NASA/DoD Aerospace Knowledge Diffusion Research Project

IN-82-TM
12079

NASA Technical Memorandum 109088

Report Number 24

P-53

The Technical Communications Practices of U.S. Aerospace Engineers and Scientists: Results of the Phase 1 SAE Mail Survey

Thomas E. Pinelli
NASA Langley Research Center
Hampton, Virginia

Rebecca O. Barclay
Rensselaer Polytechnic Institute
Troy, New York

John M. Kennedy
Indiana University
Bloomington, Indiana

May 1994

National Aeronautics and Space Administration

Department of Defense

INDIANA UNIVERSITY

THE TECHNICAL COMMUNICATIONS PRACTICES OF U.S. AEROSPACE ENGINEERS AND SCIENTISTS: RESULTS OF THE PHASE 1 SAE MAIL SURVEY

Thomas E. Pinelli, Rebecca O. Barclay, and John M. Kennedy

ABSTRACT

The U.S. government technical report is a primary means by which the results of federally funded research and development (R&D) are transferred to the U.S. aerospace industry. However, little is known about this information product in terms of its actual use, importance, and value in the transfer of federally funded R&D. Little is also known about the intermediary-based system that is used to transfer the results of federally funded R&D to the U.S. aerospace industry. To help establish a body of knowledge, the U.S. government technical report is being investigated as part of the *NASA/DoD Aerospace Knowledge Diffusion Research Project.* In this report, we summarize the literature on technical reports, present a model that depicts the transfer of federally funded aerospace R&D via the U.S. government technical report, and present the results of research that investigated aerospace knowledge diffusion vis-à-vis the technical communication practices of U.S. aerospace engineers and scientists.

INTRODUCTION

NASA and the DoD maintain scientific and technical information (STI) systems for acquiring, processing, announcing, publishing, and transferring the results of government-performed and government-sponsored research. Within both the NASA and DoD STI systems, the U.S. government technical report is considered a primary mechanism for transferring the results of this research to the U.S. aerospace community. However, McClure (1988) concludes that we actually know little about the role, importance, and impact of the technical report in the transfer of federally funded R&D because little empirical information about this product is available.

We are examining the system(s) used to diffuse the results of federally funded aerospace R&D as part of the *NASA/DoD Aerospace Knowledge Diffusion Research Project.* This project investigates, among other things, the information-seeking behavior of U.S. aerospace engineers and scientists, the factors that influence the use of STI, and the role played by U.S. government technical reports in the diffusion of federally funded aerospace STI (Pinelli, Kennedy, and Barclay, 1991; Pinelli, Kennedy, Barclay, and White, 1991). The results of this investigation could (1) advance the development of practical theory, (2) contribute to the design and development of aerospace information systems, and (3) have practical implications for transferring the results of federally funded aerospace R&D to the U.S. aerospace community. The project fact sheet is Appendix A.

In this report, we summarize the literature on technical reports, provide a model that depicts the transfer of federally funded aerospace R&D through the U.S. government technical report, and present the results of the Phase 1 SAE mail survey. We summarize the findings of the Phase 1 SAE mail survey in terms of the technical communication practices of U.S. aerospace engineers and scientists.

THE U.S. GOVERNMENT TECHNICAL REPORT

Although they have the potential for increasing technological innovation, productivity, and economic competitiveness, U.S. government technical reports may not be utilized because of limitations in the existing transfer mechanism. According to Ballard, et al. (1986), the current system "virtually guarantees that much of the Federal investment in creating STI will not be paid back in terms of tangible products and innovations." They further state that "a more active and coordinated role in STI transfer is needed at the Federal level if technical reports are to be better utilized."

Characteristics of Technical Reports

The definition of the technical report varies because the report serves different roles in communication within and between organizations. The technical report has been defined etymologically, according to report content and method (U.S. Department of Defense, 1964); behaviorally, according to the influence on the reader (Ronco, et al., 1964); and rhetorically, according to the function of the report within a system for communicating STI (Mathes and Stevenson, 1976). The boundaries of technical report literature are difficult to establish because of wide variations in the content, purpose, and audience being addressed. The nature of the report -- whether it is informative, analytical, or assertive -- contributes to the difficulty.

Fry (1953) points out that technical reports are heterogenous, appearing in many shapes, sizes, layouts, and bindings. According to Smith (1981), "Their formats vary; they might be brief (two pages) or lengthy (500 pages). They appear as microfiche, computer printouts or vugraphs, and often they are loose leaf (with periodic changes that need to be inserted) or have a paper cover, and often contain foldouts. They slump on the shelf, their staples or prong fasteners snag other documents on the shelf, and they are not neat."

Technical reports may exhibit some or all of the following characteristics (Gibb and Phillips, 1979; Subramanyam, 1981):

- Publication is not through the publishing trade.

- Readership/audience is usually limited.

- Distribution may be limited or restricted.

- Content may include statistical data, catalogs, directions, design criteria, conference papers and proceedings, literature reviews, or bibliographies.

- Publication may involve a variety of printing and binding methods.

The SATCOM report (National Academy of Sciences - National Academy of Engineering, 1969) lists the following characteristics of the technical report:

- It is written for an individual or organization that has the right to require such reports.

- It is basically a stewardship report to some agency that has funded the research being reported.

- It permits prompt dissemination of data results on a typically flexible distribution basis.

- It can convey the total research story, including exhaustive exposition, detailed tables, ample illustrations, and full discussion of unsuccessful approaches.

History and Growth of the U.S. Government Technical Report

The development of the [U.S. government] technical report as a major means of communicating the results of R&D, according to Godfrey and Redman (1973), dates back to 1941 and the establishment of the U.S. Office of Scientific Research and Development (OSRD). Further, the growth of the U.S. government technical report coincides with the expanding role of the Federal government in science and technology during the post World War II era. However, U.S. government technical reports have existed for several decades. The Bureau of Mines *Reports of Investigation* (Redman, 1965/66), the *Professional Papers of the United States Geological Survey*, and the *Technological Papers of the National Bureau of Standards* (Auger, 1975) are early examples of U.S. government technical reports. Perhaps the first U.S. government publications officially created to document the results of federally funded (U.S.) R&D were the technical reports first published by the National Advisory Committee for Aeronautics (NACA) in 1917.

Auger (1975) states that "the history of technical report literature in the U.S. coincides almost entirely with the development of aeronautics, the aviation industry, and the creation of the NACA, which issued its first report in 1917." In her study, *Information Transfer in Engineering*, Shuchman (1981) reports that 75 percent of the engineers she surveyed used technical reports; that technical reports were important to engineers doing applied work; and that aerospace engineers, more than any other group of engineers, referred to technical reports. However, in many of these studies, including Shuchman's, it is often unclear whether U.S. government technical reports, non-U.S. government technical reports, or both are included.

The U.S. government technical report is a primary means by which the results of federally funded R&D are made available to the scientific community and are added to the literature of science and technology (President's Special Assistant for Science and Technology, 1962). McClure (1988) points out that "although the [U.S.] government technical report has been variously reviewed, compared, and contrasted, there is no real knowledge base regarding the role, production, use, and importance [of this information product] in terms of accomplishing this task." Our analysis of the literature supports the following conclusions reached by McClure:

- The body of available knowledge is simply inadequate and noncomparable to determine the role that the U.S. government technical report plays in transferring the results of federally funded R&D.

- Further, most of the available knowledge is largely anecdotal, limited in scope and dated, and unfocused in the sense that it lacks a conceptual framework.

- The available knowledge does not lend itself to developing "normalized" answers to questions regarding U.S. government technical reports.

THE TRANSFER OF FEDERALLY FUNDED AEROSPACE R&D AND THE U.S. GOVERNMENT TECHNICAL REPORT

Three paradigms -- appropriability, dissemination, and diffusion -- have dominated the transfer of federally funded (U.S.) R&D (Ballard, et al., 1989; Williams and Gibson, 1990). Whereas variations of them have been tried within different agencies, overall Federal (U.S.) STI transfer activities continue to be driven by a "supply-side," dissemination model.

The Appropriability Model

The **appropriability model** emphasizes the production of knowledge by the Federal government that would not otherwise be produced by the private sector and competitive market pressures to promote the use of that knowledge. This model emphasizes the production of basic research as the driving force behind technological development and economic growth and assumes that the Federal provision of R&D will be rapidly assimilated by the private sector. Deliberate transfer mechanisms and intervention by information intermediaries are viewed as unnecessary. Appropriability stresses the supply (production) of knowledge in sufficient quantity to attract potential users. Good technologies, according to this model, sell themselves and offer clear policy recommendations regarding Federal priorities for improving technological development and economic growth. This model incorrectly assumes that the results of federally funded R&D will be acquired and used by the private sector, ignores the fact that most basic research is irrelevant to technological innovation, and dismisses the process of technological innovation within the firm.

The Dissemination Model

The **dissemination model** emphasizes the need to transfer information to potential users and embraces the belief that the production of quality knowledge is not sufficient to ensure its fullest use. Linkage mechanisms, such as information intermediaries, are needed to identify useful knowledge and to transfer it to potential users. This model assumes that if these mechanisms are available to link potential users with knowledge producers, then better opportunities exist for users to determine what knowledge is available, acquire it, and apply it to their needs. The strength of this model rests on the recognition that STI transfer and use are critical elements of the process of technological innovation. Its weakness lies in the fact that it is passive, for it does not take users into consideration except when they enter the system and request assistance. The **dissemination model** employs one-way, source-to-user transfer procedures that are seldom responsive in the user context. User requirements are seldom known or considered in the design of information products and services.

The Knowledge Diffusion Model

The **knowledge diffusion model** is grounded in theory and practice associated with the diffusion of innovation and planned change research and the clinical models of social research and mental health. Knowledge diffusion emphasizes "active" intervention as opposed to dissemination and access; stresses intervention and reliance on interpersonal communications as a means of identifying and removing interpersonal barriers between users and producers; and assumes that knowledge production, transfer, and use are equally important components of the R&D process. This approach also emphasizes the link between producers, transfer agents, and users and seeks to develop user-oriented mechanisms (e.g., products and services) specifically tailored to the needs and circumstances of the user. It makes the assumption that the results of federally funded R&D will be under utilized unless they are relevant to users and ongoing relationships are developed among users and producers. The problem with the knowledge diffusion model is that (1) it requires a large Federal role and presence and (2) it runs contrary to the dominant assumptions of established Federal R&D policy. Although U.S. technology policy relies on a "dissemination-oriented" approach to STI transfer, other industrialized nations, such as Germany and Japan, are adopting "diffusion-oriented" policies which increase the power to absorb and employ new technologies productively (Branscomb, 1991; Branscomb, 1992).

The Transfer of (U.S.) Federally-Funded Aerospace R&D

A model depicting the transfer of federally funded aerospace R&D through the U.S. government technical report appears in figure 1. The model is composed of two parts -- the **informal** that relies on collegial contacts and the **formal** that relies on surrogates, information producers, and information intermediaries to complete the "producer to user" transfer process.

When U.S. government (i.e., NASA) technical reports are published, the initial or primary distribution is made to libraries and technical information centers. Copies are sent to surrogates for secondary and subsequent distribution. A limited number of copies are set aside to be used by the author for the "scientist-to-scientist" exchange of information at the collegial level.

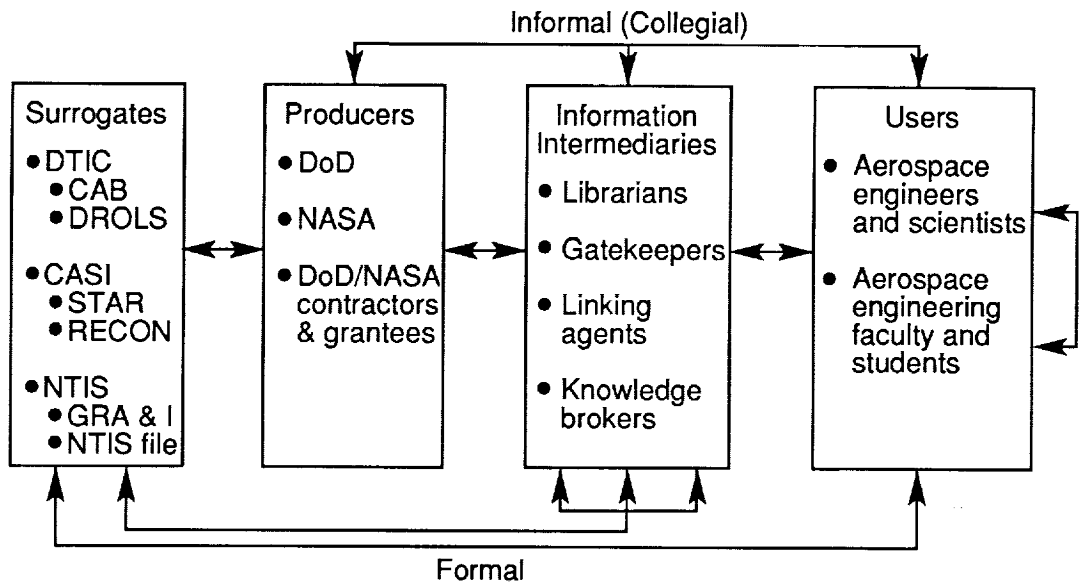


Figure 1. The U.S. Government Technical Report in a Model Depicting the Dissemination of Federally Funded Aerospace R&D.

Surrogates serve as technical report repositories or clearinghouses for the producers and include the Defense Technical Information Center (DTIC), the NASA Center for Aero Space Information (CASI), and the National Technical Information Service (NTIS). These surrogates have created a variety of technical report announcement journals such as *CAB* (Current Awareness Bibliographies), *STAR* (Scientific and Technical Aerospace Reports), and *GRA&I* (Government Reports Announcement and Index) and computerized retrieval systems such as *DROLS* (Defense RDT&E Online System), *RECON* (REsearch CONNection), and NTIS *On-line* that permit online access to technical report data bases. Information intermediaries are, in large part, librarians and technical information specialists in academia, government, and industry. Those representing the producers serve as what McGowan and Loveless (1981) describe as "knowledge brokers" or "linking agents." Information intermediaries connected with users act, according to Allen (1977), as "technological entrepreneurs" or "gatekeepers." The more "active" the intermediary, the more effective the transfer process becomes (Goldhor and Lund, 1983). Active intermediaries move information from the producer to the user, often utilizing interpersonal (i.e., face-to-face) communication in the process. Passive information intermediaries, on the other hand, "simply array information for the taking, relying on the initiative of the user to request or search out the information that may be needed" (Eveland, 1987).

The overall problem with the total Federal STI system is that "the present system for transferring the results of federally funded STI is passive, fragmented, and unfocused;" effective knowledge transfer is hindered by the fact that the Federal government "has no coherent or systematically designed approach to transferring the results of federally funded R&D to the user" (Ballard, et al., 1986). In their study of issues and options in Federal STI, Bikson and her colleagues (1984) found that many of the interviewees believed "dissemination activities were afterthoughts, undertaken without serious commitment by Federal agencies whose primary concerns were with [knowledge] production and not with knowledge transfer;" therefore, "much of what has been learned about [STI] and knowledge transfer has not been incorporated into federally supported information transfer activities."

Problematic to the **informal** part of the system is that knowledge users can learn from collegial contacts only what those contacts happen to know. Ample evidence supports the claim that no one researcher can know about or keep up with all the research in his/her area(s) of interest. Like other members of the scientific community, aerospace engineers and scientists are faced with the problem of too much information to know about, to keep up with, and to screen. Further, information is becoming more interdisciplinary in nature and more international in scope.

Two problems exist with the **formal** part of the system. First, the **formal** part of the system employs one-way, source-to-user transmission. The problem with this kind of transmission is that such formal one-way, "supply side" transfer procedures do not seem to be responsive to the user context (Bikson, et al., 1984). Rather, these efforts appear to start with an information system into which the users' requirements are retrofit (Adam, 1975). The consensus of the findings from the empirical research is that interactive, two-way communications are required for effective information transfer (Bikson, et al., 1984).

Second, the **formal** part relies heavily on information intermediaries to complete the knowledge transfer process. However, a strong methodological base for measuring or assessing the effectiveness of the information intermediary is lacking (Beyer and Trice, 1982). In addition, empirical data on the effectiveness of information intermediaries and the role(s) they play in knowledge transfer are sparse and inconclusive. The impact of information intermediaries is likely to be strongly conditional and limited to a specific institutional context.

According to Roberts and Frohman (1978), most Federal approaches to knowledge utilization have been ineffective in stimulating the diffusion of technological innovation. They claim that the numerous Federal STI programs are "highest in frequency and expense yet lowest in impact" and that Federal "information dissemination activities have led to little documented knowledge utilization." Roberts and Frohman also note that "governmental programs start to encourage utilization of knowledge only after the R&D results have been generated" rather than during the idea development phase of the innovation process. David (1986), Mowery (1983), and Mowery and Rosenberg (1979) conclude that successful [Federal] technological innovation rests more with the transfer and utilization of knowledge than with its production.

THE INFORMATION-SEEKING BEHAVIOR OF ENGINEERS

The information-seeking behavior of engineers and scientists has been variously studied by information and social scientists, the earliest studies having been undertaken in the late 1960s (Pinelli, 1991). The results of these studies have not accumulated to form a significant body of knowledge that can be used to develop a general theory regarding the information-seeking behavior of engineers and scientists. The difficulty in applying the results of these studies has been attributed to the lack of a unifying theory, a standardized methodology, and the common definitions (Rohde, 1986).

Despite the fact that numerous "information use" studies have been conducted, the information-seeking behavior of engineers and information use in engineering are neither broadly known nor well understood. There are a number of reasons (Berul, et al., 1965): (1) many of the studies were conducted for narrow or specific purposes in unique environments such as experimental laboratories; (2) many, if not most, of them focused on scientists exclusively or engineers working in a research environment; (3) few studies have concentrated on engineers, especially engineers working in manufacturing and production; (4) from an information use standpoint, some engineering disciplines have yet to be studied; (5) most of the studies have concentrated on the users' use of information in terms of a library and/or specific information packages such as professional journals rather than how users produce, transfer, and use information; and (6) many of the studies, as previously stated, were not methodologically sophisticated and few included testable hypotheses or valid procedures for testing the study's hypotheses.

Further, we know very little about the diffusion of knowledge in specific communities such as aerospace. In the past 25 years, few studies have been devoted to understanding the information environment in which aerospace engineers and scientists work, the information-seeking behavior of aerospace engineers and scientists, and the factors that influence the use of federally funded aerospace STI. Presumably, the results of such studies would have implications for current and future aerospace STI systems and for making decisions regarding the transfer and use of federally funded aerospace STI.

RESULTS OF THE PHASE 1 SAE MAIL SURVEY

This research was conducted as a Phase 1 activity of the *NASA/DoD Aerospace Knowledge Diffusion Research Project*. Three SAE surveys were conducted. The first two were telephone surveys (Pinelli and Glassman, September 1992; Pinelli, Kennedy, and White, October 1992). The third utilized survey research in the form of a self-administered (self-reported) mail questionnaire. Survey participants consisted of U.S. aerospace engineers and scientists who were on the Society of Automotive Engineers (SAE) mailing list (not necessarily members of the SAE). The survey instrument appears as Appendix B.

The Survey

The questionnaire used in this study was jointly prepared by the project team and representatives from Continental Research. On July 7, 1991, 35 pretest surveys were sent to U.S. aerospace engineers and scientists across the country along with a form to voice their opinions about the survey. Of the pretest surveys that were returned, comments indicated only a few minor concerns. Telephone follow-ups were also completed with pretest participants.

After final approval, 2,000 surveys were printed and mailed on August 6-7, 1991. Included in the envelope were an 11-page questionnaire; a cover letter; and a self-addressed, franked reply envelope. A toll-free telephone number was provided in the cover letter for respondents to call if the survey was not relevant to them. "Address Correction Requested" was stamped on the outside of each envelope so undeliverable mail would be returned.

Five hundred forty-one survey responses were generated from August 7 to September 6, 1991. Several people used the toll-free number to inform Continental Research that the survey was not relevant. Some respondents returned their completed surveys while others sent them back incomplete with a note indicating that the survey was not relevant. Some surveys were returned with a note indicating the person to whom the envelope was addressed was no longer with the company. The returned "Address Correction Requested" surveys were re-addressed and remailed. On September 6, 1991, follow-up post cards were sent to the 1,459 individuals who had not yet responded to encourage them to complete and return the survey. By October 1, 1991, the mailings had yielded 764 completed survey responses.

A reminder letter with a second copy of the survey was mailed to the 1,236 individuals who had not responded to the first mailing or the post card reminder. Between October 30 and November 6, 1991, telephone calls were made to each person on the sample list who had not responded. All calls were made at the Continental Research central telephone facility by professional staff interviewers between the hours of 9 a.m. and 9 p.m. By November 29, 1991, the cut-off date, 946 completed surveys were received. The adjusted completion rate for the survey was 67 percent.

Data Collection and Analysis

A variation of Flanagan's (1954) critical incident technique was used to guide data collection. According to Lancaster (1978), the theory behind the critical incident technique is that it is much easier for people to recall accurately what they did on a specific occurrence or occasion than it is to remember what they do in general. Respondents were asked to categorize the most important job-related projects, task, or problem they had worked on in the past 6 months. The categories included (1) educational, (2) research, (3) design/development, (4) manufacturing/production, (5) computer applications, (6) management, and (7) other.

Respondents were also asked to rate the amount of technical uncertainty and complexity they faced when they started their most important project, task, or problem. Technical uncertainty and complexity were measured on 5-point scales (1.0 = little uncertainty; 5.0 = great uncertainty; 1.0 = little complexity, 5.0 = great complexity). Survey participants were also asked to indicate whether they worked alone or with others in completing/solving the most important job-related project, task, or problem they had worked on in the past 6 months.

Technical uncertainty, complexity, and the importance of federally funded aerospace R&D were measured using ordinal scales. Hours spent communicating and the number of journal articles, conference-meeting papers, and U.S. government technical reports used were measured on an interval scale. Use of formal information sources and federally funded aerospace R&D were measured using a nominal scale. Data analysis was based on 946 responses, the total number of respondents.

Descriptive Findings

A total of 946 usable surveys was received by the established cut-off date. Of the 946 respondents, 872 (92.2%) worked in industry, 63 (6.7%) worked in government, 6 (0.6%) worked in academia, and 5 (0.5%) had some other affiliation. Survey demographics for the 946 respondents appear in table 1. The following "composite" participant profile was developed for the respondents: works in industry (92.2%), has a bachelor's degree (52.7%), has an average of 18.7 years of work experience in aerospace, was educated as and works as an engineer (90.8%, 90.1%), and works in design/development (60.1%).

Project, Task, Problem

Survey participants were asked to categorize the most important job-related project, task, or problem they had worked on in the past 6 months. The categories and responses are listed in table 2. A majority of the job-related projects, tasks, and problems (56%) were categorized as design/development. About 11 percent and 14 percent of the job-related projects, tasks, and problems were categorized as manufacturing/production and management, respectively. Most respondents (83%) worked with others (did not work alone) in completing their most important job-related project, task, or problem.

<u>Number of Groups and Group Size</u>. On average, respondents worked with 2.72 groups; each group contained an average of 6.6 members (table 2). A majority of respondents (72%) performed engineering duties while working on their most important job-related project, task, or problem. About 24 percent performed management duties.

<u>Project, Task, Problem Complexity and Uncertainty</u>. Respondents were asked to rate the overall complexity of their most important job-related project, task, or problem. The mean complexity score was 3.72 (of a possible 5.00). Respondents were also asked to rate the amount of technical uncertainty they faced when they started their most important project, task, or problem. The average (mean) technical uncertainty score was 3.19 (of a possible 5.00).

Correlation coefficients (Pearson's r) **were calculated to compare (1) the overall "level of project, task, or problem complexity" and "technical uncertainty" and (2) the level of "project, task, or problem complexity by category" and "technical uncertainty."** The correlation coefficients appear in table 3. Positive and significant correlations were found for both comparisons. These findings support the hypothesis that there is a (positive) relationship between technical uncertainty and complexity.

<u>Project, Task, or Problem and Information Use</u>. Respondents were given a list of the following information sources used to complete their most important job-related project, task, or

Table 1. Survey Demographics
[n = 946]

Demographics	Percentage	Number
Do you currently work in:		
Industry	92.2	872
Government	6.7	63
Academia	0.6	6
Not-for-Profit	0.5	5
Your highest level of education:		
No degree	5.6	53
Technical/Vocational degree	2.5	23
Bachelor's degree	52.7	498
Master's degree	27.0	255
Doctorate	5.1	48
Other type of degree	7.3	69
Your years in aerospace:		
1 through 5 years	10.5	98
6 through 10 years	24.1	224
11 through 20 years	24.5	227
21 through 40 years	39.1	362
41 or more years	1.8	18
Mean = 18.7 years Median = 16.0 years		
Your education:		
Engineer	90.8	859
Scientist	7.2	68
Other	2.0	19
Your primary duties:		
Engineer	90.1	852
Scientist	2.5	24
Other	7.4	70
Is your work best classified as:		
Teaching/Academic	0.3	3
Research	7.0	66
Management	15.4	146
Design/Development	60.1	569
Manufacturing/Production	11.6	110
Service/Maintenance	2.7	26
Sales/Marketing	1.3	12
Other	1.4	14

problem: (1) used personal store of technical information, (2) spoke with coworkers inside the organization, (3) spoke with colleagues outside of the organization, (4) spoke with a librarian/technical information specialist, and (5) used literature resources in the organization's library. They were asked to identify the steps they followed to obtain needed information by

Table 2. Project, Task, or Problem Categorization
[n = 946]

Factors	Percentage	Number
Categories of Project, Task, or Problem:		
Educational	1.7	16
Research	9.3	88
Design	30.7	290
Development	25.3	239
Manufacturing/Production	11.1	105
Computer Applications	4.2	40
Management	14.3	135
Other	3.5	33
Worked on Project, Task or Problem:		
Alone	17.0	161
With others	83.0	758
Mean number of groups = 2.72		
Mean number of people/group = 6.58		
Nature of duties performed:		
Engineering	71.7	678
Science	2.9	27
Management	24.0	227
Other	1.5	14

Table 3. Correlation of Project Complexity and Technical Uncertainty by Type of Project, Task, or Problem
[n = 946]

Complexity - Uncertainty Correlation	n	r
Overall**	946	.4563*
Education/Research	104	.3581*
Design	290	.4716*
Development	239	.4781*
Manufacturing/Production	105	.4830*
Management	135	.4235*
Computer Applications	40	.2326

* *r* values are statistically significant at $p \leq 0.05$.
** Overall mean complexity (uncertainty) score = 3.72 (3.19) out of a possible 5.00.

sequencing these items (e.g., #1,#2,#3,#4, and #5). They were instructed to place an "X" beside the step(s) (i.e., information source) they did not use. The results appear in table 4.

Table 4. Information Sources Used to Solve Project, Task, or Problem

Information Source	Used First %	Used Second %	Used Third %	Used Fourth %	Used Fifth %	Not Used %
Personal Store of Technical Information	**59.5**	17.5	10.5	2.4	1.3	8.8
Spoke With Coworker(s) Inside the Organization	26.8	**45.2**	12.3	5.3	0.5	9.8
Spoke With Colleagues Outside of the Organization	5.6	16.2	**32.1**	13.3	6.0	26.7
Used Literature Resources in My Organization's Library	4.9	11.1	19.3	**20.2**	8.7	35.8
Spoke With a Librarian/ Technical Information Specialist	3.2	3.7	7.6	12.8	**15.9**	56.9

Use of Federally Funded Aerospace R&D. About 44 percent (412) of the participants used the results of federally funded aerospace R&D in their work. Respondents who used federally funded aerospace R&D in their work were given a list of 12 sources. They were asked to indicate how often they had learned about the results of federally funded aerospace R&D from each of the 12 sources. A 4-point scale (4.0 = frequently; 1.0 = never) was used to measure frequency. In table 5, the "frequently" and "sometimes" responses were combined to determine the overall use of the 12 sources. Of the six most frequently used sources, half involve interpersonal communication and half are formal (written) communication. Three of the five "federal initiatives" were the sources used least to learn about the results of federally funded aerospace R&D.

The respondents who reported using the results of federally funded aerospace R&D were asked if they used these results in completing the most important job-related project, task, or problem they had worked on in the past 6 months. The 26 percent (250) of respondents who answered "yes" were asked about the importance of these results in completing the project, task, or problem. A 5-point scale (1.0 = very unimportant, 5.0 = very important) was used to measure importance. The mean importance rating was 3.5. Almost one-half of those who used federally funded R&D (123 respondents) responded with an importance rating of "4" or "5". Sixty-three percent (157) of those who used the results of federally funded aerospace R&D in completing

Table 5. Sources Most Frequently Used to Learn About the Results of Federally Funded Aerospace R&D
[n = 412]

Source	Percentage*	Number
1. Professional and Society Journals	78.8	325
2. Coworkers Inside My Organization	78.2	322
3. Trade Journals	71.6	295
4. NASA and DoD Technical Reports	70.9	292
5. Colleagues Outside My Organization	56.6	233
6. NASA and DoD Contacts	53.4	220
7. Professional and Society Meetings	41.0	169
8. Searches of Computerized Data Bases	37.2	153
9. NASA and DoD Sponsored Conferences and Workshops	36.4	150
10. Visits to NASA and DoD Facilities	30.9	127
11. Publications such as *STAR*	26.0	107

*Includes combined "frequently" and "sometimes" responses.

their most important job-related project, task, or problem indicated that the results were published in either a NASA or DoD technical report.

The respondents who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem were asked which problems, if any, they encountered in using these results (see table 6). Respondents were given a list of six problems from which to choose. About 52% indicated that the "time and effort it took to locate the results" was a problem. About 41% reported that the "time and effort it took to physically obtain the results" was a problem. About 24% indicated that "accuracy, precision, and reliability of the results" was a problem, and about 23% reported that "distribution limitations or security restrictions" constituted a problem. About 15%/9% indicated that "organization or format"/"legibility or readability" of the results constituted a problem.

Technical Communications Practices

Data which describe factors concerning the production and use of technical information are summarized in table 7. Participants were asked to indicate the importance of communicating technical information effectively (e.g., producing written materials or oral discussions). A 5-point scale was used to measure importance (1.0 = very unimportant; 5.0 = very important).

Importance and Time Spent. The mean importance rating was 4.35; approximately 84 percent of respondents indicated that it was important to communicate technical information effectively. Respondents were also asked to report the total number of hours per week they had

Table 6. Problems Related to Use of Federally-Funded Aerospace R&D
[n = 250]

Problem	Percentage	Number
Time and Effort to Locate Results	52.0	130
Time and Effort to Obtain Results	40.8	102
Accuracy, Precision and Reliability of Results	23.6	59
Distribution Limitations or Security Restrictions of Results	22.8	57
Organization or Format of Results	14.8	37
Legibility or Readability of Results	9.2	23

spent communicating technical information, both in written form and orally, during the past 6 months. Respondents reported spending slightly more time on producing oral discussions (an average of 10.70 hours/week) than written materials (an average of 9.03 hours/week). Approximately 62 percent of the respondents indicated that the amount of time they spent communicating technical information had increased over the past 5 years. About 7 percent indicated a decrease in the amount of time spent communicating technical information over the same period.

Respondents were also asked to report the total number of hours per week spent working with technical information, both written and oral, received from others in the past 6 months (see table 7). Respondents reported spending slightly more time working with written technical information received from others (an average of 7.78 hours/week) than with oral materials (an average of 7.10 hours/week). Approximately 58 percent of the respondents indicated that, compared with 5 years ago, the amount of time spent working with technical information received from others had increased. About 11 percent indicated a decrease in the amount of time they spent communicating technical information when compared with 5 years ago.

Collaborative Writing. An attempt was made to determine the amount of writing in U. S. aerospace that is collaborative. Survey participants were asked to indicate the percentage of their written technical communications that involved writing alone, with one other person, with a group of two to five people, and with a group of more than five people. About 41 percent of the survey respondents indicated that about 100 percent of the written technical communications they prepared involved writing alone. [The mean percent was ($\bar{X}$ = 78.25) and the median percent was 90.00.] About 45 percent indicated that their written technical communications involved

Table 7. Technical Information: Importance, Production and Use, and Change Over Time [n = 946]

Communication And Receipt Of Information	Percentage	Number
Importance Of Communicating Information:		
Unimportant	7.7	73
Neither important nor unimportant	8.0	76
Important	84.3	797
Mean = 4.35 Median = 5.00		
Time Spent Producing Written Material:		
0 hours per week	0.7	6
1 through 5 hours per week	39.0	355
6 through 10 hours per week	36.3	330
11 through 15 hours per week	8.5	77
16 through 20 hours per week	11.4	104
21 or more hours per week	3.9	36
Mean = 9.03 Median = 8.00		
Time Spent Communicating Information Orally:		
0 hours per week	0.3	3
1 through 5 hours per week	29.5	266
6 through 10 hours per week	35.1	317
11 through 15 hours per week	12.0	109
16 through 20 hours per week	17.6	159
21 or more hours per week	5.3	50
Mean = 10.70 Median = 10.00		
Change Over Past 5 Years in the Amount of Time Spent Communicating Information:		
Increased	61.5	582
Stayed the same	31.3	296
Decreased	7.2	68
Time Spent Working With Written Information Received From Others:		
0 hours per week	1.4	13
1 through 5 hours per week	48.9	449
6 through 10 hours per week	33.3	307
11 through 15 hours per week	5.6	52
16 through 20 hours per week	7.8	72
21 or more hours per week	2.8	27
Mean = 7.78 Median = 5.00		
Time Spent Receiving Information Orally From Others:		
0 hours per week	2.5	22
1 through 5 hours per week	53.1	473
6 through 10 hours per week	28.3	252
11 through 15 hours per week	6.9	61
16 through 20 hours per week	7.0	62
21 or more hours per week	2.2	20
Mean = 7.10 Median = 5.00		
Change Over Past 5 Years In The Amount Of Time Spent Receiving Information:		
Increased	57.6	545
Stayed the same	31.1	294
Decreased	11.3	107

writing with one other person. [The mean percent was ($\bar{X}$ = 9.84) and the median percent was 0.0.] About 45 percent indicated that their written technical communications involved writing with a group of two to five people. [The mean percent was ($\bar{X}$ = 9.84) and the median percent was 0.0.] About 39 percent indicated that their written technical communications involved writing with a group of more than five people. [The mean percent was ($\bar{X}$ = 3.25) and the median percent was 0.0.]

Survey participants were asked if they find writing as part of a group more or less productive (i.e., producing more written products or producing better written products) than writing alone. The responses appear in table 8. Overall, slightly more of the respondents indicated that writing with a group is more productive than writing alone. About 22 percent indicated that a group is more productive and about 21 percent indicated that a group is less productive. About 16 percent indicated that a group is about as productive as writing alone.

Table 8. Influence of Group Participation on Writing Productivity
[n = 946]

Selection	Percentage	Number
A group is more productive than writing alone	22.3	211
A group is about as productive as writing alone	16.2	153
A group is less productive than writing alone	20.5	194
I write alone (only)	41.0	388

Survey participants were asked if, during that 6 month period, they had worked with the same group of people when producing written technical communications. About 40 percent (376 respondents) indicated "yes" they had worked with the same group, about 19 percent indicated that they had worked with various groups, and 41 percent indicated that they only write alone. Of those who indicated that they had worked in the same group, these respondents were asked how many people were in the group. About 75 percent (283 respondents) indicated a group size of 2-5 people and about 17 percent (63 respondents) indicated a group size of 6-10 people. The mean number of people in the group was $\bar{X}$ = 5.75 and the median was 4.00.

Those 182 respondents who indicated "no" meaning that they did not work with the same group during the past 6 months were asked with about how many groups they had worked. About 27 percent (48 respondents) reported working with 2 groups, about 35 percent (63 respondents) reported working with 3 groups, about 15 percent (27 respondents) reported working with 4 groups, about 10 percent (18 respondents) reported working with 5 groups, and about 13 percent (24 respondents) reported working with 6-10 groups. The average (mean) number of groups was $\bar{X}$ = 3.79 and the median number of groups was 3.0. The number of people in each group varied. About 75 percent of the respondents reported working with a group of 2-5 people and about 20 percent reported working with a group of 6-10 people. The average (mean) number of people per group was $\bar{X}$ = 4.77 and the median number of people per group was 4.0.

Technical Information Products Produced. Survey participants were given a list of technical information products. They were asked to indicate the number of these products they had written or otherwise prepared in the past 6 months and if those products had been written or prepared as part of a group. The 10 most frequently produced (alone) technical information products appear in table 9.

Table 9. Technical Information Products Written or Produced Alone in the Past 6 Months [n = 946]

Products	Mean ($\bar{X}$)	Median
Memoranda	18.2	8.0
Letters	13.3	4.0
Drawings/Specifications	7.6	0.0
U.S. government technical reports	0.8	0.0
Audio/Visual materials	3.5	0.0
In-house technical reports	3.7	0.0
Computer programs and documentation	1.1	0.0
Conference/Meeting papers	1.3	0.0
Technical talks/Presentations	3.3	1.0
Technical proposals	1.6	0.0

Survey participants were also asked to indicate the number of these products they had written or otherwise prepared in the past 6 months as part of a group. The 10 most frequently prepared (as part of a group) technical information products appear in table 11. Data shown in table 10 include the number of products produced (mean and median) and the average (mean and median) numbers of people per group.

A comparison of the data contained in tables 9 and 10 reveals more similarities than differences. The production numbers vary somewhat but the products included on both lists (products produced alone or as part of a group) are essentially identical. With the exception of the "group size" for technical proposals, the average numbers of people per group for the various products produced are fairly similar in size.

Survey participants were given a list of technical information products. They were asked to indicate approximately how many times in the past 6 months they had used each of them. The 10 most frequently used technical information products appear in table 11. A comparison of the data contained in tables 9 (production) and 11 (use) reveals two differences. First, on average, more products are used than are produced. Second, there are slight differences in the types or kinds of products produced and used.

Table 10. Technical Information Products Written or Produced as Part of a Group in the Past 6 Months
[n = 946]

Information Products	In a Group		Average Number of People Per Group	
	Mean ($\bar{X}$)	Median	Mean ($\bar{X}$)	Median
Drawings/Specifications	3.5	0.00	4.31	3.00
Letters	0.7	0.00	2.64	2.00
Memoranda	0.6	0.00	4.27	2.00
Audio/Visual material	0.9	0.00	4.21	3.00
Conference/Meeting papers	0.6	0.00	3.33	2.00
In-house technical reports	0.9	0.00	4.31	3.00
Technical talks/Presentations	1.0	0.00	5.06	3.00
Computer programs and documentation	0.3	0.00	3.25	2.00
Technical manuals	0.4	0.00	4.55	3.00
Technical proposals	1.0	0.00	8.59	4.00

Table 11. Technical Information Product Used in the Past 6 Months
[n = 946]

Information Products	Mean ($\bar{X}$)	Median
Drawings/Specifications	31.9	10.0
Memoranda	22.2	5.0
Letters	14.9	2.0
Trade/Promotional literature	7.8	0.0
Technical manuals	7.5	1.0
Abstracts	3.2	0.0
In-house technical reports	9.7	5.0
Journal articles	7.1	2.0
Audio/Visual materials	4.8	0.0
Computer programs and documentation	4.5	0.0

Technical Information Products -- Use, Importance, and Frequency of Use

Survey participants were asked several questions designed to obtain a greater understanding of the factors affecting the use of technical reports. In this study, technical reports were placed within the context of two technical information products: conference/meeting papers and journal articles. AGARD, DoD, in-house, and NASA technical reports were included in this study.

Use. Survey participants were asked if they used the aforementioned technical information products in performing their present professional duties. Table 12 includes data regarding use.

Table 12. Technical Information Products Used
[n = 946]

Information Products	$\bar{X}$	Percentage	Number
Conference/Meeting papers	1.40	59.7	565
Journal articles	1.37	63.2	598
AGARD technical reports	1.17	11.5	109
In-house technical reports	1.89	83.4	789
DoD technical reports	1.56	44.4	420
NASA technical reports	1.56	44.4	420

Importance. Survey participants were asked "how important is it for you to use the aforementioned technical information products in performing your present professional duties?" Table 13 includes data regarding the importance of use technical information products. A 5-point scale (1.0 = very unimportant; 5.0 = very important) was used to measure importance.

Table 13. Importance of Technical Information Products
[n = 946]

Information Products	Mean ($\bar{X}$) Importance	Number
Conference/Meeting papers	2.54	946
Journal articles	2.65	946
AGARD technical reports	1.92	682
In-house technical reports	3.28	946
DoD technical reports	2.67	832
NASA technical reports	2.57	854

Approximately 17 percent (164 respondents) indicated that the use of conference/meeting papers was "very or somewhat"important to their work. Approximately 21 percent (202 respondents) indicated that the use of journal articles was "very or somewhat" important to their work. Approximately 43 percent (410 respondents) indicated that in-house technical reports were "very or somewhat" important to their work. About equal numbers of respondents (206 and 181) indicated that DoD and NASA technical reports were "very or somewhat" important (25 and 21 percent) to their work. About 7 percent (46 respondents) indicated that AGARD technical reports were "very or somewhat" important to their work. Data regarding use and importance are similar to findings reported for the two SAE telephone surveys (Pinelli and Glassman, September 1992; Pinelli, Kennedy, and White, October 1992).

Frequency of Use. Survey participants were asked to indicate the number of times each of the five technical information products had been used in a 6 month period in the performance of their professional duties (table 14). Data are presented both as means and medians. In-house technical reports were used ($\bar{X}$ = 9.72) to a much greater extent than were the other technical information products. Journal articles were used to a lesser extent ($\bar{X}$ = 6.90) followed by conference/meeting papers, DoD, and NASA technical reports.

Table 14. Average Number of Times (Median) Technical Information Products Used in a 6 Month Period
[n = 946]

Information Products	Mean ($\bar{X}$) Use	Median
Conference/Meeting papers	4.13	2.00
Journal articles	6.90	2.00
AGARD technical reports	0.29	0.00
In-house technical reports	9.72	5.00
DoD technical reports	3.09	0.00
NASA technical reports	2.40	0.00

Technical Information Products -- Ratings By Users and Non-Users

Even if they did not use them, survey participants were asked to rate the six technical information products on eight characteristics. For example, respondents were asked to indicate the extent to which they thought that conference/meeting papers are easy/difficult to physically obtain. A 5-point scale (1.0 = easy to physically obtain; 5.0 = difficult to physically obtain) was used to measure their opinions. The higher the number, the more difficult the information products were considered by survey participants to physically obtain. An overall mean ($\bar{X}$) rating was calculated. A mean ($\bar{X}$) rating for users and non-users is presented.

Conference/Meeting Papers. The highest overall ratings for conference/meeting papers were associated with (1) good/poor technical quality, (2) good/bad prior experiences using them, (3) inexpensive/expensive, (4) relevant/irrelevant to my work, and (5) complete/incomplete information (table 15). Statistically significant differences were found between users and non-users for the following five characteristics: (1) easy/difficult to physically obtain, (2) easy/difficult to use or read, (3) comprehensive/incomplete information, (4) relevant/irrelevant to my work, and (5) good/bad prior experiences using them. With one exception, non-users rated conference/meeting papers more favorably (e.g., easy/difficult to use and read) than did those respondents who actually used the product.

Table 15. Rating of Conference/Meeting Papers
[n = 946]

Factors	User Rating ($\bar{X}$) n = 565	Non-User Rating ($\bar{X}$) n = 381	Overall Rating ($\bar{X}$) n = 946
Being easy/difficult to physically obtain	2.92*	2.72*	2.84
Being easy/difficult to use or read	3.09*	2.76*	2.95
Being inexpensive/expensive	3.01	3.04	3.02
Being of good/poor technical quality	3.19	3.13	3.17
Having comprehensive/incomplete information	3.02*	2.85*	2.96
Being relevant/irrelevant to my work	3.20*	2.69*	3.00
Obtaining them at a nearby/distant location	2.84	2.73	2.80
Having good/bad prior experiences using them	3.18*	2.81*	3.03

* *t* values are statistically significant at $p \leq 0.05$.

Journal Articles. The ratings for journal articles appear in table 16. The highest overall ratings were associated with (1) good/poor technical quality, (2) easy/difficult to physically obtain, (3) inexpensive/expensive, (4) good/bad prior experiences using them, and (5) obtaining them at a nearby/distant location. Statistically significant differences were found between users and non-users for seven of the eight characteristics. Overall, non-users rated journal articles lower (e.g., easy/difficult to physically obtain) than did those respondents who actually used the product.

In-House Technical Reports. The highest overall ratings for in-house technical reports were associated with (1) inexpensive/expensive (2) obtaining them at a nearby/distant location, (3) easy/difficult to physically obtain, (4) relevant/irrelevant to my work, and (5) good/bad prior experiences using them. (table 17). Statistically significant differences were found between users and non-users of in-house technical reports on all eight characteristics. Non-users rated in-house technical reports more favorably (e.g., easy/difficult to use and read) than did those respondents who actually used the product.

Table 16. Rating of Journal Articles
[n = 946]

Factors	User Rating ($\bar{X}$) n = 598	Non-User Rating ($\bar{X}$) n = 348	Overall Rating ($\bar{X}$) n = 946
Being easy/difficult to physically obtain	3.57*	3.08*	3.39
Being easy/difficult to use or read	3.29*	2.94*	3.16
Being inexpensive/expensive	3.51*	3.15*	3.38
Being of good/poor technical quality	3.55*	3.36*	3.48
Having comprehensive/incomplete information	3.10	3.02	3.07
Being relevant/irrelevant to my work	3.22*	2.53*	2.97
Obtaining them at a nearby/distant location	3.42*	2.99*	3.26
Having good/bad prior experiences using them	3.55*	3.04*	3.36

* *t* values are statistically significant at $p \leq 0.05$

Table 17. Rating of In-house Technical Reports
[n = 946]

Factors	User Rating ($\bar{X}$) n = 789	Non-User Rating ($\bar{X}$) n = 157	Overall Rating ($\bar{X}$) n = 946
Being easy/difficult to physically obtain	3.96*	3.48*	3.88
Being easy/difficult to use or read	3.48*	3.03*	3.41
Being inexpensive/expensive	4.36*	4.02*	4.30
Being of good/poor technical quality	3.47*	3.08*	3.40
Having comprehensive/incomplete information	3.42*	3.03*	3.35
Being relevant/irrelevant to my work	3.75*	2.90*	3.61
Obtaining them at a nearby/distant location	4.16*	3.64*	4.07
Having good/bad prior experiences using them	3.59*	2.97*	3.49

* *t* values are statistically significant at $p \leq 0.05$.

AGARD Technical Reports. The highest overall ratings for AGARD technical reports were associated with (1) good/poor technical quality, (2) comprehensive/incomplete information, (3) easy/difficult to read and use, (4) good/bad prior experiences using them, and (5) inexpensive/expensive (table 18). Statistically significant differences were found between users and non-users of AGARD technical reports on all but two of the eight characteristics -- being inexpensive/expensive and obtaining them at a nearby/distant location.

Table 18. Rating of AGARD Technical Reports
[n = 946]

Factors	User Rating ($\bar{X}$) n = 109	Non-User Rating ($\bar{X}$) n = 837	Overall Rating ($\bar{X}$) n = 946
Being easy/difficult to physically obtain	2.87*	2.58*	2.63
Being easy/difficult to use or read	3.26*	2.99*	3.04
Being inexpensive/expensive	3.08	2.98	3.00
Being of good/poor technical quality	3.49*	3.18*	3.24
Having comprehensive/incomplete information	3.41*	3.13*	3.18
Being relevant/irrelevant to my work	3.40*	2.81*	2.91
Obtaining them at a nearby/distant location	2.86	2.76	2.78
Having good/bad prior experiences using them	3.41*	2.95*	3.03

* *t* values are statistically significant at $p \leq 0.05$.

DoD Technical Reports. The highest overall ratings for DoD technical reports were associated with (1) inexpensive/expensive, (2) good/poor technical quality, (3) comprehensive/incomplete information, (4) relevant/irrelevant to my work, (5) good/bad prior experiences using them (table 19). Statistically significant differences were found between users and non-users of DoD reports on all eight characteristics.

Table 19. Rating of DoD Technical Reports
[n = 946]

Factors	User Rating ($\bar{X}$) n = 420	Non-User Rating ($\bar{X}$) n = 526	Overall Rating ($\bar{X}$) n = 946
Being easy/difficult to physically obtain	3.01*	2.58*	2.80
Being easy/difficult to use or read	3.17*	2.87*	3.03
Being inexpensive/expensive	3.52*	3.06*	3.30
Being of good/poor technical quality	3.37*	3.16*	3.27
Having comprehensive/incomplete information	3.34*	3.13*	3.24
Being relevant/irrelevant to my work	3.51*	2.87*	3.20
Obtaining them at a nearby/distant location	3.10*	2.72*	2.92
Having good/bad prior experiences using them	3.33*	3.00*	3.17

* *t* values are statistically significant at $p \leq 0.05$.

NASA Technical Reports. The highest overall ratings for NASA technical reports were associated with (1) good/poor technical quality, (2) inexpensive/expensive, (3) comprehensive/incomplete information, (4) easy/difficult to read, (5) good/bad prior experiences using them (table 20). Statistically significant differences were found between users and non-users of NASA technical reports on all eight characteristics.

Table 20. Rating of NASA Technical Reports
[n = 946]

Factors	User Rating ($\bar{X}$) n = 420	Non-User Rating ($\bar{X}$) n = 526	Overall Rating ($\bar{X}$) n = 946
Being easy/difficult to physically obtain	3.51*	2.95*	3.23
Being easy/difficult to use or read	3.54*	3.15*	3.35
Being inexpensive/expensive	3.76*	3.26*	3.52
Being of good/poor technical quality	3.68*	3.48*	3.59
Having comprehensive/incomplete information	3.52*	3.36*	3.44
Being relevant/irrelevant to my work	3.50*	2.79*	3.15
Obtaining them at a nearby/distant location	3.28*	2.78*	3.04
Having good/bad prior experiences using them	3.54*	3.09*	3.33

* *t* values are statistically significant at $p \leq 0.05$.

Technical Information Products -- Factors Affecting Use

Even if they did not use them, survey participants were asked if they were deciding whether or not to use any of the six technical information products in performing their present professional duties, how important each of the eight characteristics (factors) would be in making that decision. For example, respondents were asked to indicate how important the factor, "they are easy to physically obtain," would be in making a decision to use conference/meeting papers. A 5-point scale (1.0 = very unimportant; 5.0 = very important) was used to measure importance. The higher the number, the greater the influence of the factor on the use of conference/meeting papers. An overall mean ($\bar{X}$) rating was calculated. A mean ($\bar{X}$) rating for users and non-users of each product is presented.

Conference/Meeting Papers. The importance factor ratings for conference/meeting papers appear in table 21. The factors exerting the greatest influence on use were (1) good technical quality ($\bar{X}$ = 4.08), (2) relevant to my work ($\bar{X}$ = 4.06), (3) comprehensive data and information ($\bar{X}$ = 4.02), (4) easy to use or read ($\bar{X}$ = 3.71), and (5) easy to physically obtain ($\bar{X}$ = 3.58). One statistically significant difference was found between users and non-users of conference/meeting papers and easy to use or read.

Table 21. Factors Affecting the Use of Conference/Meeting Papers
[n = 946]

Factors	User Rating ($\bar{X}$)	Non-User Rating ($\bar{X}$)	Overall Rating ($\bar{X}$)
	n = 565	n = 381	n = 946
Are easy to physically obtain	3.55	3.61	3.58
Are easy to use or read	3.64*	3.82*	3.71
Are inexpensive	3.08	2.96	3.03
Have good technical quality	4.05	4.12	4.08
Have comprehensive data and information	3.98	4.07	4.02
Are relevant to my work	4.05	4.08	4.06
Can be obtained at a nearby location or source	3.28	3.30	3.29
Had good prior experiences using them	3.10	3.11	3.11

* *t* values are statistically significant at $p \leq 0.05$.

Journal Articles. The importance factor ratings for journal articles appear in table 22. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.11), (2) good technical quality ($\bar{X}$ = 4.10), (3) comprehensive data and information ($\bar{X}$ = 4.03), (4) easy to use or read ($\bar{X}$ = 3.74), and (5) easy to physically obtain ($\bar{X}$ = 3.61). Statistically significant differences were found between users and non-users of journal articles and good prior experiences using them.

Table 22. Factors Affecting the Use of Journal Articles
[n = 872]

Factors	User Rating ($\bar{X}$)	Non-User Rating ($\bar{X}$)	Overall Rating ($\bar{X}$)
	n = 598	n = 348	n = 946
Are easy to physically obtain	3.63	3.59	3.61
Are easy to use or read	3.73	3.75	3.74
Are inexpensive	3.07	3.01	3.04
Have good technical quality	4.14	4.01	4.10
Have comprehensive data and information	4.05	4.01	4.03
Are relevant to my work	4.15	4.04	4.11
Can be obtained at a nearby location or source	3.43	3.43	3.43
Had good prior experiences using them	3.26*	2.97*	3.15

* *t* values are statistically significant at $p \leq 0.05$.

In-House Technical Reports. The importance factor ratings for in-house technical reports appear in table 23. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.06), (2) good technical quality ($\bar{X}$ = 4.04), (3) comprehensive data and information ($\bar{X}$ = 4.04), (4) easy to use or read ($\bar{X}$ = 3.71), and (5) easy to physically obtain ($\bar{X}$ = 3.61). Statistically significant differences were found between users and non-users of in-house technical reports and good prior experiences using them.

Table 23. Factors Affecting the Use of In-house Technical Reports
[n = 946]

Factors	User Rating ($\bar{X}$) n = 731	Non-User Rating ($\bar{X}$) n = 141	Overall Rating ($\bar{X}$) n = 946
Are easy to physically obtain	3.58	3.73	3.61
Are easy to use or read	3.68	3.85	3.71
Are inexpensive	2.90	2.97	2.91
Have good technical quality	4.04	4.03	4.04
Have comprehensive data and information	4.04	4.03	4.04
Are relevant to my work	4.09	3.95	4.06
Can be obtained at a nearby location	3.37	3.54	3.40
Had good prior experiences using them	3.28*	3.04*	3.24

* *t* values are statistically significant at $p \leq 0.05$.

AGARD Technical Reports. The importance factor ratings for AGARD technical reports appear in table 24. The factors exerting the greatest influence on use were (1) good technical quality ($\bar{X}$ = 3.89), (2) comprehensive data and information ($\bar{X}$ = 3.86), (3) relevant to my work ($\bar{X}$ = 3.84), (4) easy to use or read ($\bar{X}$ = 3.61), and (5) easy to physically obtain ($\bar{X}$ = 3.53). Statistically significant differences were found between users and non-users of AGARD technical reports and good prior experiences using them and relevant to my work.

DoD Technical Reports. The importance factor ratings for DoD technical reports appear in table 25. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.02), (2) good technical quality ($\bar{X}$ = 4.01), (3) comprehensive data and information ($\bar{X}$=3.98), (4) easy to use or read ($\bar{X}$ = 3.67), and (5) easy to physically obtain ($\bar{X}$ = 3.54). Statistically significant differences were found between users and non-users of DoD technical reports and good prior experiences using them.

Table 24. Factors Affecting the Use of AGARD Technical Reports
[n = 946]

Factors	User Rating ($\bar{X}$) n = 109	Non-User Rating ($\bar{X}$) n = 837	Overall Rating ($\bar{X}$) n = 946
Are easy to physically obtain	3.57	3.52	3.53
Are easy to use or read	3.73	3.59	3.61
Are inexpensive	2.99	3.07	3.06
Have good technical quality	4.10	3.85	3.89
Have comprehensive data and information	4.06	3.82	3.86
Are relevant to my work	4.07*	3.80*	3.84
Can be obtained at a nearby location or source	3.28	3.31	3.30
Had good prior experiences using them	3.31*	3.05*	3.09

* t values are statistically significant at $p \leq 0.05$.

Table 25. Factors Affecting the Use of DoD Technical Reports
[n = 946]

Factors	User Rating ($\bar{X}$) n = 420	Non-User Rating ($\bar{X}$) n = 526	Overall Rating ($\bar{X}$) n = 946
Are easy to physically obtain	3.54	3.54	3.54
Are easy to use or read	3.67	3.67	3.67
Are inexpensive	3.07	3.05	3.06
Have good technical quality	4.04	3.98	4.01
Have comprehensive data and information	4.03	3.93	3.98
Are relevant to my work	4.05	3.98	4.02
Can be obtained at a nearby location or source	3.29	3.31	3.30
Had good prior experiences using them	3.32*	3.01*	3.17

* t values are statistically significant at $p \leq 0.05$.

NASA Technical Reports. The importance factor ratings for NASA technical reports appear in table 26. The factors exerting the greatest influence on use were (1) good technical quality ($\bar{X}$ = 4.07), (2) comprehensive data and information ($\bar{X}$ = 4.04), (3) relevant to my work ($\bar{X}$ = 4.03), (4) easy to use or read ($\bar{X}$ = 3.72), and (5) easy to physically obtain ($\bar{X}$ = 3.54). No statistically significant differences were found between users and non-users of NASA technical reports and the eight characteristics or factors.

Table 26. Factors Affecting the Use of NASA Technical Reports
[n = 946]

Factors	User Rating ($\bar{X}$) n = 420	Non-User Rating ($\bar{X}$) n = 526	Overall Rating ($\bar{X}$) n = 946
Are easy to physically obtain	3.47	3.61	3.54
Are easy to use or read	3.65	3.79	3.72
Are expensive	2.99	3.16	3.08
Have good technical quality	4.08	4.06	4.07
Having comprehensive data and information	4.04	4.04	4.04
Are relevant to my work	4.03	4.04	4.03
Can be obtained at a nearby location or source	3.26	3.32	3.29
Had good prior experiences using them	3.21	3.14	3.17

* t values are statistically significant at $p \leq 0.05$.

Technical Information Products -- Influence of Accessibility.

Conventional wisdom considers *accessibility* to be a dominant factor in information-seeking behavior and in the information seeking-behavior of engineers. Buckland (1983, p. 114;173) states that "it is known that accessibility is a dominant factor in information-gathering behavior." Buckland cites research by Rosenberg (1967), Gerstberger and Allen (1968), and Harris (1966) to support his position.

In a survey of U.S. aerospace engineers and scientists belonging to the AIAA, relevance and technical quality or reliability exerted greater influence on the use of conference/meeting papers, journal articles, in-house technical reports, and U.S. government technical reports than did accessibility (Pinelli, January 1991). In the first SAE telephone survey, relevance, technical accuracy, and reliable data exerted greater influence on the use of conference/meeting papers, journal articles, in-house technical reports, and U.S. government technical reports than did accessibility (Pinelli and Glassman, September 1992).

Technical Information Products -- Usage and Product Ratings

Usage and Product Rating. Correlation coefficients (Pearson's r) were calculated. The correlation compared "past month's usage" with "opinion" ratings for each of the six technical information products. A positive and significant correlation ($p \leq 0.05$) was found between the use of the six information products and the following rating factors:

Conference/Meeting Papers

	r
• easy to use or to read	.1236*
• good prior experiences	.1135*
• relevant to my work	.1661*

Journal Articles

	r
• good prior experiences	.1870*
• easy to physically obtain	.1464*
• relevant to my work	.1870*
• easy to use or read	.1305*
• nearby location or source	.0813*

In-House Technical Reports

	r
• easy to physically obtain	.0666*
• comprehensive data and information	.0728*
• relevant to my work	.1649*
• nearby location or source	.0801*
• good prior experiences	.1260*

AGARD Technical Reports

	r
• good technical quality	.1280*
• comprehensive data and information	.1020*
• relevant to my work	.1799*
• good prior experiences	.2524*
• easy to read or use	.0830*

DoD Technical Reports

	r
• easy to physically obtain	.0680*
• inexpensive	.1102*
• relevant to my work	.1429*
• nearby location or source	.0496*
• good prior experiences	.1420*

NASA Technical Reports

	r
• easy to physically obtain	.1691*
• ease to read or use	.1111*
• inexpensive	.1444*
• good technical quality	.0483*
• comprehensive data and information	.0184*
• relevant to my work	.2009*
• nearby location or source	.0295*
• good prior experiences	.1172*

*r values are statistically significant at $p \leq 0.05$.

FINDINGS

Readers should note that the data contained in this report reflect the responses of U.S. aerospace engineers and scientists who were on the Society of Automotive Engineers mailing list (not necessarily members of the SAE). The results, therefore, are not generalizable to (1) the membership of the SAE, (2) all U.S. aerospace engineers and scientists working in design/development, or (3) all U.S. aerospace engineers and scientists. Further, the survey was conducted in July-November 1991, almost 3 years ago. The U.S. aerospace industry has undergone significant changes in the years since the research was conducted.

1. The "average" participant works in industry (92.2%), has a bachelor's degree (52.7%), has an average of 18.7 years of work experience in aerospace, was educated as and works as an engineer (90.8%, 90.1%), and works in design/development (60.1%).

2. Their most important job-related project, task, or problem worked on in the past 6 months was categorized as design/development (56.0%); 83.0% of the participants worked on this project, task, or problem with others. The mean number of groups involved was 2.72, and the mean number of people in a work group was 6.58. Engineering duties predominated (71.7%) followed by management duties (24.0%) in the completion of the most important job-related project, task, or problem worked on in the past 6 months.

3. A positive and significant correlation was found between the overall complexity and technical uncertainty of the most important job-related project, task, or problem that respondents had worked on in the past 6 months.

4. To complete their most important job-related project, task, or problem, respondents first went to their personal stores of technical information (59.5%); next, spoke with coworker(s) inside the organization (45.2%); third, spoke with colleagues outside of the organization (32.1%); fourth, used literature resources in the organization's library (20.2%); and last, spoke with a librarian/technical information specialist (15.9%).

5. Approximately 44% of the respondents reported using the results of federally funded aerospace R&D in their work. Of the six sources most frequently used to find out about the results of federally funded aerospace R&D, half involve interpersonal communication and half are formal (written) communication. Three of five "federal initiatives" were the sources used least to learn about the results of federally funded aerospace R&D.

6. About 26% of the respondents had used the results of federally funded aerospace R&D to complete their most important job-related project, task, or problem during the last 6 months. About half of this group indicated that federally funded aerospace R&D was "important" or "very important" for completing this work. Sixty-three percent (157) of those who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem indicated that the results were published in either a NASA or DoD technical report.

7. Of the respondents who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem, 52% indicated that the "time and effort it took to locate the results" was a problem, and 41% reported that the "time and effort it took to obtain the results" was a problem.

8. More than 84% of the respondents indicated that it was important to communicate technical information effectively; respondents spent an average of 9.03 hours per week producing written material and 10.70 hours per week communicating information orally. Over the past 5 years approximately 62% have increased the amount of time they spend communicating information to others. Survey respondents reported spending an average of 7.78 hours per week working with written information received from others and an average of 7.10 hours per week working with information received orally from others. More than 57% of the respondents indicated that the amount of time they spend receiving information from others has increased over the last 5 years.

9. About 41% of the respondents reported that all of the written technical communications they prepared involved writing alone. About 45% indicated that their written technical communications involved writing with one other person. About 45% indicated that their written technical communications involved writing with a group of two to five people. About 39% indicated that their written technical communications involved writing with a group of more than five people.

10. In terms of the perceived productivity of collaborative writing, slightly more of the respondents indicated that writing with a group is more productive than writing alone. About 22% indicated that a group is more productive and about 21% indicated that a group is less productive. About 16% indicated that a group is about as productive as writing alone.

11. A comparison of the technical information products produced and used reveals that on average, the survey respondents use more products than they produce. There are also slight differences in the types of technical information products produced and used.

12. Survey respondents were asked to indicate their use of and the importance to them of six technical information products. In-house technical reports were used most frequently and were rated most important. NASA and DoD technical reports were used by approximately 44% of the respondents and were rated about equal in importance.

13. Both users and non-users of the six information products were asked to rate them on eight characteristics. The highest overall ratings for these products follow.

Conference/meeting papers -- (1) good/poor technical quality, (2) inexpensive/expensive, (3) good/bad prior experiences using them, (4) relevant/irrelevant to my work, and (5) complete/ incomplete information.

Journal articles -- (1) good/poor technical quality, (2) easy/difficult to physically obtain, (3) inexpensive/expensive, (4) good/bad prior experiences using them, and (5) obtaining them at a nearby/distant location.

In-house technical reports -- (1) inexpensive/expensive (2) obtaining them at a nearby/distant location, (3) easy/difficult to physically obtain, (4) relevant/irrelevant to my work, and (5) good/bad prior experiences using them.

AGARD technical reports -- (1) good/poor technical quality, (2) easy/difficult to read and use, (3) comprehensive/incomplete information, (4) good/bad prior experiences using them, and (5) inexpensive/expensive.

DoD technical reports -- (1) inexpensive/expensive, (2) comprehensive/incomplete information, (3) good/poor technical quality, (4) relevant/irrelevant to my work, (4) good/bad prior experiences using them.

NASA technical reports -- (1) good/poor technical quality, (2) inexpensive/expensive, (3) comprehensive/incomplete information, (4) easy/difficult to read, (5) good/bad prior experiences using them.

14. Both users and non-users of the six information products were asked to indicate about the importance of eight factors in deciding whether to use any of the six information products. The factors exerting the greatest influence on decisions to use products follow.

Conference/meeting papers -- (1) good technical quality, (2) relevant to my work, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

Journal articles -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

In-house technical reports -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

AGARD technical reports -- (1) good technical quality, (2) comprehensive data and information, (3) relevant to my work, (4) easy to use or read, and (5) easy to physically obtain.

DoD technical reports -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

NASA technical reports -- (1) good technical quality, (2) comprehensive data and information, (3) relevant to my work, (4) easy to use or read, and (5) easy to physically obtain.

15. Use of the six technical information products was correlated with product ratings. For all but one product (i.e., AGARD technical reports), the highest correlation (*r* value) was "relevant to my work." In the case of AGARD technical reports, the highest correlation (*r* value) was "good prior experiences" in using these reports.

REFERENCES

Adam, R. 1975 — "Pulling the Minds of Social Scientists Together: Towards a Science Information System." *International Social Journal* 27(3): 519-531.

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

Auger, C. P. 1975 — *Use of Technical Reports Literature.* Hamden, CT: Archon Books.

Ballard, S., et. al. 1989 — *Innovation Through Technical and Scientific Information: Government and Industry Cooperation.* Westport, CT: Quorum Books.

Ballard, S., et. al. 1986 — *Improving the Transfer and Use of Scientific and Technical Information. The Federal Role: Volume 2 - Problems and Issues in the Transfer and Use of STI.* Washington, DC: National Science Foundation. (Available from NTIS, Springfield, VA; PB-87-14923.)

Berul, L. H., et. al. 1965 — *DoD User-Needs Study, Phase 1. Volume 1: Management Report, Conduct of the Study, and Analysis of Data.* Philadelphia, PA: Auerbach Corporation. (Available from NTIS, Springfield, VA; AD-615 501.

Beyer, J. M. and H.M. Trice 1982 — "The Utilization Process: A Conceptual Framework and Synthesis of Empirical Findings." *Administrative Science Quarterly* 27: 591-622.

Bikson, T. K., B. E. Quint, and L. L. Johnson 1984 — *Scientific and Technical Information Transfer: Issues and Option.* Washington, DC: National Science Foundation. (Available from NTIS, Springfield, VA; PB-85-150357; also available as Rand Note 2131.)

Branscomb, L. G. 1992 — "America's Emerging Technology Policy." *Minerva* 30:3 (August): 317-336.

Branscomb, L. G. 1991 — "Toward a U.S. Technology Policy." *Issues in Science and Technology* 7:4 (Fall): 50-55.

Buckland, M. K. 1983 — *Library Services in Theory and Content.* NY: Pergamon Press.

David, P. A. 1986 — "Technology Diffusion, Public Policy, and Industrial Competitiveness." In *The Positive Sum Strategy: Harnessing Technology for Economic Growth.* R. Landau and N. Rosenberg, eds. Washington, DC: National Academy Press.

Eveland, J. D. 1987 — *Scientific and Technical Information Exchange: Issues and Findings.* Washington, DC: National Science Foundation. (Not available from NTIS.)

Fry, B. M. 1953 — *Library Organization and Management of Technical Reports Literature.* Washington, DC: The Catholic University of America Press.

Gerstberger, P. G. and T. J. Allen 1968 — "Criteria Used by Research and Develoment Engineers in the Selection of an Information Source." *Journal of Applied Psychology.* 52:4 (August): 272-279.

Gibb, J. M. and E. Phillips 1979 — Better Fate for the Grey, or Non-Conventional, Literature." *Journal of Communication Studies* 1: 225-234.

Godfrey, L. E. and H.F. Redman 1973 — *Dictionary of Report Series Codes.* (2nd ed.) NY: Special Libraries Association.

Goldhor, R. S. and R. T. Lund 1983 — "University-to-Industry Advanced Technology Transfer: A Case Study." *Research Policy* 12: 121-152.

Harris, I. W. 1966 — *The Influence of Accessibility on Academic Library Use.* Ph.D. Diss., Rutgers University, 1966. UMI 67-5262.

Mathes, J. C. and D. W. Stevenson 1976 — *Designing Technical Reports.* Indianapolis, IN: Bobbs-Merill.

McClure, C. R. 1988 — "The Federal Technical Report Literature: Research Needs and Issues." *Government Information Quarterly.* 5(1): 27-44.

McGowan, R. P. and S. Loveless 1981 — "Strategies for Information Management: The Administrator's Perspective." *Public Adminstration Review* 41(3): 331-339.

Mowery, D. C. 1983 — "Economic Theory and Government Technology Policy." *Policy Sciences* 16: 27-43.

Mowery, D. C. and N. Rosenberg 1979 — "The Influence of Market Demand Upon Innovation: A Critical Review of Some Recent Empirical Studies." *Research Policy* 8(2): 102-153.

National Academy of Sciences - National Academy of Engineering 1969 — *Scientific and Technical Communication: A Pressing National Problem and Recommendations for Its Solution.* Report by the Committee on Scientific and Technical Communication. Washington, DC: National Academy Sciences; AKA the SATCOM Report.

Pinelli, T. E. 1991 — "The Information-Seeking Habits and Practices of Engineers." *Science and Technology Libraries* 11(3): 5-25.

Pinelli, T. E. 1991 — *The Relationship Between the Use of U.S. Government Technical Reports by U.S. Aerospace Engineers and Scientists and Selected Institutional and Sociometric Variables.* Washington, DC: National Aeronautics and Space Administration. NASA TM-102774, January. (Available from NTIS, Springfield, VA; N9118898.)

Pinelli, T. E. and N. A. Glassman 1992 — *Source Selection and Information Use by U.S. Aerospace Engineers and Scientists: Results of a Telephone Survey.* Washington, DC: National Aeronautics and Space Administration. NASA TM-107658, September. (Available from NTIS, Springfield, VA; 92N33299.)

Pinelli, T. E., J. M. Kennedy, and R. O. Barclay 1991 — "The NASA/DoD Aerospace Knowledge diffusion Research Project." *Government Information Quarterly* 8(2): 219-233.

Pinelli, T. E., J. M. Kennedy, R. O. Barclay, and T. F. White 1991 — "Aerospace Knowledge Diffusion Research." *World Aerospace Technology '91: The International Review of Aerospace Design and Development* 1(1): 31-34.

Pinelli, T. E., J. M. Kennedy, and T. F. White 1992 — *Engineering Work and Information Use in Aerospace: Results of a Telephone Survey.* Washington, DC: National Aeronautics and Space Administration. NASA TM-107673, October. (Available from NTIS, Springfield, VA; 92N34233.)

President's Special Assistant for Science and Technology 1962 — *Scientific and Technological Communication in the Government.* Washington, DC: Government Printing Office; AKA the Crawford Report.

Redman, H. F. 1965/1966 — "Technical Reports: Problems and Predictions." *Arizona Librarian* 23: 11-17.

Roberts, E. B. and A. L. Frohman 1978 — "Strategies for Improving Research Utilization." *Technology Review* 80 (March/April): 32-39.

Rohde, Nancy F. 1986 — "Information Needs." In *Advances in Librarianship,* Vol. 14. W. Simonton, ed. NY: Academic Press, 49-73.

Ronco, P. G., et. al. 1964 — *Characteristics of Technical Reports That Affect Reader Behavior: A Review of the Literature.* Boston, MA: Tufts University, Institute for Psychological Research. (Available from NTIS, Springfield, VA PB-169 409.)

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

Shuchman, H. L. 1981 — *Information Transfer in Engineering.* Glastonbury, CT: The Futures Group.

Smith, R. S. 1981 — "Interaction Within the Technical Report Community." *Science and Technology Libraries* 1(4): 5-18.

Subramanyam, K. 1981 — *Scientific and Technical Information Resources.* NY: Marcel Dekker.

U.S. Department of Defense 1964	*Glossary of Information Handling.* Defense Logistics Agency, Defense Documentation Center. Cameron Station, Alexandria, VA.
Williams, F. and D. V. Gibson 1990	*Technology Transfer: A Communication Perspective.* Newbury Park, CA: Sage Publications.

APPENDIX A: PROJECT FACT SHEET

NASA/DoD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT

The process of producing, transferring, and using scientific and technical information (STI), which is an essential part of aerospace research and development (R&D), can be defined as *Aerospace Knowledge Diffusion*. Studies tell us that timely access to STI can increase productivity and innovation and help aerospace engineers and scientists maintain and improve their professional skills. These same studies indicate, however, that we know little about aerospace knowledge diffusion or about how aerospace engineers and scientists find and use STI. To learn more about this process, we have organized a research project to study knowledge diffusion. Sponsored by NASA and the Department of Defense (DoD), the *NASA/DoD Aerospace Knowledge Diffusion Research Project* is being conducted by researchers at the NASA Langley Research Center, the Indiana University Center for Survey Research, and Rensselaer Polytechnic Institute. This research is endorsed by several aerospace professional societies including the AIAA, RAeS, and DGLR and has been sanctioned by the AGARD and AIAA Technical Information Panels.

This 4-phase project is providing descriptive and analytical data about the flow of STI at the individual, organizational, national, and international levels. It is examining both the channels used to communicate STI and the social system of the aerospace knowledge diffusion process. Phase 1 investigates the information-seeking habits and practices of U.S. aerospace engineers and scientists, in particular their use of government-funded aerospace STI. Phase 2 examines the industry-government interface and emphasizes the role of the information intermediary in the knowledge diffusion process. Phase 3 concerns the academic-government interface and emphasizes the information intermediary-faculty-student interface. Phase 4 explores the information-seeking behaviors of non-U.S. aerospace engineers and scientists from Western European nations, India, Israel, Japan, and the former Soviet Union.

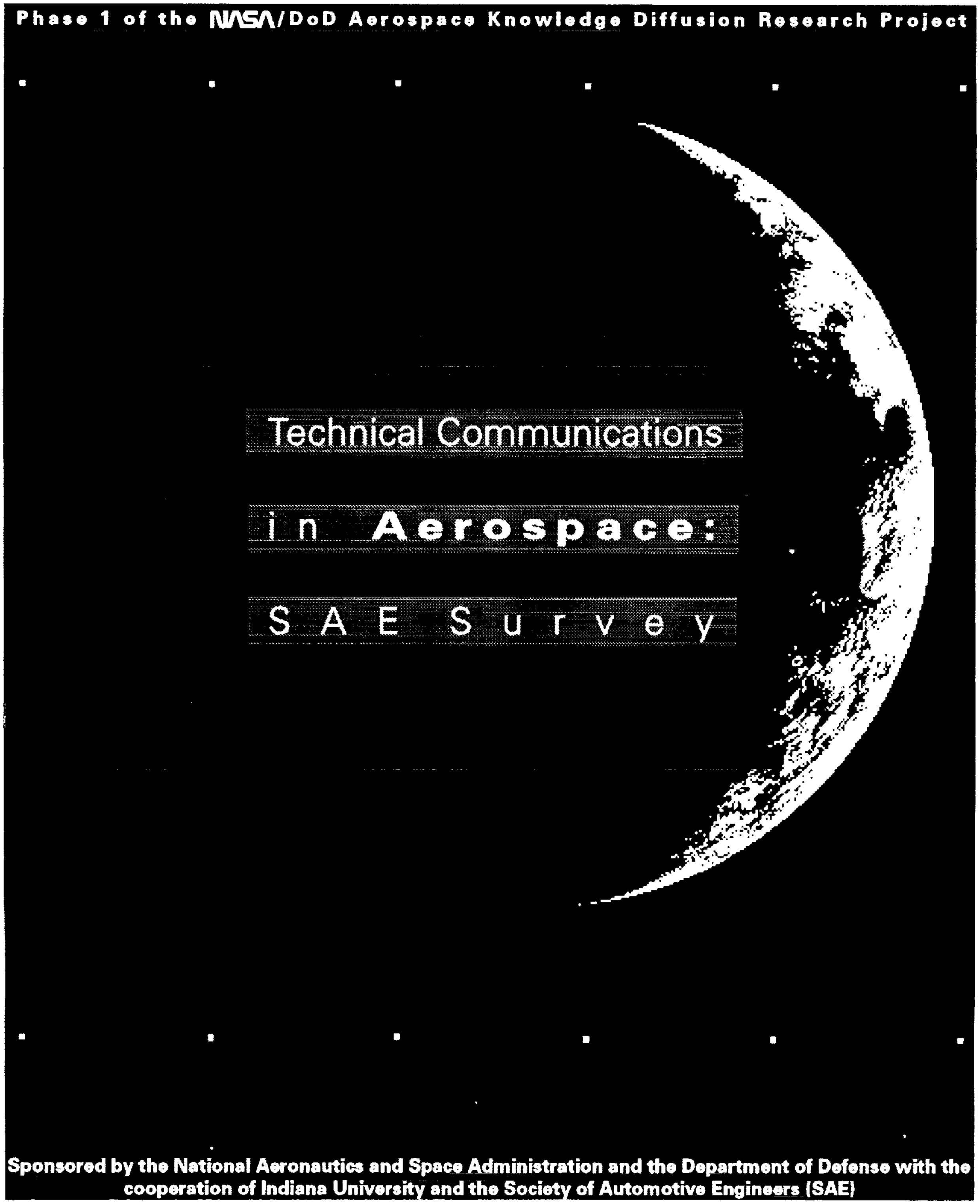
The results of this research project will help us to understand the flow of STI at the individual, organizational, national, and international levels. The findings can be used to identify and correct deficiencies; to improve access and use; to plan new aerospace STI systems; and should provide useful information to R&D managers, information managers, and others concerned with improving access to and utilization of STI. These results will contribute to increasing productivity and to improving and maintaining the professional competence of aerospace engineers and scientists. The results of our research are being shared freely with those who participate in the study.

Dr. Thomas E. Pinelli
Mail Stop 180A
NASA Langley Research Center
Hampton, VA 23681-0001
(804) 864-2491
Fax (804) 864-8311
T.E.Pinelli@larc.nasa.gov

Dr. John M. Kennedy
Center for Survey Research
Indiana University
Bloomington, IN 47405
(812) 855-2573
Fax (812) 855-2818
kennedy@isrmail.soc.indiana.edu

Ms. Rebecca O. Barclay
Electronic Information Age, Inc.
462 Washington Street
Portsmouth, VA 23704
(804) 399-5666
Fax (804) 465-0828
barclay@infi.net

APPENDIX B: SAE QUESTIONNAIRE



Phase 1 of the NASA/DoD Aerospace Knowledge Diffusion Research Project

Technical Communications in Aerospace: SAE Survey

Sponsored by the National Aeronautics and Space Administration and the Department of Defense with the cooperation of Indiana University and the Society of Automotive Engineers (SAE)

1. **Think of the most important job-related project, task, or problem you have worked on in the past 6 months. Which category <u>best</u> describes this work? (Check <u>ONLY</u> <u>ONE</u> Box)**

☐ Educational (e.g., for professional development or preparation of a lecture)

☐ Research (either basic or applied)

☐ Design

☐ Development

☐ Manufacturing

☐ Production

☐ Computer applications

☐ Management (e.g., planning, budgeting, and managing research)

☐ Other (specify)____

2. **How would you describe the overall complexity of the technical project, task, or problem you categorized in Q.1? (Circle Number)**

Very Simple 1 2 3 4 5 **Very Complex**

3. **How would you rate the amount of technical uncertainty that you faced when you started the technical project, task, or problem categorized in Q.1? (Circle Number)**

Little Uncertainty 1 2 3 4 5 **Great Uncertainty**

4. **While you were involved in the technical project, task, or problem, did you work alone or with others? (Check Box)**

☐ **Alone** ☐ **With others** → In how many groups did you work? ________________

About how many people were in each group? ________

5. **Which of the following best describes the kinds of duties you performed while working on the project? (Check Box)**

☐ Engineering ☐ Science ☐ Management ☐ Other (specify)______________________

6. **What steps did you follow to get the <u>information you needed</u> for this project, task, or problem? Please sequence these items (e.g., #1, #2, #3, #4, #5) or put an <u>X</u> beside the steps you did not use.**

<u>Sequence</u>

_____ Used my personal store of technical information, including sources I keep in my office

_____ Spoke with co-workers or people <u>inside</u> my organization

_____ Spoke with colleagues <u>outside</u> my organization

_____ Spoke with a librarian or technical information specialist

_____ Used literature resources (e.g., conference papers, journals, technical reports) found in my organization's library

(If you used none of the above steps, check here_____)

20. **Approximately how many times in the past 6 months did you write or prepare the following alone or in a group? (If in a group, how many people were in each group?)**

Times in Past 6 Months Produced

		Alone	In a group	Average No. of People
a	Abstracts	______ times	______ times →	______
b	Journal articles	______	______	______
c	Conference/Meeting papers	______	______	______
d	Trade/Promotional literature	______	______	______
e	Drawings/Specifications	______	______	______
f	Audio/Visual materials	______	______	______
g	Letters	______	______	______
h	Memoranda	______	______	______
i	Technical proposals	______	______	______
j	Technical manuals	______	______	______
k	Computer program documentation	______	______	______
l	AGARD technical reports	______	______	______
m	U.S. Government technical reports	______	______	______
n	In-house technical reports	______	______	______
o	Technical talks/Presentations	______	______	______

21. **Approximately how many times in the past 6 months did you <u>use</u> the following?**

		Times used in 6 months
a	Abstracts	______
b	Journal articles	______
c	Conference/Meeting papers	______
d	Trade/Promotional literature	______
e	Drawings/Specifications	______
f	Audio/Visual materials	______
g	Letters	______
h	Memoranda	______
i	Technical proposals	______
j	Technical manuals	______
k	Computer program documentation	______
l	AGARD technical reports	______
m	U.S. Government technical reports	______
n	In-house technical reports	______
o	Technical talks/Presentations	______

22. (Even if you don't use them...) What is your opinion of JOURNAL ARTICLES? (Circle Number)

They are easy to physically obtain	1	2	3	4	5	They are difficult to physically obtain
They are easy to use or to read	1	2	3	4	5	They are difficult to use or to read
They are inexpensive	1	2	3	4	5	They are expensive
They are of good technical quality	1	2	3	4	5	They are of poor technical quality
They have comprehensive data and information	1	2	3	4	5	They have incomplete data and information
They are relevant to my work	1	2	3	4	5	They are irrelevant to my work
They can be obtained at a nearby location or source	1	2	3	4	5	They must be obtained from a distant location or source
I've had good prior experiences using them	1	2	3	4	5	I've had bad prior experiences using them

23. If you were deciding whether or not to use JOURNAL ARTICLES in your work, how important would the following factors be? (Check Box)

	Very Unimportant Factor				Very Important Factor
Are easy to physically obtain	☐	☐	☐	☐	☐
Are easy to use or to read	☐	☐	☐	☐	☐
Are inexpensive	☐	☐	☐	☐	☐
Have good technical quality	☐	☐	☐	☐	☐
Have comprehensive data and information	☐	☐	☐	☐	☐
Are relevant to my work	☐	☐	☐	☐	☐
Can be obtained at a nearby location or source	☐	☐	☐	☐	☐
Had good prior experiences using them	☐	☐	☐	☐	☐

24. In your work, how important is it for you to use JOURNAL ARTICLES? (Circle Number)

Very Unimportant 1 2 3 4 5 **Very Important**

25. Do you use JOURNAL ARTICLES in your work? (Check Box)

☐ **Yes** ☐ **No (Skip to Q.27)**

26. How many times in the past 6 months have you used JOURNAL ARTICLES?

__________**Times in the Past 6 Months**

27. **(Even if you don't use them...) What is your opinion of CONFERENCE or MEETING PAPERS? (Circle Number)**

They are easy to physically obtain	1	2	3	4	5	They are difficult to physically obtain
They are easy to use or to read	1	2	3	4	5	They are difficult to use or to read
They are inexpensive	1	2	3	4	5	They are expensive
They are of good technical quality	1	2	3	4	5	They are of poor technical quality
They have comprehensive data and information	1	2	3	4	5	They have incomplete data and information
They are relevant to my work	1	2	3	4	5	They are irrelevant to my work
They can be obtained at a nearby location or source	1	2	3	4	5	They must be obtained from a distant location or source
I've had good prior experiences using them	1	2	3	4	5	I've had bad prior experiences using them

28. **If you were deciding whether or not to use CONFERENCE or MEETING PAPERS in your work, how important would the following factors be? (Check Box)**

	Very Unimportant Factor				Very Important Factor
Are easy to physically obtain	☐	☐	☐	☐	☐
Are easy to use or to read	☐	☐	☐	☐	☐
Are inexpensive	☐	☐	☐	☐	☐
Have good technical quality	☐	☐	☐	☐	☐
Have comprehensive data and information	☐	☐	☐	☐	☐
Are relevant to my work	☐	☐	☐	☐	☐
Can be obtained at a nearby location or source	☐	☐	☐	☐	☐
Had good prior experiences using them	☐	☐	☐	☐	☐

29. **In your work, how important is it for you to use CONFERENCE or MEETING PAPERS? (Circle Number)**

Very Unimportant 1 2 3 4 5 **Very Important**

30. **Do you use CONFERENCE or MEETING PAPERS in your work? (Check Box)**

☐ **Yes** ☐ **No (Skip to Q.32)**

31. **How many times in the past 6 months have you used CONFERENCE or MEETING PAPERS?**

__________**Times in the Past 6 Months**

32. (Even if you don't use them...) What is your opinion of IN-HOUSE TECHNICAL REPORTS? (Circle Number)

They are easy to physically obtain	1	2	3	4	5	They are difficult to physically obtain
They are easy to use or to read	1	2	3	4	5	They are difficult to use or to read
They are inexpensive	1	2	3	4	5	They are expensive
They are of good technical quality	1	2	3	4	5	They are of poor technical quality
They have comprehensive data and information	1	2	3	4	5	They have incomplete data and information
They are relevant to my work	1	2	3	4	5	They are irrelevant to my work
They can be obtained at a nearby location or source	1	2	3	4	5	They must be obtained from a distant location or source
I've had good prior experiences using them	1	2	3	4	5	I've had bad prior experiences using them

33. If you were deciding whether or not to use IN-HOUSE TECHNICAL REPORTS in your work, how important would the following factors be? (Check Box)

	Very Unimportant Factor				Very Important Factor
Are easy to physically obtain	☐	☐	☐	☐	☐
Are easy to use or to read	☐	☐	☐	☐	☐
Are inexpensive	☐	☐	☐	☐	☐
Have good technical quality	☐	☐	☐	☐	☐
Have comprehensive data and information	☐	☐	☐	☐	☐
Are relevant to my work	☐	☐	☐	☐	☐
Can be obtained at a nearby location or source	☐	☐	☐	☐	☐
Had good prior experiences using them	☐	☐	☐	☐	☐

34. In your work, how important is it for you to use IN-HOUSE TECHNICAL REPORTS? (Circle Number)

Very Unimportant 1 2 3 4 5 **Very Important**

35. Do you use IN-HOUSE TECHNICAL REPORTS in your work? (Check Box)

☐ **Yes** ☐ **No (Skip to Q.37)**

36. How many times in the past 6 months have you used IN-HOUSE TECHNICAL REPORTS?

__________Times in the Past 6 Months

47. **(Even if you don't use them...) What is your opinion of <u>NASA TECHNICAL REPORTS</u>? (Circle Number)**

They are easy to physically obtain	1	2	3	4	5	They are difficult to physically obtain
They are easy to use or to read	1	2	3	4	5	They are difficult to use or to read
They are inexpensive	1	2	3	4	5	They are expensive
They are of good technical quality	1	2	3	4	5	They are of poor technical quality
They have comprehensive data and information	1	2	3	4	5	They have incomplete data and information
They are relevant to my work	1	2	3	4	5	They are irrelevant to my work
They can be obtained at a nearby location or source	1	2	3	4	5	They must be obtained from a distant location or source
I've had good prior experiences using them	1	2	3	4	5	I've had bad prior experiences using them

48. **If you were deciding whether or not to use <u>NASA TECHNICAL REPORTS</u> in your work, how important would the following factors be? (Check Box)**

	Very Unimportant Factor				Very Important Factor
Are easy to physically obtain	☐	☐	☐	☐	☐
Are easy to use or to read	☐	☐	☐	☐	☐
Are inexpensive	☐	☐	☐	☐	☐
Have good technical quality	☐	☐	☐	☐	☐
Have comprehensive data and information	☐	☐	☐	☐	☐
Are relevant to my work	☐	☐	☐	☐	☐
Can be obtained at a nearby location or source	☐	☐	☐	☐	☐
Had good prior experiences using them	☐	☐	☐	☐	☐

49. **In your work, how important is it for you to use <u>NASA TECHNICAL REPORTS</u>? (Circle Number)**

Very Unimportant 1 2 3 4 5 **Very Important**

50. **Do you use <u>NASA TECHNICAL REPORTS</u> in your work? (Check Box)**

☐ **Yes** ☐ **No (Skip to Q.52)**

51. **How many times in the past 6 months have you used <u>NASA TECHNICAL REPORTS</u>?**

__________Times in the Past 6 Months

over ⟶

The following data will be used to determine whether people with different backgrounds have different technical communication practices.

52. Please list all of your degrees.

- ☐ No degree
- ☐ Bachelors in ____________________
- ☐ Masters in ____________________
- ☐ M B A
- ☐ J D
- ☐ Doctorate in ____________________
- ☐ Other (specify) ____________________

53. Your years of professional aerospace work experience: __________Years

54. The type of organization where you work: (Check ONLY ONE Box)

- ☐ Academic
- ☐ Industry
- ☐ Government
- ☐ Not-for-profit
- ☐ Other (specify) ________________

55. Which of the following BEST describes your primary professional duties? (Check ONLY ONE Box)

- ☐ Research
- ☐ Administration/Mgt (private sector)
- ☐ Administration/Mgt (not-for-profit)
- ☐ Design/Development
- ☐ Teaching/Academic (may include research)
- ☐ Manufacturing/Production
- ☐ Private consultant
- ☐ Service/Maintenance
- ☐ Marketing/Sales
- ☐ Other (specify) ____________________

56. Your academic preparation was as a(n):

- ☐ Engineer
- ☐ Scientist
- ☐ Other (specify) ____________________

57. In your present job, you consider yourself primarily a(n):

- ☐ Engineer
- ☐ Scientist
- ☐ Other (specify) ____________________

58. The SAE aerospace membership categories are listed below. Please check the ONE box that best classifies your organization.

- ☐ Airplanes
- ☐ Helicopters
- ☐ Space vehicles (incls. missiles & satellites)
- ☐ Parts, accessories, & component mfg.
- ☐ Operations & maintenance
- ☐ Avionics, electronic, and electrical systems
- ☐ Ground support
- ☐ Air transportation - trunk, regional & int'l
- ☐ Air transportation - business & general aviation
- ☐ Other (specify)____________________

Project Number :

Reply to: **NASA Langley Research Center**
Mail Stop 180 A
Hampton, VA 23665-5225

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.			
1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE May 1994	3. REPORT TYPE AND DATES COVERED Technical Memorandum	
4. TITLE AND SUBTITLE The Technical Communications Practices of U.S. Aerospace Engineers and Scientists: Results of the Phase 1 SAE Mail Survey*			5. FUNDING NUMBERS WU 505-90
6. AUTHOR(S) Thomas E. Pinelli, Rebecca O. Barclay, and John M. Kennedy			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) NASA Langley Research Center Hampton, VA 23681-0001			8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Aeronautics and Space Administration Washington, DC 20546-0001			10. SPONSORING/MONITORING AGENCY REPORT NUMBER NASA TM-109088
11. SUPPLEMENTARY NOTES *Report number 24 under the NASA/DoD Aerospace Knowledge Diffusion Research Project. Thomas E. Pinelli: Langley Research Center, Hampton, VA; Rebecca O. Barclay: Rensselaer Polytechnic Institute, Troy, NY; John M. Kennedy: Indiana University, Bloomington, IN.			
12a. DISTRIBUTION/AVAILABILITY STATEMENT Unclassified–Unlimited Subject Category 82			12b. DISTRIBUTION CODE
13. ABSTRACT *(Maximum 200 words)* The U.S. government technical report is a primary means by which the results of federally funded research and development (R&D) are transferred to the U.S. aerospace industry. However, little is known about this information product in terms of its actual use, importance, and value in the transfer of federally funded R&D. To help establish a body of knowledge, the U.S. government technical report is being investigated as part of the *NASA/DoD Aerospace Knowledge Diffusion Research Project*. In this report, we summarize the literature on technical reports and provide a model that depicts the transfer of federally funded aerospace R&D via the U.S. government technical report. We present results from our investigation of aerospace knowledge diffusion vis-á-vis the U.S. government technical report, and present the results of research that investigated aerospace knowledge diffusion vis-á-vis the technical communications practices of U.S. aerospace engineers and scientists affiliated with the Society of Automotive Engineers (SAE).			
14. SUBJECT TERMS Knowledge diffusion; Aerospace engineers and scientists; Information use; and U.S. government technical reports			15. NUMBER OF PAGES 52 16. PRICE CODE A04
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT