AD-A235,648

NASA-TM-101,746

NASA/DoD Aerospace Knowledge Diffusion Research Project

NASA-TM-101746 19910018719

Paper Seven

The NASA/DoD Aerospace Knowledge Diffusion Research Project: "The DoD Perspective"

Paper Presented at the
Defense Technical Information Center (DTIC)
1990 Annual Users Training Conference
Alexandria, VA
November 1, 1990

Thomas E. Pinelli
NASA Langley Research Center
Hampton, Virginia

John M. Kennedy
Indiana University
Bloomington, Indiana

KNOWLEDGE DIFFUSION INNOVATION NASA DoD AEROSPACE

NASA
National Aeronautics and Space Administration

Department of Defense

INDIANA UNIVERSITY

ACKNOWLEDGEMENT

The authors wish to express their appreciation to Mr. Kurt N. Molholm, Administrator, Defence Technical Information Center, and to Mr. Walter R. Blados, Deputy, Scientific and Technical Information, Assistant Secretary of the Air Force (retired), for their financial and moral support of the NASA/DoD Aerospace Knowledge Diffusion Research Project.

Dr. John M. Kennedy
Center for Survey Research
Indiana University
1022 East Third Street
Bloomington, IN 47401
(812) 855-2573
(812) 855-2818 FAX

Dr. Thomas E. Pinelli
Mail Stop 180A
NASA Langley Research Center
Hampton, VA 23665-5225
(804) 864-2491
(804) 864-6131 FAX

INTRODUCTION

Although the U.S. aerospace industry continues to be the leading positive contributor to the balance of trade among all merchandise industries, it is experiencing significant changes whose implications may not be well understood.[1] Increasing U.S. collaboration with foreign producers will result in a more international manufacturing environment, which will allow for a more rapid diffusion of technology, increasing pressure on U.S. aerospace companies to push forward with new technological developments, and to take steps designed to maximize the inclusion of recent technological developments into the research and development (R&D) process.

To remain a world leader in aerospace, the U.S. must take the steps necessary to improve and maintain the professional competency of aerospace engineers and scientists, and enhance innovation and productivity. How well these objectives are met, and at what cost, depends on a variety of factors, but largely on the ability of aerospace engineers and scientists to acquire and process the results of NASA/DoD funded R&D.

The ability of U.S. aerospace engineers and scientists to identify, acquire, and use scientific and technical information (STI) is of paramount importance to the efficiency of the R&D process. Testimony to the central role of STI in the R&D process is found in numerous studies (Fischer, 1980). These studies show, among other things, that U.S. aerospace engineers and scientists devote more time, on the average, to the communication of technical information than to any other scientific or technical activity (Pinelli, et al., 1989). We concur, therefore, with Fischer's (1980) conclusion that the "role of scientific and technical communication is thus central to the success of the innovation process, in general, and the management of R&D activities, in particular."

The **NASA/DoD Aerospace Knowledge Diffusion Research Project** was developed because, in terms of empirically derived data, very little is known about the diffusion of knowledge in the aerospace industry both in terms of the channels used to communicate the ideas and the information-gathering habits and practices of the members of the social system (i.e., aerospace engineers and scientists). Even less is known about the system through which the results of federally-funded aerospace R&D is diffused throughout the aerospace community. Understanding how STI is communicated through certain channels over time among members of the social system would contribute to increasing productivity, stimulating innovation, and improving and maintaining the professional competence of U.S. aerospace engineers and scientists.

---

[1] "Aerospace" includes aeronautics, space science, space technology, and related fields.

PROJECT OVERVIEW

The **NASA/DoD Aerospace Knowledge Diffusion Research Project** is a cooperative effort that is sponsored by NASA, Codes RF and NTT, and the DoD, Office of the Assistant Secretary of the Air Force, Deputy for Scientific and Technical Information. The research project is a joint effort of the Indiana University Center for Survey Research and the NASA Langley Research Center.

The project will provide descriptive and analytical data regarding the flow of STI at the individual, organizational, national, and international levels. It will examine both the channels used to communicate information and the social system of the aerospace knowledge diffusion process. The results of the project should provide useful information to R&D managers, information managers, and others concerned with improving access to and use of STI.

Several major barriers to effective knowledge diffusion exist in the U.S. **First,** the very low level of monetary support for knowledge transfer compared with knowledge production suggests that dissemination efforts are not viewed as an important component of the R&D process. **Second,** there are mounting reports from users about difficulties in getting appropriate information useful for problem solving and decision making. **Third,** rapid advances in many areas of STI knowledge can be fully exploited only if they are quickly translated into further research and application. **Fourth,** current mechanisms are often inadequate to help the user assess the quality of available information. **Fifth,** the characteristics of actual usage behavior are not considered in making available useful and easily retrieved information.

These deficiencies must be remedied if the results of federally funded R&D are to be successfully applied to innovation, problem solving, and productivity. Only by maximizing the R&D process can the U.S. maintain its international competitive edge in aerospace.

Project Assumptions

1. Rapid diffusion of technology and technological developments requires an understanding of the aerospace knowledge diffusion process.

2. Knowledge production, transfer, and utilization are equally important components of the aerospace knowledge diffusion process.

3. Understanding the channels; the information products involved in the production, transfer, and utilization of aerospace information; and the information-seeking habits, practices, and preferences of aerospace engineers and scientists is necessary to understand aerospace knowledge diffusion.

4. The knowledge derived from federally funded aerospace R&D is indispensable in maintaining the vitality and international competitiveness of the U.S.

aerospace industry and essential in maintaining and improving the professional competency of U.S. aerospace engineers and scientists.

5. The U.S. government technical report plays an important, but as yet undefined, role in the transfer and utilization of knowledge derived from federally funded aerospace R&D.

6. Librarians, as information intermediaries, play an important, but as yet undefined, role in the transfer and utilization of knowledge derived from federally funded aerospace R&D.

Project Objectives

1. Understanding the aerospace knowledge diffusion process at the individual, organizational, and national levels, placing particular emphasis on the diffusion of federally funded aerospace STI.

2. Understanding the international aerospace knowledge diffusion process at the individual and organizational levels, placing particular emphasis on the systems used to diffuse the results of federally funded aerospace STI.

3. Understanding the roles NASA/DoD technical reports and aerospace librarians play in the transfer and utilization of knowledge derived from federally funded aerospace R&D.

4. Achieving recognition and acceptance within NASA, DoD and throughout the aerospace community that STI is a valuable strategic resource for innovation, problem solving, and productivity.

5. Providing results that can be used to optimize the effectiveness and efficiency of the Federal STI aerospace transfer system and exchange mechanism.

Project Design

The initial thrust of the aerospace knowledge diffusion research project is largely exploratory and descriptive; it focuses on the information channels and the members of the social system associated with the Federal aerospace knowledge diffusion process. It provides a pragmatic basis for understanding how the results of NASA/DoD research diffuse into the aerospace R&D process. Over the long term, the project will provide an empirical basis for understanding the aerospace knowledge diffusion process at the individual, organizational, national, and international levels. An outline of the descriptive portion of the project is contained in Table 1 as "A Five Year Program of Research on Aerospace Knowledge Diffusion."

Table 1. A Five Year Program of Research on Aerospace Knowledge Diffusion

	Phase 1 1989–1991	Phase 2 1990–1992	Phase 3 1990–1991	Phase 4 1991–1994
Level	•National •Individuals •U.S. Aerospace Engineers and Scientists	•National •Individuals and Organizations •Aerospace librarians in gov't and industry •U.S. gov't and aerospace industries	•National •Individuals and Organizations •U.S. academic faculty, students, and engineering libraries	•International •Individuals and Organizations
Focus	•Knowledge production and use	•Knowledge transfer and use	•Knowledge transfer and use	•Knowledge production, transfer, and use
Emphasis	•Use, importance, and production of NASA/DOD STI (e.g., technical reports) •Impediments to access, transfer, and use of NASA/DOD STI •Use and importance of AGARD and non-U.S. STI •Use and importance of information technology •Information sources used in problem solving	•Use, importance, and production of NASA/DOD STI (e.g., technical reports) •Impediments to access, transfer, and use of NASA/DOD STI •Use and importance of AGARD and non-U.S. STI •Use and importance of information technology •Effectiveness of system used to transfer U.S. gov't funded STI	•Use, importance, and production of NASA/DOD STI (e.g., technical reports) •Impediments to access, transfer, and use of NASA/DOD STI •Use and importance of AGARD and non-U.S. STI •Use and importance of information technology •Effectiveness of system used to transfer U.S. gov't funded STI	•Use and importance of NASA/DOD STI •Use of AGARD and non-U.S. STI •Impediments to access, transfer, and use of aerospace STI •Use of information technology •System used to transfer results of gov't funded aerospace STI non-U.S. aerospace STI, and systems, policies, and practices
Subjects	•AIAA membership •SAE membership	•U.S. aerospace librarians in gov't and industry •Selected U.S. gov't facilities and aerospace companies	•U.S. aerospace faculty, academic engineering libraries, and U.S. aerospace students (seniors) in USRA capstone design courses	•RAeS •aerospace faculties and students •DGLR •JSASS •aerospace librarians
Method	•Pilot study •Self-administered mail questionnaires •Telephone follow-ups	•Self-administered mail questionnaires •Personal interviews •Telephone follow-ups	•Self-administered mail questionnaires •Personal interviews •Telephone follow-ups	•Pilot study •Self-administered mail questionnaires
Desired Outcomes	•Understanding of individual information-seeking behaviors of U.S. aerospace engineers and scientists •Explain use/non-use of U.S. gov't funded STI products and services by U.S. aerospace engineers and scientists	•Understanding of the internal flow of aerospace STI in gov't and industry •Understanding of the system used to transfer results of U.S. gov't funded aerospace STI	•Understanding of the internal flow of aerospace STI in academia •Understanding of the system used to transfer results of U.S. gov't funded aerospace STI	•Understanding of individual information-seeking behavior •Understanding of the system used to transfer results of gov't funded aerospace STI •Understanding of non-U.S. aerospace STI systems, policies, and practices

Phase 1 of the 4-phase project is concerned with the information-seeking habits and practices of U.S. aerospace engineers and scientists, with particular emphasis being placed on their use of federally funded aerospace STI products and services. The conceptual model shown in figure 1 assumes a consistent internal logic that governs the information-seeking and processing behavior of aerospace engineers and scientists despite any individual differences they may exhibit.

The results of the **Phase 1 Pilot Study** indicate that U.S. aerospace engineers and scientists spend approximately 65 percent of a 40-hour work week communicating STI. The types of information and the information products used and produced in performing professional duties are similar, with basic STI and in-house technical data most frequently reported. **Internal** STI to the organization, which includes NASA/DoD technical reports, journal articles, and conference/ meeting papers is preferred over **external** STI. Respondents identified informal channels and personalized sources as the primary methods of seeking STI, followed by the use of formal information sources when solving technical problems. Only after completing an informal search, followed by using formal information sources, do they turn to librarians and technical information specialists for assistance.

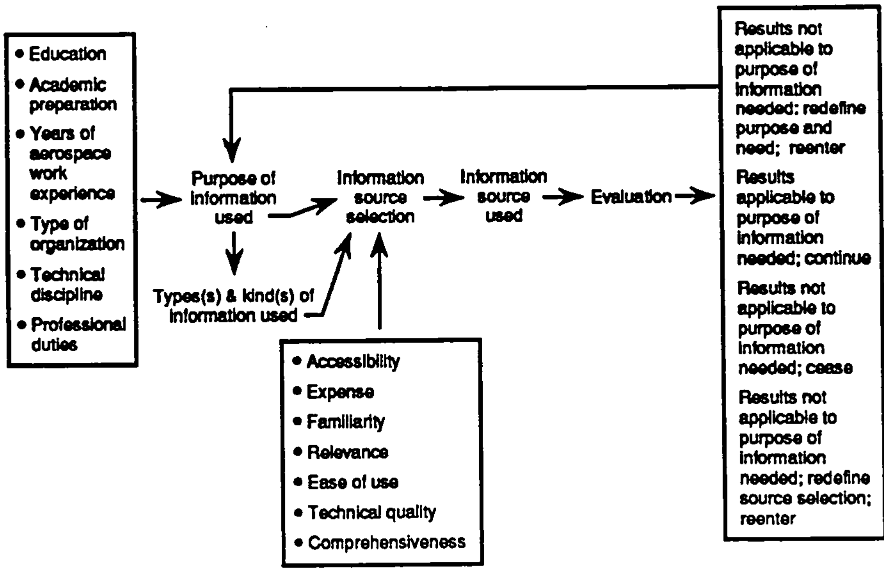

Figure 1. A Conceptual Model for the Use, Transfer, and Production of STI by U.S. Aerospace Engineers and Scientists

Phase 2 focuses on aerospace knowledge transfer and use within the larger social system, placing particular emphasis on the flow of aerospace STI in government and industry and the role of the information intermediary (i.e., the aerospace librarian/technical information specialist) in knowledge transfer. In Phase 2, the process of innovation in the U.S. aerospace industry is conceptualized as an infor- mation processing system which must deal with work-related uncertainty through patterns of technical communications. Information processing in aerospace R&D (figure 2) is viewed as an ongoing problem solving cycle involving each activity within the innovation process, the larger organization, and the external world.

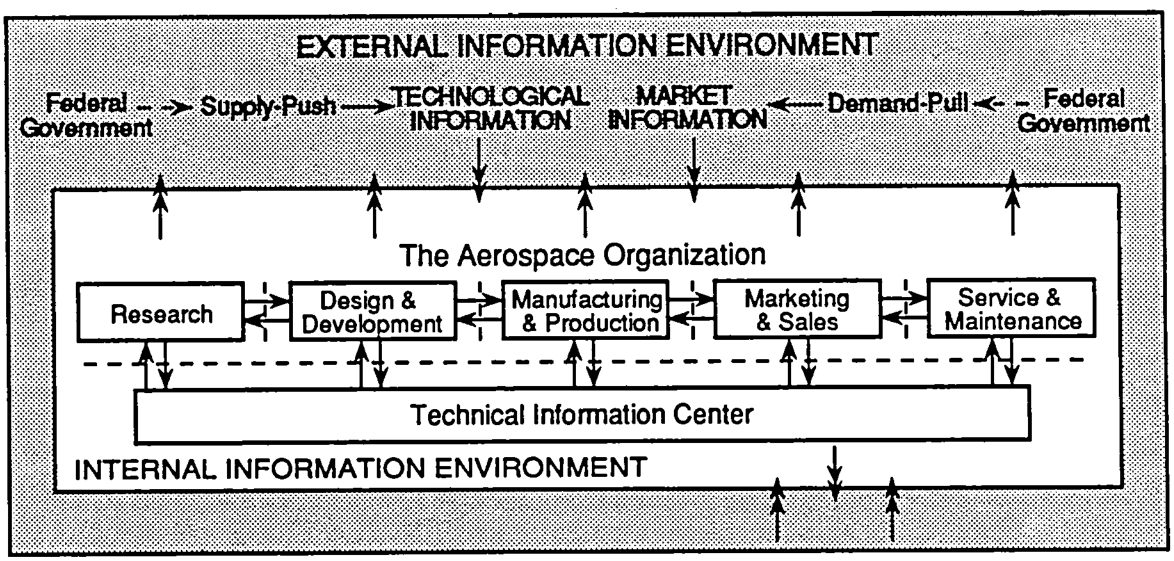

Figure 2. The Aerospace R&D Process as an Information Processing System.

Phase 3 focuses on knowledge use and transfer at the individual and organizational levels in the academic sector of the aerospace community. Faced with shrinking enrollments, particularly at the graduate level, university aerospace programs must find ways to maintain the talent pool that will advance aerospace technological development and guarantee U.S. competitiveness.

Phase 4 examines knowledge production, use, and transfer among non-U.S. individuals and aerospace organizations, specifically in Western Europe and Japan. As U.S. collaboration with foreign aerospace technology producers increases, a more international manufacturing environment will arise, fostering an increased flow of U.S. trade. To cooperate in joint ventures as well as to compete successfully at the international level, U.S. aerospace industries will need to develop methods to collect, translate, analyze, and disseminate the best of foreign aerospace STI.

OVERVIEW OF THE FEDERAL AEROSPACE KNOWLEDGE DIFFUSION PROCESS

A model (figure 3) that depicts the transfer of federally funded aerospace R&D from "producer to user" is composed of two parts -- the **informal** that relies on collegial contacts and the **formal** that relies on surrogates, information products, and information intermediaries to complete the transfer process.

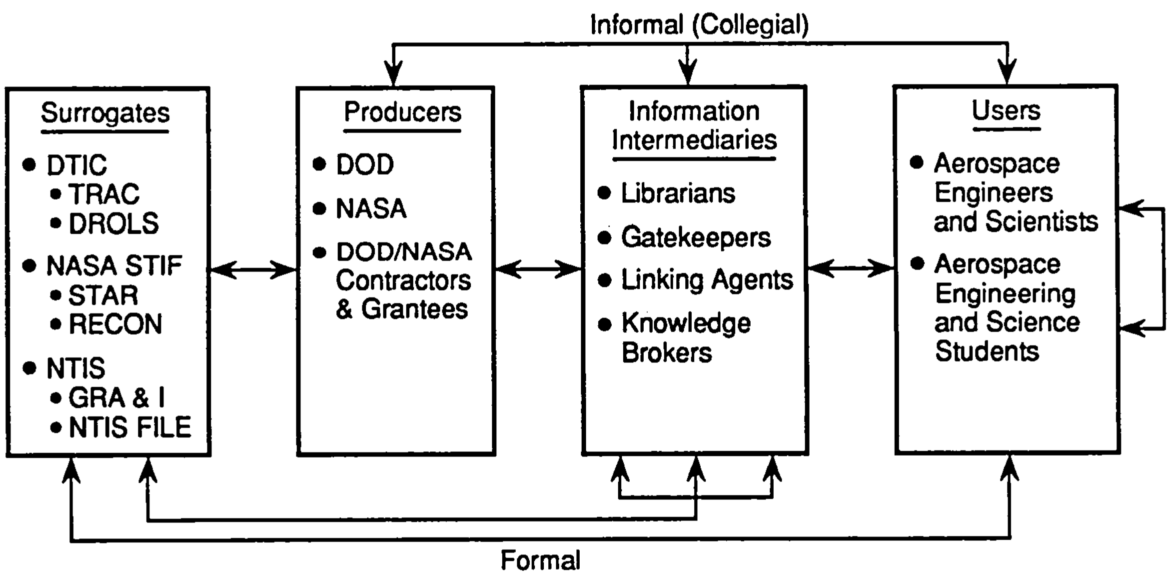

Figure 3. A Model Depicting the Transfer of Federally Funded Aerospace R&D.

Surrogates serve as technical report repositories or clearinghouses for the producers and include the Defense Technical Information Center (DTIC), the NASA Scientific and Technical Information Facility (NASA STIF), and the National Technical Information Service (NTIS). These surrogates have created a variety of technical report announcement journals such as TRAC (Technical Report Announcement Circular) and

STAR (Scientific and Technical Aerospace Reports) and computerized retrieval systems such as DROLS (Defense RDT&E Online System) and RECON (REmote CONsole) that permit online access to technical report databases.

The producers are NASA and the DoD and their contractors and grantees. Producers depend upon surrogates and information intermediaries to complete the knowledge transfer process. When U.S. government 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 are set aside to be used by the author for the "scientist-to-scientist" exchange of information at the individual level.

Information intermediaries are, in large part, librarians and technical information specialists in academia, government, and industry. Information intermediaries represent the producers and serve as what McGowan and Loveless (1981) describe as "knowledge brokers" or "linking agents." The more "active" the intermediary, the more effective the transfer process becomes (Goldhar and Lund, 1985). Active intermediaries take information from one place and move it to another, often face-to-face. 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).

Two problems exist with the **formal** part of the system. First, the **formal** part of the system uses one-way producer-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). Second, the **formal** part relies heavily on information intermediaries to complete the knowledge transfer process. Empirical findings on the effectiveness of information intermediaries and the role(s) they play in knowledge transfer are sparse and inconclusive.

The problem with the **informal** part of the system is that 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 of 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 -- information that is becoming more interdisciplinary in nature and more international in scope.

THE DoD PERSPECTIVE

The U.S. aerospace industry exhibits certain characteristics which make it unique among other industries. First, the U.S. aerospace sector leads all other industries in expenditures for R&D (U.S. Department of Commerce, 1990). Second, the U.S. aerospace industry has benefitted as a technological "borrower" from developments in other industries such as metallurgy, materials, chemicals, and petroleum (Mowery and Rosenberg, 1982). Third, the aerospace industry, in particular the commercial aviation sector, is characterized by the high degree of systemic complexity embodied in its products. Finally, the U.S. aerospace industry, principally the commercial aviation sector, has been the beneficiary of federally funded R&D for nearly a century. The commercial aviation sector has also benefitted from considerable investment, in terms of research and procurement, by the Department of Defense (DoD). "Although not intended to support innovation in any but military airframe and propulsion technologies, [this investment] has, nonetheless, yielded indirect, but very important, technological spillovers to the commercial aircraft industry" (Mowery, 1985).

The DoD plays an enormously significantly role in the "supply-push" side of the aerospace knowledge diffusion process. Research supported by the DoD has yielded indirect, but very important, innovative spillovers to the commercial aircraft sector of the U.S. aerospace industry, most notably in the areas of airframe development, aircraft propulsion, avionics, and flight control systems. The demands of the military for performance pushed the development and early application of many technologies. The military supported jet engine development, provided continued support for the development of specific military engines whose cores were adapted for commercial use, and provided the test-beds for the technological development of early commercial jet aircraft (March, 1989). The development of the first jet engine in the United States was financed entirely by the DoD, reflecting "both the perceived military urgency of the project, and the lack of interest in the development of such an engine expressed by commercial aircraft firms prior to 1940" (Mowery and Rosenberg, 1982).

Data and Research Methods

The data for this paper were collected as parts of Phases 1, 2 and 3 of the **NASA/DoD Aerospace Knowledge Diffusion Project**. The results of surveys conducted in each Phase are reported separately. These results comprise only a selected portion of the DoD data collected in the Project.

Phase 1. The sample for Phase 1 of the NASA/DoD Aerospace Knowledge Diffusion Project was drawn from the membership of the American Institute of Astronautics and Aeronautics (AIAA) as of January, 1988. The AIAA is a professional research society comprised of aerospace engineers and scientists. A twenty percent sample of AIAA members were selected for the Phase 1 surveys.

Three surveys of AIAA members were conducted as part of Phase 1. The sample for the first survey was 3298 AIAA members. 2016 members returned usable questionnaires. The second survey had a sample of 1735 members and 975 usable questionnaires were returned. For the third survey, the numbers were 1705 and 955 respectively. In earlier research, (Kennedy and Pinelli, 1990) we reported an analysis of the response rates and patterns. The adjusted response rate for these surveys was between 65 and 70 percent. The surveys were conducted from May 1989 through February 1990.

The first questionnaire focused on the following topics: the use and evaluation of conference and meeting papers, journal articles, government technical reports, and in-house technical reports. It also contained questions related to the use of information technology, the steps used in conducting information searches and demographic information. This survey is not reported here.

The second questionnaire focused on the use and evaluation of NASA technical reports, DoD technical reports, AGARD technical reports, foreign technical reports, journal articles and conference and meeting papers. The questionnaire also asked about the current sources of research funding and demographic information. Figures 4 through 9 are based on these data. Eighty-four percent of these respondents received some federal funding. Most are well-educated: 25 percent have a BS; 39 percent a MS; and 27 percent a Ph.D. Eighty-four percent were trained as engineers and eleven percent as scientists, but 67 percent classify their current duties as engineers.

Figure 4 shows the proportion of respondents who used a NASA, DoD or AGARD technical report in the six months prior to completing the questionnaire.

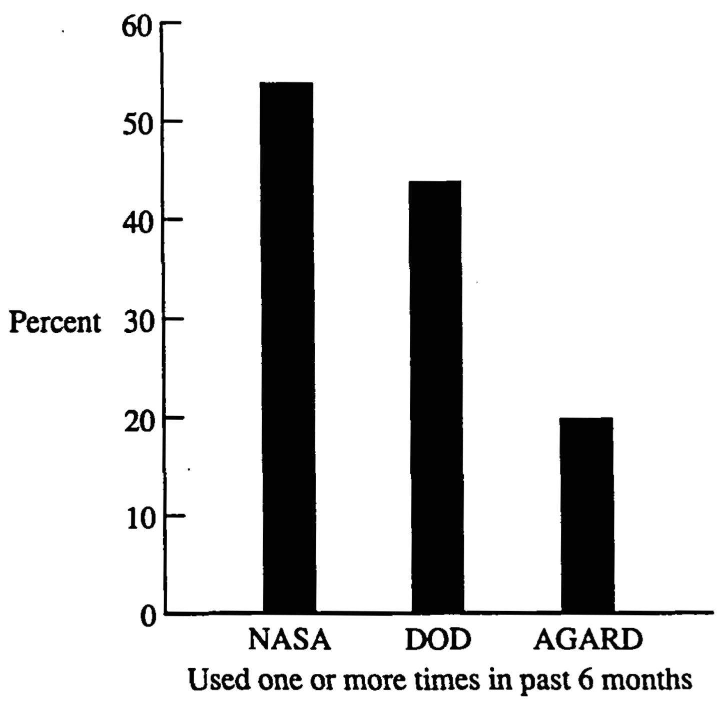

Figure 4. Use of Technical Reports by U.S. Aerospace Engineers and Scientists.

Approximately 50 percent of the sample reported using at least one NASA technical report in the period. Forty-three percent reported using a DoD technical report and about 19 percent said they used at least one AGARD technical report.

The respondents were asked to evaluate the importance of information sources in performing their current professional duties. They were asked to use a five point scale where the end scores were "very important" and "not at all important". Figure 5 shows the proportion who answered with either a "1" or a "2" on the scale.

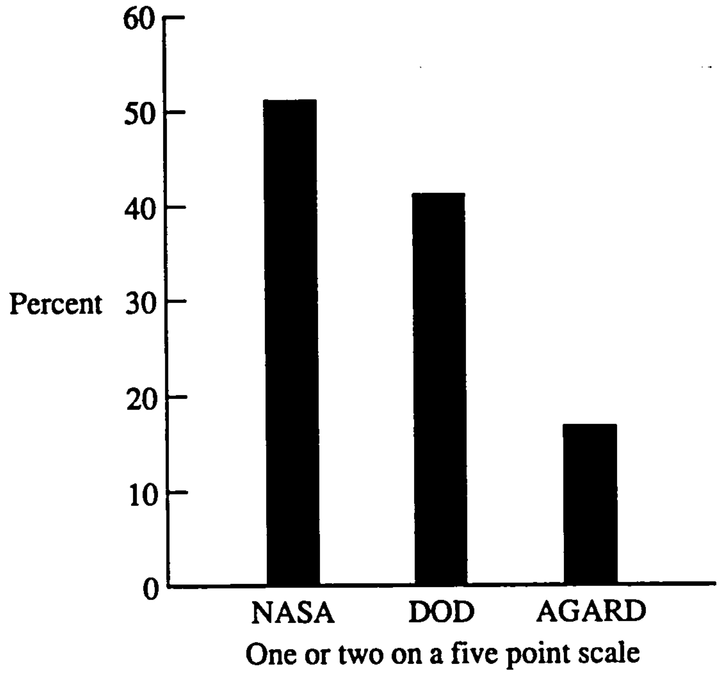

Figure 5. Importance of Technical Reports to U.S. Aerospace Engineers and Scientists.

Forty-one percent reported that DoD technical reports were important in performing their current duties. The percentages of the sample reporting similar importance for NASA and AGARD technical reports were 51 and 17 percent respectively. The data from Figures 4 and 5 indicate that the NASA and DoD technical reports were used regularly by U.S. aerospace researchers and that these technical reports were important to their research.

Those who reported they did not use each of the technical reports were asked the reasons why they were not used. Figure 6 contains the proportion who responded "yes" to each reason when asked specifically about DoD reports. The reasons reported in figure 6 were: not available (27 percent); not used in my discipline (18 percent); and, not timely (7 percent). However, the reason offered most often for not using DoD technical reports was that they were not relevant to the research being conducted (40 percent). Only 2 percent of the researchers cited problems with the reliability or accuracy as reasons for not using DoD technical reports.

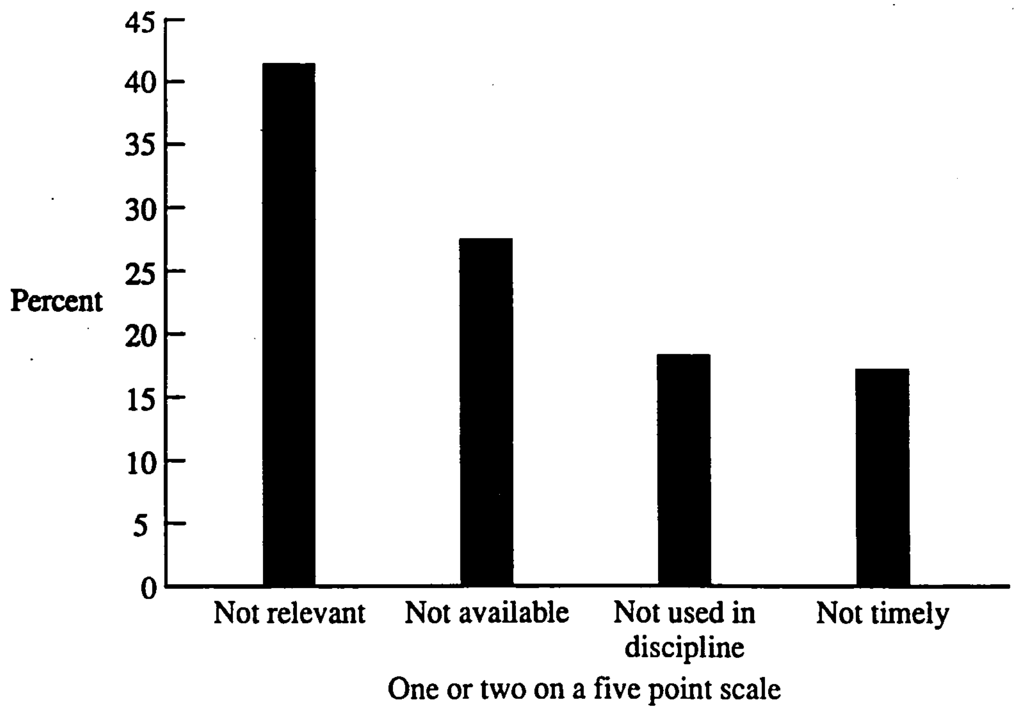

Figure 6. Reasons Why DoD Technical Reports
Are Not Used by U.S. Aerospace Engineers and Scientists

Figures 7 through 9 contain questions asked of those who used DoD technical reports in the six months prior to the survey. Most the respondents (figure 7) reported

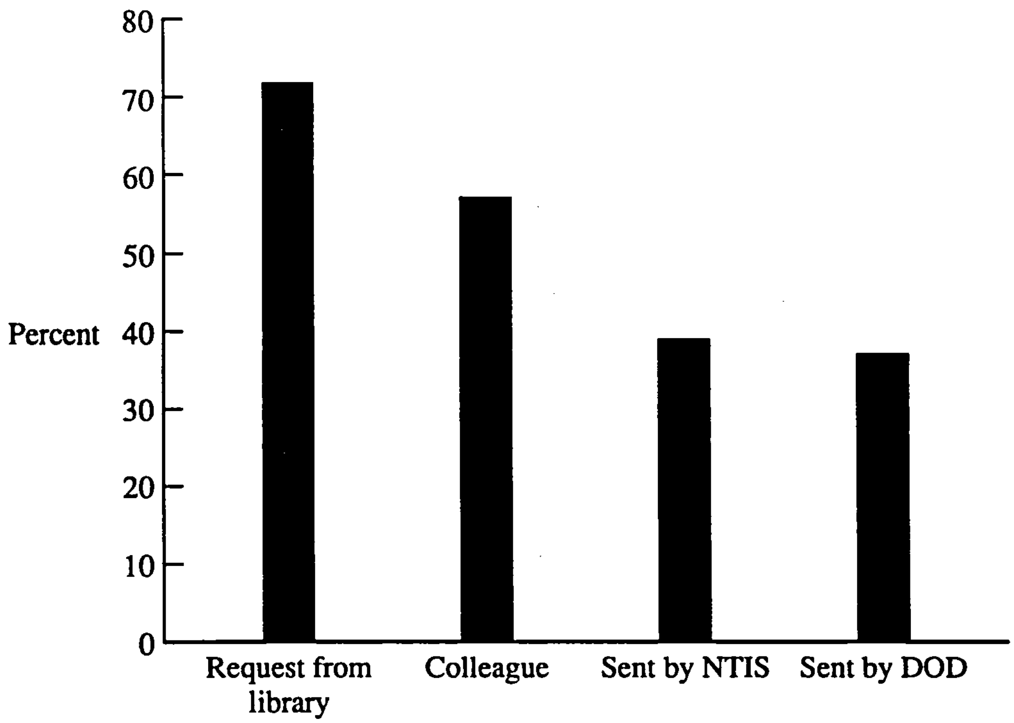

Figure 7. How U.S. Aerospace Engineers and Scientists
Obtain DoD Technical Reports

obtaining DoD technical reports from a library (71 percent) and/or from a colleague (57 percent). Substantial portions reported obtaining DoD technical reports from NTIS (39 percent) and from DoD (37 percent). These data indicate that while the largest percentage came from libraries, many researchers used other means of obtaining DoD technical reports.

Users were asked to rate DoD technical reports (figure 8). A four point scale from excellent to poor was given for each rating characteristic. Readers should

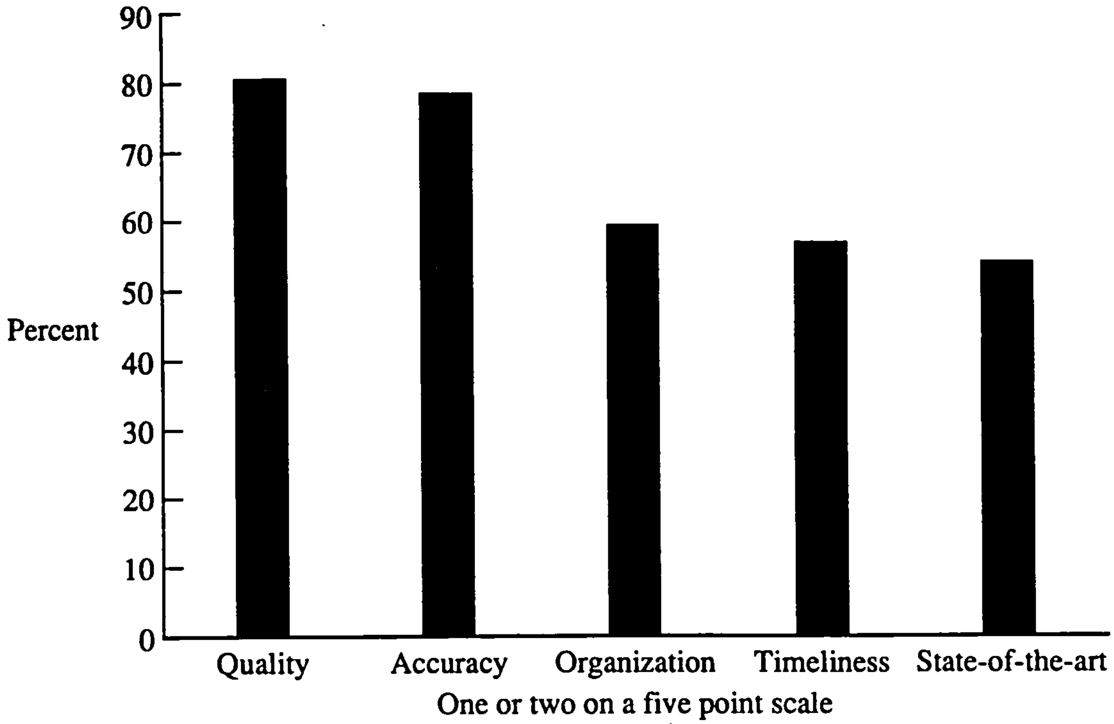

Figure 8. How U.S. Aerospace Engineers and Scientists Rate DoD Technical Reports

interpret these data as relative rather than absolute numbers. That is, the interpretation should be across characteristics, e.g., quality and accuracy were more important than organization. Over three-fourths of the users gave the two highest responses when asked about the quality (80 percent) and accuracy (78 percent) of DoD technical reports. High ratings were also given to the organization (59 percent) and timeliness (56 percent) of the reports.

Most users felt that relevance (72 percent) and accessibility (72 percent) influenced their decision to use DoD technical reports (figure 9). Familiarity (62 percent), technical quality (56 percent) and ease of use (54 percent) also influenced more than one-half of the users. Together, the data in figures 7 through 9 indicate that users of DoD technical reports rated them highly in quality and accuracy, used them because they are relevant and accessible, and received them primarily from a library.

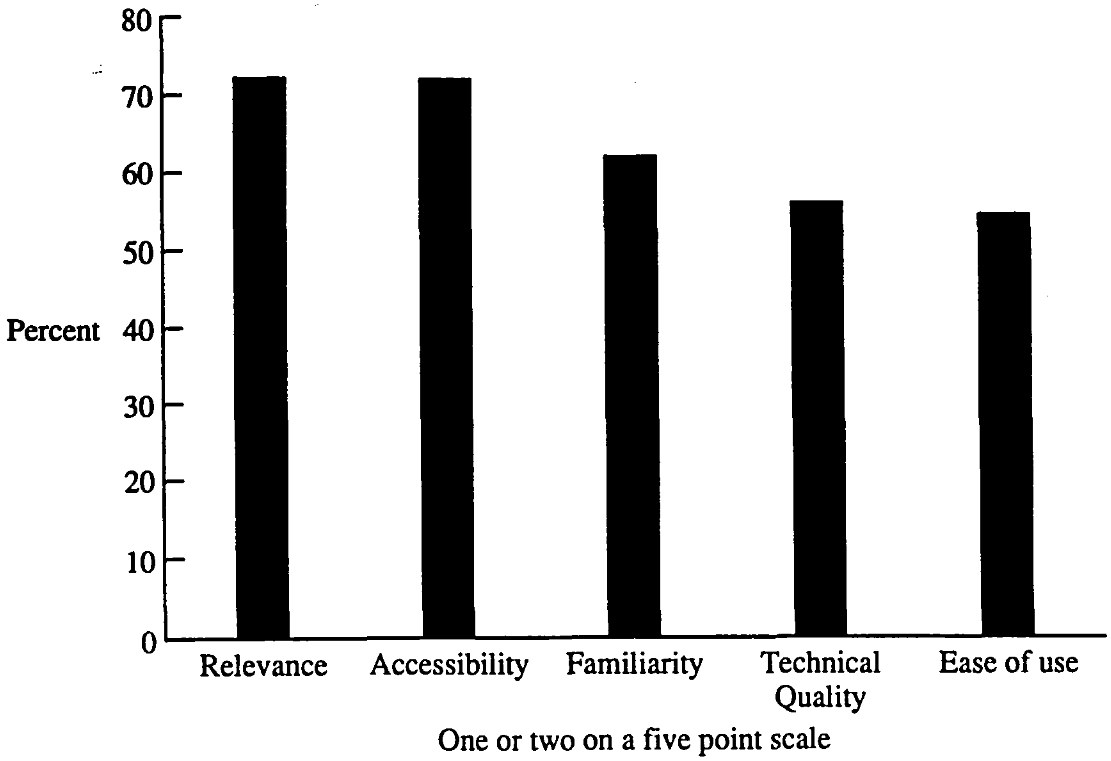

Figure 9. How U.S. Aerospace Engineers and Scientists Rate DoD Technical Reports

The third questionnaire sent as part of Phase 1 focused on the knowledge and the use of Federal announcement, current awareness, and bibliographic tools (figure 10).

Source	Percent use	Percent not use	
		Percent familiar	Percent not familiar
STAR	23.8	19.7	56.6
NASA SP-7037	6.7	9.2	84.1
CAB	2.0	3.7	94.3
GRA&I	3.8	3.3	92.9
RECON	12.2	5.4	82.3
DROLS	3.7	1.8	94.5
NTIS	18.0	11.4	70.6

Figure 10. Use and Nonuse of Federal Information Sources by U.S. Aerospace Engineers and Scientists

Many of these sources are designed primarily for use by intermediaries rather than researchers end users). The data in figure 10 indicate that only a small proportion of the sample used these sources. STAR had been used by 24 percent of the sample and fewer than 50 percent were aware that it exists. Two percent of the sample used CAB and 94 percent were not aware of its existence. Use of on line systems was low and ranged from a high of 18 percent for NTIS to a low of about 4 percent for DROLS. Overall, use of these products was low; most respondents were simply not aware of many of these sources.

Phase 3. In Phase 3 of the NASA/DoD Aerospace Knowledge Diffusion Project surveys were conducted among aerospace students, faculty, and librarians in aerospace or engineering libraries. The student survey consisted of students who were enrolled in a capstone design course that was funded by NASA through the University Space Research Association. Forty-four design courses were funded in the 1989-1990 school year. Of this group 33 schools participated in the survey. Some schools could not participate because their capstone design course was taught in the fall and the student survey was conducted during April and May 1990. Twenty-one of the courses were taught in aerospace departments, twelve in other departments, primarily mechanical engineering and architecture. Useable questionnaires were returned by 591 students.

The faculty who participated in the survey were members of aerospace departments where the USRA design courses were taught. Those faculty who were sent questionnaires in Phase 1 were excluded from the sample. Questionnaires were sent to 501 faculty and 275 returned them by early summer. The faculty and student questionnaires were almost identical. They focused on the knowledge and use of technical reports, training in technical communications, the use of bibliographic databases and demographic characteristics.

In the Phase 3 questionnaires, the respondents were <u>not</u> asked how many times they used an information source as was asked in Phase 1. Rather they were asked how often, on a five point scale, they had used information sources during the current school year. Figure 11 shows the distribution of use for five information sources. As might be expected, the faculty used journal articles (80 percent) most often followed by NASA technical reports (39 percent). Faculty made less use of DoD, AGARD, and foreign technical reports. Students, however, used journal articles and NASA technical reports about equally (52 percent and 51 percent, respectively) and made greater use of NASA technical reports than did faculty members. It might be expected that the students in these design courses would make relatively heavy use of NASA technical reports. DoD, AGARD, and Foreign technical reports were used relatively less often.

The faculty and students rated the importance of information sources in the same ranking as their use (figure 12). Most faculty (87 percent) rated journal articles as one or two on a five point scale. The students rated journal articles (58 percent) and NASA technical reports (55 percent) as about equally important. Both faculty (26 percent) and students (16 percent) rated DoD technical reports as relatively more important than would be expected from their use.

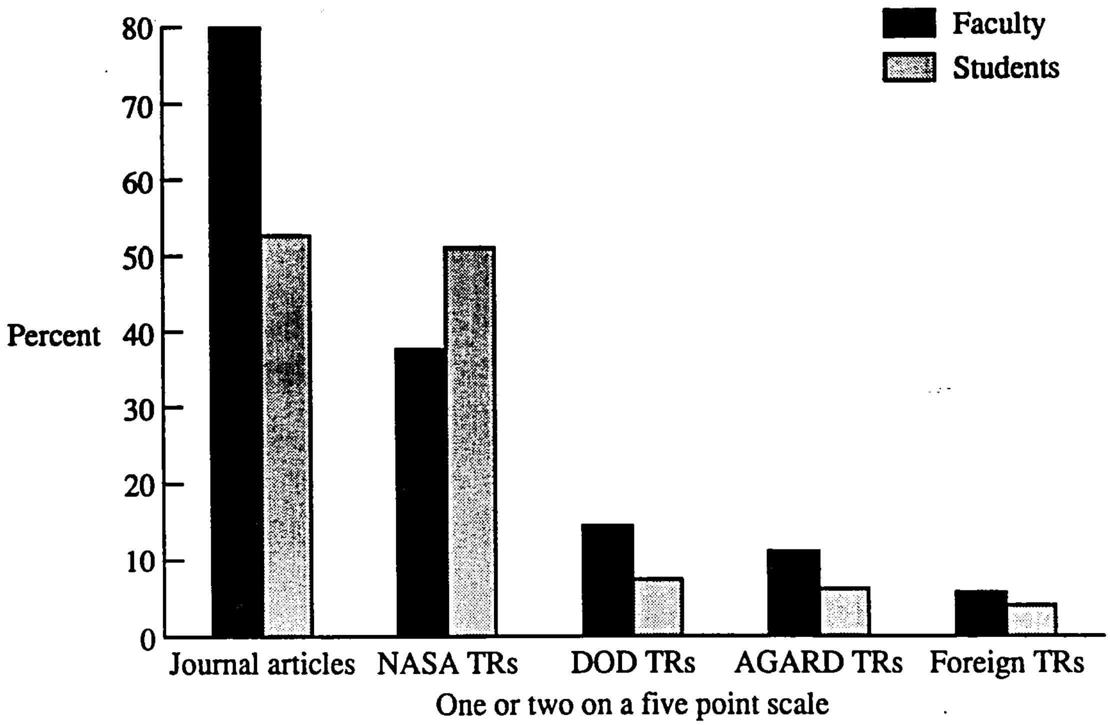

Figure 11. Use of Selected Information Products by U.S. Aerospace Faculty and Students

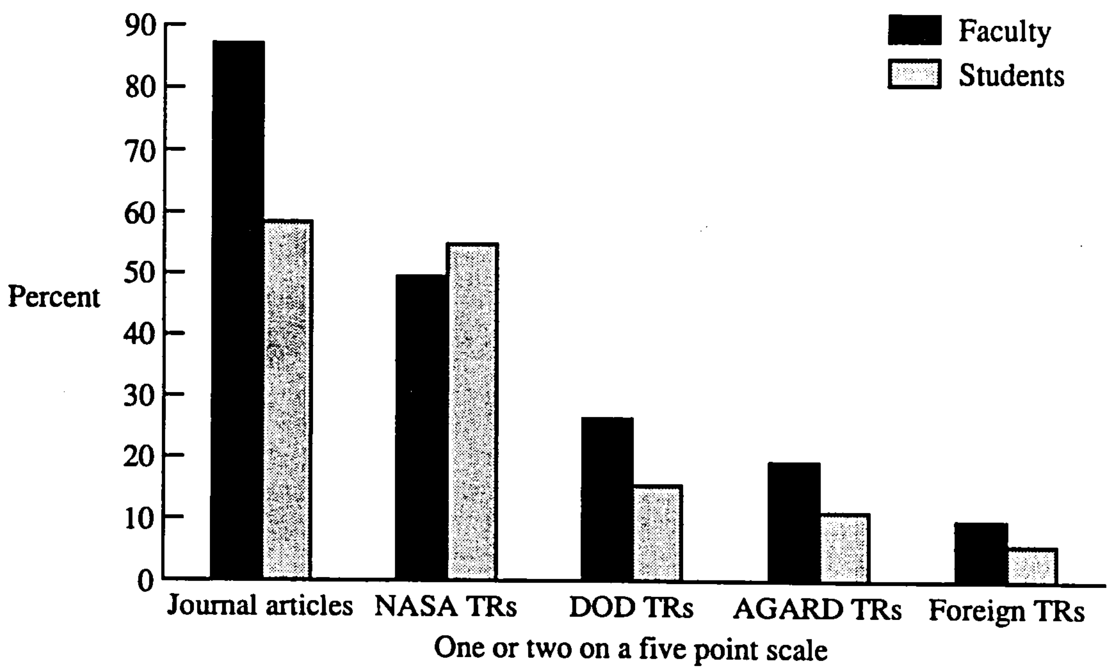

Figure 12. Importance of Selected Information Products to U.S. Aerospace Faculty and Students

As shown in figure 13, some faculty, but few students are aware of RECON (40 and 14 percent, respectively), DROLS (29 and 6 percent, respectively) and NTIS Online (47 and 14 percent, respectively). Both faculty and students were most familiar with NTIS Online and least familiar with DROLS.

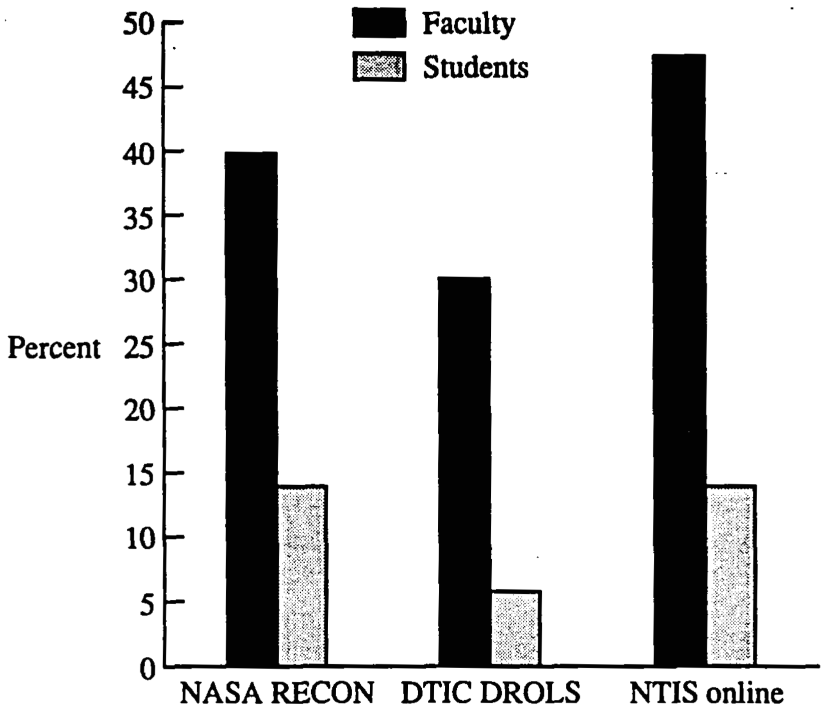

Figure 13. Familiarity with Federal On Line Databases by U.S. Aerospace Faculty and Students

Library Surveys. Two library surveys were conducted. The first survey, conducted as part of **Phase 2**, included 156 technical libraries located within government and industrial organizations that held aerospace collections including U.S. government technical reports. The second survey, conducted as part of **Phase 3**, included 68 academic libraries associated with aerospace engineering programs.

Of the first group, most libraries or technical information centers (TIC) were cost centers in which the library/TIC costs were charged to the overhead of the organization (figure 14). Twelve percent of the libraries surveyed were cost-justified centers in which the library operates on its own budget. The remaining libraries functioned as self-sufficient or profit centers.

Both government, industry, and academic libraries regularly received both NASA (82 and 71 percent) and DoD (76 and 36 percent) technical reports in paper form (figure 15). A smaller number of academic libraries received DoD (36 percent) than AGARD (63 percent) paper technical reports.

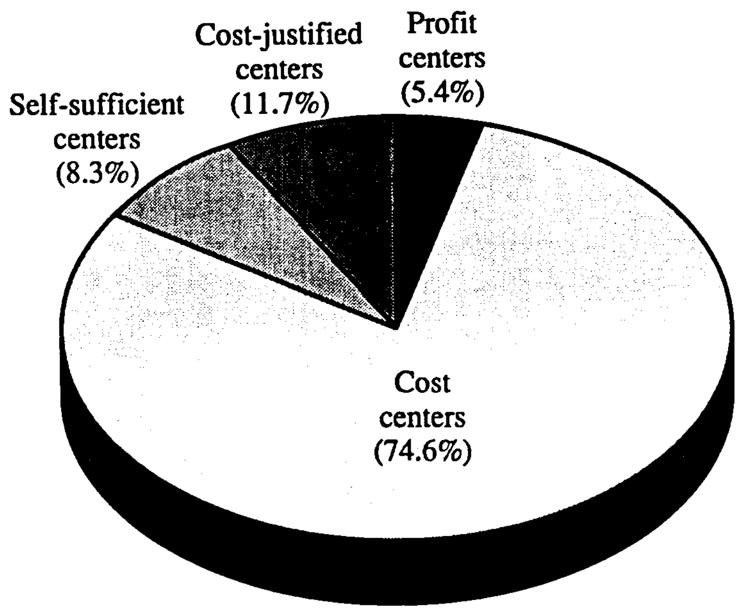

Figure 14. How U.S. Aerospace Libraries in Government and Industry and Organizaed

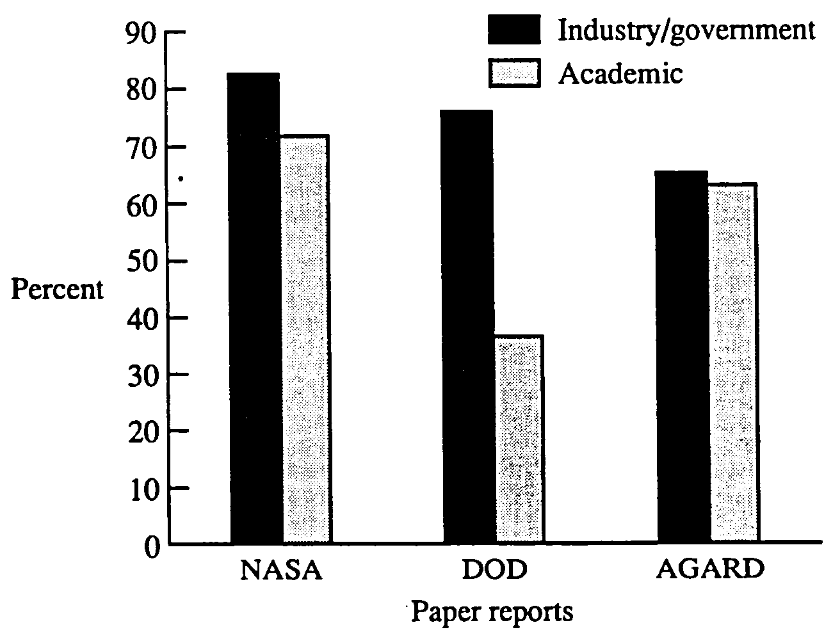

Figure 15. Receipt of NASA and DoD Technical Reports in Paper by U.S. Government, Industry, and Academic Libraries

Academic libraries regularly received more NASA technical reports in fiche (91 percent) form than in paper (71 percent) form (figure 16). DoD and AGARD technical reports in fiche form were received less regularly by both industry/government and academic libraries than paper reports.

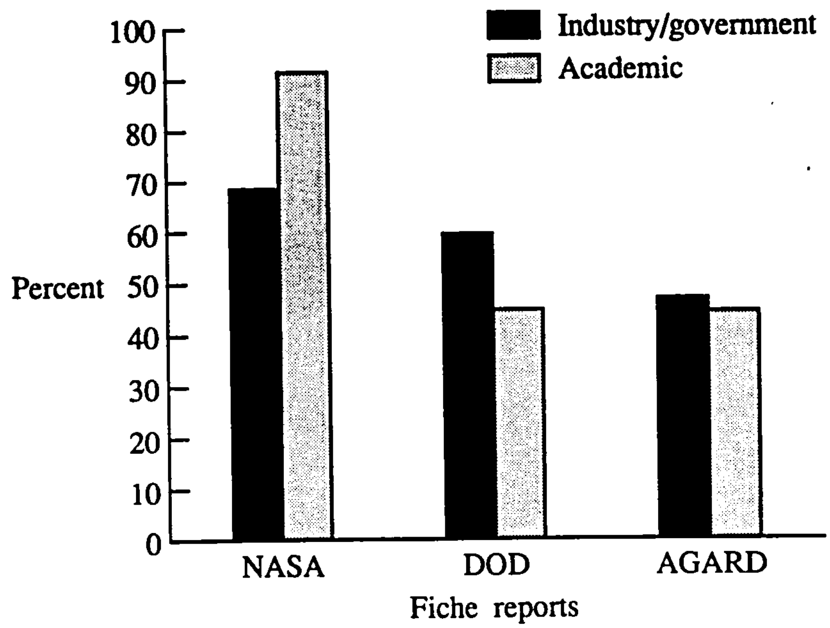

Figure 16. Receipt of NASA and DoD Technical Reports in Fiche by U.S. Government, Industry, and Academic Libraries

Government and industry technical libraries received more foreign technical reports than did academic libraries (figure 17). British (32 percent), ESA (32 percent)

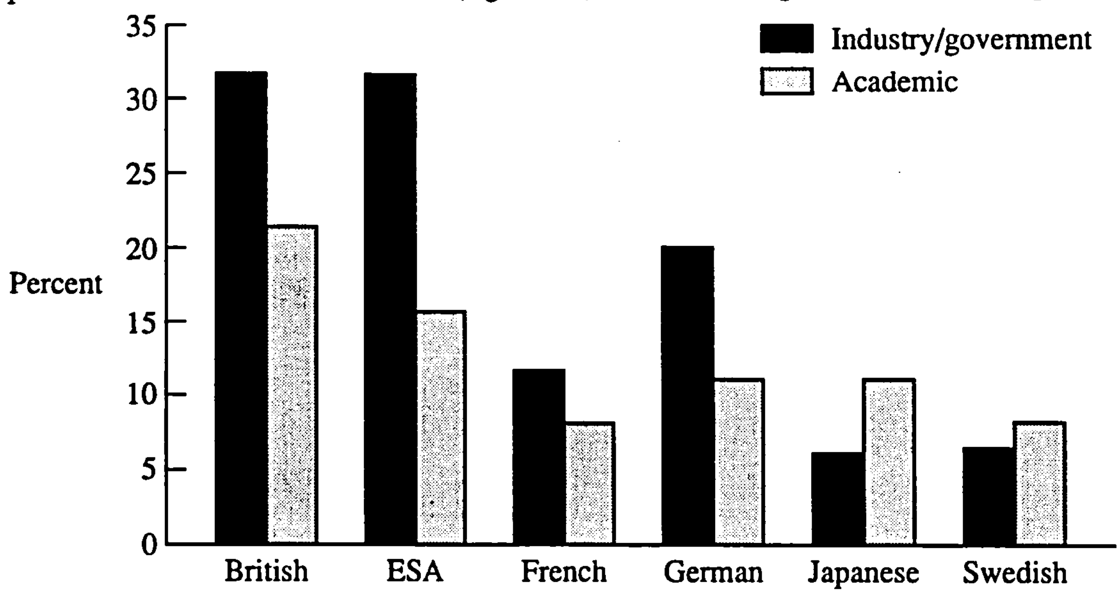

Figure 17. Receipt of Foreign Technical Reports by U.S. Government, Industry, and Academic Libraries

and German (20 percent) technical reports were received more frequently than French (12 percent), Japanese (6 percent) and Swedish (6 percent) reports. Academic libraries received more Japanese and Swedish reports than did government and industry libraries.

The data in figure 18 report the use of on line databases in U.S. government and industry aerospace libraries. RECON and DROLS were not used or were not

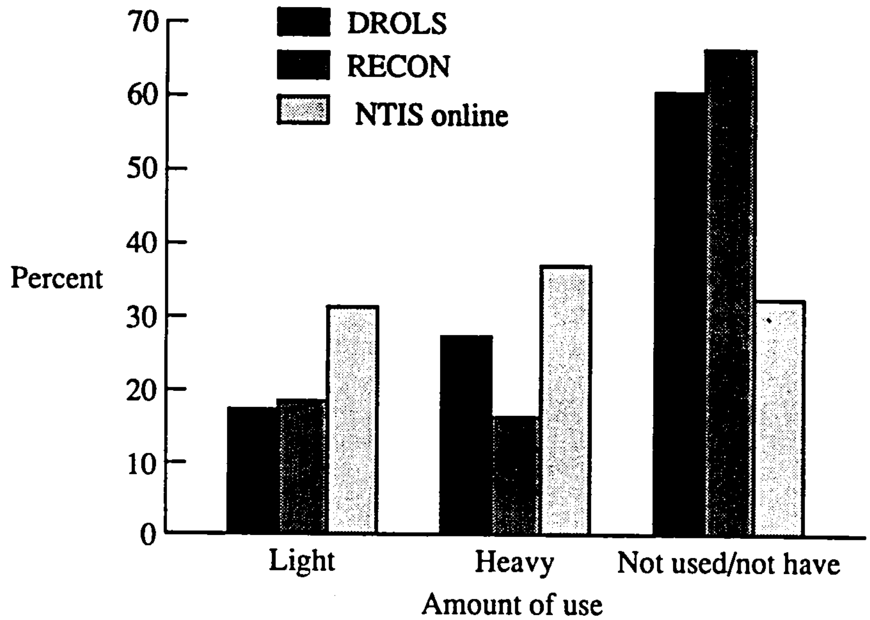

Figure 18. Use of DROLS, RECON, and NTIS by U.S. Government and Industry Aerospace Libraries

available to 60 percent of the libraries. NTIS Online had the heaviest use and availability. Of the libraries that use these on line databases, DROLS was used more than RECON. DROLS and RECON had the highest "not used/not have" scores.

Among users of online databases DROLS and NTIS Online were of about equal importance (figure 19). RECON was found to be less important than NTIS and DROLS but still rated as important to many U.S. government and industry libraries.

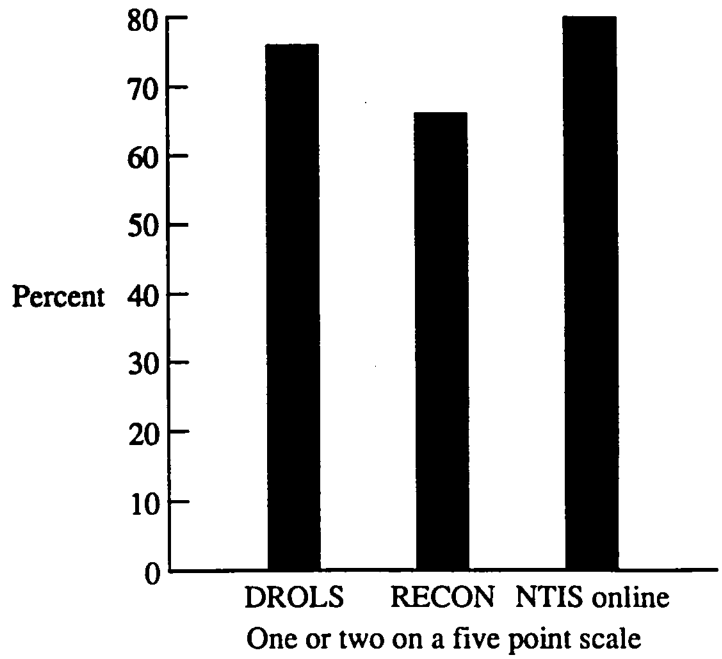

Figure 19. Importance of DROLS, RECON, and NTIS to U.S. Government and Industry Aerospace Libraries

CONCLUDING REMARKS

To remain world leaders in industry, aerospace producers must take the steps necessary to improve and maintain the professional competency of aerospace engineers and scientists and to enhance innovation and productivity as well as maximize the inclusion of recent technological developments into the R&D process. How well these objectives are met in the U.S., and at what cost, depends on the ability of aerospace engineers and scientists to acquire and process the results of government funded R&D. However, very little is known about the channels used to communicate this knowledge and the information-seeking habits and practices of the members of the aerospace social system (i.e. aerospace engineers and scientists). The NASA/DoD Aerospace Knowledge Diffusion Research Project seeks to remedy this situation by exploring the interface between the user, the information products and services used (e.g., NASA and DoD technical reports), and the criteria and factors associated with the selection or use of a particular information product or service.

Overall, the data collected thus far indicate that DoD technical reports are an important information source to the U.S. aerospace research community. Researchers and intermediaries in government and industry settings tend to use them more regularly than faculty, students, and intermediaries in academic settings. The differences, however, may be due to the samples selected for Phase 3 of the NASA/DoD Aerospace Knowledge Diffusion Project. Further analysis is needed, however, before definitive conclusions and interpretations can be reached.

REFERENCES

Bikson, Tora K.; Barbara E. Quint; and Leland L. Johnson. Scientific and Technical Information Transfer: Issues and Options. Washington, DC: National Science Foundation, March 1984. (Available from NTIS, Springfield, VA PB-85-150357; also available as Rand Note 2131.)

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

Fischer, William A. "Scientific and Technical Information and the Performance of R&D Groups." In Management of Research and Innovation, Burton V. Dean and Joel L. Goldhar, eds. (NY: North-Holland Publishing Company, 1980,) 67-89.

Goldhor, Richard S. and Robert T. Lund. "University-to-Industry Advanced Technology Transfer: A Case Study." Research Policy 12 (1983): 121-152.

Kennedy, John M. and Thomas E. Pinelli. The Impact of a Sponsor Letter on Mail Survey Response Rates. Paper presented at the Annual Meeting of the American Association for Public Opinion Research, Lancaster, PA, May 19, 1990.

March, Artemis. "The US Commercial Aircraft Industry and Its Foreign Competition." MIT Commission on Industrial Productivity Working Paper. Cambridge, MA: MIT Press, 1989.

McGowan, Robert P. and Stephen Loveless. "Strategies for Information Management: The Administrator's Perspective." Public Administration Review 41:3 (May/June 1981): 331-339.

Mowery, David C. "Federal Funding of R&D in Transportation: The Case of Aviation." Paper commissioned for a workshop on The Federal Role in Research and Development, November 21-22, 1985, held in Washington, DC and sponsored by the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine.

Mowery, David C. and Nathan Rosenberg. "The Commercial Aircraft Industry." Chapter 3 in Government and Technical Progress: A Cross-Industry Analysis, Richard R. Nelson, ed. (NY: Pergamon Press, 1982,) 101-161.

Pinelli, Thomas E.; Myron Glassman; Walter E. Oliu; and Rebecca O. Barclay. **Technical Communications in Aeronautics: Results of an Exploratory Study.** Washington, DC: National Aeronautics and Space Administration. NASA TM-101534, **Report 1, Part 1**. February 1989. 106 p. (Available from NTIS, Springfield, VA; 89N26772.)

U.S. Department of Commerce. 1990 U.S. Industrial Outlook: Prospects for Over 350 Manufacturing and Service Industries. (Washington, DC: Government Printing Office, January 1990.)

BIBLIOGRAPHY

Berul, Lawrence H. et al. DoD User-Needs Study, Phase 1. Volume 1: Management Report Conduct of the Study and Analysis of Data. Philadelphia, PA: Auerbach Corp., May 1965a. (Available from NTIS, Springfield, VA AD-615 501.)

Berul, Lawrence H. et al. DoD User-Needs Study, Phase 1. Volume 2: Interview Guide Handbook, Computer Program Documentation, and Statistical Tables. Philadelphia, PA: Auerbach Corp., May 1965b. (Available from NTIS, Springfield, VA AD-615 502.)

Goodman, Arnold F.; John D. Hodges, Jr.; and Forrest G. Allen. DoD User-Needs Study. Phase II Flow of Scientific and Technical Information Within the Defense Industry. Volume 1: Overview. Anaheim, CA: North America Aviation, Inc., November 1966a. (Available from NTIS, Springfield, VA AD-647 111.)

Goodman, Arnold F.; John D. Hodges, Jr.; Bruce W. Angelet; and Richard B. McCord. DoD User-Needs Study. Phase II: Flow of Scientific and Technical Information Within the Defense Industry. Volume 2: Technical Description and Technical Appendices. Anaheim, CA: North American Aviation, Inc., November 1966b. (Available from NTIS, Springfield, VA AD-647 112.)

Goodman, Arnold F.; John D. Hodges, Jr.; Bruce W. Angelet; Richard B. McCord; and Carol C. Taylor. DoD User-Needs Study. Phase II: Flow of Scientific and Technical Information Within the Defense Industry. Volume 3: Frequency Distribution and Correlations and Relationship and Comparison. Anaheim, CA: North American Aviation, Inc., November 1966c. (Available from NTIS, Springfield, VA AD-649 284.)

Roderer, Nancy K.; Donald W. King; and Sandra E. Brovard. Use and Value of Defense Technical Information Center Products and Services. Rockville, MD: King Research Inc., June 1983. (Available from NTIS, Springfield, VA AD-AI30 805.)

NASA/DoD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT PUBLICATIONS

Reports

Pinelli, Thomas E.; Myron Glassman; Walter E. Oliu; and Rebecca O. Barclay. **Technical Communications in Aeronautics: Results of an Exploratory Study.** Washington, DC: National Aeronautics and Space Administration. NASA TM-101534, **Report 1, Part 1.** February 1989. 106 p. (Available from NTIS, Springfield, VA; 89N26772.)

Pinelli, Thomas E.; Myron Glassman; Walter E. Oliu; and Rebecca O. Barclay. **Technical Communications in Aeronautics: Results of an Exploratory Study.** Washington, DC: National Aeronautics and Space Administration. NASA TM-101534, **Report 1, Part 2.** February 1989. 84 p. (Available from NTIS, Springfield, VA; 89N26773.)

Pinelli, Thomas E.; Myron Glassman; Rebecca O. Barclay; and Walter E. Oliu. **Technical Communications in Aeronautics: Results of an Exploratory Study -- An Analysis of Managers' and Nonmanagers' Responses.** Washington, DC: National Aeronautics and Space Administration. NASA TM-101625, **Report 2.** August 1989. 58 p. (Available from NTIS, Springfield, VA; 90N11647.)

Pinelli, Thomas E.; Myron Glassman; Rebecca O. Barclay; and Walter E. Oliu. **Technical Communications in Aeronautics: Results of an Exploratory Study -- An Analysis of Profit Managers' and Nonprofit Managers' Responses.** Washington, DC: National Aeronautics and Space Administration. NASA TM-101626, **Report 3.** October 1989. 71 p. (Available from NTIS, Springfield, VA; 90N15848.)

Pinelli, Thomas E.; John M. Kennedy; and Terry F. White. **Summary Report to Phase 1 Respondents.** Washington, DC: National Aeronautics and Space Administration. NASA TM-102772, **Report 4.** January 1991. (Available from NTIS, Springfield, VA.)

Pinelli, Thomas E.; John M. Kennedy; and Terry F. White. **Summary Report to Phase 1 Respondents Including Frequency Distributions.** Washington, DC: National Aeronautics and Space Administration. NASA TM-102773, **Report 5.** January 1991. (Available from NTIS, Springfield, VA.)

Pinelli, Thomas E. **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, **Report 6.** January 1991. 350 p. (Available from NTIS, Springfield, VA.)

Papers

Pinelli, Thomas E.; Myron Glassman; Rebecca O. Barclay; and Walter E. Oliu. **The Value of Scientific and Technical Information (STI), Its Relationship to Research and Development (R&D), and Its Use by U.S. Aerospace Engineers and Scientists. Paper 1.** Paper presented at the European Forum "External Information: A Decision Tool" 19 January 1990, Strasbourg, France.

Blados, Walter R.; Thomas E. Pinelli; John M. Kennedy; and Rebecca O. Barclay. **External Information Sources and Aerospace R&D: The Use and Importance of Technical Reports by U.S. Aerospace Engineers and Scientists. Paper 2.** Paper prepared for the 68th AGARD National Delegates Board Meeting, 29 March 1990, Toulouse, France.

Kennedy, John M. and Thomas E. Pinelli. **The Impact of a Sponsor Letter on Mail Survey Response Rates. Paper 3.** Paper presented at the Annual Meeting of the American Association for Public Opinion Research, Lancaster, PA, May 19, 1990.

Pinelli, Thomas E. and John M. Kennedy. **Aerospace Librarians and Technical Information Specialists as Information Intermediaries: A Report of Phase 2 Activities of the NASA/DoD Aerospace Knowledge Diffusion Research Project. Paper 4.** Paper presented at the Special Libraries Association, Aerospace Division - 81st Annual Conference, Pittsburgh, PA, June 13, 1990.

Pinelli, Thomas E.; Rebecca O. Barclay; John M. Kennedy; and Myron Glassman. **Technical Communications in Aerospace: An Analysis of the Practices Reported by U.S. and European Aerospace Engineers and Scientists. Paper 5.** Paper presented at the International Professional Communication Conference (IPCC), Post House Hotel, Guilford, England, September 14, 1990.

Pinelli, Thomas E. and John M. Kennedy. **Aerospace Knowledge Diffusion in the Academic Community: A Report of Phase 3 Activities of the NASA/DoD Aerospace Knowledge Diffusion Research Project. Paper 6.** Paper presented at the 1990 Annual Conference of the American Society for Engineering Education - Engineering Libraries Division, Toronto, Canada, June 27, 1990.

Pinelli, Thomas E. and John M. Kennedy. **The NASA/DoD Aerospace Knowledge Diffusion research Project: The DoD Perspective." Paper 7.** Paper presented at the Defense Technical Information Center (DTIC) 1990 Annual Users Training Conference, Alexandria, VA, November 1, 1990.