Passman, Sidney
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
329 Pinelli, Thomas E. (Report 4)
342 Pinelli, Thomas E. (1981)
343 Poland, Jean
369 Scott, Christopher
373 Sheppard, Margaret O.
433 Weinschel, Bruno O.

Automated Numeric Databases, Searching

22 Baltatu, Monica E.
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
194 King, D.W (1985)
220 Kröckel, H.
388 Sterling, Theodor D.
423 Veyette Jr., John H.
441 Williams, M.E. (1985)

Measures Related to Database Use

Number of searches, uses or proportion of potential users who use

25 Barclay, Rebecca O. (Paper 37)
32 Bayer, Alan E. (1981)
33 Bayer, Alan E. (1979)
85 Dedert, Patricia L.
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
142 Hall, Angela M. ("Comparative Use and Value of INSPEC Services", 1972)
143 Hall, Angela M. (*INSPEC: User Preference in Printed Indexes*, 1972)
144 Hall, Angela (*The Effect and Use of an SDI Service on the Information-Gathering Habits of Scientists and Technologists*, 1972)
167 Hurd, Julie M.
196 King, Donald W. (1982)
207 King, Donald W. (1972)
224 Lancaster, F.W. (1993)
268 Mondschein, Lawrence G. ("Selective Dissemination of Information (SDI) Use and Productivity in the Corporate Research Environment", 1990)
283 Page, Gillian
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
339 Pinelli, Thomas E. (Report 1)
352 Richardson, Robert J.
428 Walton, Kenneth R.

429 Wanger, Judith
433 Weinschel, Bruno O.
440 Williams, M.E. (annual since 1982)

Searchers are end-users, engineers or scientists

62 Buntrock, Robert E.
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
196 King, Donald W. (1982)
221 Kuhlthau, Carol Collier
224 Lancaster, F.W. (1993)
352 Richardson, Robert J.
428 Walton, Kenneth R.

Searchers are intermediaries, information specialists, reference librarians

137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
196 King, Donald W. (1982)
224 Lancaster, F.W. (1993)
328 Pinelli, Thomas E. (Report 5)
352 Richardson, Robert J.
428 Walton, Kenneth R.

Time spent searching, costs of searching

32 Bayer, Alan E. (1981)
33 Bayer, Alan E. (1979)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
196 King, Donald W. (1982)
207 King, Donald W. (1972)
224 Lancaster, F.W. (1993)
352 Richardson, Robert J.
428 Walton, Kenneth R.

Factors affecting use of searching, such as ease of use, availability, quality, timeliness, user characteristics

33 Bayer, Alan E. (1979)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
170 Jahoda, Gerald
196 King, Donald W. (1982)
208 King, Donald W. (1971)
224 Lancaster, F.W. (1993)
269 Mondschein, Lawrence G. ("SDI: Relationship to Productivity in the Corporate Environment", 1990)
283 Page, Gillian
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
341 Pinelli, Thomas E. (1982)
342 Pinelli, Thomas E. (1981)
364 Saracevik, Tefko (1970)

401 Thompson, Benna
423 Veyette Jr., John H.

Number of search outputs read
32 Bayer, Alan E. (1981)
137 Griffiths, José-Marie (1993)
170 Jahoda, Gerald
196 King, Donald W. (1982)
208 King, Donald W. (1971)
224 Lancaster, F.W. (1993)

Purpose of use, such as research, research stage, education
137 Griffiths, José-Marie (1993)
170 Jahoda, Gerald
194 King, D.W. (1985)
196 King, Donald W. (1982)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)

Usefulness, utility, importance, value of information, services
32 Bayer, Alan E. (1981)
99 Fairbanks, Aline M.
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
191 Keisler, Sara B.
196 King, Donald W. (1982)
224 Lancaster, F.W. (1993)
231 Lescoheir, R.S.
268 Mondschein, Lawrence G. ("Selective Dissemination of Information (SDI) Use and Productivity in the Corporate Research Environment", 1990)
269 Mondschein, Lawrence G. ("SDI: Relationship to Productivity in the Corporate Environment", 1990)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
369 Scott, Christopher

7.1.6 STI Communication Through Intermediary Organizations, Libraries, Information Analysis Centers (IACs), Clearinghouses

238 Llull, Harry

Libraries, Library Services
38 Bichteler, Julie (1991)
60 Broadbent, Marianne
69 Cho, Yong-Ja
81 Cumming, Denise
92 Ellis, Richard A.
95 Estabrook, Leigh Stewart
99 Fairbanks, Aline M.
105 Fraser, Emily Jean
128 Glassman, Nanci A. (Report 12)
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
139 Griffiths, José-Marie (1991)

185 Kaula, P.N.
195 King, Donald W. (1984)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. 1*, 1976)
224 Lancaster, F.W. (1993)
238 Llull, Harry
272 Morris, Ruth C.T.
295 Pinelli, Thomas E. (Report 22)
296 Pinelli, Thomas E. (Report 21)
310 Pinelli, Thomas E. (Paper 27)
321 Pinelli, Thomas E. (Report 10)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
331 Pinelli, Thomas E. (Paper 8)
335 Pinelli, Thomas E. (Paper 5)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
350 Rawdin, Eugene
361 Rowley, J.E.
369 Scott, Christopher
377 Shuchman, Hedvah L. (1981)
379 Siess, Judith A.
391 Strain, Paula M.
420 Van House, Nancy A.

Information Analysis Centers (IACs)

72 Corridiodore, Michael C.
145 Hall, Homer J.
195 King, Donald W. (1984)
249 Mason, Robert M.
288 Passman, Sidney
390 Sternberg, Virginia Ashworth
423 Veyette Jr., John H.
431 Weggel, J. Richard

Clearinghouses, Information Centers

126 Glassman, Myron (no date)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
253 McClure, Charles R. (1986)
281 Oen, Carol
299 Pinelli, Thomas E. (Report 19)
310 Pinelli, Thomas E. (Paper 27)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
346 Pryor, Harold E. ("An Evaluation of the NASA Scientific and Technical Information System", 1976)
351 Report of the Comptroller General of the United States
389 Stern, Arnold

Measures Related to Intermediary Organizations

Number of visits, uses of libraries, IACs, clearinghouses

60 Broadbent, Marianne
137 Griffiths, José-Marie (1993)

138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
195 King, Donald W. (1984)
224 Lancaster, F.W. (1993)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
339 Pinelli, Thomas E. (Report 1)
350 Rawdin, Eugene
369 Scott, Christopher
379 Siess, Judith A.

Extent of use of specific services

29 Barclay, Rebecca O. (Paper 15)
60 Broadbent, Marianne
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
224 Lancaster, F.W. (1993)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
350 Rawdin, Eugene

Time spent using, costs

60 Broadbent, Marianne
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
195 King, Donald W. (1984)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. 1*, 1976)
224 Lancaster, F.W. (1993)
249 Mason, Robert M.
264 Mick, Colin K.

Factors affecting use

60 Broadbent, Marianne
81 Cumming, Denise
92 Ellis, Richard A.
137 Griffiths, José-Marie (1993)
224 Lancaster, F.W. (1993)
321 Pinelli, Thomas E. (Report 10)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)

Purposes of use, such as research, research stage, education

60 Broadbent, Marianne
137 Griffiths, José-Marie (1993)
195 King, Donald W. (1984)
389 Stern, Arnold

Usefulness, utility, importance, value of libraries, IACs, clearinghouses, services

60 Broadbent, Marianne
81 Cumming, Denise
95 Estabrook, Leigh Stewart

99 Fairbanks, Aline M.
128 Glassman, Nanci A. (Report 12)
137 Griffiths, José-Marie (1993)
195 King, Donald W. (1984)
224 Lancaster, F.W. (1993)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
369 Scott, Christopher

Effects of use

60 Broadbent, Marianne
95 Estabrook, Leigh Stewart
137 Griffiths, José-Marie (1993)
195 King, Donald W. (1984)
224 Lancaster, F.W. (1993)

7.1.7 Other Aspects of STI Communication, Information Presented

Distinguish Information Needs, Information-Seeking Processes, Information Use of Engineers and Scientists

6 Allen, Thomas J. (1988)
17 Aloni, Michaela
44 Blade, Mary Frances
68 Chang, Shan-Ju
105 Fraser, Emily Jean
111 Garvey, William (*Communication: The Essence of Science*, 1979)130 Gould, Constance C.
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
197 King, Donald W. (1981)
227 Landendorf, Janice M.
368 Schrage, Michael (1967)
382 Skelton, Barbara

Comparisons Among Countries, Communication Among Countries

5 Allen, Thomas J. (1992)
7 Allen, Thomas J. (1983)
21 Auster, Ellen
24 Barclay, Rebecca O. (Paper 41)
25 Barclay, Rebecca O. (Paper 37)
26 Barclay, Rebecca O. (Paper 33)
27 Barclay, Rebecca O. (Report 17)
28 Barclay, Rebecca O. (Paper 14)
54 Brady, Edward L.
56 Branscomb, Lewis M.
102 Flammia, Madelyn (Paper 32)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
148 Hecht, Laura M. (1994)
158 Hills, Phillip
163 Hosono, Kimio
164 Houghton, Bernard
168 Hutchinson, Robert A.
180 Katz, Ralph (1988)
214 Kohl, John R. (Paper 25)

265 Mikhailov, A.I.
279 Newell, Sue
288 Passman, Sidney
293 Pinelli, Thomas E. (Report 25)
302 Pinelli, Thomas E. (Report 18)
304 Pinelli, Thomas E. (Report 16)
307 Pinelli, Thomas E. (Paper 28)
308 Pinelli, Thomas E. (Paper 26)
318 Pinelli, Thomas E. (Paper 21)
333 Pinelli, Thomas E. (Paper 4)
343 Poland, Jean
403 Tombaugh, Jo W.
417 U.S. Department of Commerce
451 Workshop Steering Group

Training, Education Needs, Learning Styles, Bibliographic Instruction

19 Arthur, Richard H.
53 Boulgarides, J.D.
62 Buntrock, Robert E.
85 Dedert, Patricia L.
105 Fraser, Emily Jean
107 Freeman, James E.
148 Hecht, Laura M. (Report 28)
149 Hecht, Laura M. (Report 27)
150 Hecht, Laura M. (Report 26)
188 Kennedy, John M. (Paper 40)
231 Lescoheir, R.S.
237 Little, S.B.
244 Mailloux, Elizabeth N.
286 Palmer, Judith (1992)
287 Palmer, Judith (1991)
294 Pinelli, Thomas E. (Report 23)
322 Pinelli, Thomas E. (Report 9)
323 Pinelli, Thomas E. (Report 8)
327 Pinelli, Thomas E. (Report 6)
333 Pinelli, Thomas E. (Paper 4)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
341 Pinelli, Thomas E. (1982)

STI Communication Policies, Issues

40 Bikson, T.K.
41 Bishop, A.
54 Brady, Edward L.
56 Branscomb, Lewis M.
107 Freeman, James E.
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
154 Hernon, Peter (Paper 18)
164 Houghton, Bernard
250 McClure, C.R. (1989)
251 McClure, C.R. (no date)
252 McClure, Charles R. (1987)

253 McClure, Charles R. (1986)
265 Mikhailov, A.I.
275 National Academy of Engineering
276 National Academy of Sciences
310 Pinelli, Thomas E. (Paper 27)
316 Pinelli, Thomas E. (1992)
376 Shuchman, Hedvah L. (1982)
415 U.S. Congress. Office of Technology Assessment (1986)
418 United States. House. Committee on Science
441 Williams, M.E. (1985)
451 Workshop Steering Group

Openness, Intellectual Property, Copyright, Patenting

96 Etnier, Carl
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
415 U.S. Congress. Office of Technology Assessment (1986)
441 Williams, M.E. (1985)

Electronic Publishing

158 Hills, Phillip
197 King, Donald W. (1981)
198 King, Donald W. (1980)
199 King, Donald W. (1978)
216 Krall, George F.
234 Leivrouw, Leigh A.
255 McDonald, K.A.
367 Schauder, Don
405 Tuck, Bill
406 Turoff, M. (1982)
415 U.S. Congress. Office of Technology Assessment (1986)
416 U.S. Congress. Office of Technology Assessment (1989)

Other Electronic Technologies, Such as Telecommunication, Local Area Networks, Imaging, Video, Distance Learning, Computer Workstations

35 Beckert, Beverly A.
45 Blados, Walter R. (Paper 2)
86 DeFanti, Thomas A.
90 Doty, Philip
91 Eckerson, Wayne
93 Er, M.C.
94 Ercegovac, Zorana
157 Hill, R. John
174 Kant, Raj
191 Keisler, Sara B.
212 Kleinman, Larry
234 Leivrouw, Leigh A.
244 Mailloux, Elizabeth N.
246 Martino, Al
251 McClure, C.R. (no date)
273 Murphy, Daniel J.
289 Pauley, William
291 Peterson, Ivars

309 Pinelli, Thomas E. (Paper 30)
314 Pinelli, Thomas E. (Paper 22)
315 Pinelli, Thomas E. (Paper 19)
327 Pinelli, Thomas E. (Report 6)
328 Pinelli, Thomas E. (Report 5)
333 Pinelli, Thomas E. (Paper 4)
339 Pinelli, Thomas E. (Report 1)
376 Shuchman, Hedvah L. (1982)
377 Shuchman, Hedvah L. (1981)
384 Smith, Elaine Davis
388 Sterling, Theodor D.
405 Tuck, Bill
418 United States. House. Committee on Science
438 Williams, Frederick ("Transfer via Telecommunications: Networking Scientists and Industry", 1990)
442 Williams, Martha E. (1994)
451 Workshop Steering Group

Future Communication

70 Clayton, Audrey
86 DeFanti, Thomas A.
90 Doty, Philip
244 Mailloux, Elizabeth N.
384 Smith, Elaine Davis
405 Tuck, Bill
418 United States. House. Committee on Science

7.1.8 Study Methods Used

Primarily a Discussion of Measurement, Models, Methods

19 Arthur, Richard H.
20 Association of Research Libraries
113 Garvey, William ("Research Studies in Patterns of Scientific Communication: 1, General Description of Research Program", 1979)
139 Griffiths, José-Marie (1991)
145 Hall, Homer J.
189 Kennedy, John M. (Paper 3)
420 Van House, Nancy A.
444 Wilson, T.D.

Trends

197 King, Donald W. (1981)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. I*, 1976)
201 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. II*, 1976)
202 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, 1977 Edition*, 1977)
203 King, D.W. (*A Chart Book of Indicators of Scientific and Technical Communication in the United States*, 1977)
204 King, D.W. (1979)
221 Kuhlthau, Carol Collier

Surveys, Including Self-Administered, Personal Interviews, Telephone Interviews, Diary-Like Instruments

5 Allen, Thomas J. (1992)
7 Allen, Thomas J. (1983)

8 Allen, Thomas J. (1977)
9 Allen, Thomas J. ("Communication Networks in R&D Laboratories", 1970)
10 Allen, Thomas J. ("Roles in Technical Communication Networks", 1970)
12 Allen, Thomas J. ("Information Flow in Research and Development Laboratories", 1969)
13 Allen, Thomas J. (1968)
14 Allen, Thomas J. ("Studies of the Problem Solving Process in Engineering Design", 1966)
15 Allen, Thomas J. (*Managing the Flow of Scientific and Technical Information*, 1966)
16 Allen, Thomas J. (1964)
18 Arechavala-Vargas, Ricardo
19 Arthur, Richard H.
20 Association of Research Libraries
24 Barclay, Rebecca O. (Paper 41)
25 Barclay, Rebecca O. (Paper 37)
26 Barclay, Rebecca O. (Paper 33)
27 Barclay, Rebecca O. (Report 17)
30 Barczak, Gloria
32 Bayer, Alan E. (1981)
33 Bayer, Alan E. (1979)
37 Berul, Lawrence H.
42 Bishop, Ann P. (Paper 39)
51 Borgman, Christine L. (1985)
53 Boulgarides, J.D.
60 Broadbent, Marianne
61 Brown, James William
62 Buntrock, Robert E.
67 Chakrabarti, Alok K.
77 Crane, Diana (1972)
95 Estabrook, Leigh Stewart
96 Etnier, Carl
105 Fraser, Emily Jean
107 Freeman, James E.
109 Frost, Penelope A.
111 Garvey, William (*Communication: The Essence of Science*, 1979)
114 Garvey, William ("Changing the System: Innovations in the Interactive Social System of Scientific Communication", 1979)
115 Garvey, William (1978)
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122 Gerstberger, Peter G.
123 Gerstenfeld, Arthur
124 Gilchrist, Alan
126 Glassman, Myron (no date)
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132 Graham, Warren R.
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148 Hecht, Laura M. (Report 28)
149 Hecht, Laura M. (Report 27)
150 Hecht, Laura M. (Report 26)
153 Herner, Saul (1954)
162 Holmfeld, John D.
165 Hoyt, J.W.
166 Hunter, J.F.
167 Hurd, Julie M.
168 Hutchinson, Robert A.
170 Jahoda, Gerald
171 Johns Hopkins University
177 Kasperson, Conrad J. ("Psychology of the Scientist: XXXVII.", 1978)
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188 Kennedy, John M. (Paper 40)
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193 King, Donald W. (1989)
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206 King, Donald W. 1972
214 Kohl, John R. (Paper 25)
216 Krall, George F.
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223 Lacy, William B.
232 Levinson, Nanette S.
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245 Marshall, Doris B.
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272 Newell, Sue
273 Murphy, Daniel J.
280 Nochur, K.S.
286 Palmer, Judith (1992)

287 Palmer, Judith (1991)
293 Pinelli, Thomas E. (Report 24)
294 Pinelli, Thomas E. (Report 23)
296 Pinelli, Thomas E. (Report 21)
297 Pinelli, Thomas E. (Report 20)
298 Pinelli, Thomas E. (Paper 36)
299 Pinelli, Thomas E. (Report 19)
300 Pinelli, Thomas E. (Paper 35)
301 Pinelli, Thomas E. (Paper 34)
302 Pinelli, Thomas E. (Report 18)
303 Pinelli, Thomas E. (Report 15)
304 Pinelli, Thomas E. (Report 16)
305 Pinelli, Thomas E. (Paper 31)
306 Pinelli, Thomas E. (Paper 29)
306 Pinelli, Thomas E. (Paper 29)
308 Pinelli, Thomas E. (Paper 26)
309 Pinelli, Thomas E. (Paper 17)
309 Pinelli, Thomas E. (Paper 30)
321 Pinelli, Thomas E. (Report 10)
322 Pinelli, Thomas E. (Report 9)
325 Pinelli, Thomas E. (Paper 11)
335 Pinelli, Thomas E. (Paper 5)
336 Pinelli, Thomas E. (Paper 1)
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348 Quinn, John J.
350 Rawdin, Eugene
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358 Rosenbloom, Richard S. (1970)
367 Schauder, Don
368 Schrage, Michael (1967)
369 Scott, Christopher
371 Shapero, Albert
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376 Shuchman, Hedvah L. (1982)
377 Shuchman, Hedvah L. (1981)
379 Siess, Judith A.
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382 Skelton, Barbara
383 Smith, Clagett G.
384 Smith, Elaine Davis
389 Stern, Arnold
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395 Taylor, Robert L. (1977)
396 Taylor, Robert L. ("The Technological Gatekeeper", 1975)
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409 Tushman, Michael L. (1981)
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414 Tushman, Michael L. (1977)
420 Van House, Nancy A.
423 Veyette Jr., John H.
427 Waldhart, Thomas J.
429 Wanger, Judith
432 Weil, Ben H.
433 Weinschel, Bruno O.
438 Whitley, Richard
440 Williams, M.E. (annual since 1982)

Case Studies, Focus Group Interviews, Small Sample Surveys, Delphi Method

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10 Allen, Thomas J. ("Roles in Technical Communication Networks", 1970)
22 Baltatu, Monica E.
36 Bermar, Amy
38 Bichteler, Julie (1991)
39 Bichteler, Julie (1989)
62 Buntrock, Robert E.
70 Clayton, Audrey
71 Collins, H.M.
82 Dalton, Marie
83 Davis, Peter
99 Fairbanks, Aline M.
125 Glaser, Edward M.
221 Kuhlthau, Carol Collier
229 Leibson, David E.
230 Leonard-Barton, Dorothy
253 McClure, Charles R. (1986)
281 Oen, Carol
356 Rogers, Everett M. (1982)
377 Shuchman, Hedvah L. (1981)
383 Smith, Clagett G.
385 Spilka, Rachel
407 Turoff, Murray
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6 Allen, Thomas J. (1988)
11 Allen, Thomas J. ("Information Needs and Uses", 1969)
17 Aloni, Michaela
21 Auster, Ellen
22 Baltatu, Monica E.
31 Batson, Robert G.
34 Beardsley, Charles W.

52 Bouazza, Abdelmajid
54 Brady, Edward L.
60 Broadbent, Marianne
68 Chang, Shan-Ju
70 Clayton, Audrey
77 Crane, Diana 1971
79 Crawford, Susan
88 Dervin, Brenda
90 Doty, Philip
98 Faibisoff, Sylvia G.
106 Fraser, Jay
135 Griffith, Belver C. (1980)
140 Gupta, B.M.
141 Gupta, R.C.
146 Harris Jr., William J.
151 Hensley, Susan
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154 Hernon, Peter
156 Hewins, Elizabeth T.
159 Hoch, Paul K.
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236 Lipetz, Ben-Ami
238 Llull, Harry
240 Lowry, Glenn R.
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265 Mikhailov, A.I.
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272 Morris, Ruth C.T.
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276 National Academy of Sciences
277 Neale, Michael
284 Paisley, William (1980)
285 Paisley, William J. (1968)
288 Passman, Sidney
343 Poland, Jean
354 Roderer, Nancy K.

361 Rowley, J.E.
364 Saracevik, Tefko (1970)
365 Schaefermeyer, Mark J.
370 Senders, J.W.
371 Shapero, Albert
378 Shuchman, Hedvah L. (1980)
388 Sterling, Theodor D.
399 Taylor, Robert S. (1986)
402 Thompson, Charles W.N.
404 Tucci, Valerie K.
418 United States. House. Committee on Science
435 White, Howard D.
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441 Williams, M.E. (1985)
448 Wolek, Francis W. (1969)
449 Wood, D.N.
451 Workshop Steering Group
453 Zinn, Karl

Based on One's Experience, Opinions, or Assertions

6 Allen, Thomas J. (1988)
21 Auster, Ellen
22 Baltatu, Monica E.
31 Batson, Robert G.
35 Beckert, Beverly A.
39 Bichteler, Julie (1989)
47 Borchardt, John K.
52 Bouazza, Abdelmajid
54 Brady, Edward L.
55 Braham, James
56 Branscomb, Lewis M.
58 Brinberg, Herbert R. (Paper 24)
64 Burte, Harris M.
70 Clayton, Audrey
76 Coyne, J.G.
81 Cumming, Denise
89 Dixon, John R.
90 Doty, Philip
92 Ellis, Richard A.
98 Faibisoff, Sylvia G.
99 Fairbanks, Aline M.
104 Franke, Earnest A.
105 Fraser, Emily Jean
106 Fraser, Jay
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124 Gilchrist, Alan
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132 Graham, Warren R.
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146 Harris Jr., William J.
154 Hernon, Peter
155 Heroux, Ronald G.
164 Houghton, Bernard
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185 Kaula, P.N.
191 Keisler, Sara B.
205 King, Donald W. ("Systemic and Economic Interdependencies in Journal Publication", 1977)
212 Kleinman, Larry
215 Korfhage, Robert R.
217 Kranzberg, Melvin
226 Landau, Herbert B.
227 Landendorf, Janice M.
233 Leivrouw, L.A.
234 Leivrouw, Leigh A.
239 Lorenz, Patricia
242 Machlup, Fritz
244 Mailloux, Elizabeth N.
252 McClure, Charles R. (1987)
253 McClure, Charles R. (1986)
255 McDonald, K.A.
258 Meadows, A.J. (1974)
265 Mikhailov, A.I.
275 National Academy of Engineering
276 National Academy of Sciences
277 Neale, Michael
284 Paisley, William (1980)
288 Passman, Sidney
310 Pinelli, Thomas E. (Paper 27)
354 Roderer, Nancy K.
355 Rogers, Everett M. (1983)
361 Rowley, J.E.
370 Senders, J.W.
378 Shuchman, Hedvah L. (1980)
387 Stenzler-Centonze, Marjorie
399 Taylor, Robert S. (1986)
400 Thomas, Rick
403 Tombaugh, Jo W.
406 Turoff, M. (1982)
418 United States. House. Committee on Science
433 Weinschel, Bruno O.
438 Williams, Frederick ("Transfer via Telecommunications: Networking Scientists and Industry", 1990)
441 Williams, M.E. (1985)
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451 Workshop Steering Group
453 Zinn, Karl
456 --, *Engineering Digest*

Systems Analysis, Design, Tests, Experiments, or Evaluation

49 Borgman, Christine L. ("The Design and Evaluation of a Front-End User Interface for Energy Researchers", 1989)
60 Broadbent, Marianne
65 Case, Donald (1986)
66 Case, Donald (1985)
85 Dedert, Patricia L.
86 DeFanti, Thomas A.
94 Ercegovac, Zorana
100 Featheringham, Tom R.
132 Graham, Warren R.
157 Hill, R. John
161 Holmes, P.L.
174 Kant, Raj
183 Katzen, May
198 King, Donald W. (1980)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. I*, 1976)
201 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. II*, 1976)
202 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, 1977 Edition*, 1977)
203 King, D.W. (*A Chart Book of Indicators of Scientific and Technical Communication in the United States*, 1977)
207 King, Donald W. (1972)
208 King, Donald W. (1971)
215 Korfhage, Robert R.
222 Kuhn, Allan D.
231 Lescoheir, R.S.
235 Lin, Nan
246 Martino, Al
254 McCullough, Robert A.
259 Meadows, Charles T.
345 Posey, Edwin D.
403 Tombaugh, Jo W.
406 Turoff, M. (1982)
407 Turoff, Murray
426 Wagner, Michael M.
428 Walton, Kenneth R.
452 Zielstorff, Rita D.
455 Zirnan, J.M.

7.1.9 Communicator Characteristics Discussed or Observed

Communicators Are Engineers or Mostly Engineers, or Information and/or Data Are Given for Engineers

6 Allen, Thomas J. (1988)
7 Allen, Thomas J. (1983)
8 Allen, Thomas J. (1977)
9 Allen, Thomas J. ("Communication Networks in R&D Laboratories", 1970)
10 Allen, Thomas J. ("Roles in Technical Communication Networks", 1970)
12 Allen, Thomas J. ("Information Flow in Research and Development Laboratories", 1969)
13 Allen, Thomas J. (1968)
14 Allen, Thomas J. ("Studies of the Problem Solving Process in Engineering Design", 1966)
15 Allen, Thomas J. (*Managing the Flow of Scientific and Technical Information*, 1966)
16 Allen, Thomas J. (1964)

19 Arthur, Richard H.
22 Baltatu, Monica E.
23 Battelle Columbus Laboratories
24 Barclay, Rebecca O. (Paper 41)
26 Barclay, Rebecca O. (Paper 33)
27 Barclay, Rebecca O. (Report 17)
28 Barclay, Rebecca O. (Paper 14)
29 Barclay, Rebecca O. (Paper 15)
30 Barczak, Gloria
34 Beardsley, Charles W.
35 Beckert, Beverly A.
36 Bermar, Amy
42 Bishop, Ann P. (Paper 39)
45 Blados, Walter R. (Paper 2)
47 Borchardt, John K.
53 Boulgarides, J.D.
54 Brady, Edward L.
55 Braham, James
58 Brinberg, Herbert R. (Paper 24)
69 Cho, Yong-Ja
81 Cumming, Denise
82 Dalton, Marie
84 Davis, Richard M.
89 Dixon, John R.
91 Eckerson, Wayne
93 Er, M.C.
94 Ercegovac, Zorana
95 Estabrook, Leigh Stewart
97 Eveland, J.D. (Paper 9)
99 Fairbanks, Aline M.
102 Flammia, Madelyn (Paper 32)
104 Franke, Earnest A.
105 Fraser, Emily Jean
108 Fries, James R.
111 Garvey, William (*Communication: The Essence of Science*, 1979)
122 Gerstberger, Peter G.
124 Gilchrist, Alan
128 Glassman, Nanci A. (Report 12)
131 Gould, Constance C.
133 Gralewska-Vickery, A.
134 Griffin, Abbie
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
141 Gupta, R.C.
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144 Hall, Angela (*The Effect and Use of an SDI Service on the Information-Gathering Habits of Scientists and Technologists*, 1972)
148 Hecht, Laura M. (Report 28)
149 Hecht, Laura M. (Report 27)
150 Hecht, Laura M. (Report 26)
154 Hernon, Peter
157 Hill, R. John
160 Holland, Maurita P. (Paper 20)

162 Holmfeld, John D.
164 Houghton, Bernard
167 Hurd, Julie M.
171 Johns Hopkins University
172 Johnson, Alan W.
173 Johnston, Ron
174 Kant, Raj
176 Karon, Paul
184 Kaufman, Harold G.
187 Kennedy, John M. (Paper 42)
188 Kennedy, John M. (Paper 40)
189 Kennedy, John M. (Paper 3)
194 King, D.W. (1985)
197 King, Donald W. (1981)
200 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. I*, 1976)
201 King, D.W. (*Statistical Indicators of Scientific and Technical Communication, Vol. II*, 1976)
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204 King, D.W. (1979)
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216 Krall, George F.
220 Kröckel, H.
227 Landendorf, Janice M.
228 Leggett, Robert G.
229 Leibson, David E.
239 Lorenz, Patricia
241 Lufkin, J.M.
244 Mailloux, Elizabeth N.
246 Martino, Al
272 Newell, Sue
273 Murphy, Daniel J.
275 National Academy of Engineering
277 Neale, Michael
293 Pinelli, Thomas E. (Report 25)
293 Pinelli, Thomas E. (Report 24)
294 Pinelli, Thomas E. (Report 23)
296 Pinelli, Thomas E. (Report 21)
297 Pinelli, Thomas E. (Report 20)
298 Pinelli, Thomas E. (Paper 36)
299 Pinelli, Thomas E. (Report 19)
300 Pinelli, Thomas E. (Paper 35)
301 Pinelli, Thomas E. (Paper 34)
302 Pinelli, Thomas E. (Report 18)
303 Pinelli, Thomas E. (Report 15)
304 Pinelli, Thomas E. (Report 16)
305 Pinelli, Thomas E. (Paper 31)
306 Pinelli, Thomas E. (Paper 29)
306 Pinelli, Thomas E. (Paper 29)
308 Pinelli, Thomas E. (Paper 26)
309 Pinelli, Thomas E. (Paper 30)
309 Pinelli, Thomas E. (Paper 17)
311 Pinelli, Thomas E. (Paper 23)
312 Pinelli, Thomas E. (Report 14)

313 Pinelli, Thomas E. (Report 13)
314 Pinelli, Thomas E. (Paper 22)
315 Pinelli, Thomas E. (Paper 19)
316 Pinelli, Thomas E. (Report 11)
317 Pinelli, Thomas E. (Paper 13)
318 Pinelli, Thomas E. (Paper 21)
320 Pinelli, Thomas E. (1991)
321 Pinelli, Thomas E. (Report 10)
322 Pinelli, Thomas E. (Report 9)
323 Pinelli, Thomas E. (Report 8)
324 Pinelli, Thomas E. (Paper 12)
325 Pinelli, Thomas E. (Paper 11)
326 Pinelli, Thomas E. (Report 7)
328 Pinelli, Thomas E. (Report 5)
329 Pinelli, Thomas E. (Report 4)
330 Pinelli, Thomas E. (Paper 10)
331 Pinelli, Thomas E. (Paper 8)
332 Pinelli, Thomas E. (Paper 7)
333 Pinelli, Thomas E. (Paper 4)
334 Pinelli, Thomas E. (Paper 6)
335 Pinelli, Thomas E. (Paper 5)
336 Pinelli, Thomas E. (Paper 1)
337 Pinelli, Thomas E. (Report 3)
338 Pinelli, Thomas E. (Report 2)
339 Pinelli, Thomas E. (Report 1)
340 Pinelli, Thomas E. (1989)
341 Pinelli, Thomas E. (1982)
342 Pinelli, Thomas E. (1981)
345 Posey, Edwin D.
353 Rickards, Janice
358 Rosenbloom, Richard S. (1970)
368 Schrage, Michael (1967)
373 Sheppard, Margaret O.
375 Shuchman, Hedvah L. (1983)
376 Shuchman, Hedvah L. (1982)
377 Shuchman, Hedvah L. (1981)
378 Shuchman, Hedvah L. (1980)
379 Siess, Judith A.
385 Spilka, Rachel
386 Spretnak, Charles M.
387 Stenzler-Centonze, Marjorie
391 Strain, Paula M.
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396 Taylor, Robert L. ("The Technological Gatekeeper", 1975)
397 Taylor, Robert L. ("A Longitudinal Study of Communication in Research: Technical and Managerial Influences", 1975)
400 Thomas, Rick
423 Veyette Jr., John H.
427 Waldhart, Thomas J.
431 Weggel, J. Richard
433 Weinschel, Bruno O.
446 Winsor, Dorothy A. (1990)
447 Wolek, Francis W. (1970)

448 Wolek, Francis W. (1969)
451 Workshop Steering Group

Communicators Are Specified as Working in Research and Development (R&D), or Information and Data Are about Scientists and Engineers Without Distinguishing Them

3 Allen, Robert S.
5 Allen, Thomas J. (1992)
17 Aloni, Michaela
18 Arechavala-Vargas, Ricardo
20 Association of Research Libraries
21 Auster, Ellen
22 Baltatü, Monica E.
26 Barclay, Rebecca O. (Paper 33)
31 Batson, Robert G.
32 Bayer, Alan E. (1981)
33 Bayer, Alan E. (1979)
37 Berul, Lawrence H.
39 Bichteler, Julie (1989)
40 Bikson, T.K.
41 Bishop, A.
49 Borgman, Christine L. ("The Design and Evaluation of a Front-End User Interface for Energy Researchers", 1989)
50 Borgman, Christine L. (1986)
51 Borgman, Christine L. (1985)
61 Brown, James William
64 Burte, Harris M.
65 Case, Donald (1986)
66 Case, Donald (1985)
67 Chakrabarti, Alok K.
68 Chang, Shan-Ju
70 Clayton, Audrey
72 Corridiodore, Michael C.
77 Crane, Diana (1972)
83 Davis, Peter
85 Dedert, Patricia L.
86 DeFanti, Thomas A.
90 Doty, Philip
92 Ellis, Richard A.
96 Etnier, Carl
100 Featheringham, Tom R.
105 Fraser, Emily Jean
106 Fraser, Jay
107 Freeman, James E.
109 Frost, Penelope A.
110 Gaffney, Inez M.
111 Garvey, W.D. ("Communication and Information Processing with Scientific Disciplines: Empirical Findings for Psychology", 1979)
113 Garvey, William ("Research Studies in Patterns of Scientific Communication: I, General Description of Research Program", 1979)
116 Garvey, William (1972)
121 Gellman, Aaron J.
123 Gerstenfeld, Arthur
126 Glassman, Myron (no date)

127 Glassman, Myron (1981)
129 Glock, C.Y.
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136 Griffith, Belver C. (1992)
137 Griffiths, José-Marie (1993)
139 Griffiths, José-Marie (1991)
140 Gupta, B.M.
145 Hall, Homer J.
146 Harris Jr., William J.
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154 Hernon, Peter
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165 Hoyt, J.W.
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168 Hutchinson, Robert A.
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206 King, Donald W. (1974)
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208 King, Donald W. (1971)
209 King, Donald W. (1968)
211 King, William R
217 Kranzberg, Melvin
226 Landau, Herbert B.
227 Landendorf, Janice M.
231 Lescoheir, R.S.
232 Levinson, Nanette S.
233 Leivrouw, L.A.
234 Leivrouw, Leigh A.
237 Little, S.B.
238 Llull, Harry
247 Martyn, John (1987)
249 Mason, Robert M.
250 McClure, C.R. (1989)
252 McClure, Charles R. (1987)

253 McClure, Charles R. (1986)
254 McCullough, Robert A.
256 Meadows, A.J. (1993)
261 Menzel, Herbert ("Scientific Communication: Five Themes from Social Science Research", 1966)
262 Menzel, Herbert (1962)
264 Mick, Colin K.
265 Mikhailov, A.I.
267 Moenaert, Rudy K.
269 Mondschein, Lawrence G. ("SDI: Relationship to Productivity in the Corporate Environment", 1990)
270 Monge, Peter R.
276 National Academy of Sciences
278 Nelson, Carnot E.
280 Nochur, K.S.
281 Oen, Carol
282 Packer, K.H.
288 Passman, Sidney
301 Pinelli, Thomas E. (Paper 34)
334 Pinelli, Thomas E. (Paper 6)
343 Poland, Jean
349 Raitt, David I.
352 Richardson, Robert J.
354 Roderer, Nancy K.
356 Rogers, Everett M. (1982)
357 Rosenberg, Victor
368 Schrage, Michael (1967)
369 Scott, Christopher
370 Senders, J.W.
371 Shapero, Albert
380 Sieving, Pamela C.
383 Smith, Clagett G.
384 Smith, Elaine Davis
388 Sterling, Theodor D.
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401 Thompson, Benna
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408 Tushman, Michael L. (1990)
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427 Waldhart, Thomas J.
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441 Williams. M.E. (1985)
453 Zinn, Karl
455 Ziman, J.M.

Communicators Are Specified as Scientists or Medical Professionals

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18 Arechavala-Vargas, Ricardo
38 Bichteler, Julie (1991)
46 Blaxter, K.L.
113 Garvey, William ("Research Studies in Patterns of Scientific Communication: I, General Description of Research Program", 1979)
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287 Palmer, Judith (1991)
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382 Skelton, Barbara
389 Stern, Arnold
421 Van Styvendale, B.J.H. (1981)
422 Van Styvendale, B.J.H. (1977)
428 Walton, Kenneth R.

Communicators Are from Some Other Field or Not Specified

134 Griffin, Abbie
137 Griffiths, José-Marie (1993)
191 Keisler, Sara B.
253 McClure, Charles R. (1986)
267 Moenaert, Rudy K.
392 Subramanyam, K.
409 Tushman, Michael L. (1981)
426 Wagner, Michael M.
429 Wanger, Judith
452 Zielstorff, Rita D.

7.1.10 Employment Sector or Affiliation of Communicators Observed, Discussed

Communicators Are Affiliated with Industry, Companies

3 Allen, Robert S.
5 Allen, Thomas J. (1992)

6 Allen, Thomas J. (1988)
7 Allen, Thomas J. (1983)
8 Allen, Thomas J. (1977)
9 Allen, Thomas J. ("Communication Networks in R&D Laboratories", 1970)
10 Allen, Thomas J. ("Roles in Technical Communication Networks", 1970)
12 Allen, Thomas J. ("Information Flow in Research and Development Laboratories", 1969)
13 Allen, Thomas J. (1968)
14 Allen, Thomas J. ("Studies of the Problem Solving Process in Engineering Design", 1966)
15 Allen, Thomas J. (*Managing the Flow of Scientific and Technical Information*, 1966)
16 Allen, Thomas J. (1964)
17 Aloni, Michaela
18 Arechavala-Vargas, Ricardo
21 Auster, Ellen
22 Baltatu, Monica E.
30 Barczak, Gloria
31 Batson, Robert G.
32 Bayer, Alan E. (1981)
33 Bayer, Alan E. (1979)
34 Beardsley, Charles W.
36 Bermar, Amy
39 Bichteler, Julie (1989)
47 Borchardt, John K.
53 Boulgarides, J.D.
55 Braham, James
61 Brown, James William
67 Chakrabarti, Alok K.
81 Cumming, Denise
83 Davis, Peter
85 Dedert, Patricia L.
89 Dixon, John R.
92 Ellis, Richard A.
95 Estabrook, Leigh Stewart
99 Fairbanks, Aline M.
104 Franke, Earnest A.
105 Fraser, Emily Jean
109 Frost, Penelope A.
122 Gerstberger, Peter G.
123 Gerstenfeld, Arthur
134 Griffin, Abbie
137 Griffiths, José-Marie (1993)
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
145 Hall, Homer J.
157 Hill, R. John
162 Holmfeld, John D.
165 Hoyt, J.W.
168 Hutchinson, Robert A.
169 Irwin, Harry
170 Jahoda, Gerald
176 Karon, Paul
178 Kasperson, Conrad J. ("An Analysis of the Relationship between Information Sources and Creativity in Scientists and Engineers", 1978)
179 Kasperson, C.J. (1976)
180 Katz, Ralph (1988)

181 Katz, Ralph (1981)
182 Katz, Ralph (1979)
184 Kaufman, Harold G.
192 King, Donald W. (1991)
193 King, Donald W. (1989)
194 King, D.W. (1985)
216 Krall, George F.
217 Kranzberg, Melvin
218 Kremer, Jeanette Marguerite
227 Landendorf, Janice M.
229 Leibson, David E.
230 Leonard-Barton, Dorothy
232 Levinson, Nanette S.
239 Lorenz, Patricia
241 Lufkin, J.M.
244 Mailloux, Elizabeth N.
246 Martino, Al
264 Mick, Colin K.
267 Moenaert, Rudy K.
268 Mondschein, Lawrence G. ("Selective Dissemination of Information (SDI) Use and Productivity in the Corporate Research Environment", 1990)
272 Newell, Sue
274 Myers, L.A.
280 Nochur, K.S.
281 Oen, Carol
296 Pinelli, Thomas E. (Report 21)
298 Pinelli, Thomas E. (Paper 36)
303 Pinelli, Thomas E. (Report 15)
348 Quinn, John J.
352 Richardson, Robert J.
353 Rickards, Janice
356 Rogers, Everett M. (1982)
357 Rosenberg, Victor
368 Schrage, Michael (1967)
369 Scott, Christopher
382 Skelton, Barbara
383 Smith, Clagett G.
384 Smith, Elaine Davis
385 Spilka, Rachel
387 Stenzler-Centonze, Marjorie
389 Stern, Arnold
400 Thomas, Rick
408 Tushman, Michael L. (1990)
409 Tushman, Michael L. (1981)
410 Tushman, Michael ("Managing Communication Networks in R&D Laboratories", 1979)
412 Tushman, Michael L. ("Technical Communication in R&D Laboratories: The Impact of Project Work Characteristics", 1978)
413 Tushman, Michael L. ("Information Processing as an Integrating Concept in Organizational Design", 1978)
423 Veyette Jr., John H.
427 Waldhart, Thomas J.
428 Walton, Kenneth R.
432 Weil, Ben H.
433 Weinschel, Bruno O.

446 Winsor, Dorothy A. (1990)
447 Wolek, Francis W. (1970)
448 Wolek, Francis W. (1969)
453 Zinn, Karl

Communicators Are Affiliated with Universities, Colleges

19 Arthur, Richard H.
32 Bayer, Alan E. (1981)
33 Bayer, Alan E. (1979)
38 Bichteler, Julie (1991)
69 Cho, Yong-Ja
96 Etnier, Carl
105 Fraser, Emily Jean
127 Glassman, Myron (1981)
130 Glueck, William F.
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
148 Hecht, Laura M. (Report 28)
149 Hecht, Laura M. (Report 27)
150 Hecht, Laura M. (Report 26)
153 Herner, Saul (1954)
160 Holland, Maurita P. (Paper 20)
167 Hurd, Julie M.
168 Hutchinson, Robert A.
170 Jahoda, Gerald
178 Kasperson, Conrad J. ("An Analysis of the Relationship between Information Sources and Creativity in Scientists and Engineers", 1978)
179 Kasperson, C.J. (1976)
188 Kennedy, John M. (Paper 40)
227 Landendorf, Janice M.
238 Llull, Harry
244 Mailloux, Elizabeth N.
245 Marshall, Doris B.
256 Meadows, A.J. (1993)
271 Mooney, C.J.
286 Palmer, Judith (1992)
287 Palmer, Judith (1991)
294 Pinelli, Thomas E. (Report 23)
295 Pinelli, Thomas E. (Report 22)
321 Pinelli, Thomas E. (Report 10)
322 Pinelli, Thomas E. (Report 9)
323 Pinelli, Thomas E. (Report 8)
334 Pinelli, Thomas E. (Paper 6)
345 Posey, Edwin D.
367 Schauder, Don
384 Smith, Elaine Davis
389 Stern, Arnold
420 Van House, Nancy A.
455 Ziman, J.M.

Communicators Are Affiliated with Federal, State, or Local Government, Including the Military

64 Burte, Harris M.
138 Griffiths, J-M (*Description of Scientific and Technical Information in the U.S.*, 1991)
155 Heroux, Ronald G.
165 Hoyt, J.W.
172 Johnson, Alan W.
186 Keller, Robert T.
207 King, Donald W. (1972)
222 Kuhn, Allan D.
223 Lacy, William B.
252 McClure, Charles R. (1987)
357 Rosenberg, Victor
379 Siess, Judith A.
389 Stern, Arnold
395 Taylor, Robert L. (1977)
396 Taylor, Robert L. ("The Technological Gatekeeper", 1975)
397 Taylor, Robert L. ("A Longitudinal Study of Communication in Research: Technical and Managerial Influences", 1975)
438 Whitley, Richard
446 Winsor, Dorothy A. (1990)

7.1.11 State-of-the-Art Reviews, Articles, Chapters, Book Reviews

2 Allen, Bryce L.
11 Allen, Thomas J. ("Information Needs and Uses", 1969)
17 Aloni, Michaela
60 Broadbent, Marianne
68 Chang, Shan-Ju
78 Crane, Diana (1971)
79 Crawford, Susan
88 Dervin, Brenda
123 Gerstenfeld, Arthur
135 Griffith, Belver C. (1980)
140 Gupta, B.M.
147 Havelock, Ronald G.
151 Hensley, Susan
152 Herner, Saul (1967)
156 Hewins, Elizabeth T.
175 Kantor, Paul B.
190 Kent, Allen
206 King, Donald W. (1974)
209 King, Donald W. (1968)
235 Lin, Nan
236 Lipetz, Ben-Ami
240 Lowry, Glenn R.
241 Lufkin, J.M.
244 Mailloux, Elizabeth N.
248 Martyn, John (1974)
260 Menzel, Herbert ("Information Needs and Uses in Science and Technology", 1966)
263 Metayer-Duran, Cheryl
265 Mikhailov, A.I.
266 Mischo, William H.
278 Nelson, Carnot E.

285 Paisley, William J. (1968)
314 Pinelli, Thomas E. (Paper 22)
316 Pinelli, Thomas E. (Report 11)
317 Pinelli, Thomas E. (Paper 13)
367 Schauder, Don
402 Thompson, Charles W.N.
404 Tucci, Valerie K.
435 White, Howard D.
449 Wood, D.N.

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