REPORT

PROGRAM FOR TRANSFER RESEARCH AND IMPACT STUDIES

Semiannual Report: 1 January 1973-30 June 1973

Contract NASW-2362

DENVER RESEARCH INSTITUTE

UNIVERSITY OF DENVER

PROGRAM FOR TRANSFER RESEARCH AND IMPACT STUDIES

SEMIANNUAL REPORT

1 January 1973 - 30 June 1973

- Prepared for -

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REPORT HIGHLIGHTS

- During the first six months of 1973, research efforts conducted under the Program for Transfer Research and Impact Studies (TRIS) continued, including:

  Preparation of 4,714 TSP requests for TRIS application analysis;

  Questionnaire follow up with 1,414 TSP requesters;

  Telephone interviews with over 100 TSP users;

  Publication of two technology transfer case studies;

  Preparation of 27 new technology transfer example files and 72 new transfer cases;

  Review of 319 NASA-related newspaper and magazine clippings;

  Distribution of a newsletter containing discrete transfer cases; and

  Maintenance of a technology transfer library containing more than 3,000 titles.

- An analysis of the characteristics, or behavior patterns, of Tech Brief-Technical Support Package Program users was conducted during this reporting period. The essential results of this study restate the proven value of the NASA-prepared technical information service to the user who is operating in a problem-solving environment. However, the impact of this information service is limited by certain constraints associated with inefficient communication mechanisms.

SECTION I. TRIS RESEARCH ACTIVITIES: JANUARY-JUNE 1973

Research activities conducted under the Program for Transfer Research and Impact Studies (TRIS) during the period of January 1 through June 30, 1973 are reviewed in this section.

Tech Brief-Technical Support Package Program

During the first six months of 1973, NASA received 34,838 requests for Technical Support Packages (TSP's) from persons seeking information on specific space program technologies. Three main mechanisms for disseminating NASA technology were responsible for generating those requests: the regular Tech Brief distribution system, the Technology Utilization (TU) Compilations, and the Small Business Administration's (SBA) publications which announced the availability of NASA Tech Brief-TSP Program information. The TSP requests generated by the TU Compilations and SBA publications totaled 30,124 (86 percent); the other 4,714 requests resulted from normal Tech Brief distribution. As Figure 1-1 illustrates, the number of TSP requests received during the first half of 1973 is not significantly different from the 37,084 requests received during the previous six-month period. In addition, the proportion of requests that resulted from Tech Brief distribution is essentially the same for both time periods.

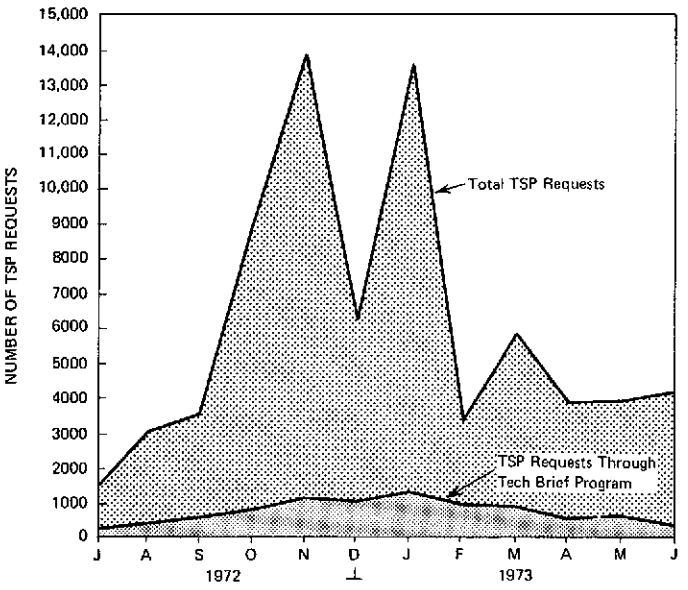

Figure 1-1. Monthly Requests for Technical Support Packages: July 1972-June 1973.

Between October 1972 and January 1973, the number of monthly TSP requests increased substantially, as can be seen in the above figure. This increase resulted from the introduction of a new SBA publication series, entitled Current Index of Technical Briefs (C1 Series). Six editions of the Index were published between June and November 1972, containing an average of 55 short (one or two sentences) descriptions of current NASA Tech Briefs. With the normal time lag that occurs from distribution to reader response, the majority of the requests that resulted from this series spanned the peak period noted above.

Of the total TSP requests in each six-month period, the C1 Series accounted for 72 percent in 1972 and 70 percent in 1973. Figure 1-2 shows the proportion of TSP requests that resulted from each of the three main dissemination mechanisms during both time periods. Since other SBA publications accounted for only a few percent of the total requests during the past twelve months (these were residual requests from earlier publications), they were combined with the C1 Series in the figure. For a more detailed discussion of the different types of SBA publications and the TU Compilations, as well as how they have affected the ways in which the nonaerospace community acquires space program technology, see TRIS Semiannual Report: 1 January 1972-30 June 1972 (November 1972).

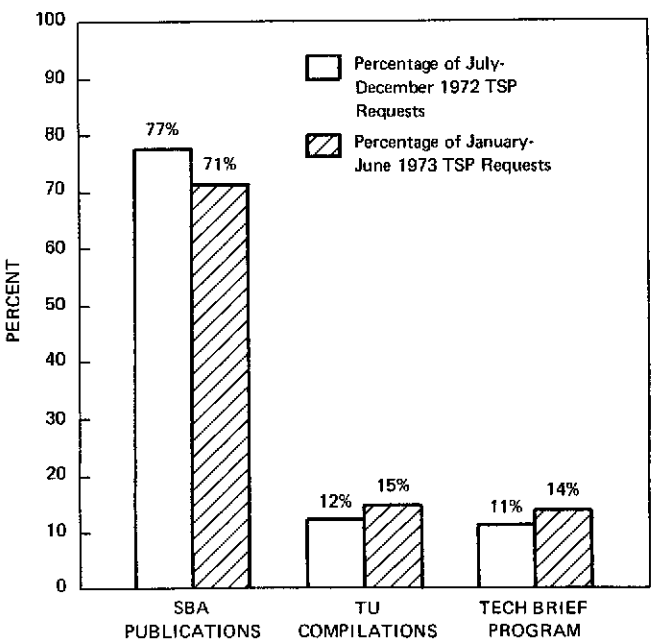

Figure 1-2. Proportion of TSP Requests, by Origin: July-December 1972 and January-June 1973.

The TSP requests that are generated through the regular Tech Brief distribution system are forwarded to TRIS by the different NASA field centers for inclusion in the transfer data bank and subsequent transfer documentation activities. By the end of this reporting period, 90,550 cases had been processed into the data bank since November 1967. More than 98 percent of these cases were initiated by TSP requests; the remaining cases resulted from other sources of follow-up leads, such as contractor commercialization activities or news clippings.

While the SBA publications and TU Compilations have had a significant impact on the amount of technical information being disseminated by the NASA field centers in recent years, their transfer effectiveness has not yet been determined. In June, plans were formalized with the Technology Utilization Office, NASA Headquarters, to conduct a survey among persons who had acquired TSP's through these mechanisms. Data from the survey (to be conducted during the second half of 1973) will be used to generate a profile of user behavior so that some generalizations concerning the impact of each mechanism can be formulated.

Transfer Documentation Activities

In order to obtain information concerning the application of NASA-generated technology, questionnaires are mailed to TSP requesters six months after the date of their request. This delay is considered sufficient time to allow TSP users to reach tentative conclusions concerning applications for the technologies. During the first six months of 1973, TRIS distributed 1,414 questionnaires, of which approximately 78 percent were returned.

Respondents who indicated that they had made substantial progress in their attempts to adapt the aerospace technology were selected for additional contact. Over 100 telephone interviews were conducted by TRIS personnel with these TSP users during the reporting period.

Technology Transfer Profiles

The preparation of transfer profiles has been a major program effort during the past 30 months. Seven profiles which examined industrial applications of aerospace technology within particular fields of technology have been published--plastics, lubrication, contamination

control, fire safety, cryogenics, nondestructive testing and visual display systems. Three similar reports, entitled A Case Study in Technology Utilization: Fracture Mechanics, A Case Study in Technology Utilization: Industrial Products and Practices, and A Case Study of Technology Transfer: Rehabilitative Engineering at Rancho Los Amigos Hospital, have also been published, the latter two in 1973.

By the end of June, another report similar to the profiles was near completion. This document describes the ways in which aerospace technology, through advances to scientific and engineering disciplines, is effecting progress in the electric power industry. Publication of this report will be completed in November 1973.

Other TRIS Activities

TRIS newsletter. During the first six months of 1973, TRIS continued to prepare newsletters containing up-to-date information on discrete transfers of space program technology. By the end of this reporting period, six editions of the newsletter had been distributed to Technology Utilization Officers at the different NASA field centers and to the program directors of the Regional Dissemination Centers and Application Teams.

Technology transfer example files. Development activities associated with the files continued in 1973, both to aid in the preparation of technology transfer profiles and newsletters and to provide interested persons with ready access to descriptions of NASA-related transfer activities. By the end of June, 468 files had been established, containing 970 individual transfer cases; 27 files and 72 new cases were added to the system during this reporting period. In addition, 188 files had been updated one or more times over the past three years, including the preparation of comprehensive file summaries. These summaries describe the space program technology involved and its role in meeting mission objectives; in addition, they present one or more examples of how different organizations or individuals in the nonaerospace community have used the technology.

NASA-related news clippings. TRIS personnel continued to review news items taken from selected magazines and newspapers distributed in the United States and Canada. The clippings, which expand the program's sources of leads to technology transfer activities, are compiled for NASA's Technology Utilization Office by a professional clipping

service. During the first six months of 1973, TRIS personnel processed 319 news items that referenced space program activities and technology. Those items which indicated transfer activity were selected for follow-up and, subsequently, were included in the transfer example files.

Technology transfer library. The collection in the library increased to more than 3,000 titles during this reporting period.

SECTION II. A SELECTED ANALYSIS OF USER BEHAVIOR PATTERNS

One of the principal research activities of the Program for Transfer Research and Impact Studies (TRIS) has been to accumulate accurate and comprehensive data related to the acquisition, adaptation, and use by nonaerospace firms of technology developed initially for the civilian aerospace program. This effort has been carried out through a process of systematically acquiring applications data provided by users of the NASA Tech Brief-Technical Support Package (TSP) Program. At the same time, attempts to analyze and interpret the data collected through this research have led to a greater understanding of the nature of the technology and characteristics of user behavior.

In a study undertaken during the first six months of 1973, TRIS personnel sought to reassess user behavior and experience in order to update TRIS commentary on the effectiveness of technology transfer efforts undertaken by the NASA Technology Utilization Office (TUO). The concept of transfer in stages will be briefly reviewed since it is the basis for evaluating user behavior associated with the Tech Brief-TSP Program.

Transfer Stages

Technology transfer may be broadly described as the process through which technical capability generated for one purpose is adapted and used for other purposes. In this process, adaptation occurs in a commercial firm through a series of related activities now described as transfer stages. With the completion of adaptation activities, diffusion of the adapted innovation takes place in a fourth stage. Figure 2-1 illustrates this "transfer stages" concept.

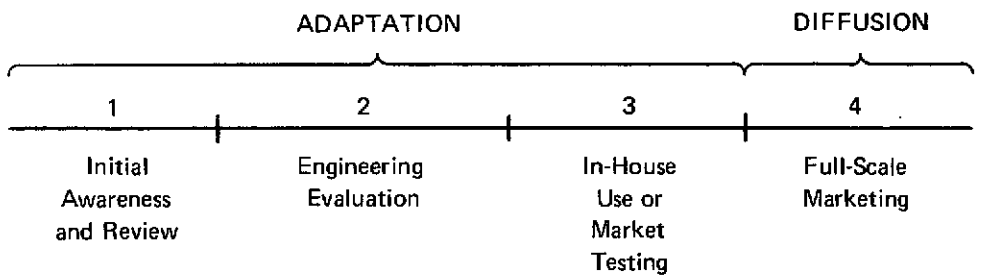

Figure 2-1. Stages of Technology Transfer.

Stage one is characterized by an initial awareness on the part of a potential innovator of the existence of a new technology generated originally for space program purposes. In this transfer stage, the potential innovator may also search for additional information concerning the technology in order to determine its relevance to his interests. Stage two involves specific attempts to adapt the new technology to fit the requirements of the ultimate user or customer. These attempts usually involve laboratory tests and evaluations. The resulting technology progresses into stage three under one of two conditions: either an industrial firm begins to use the adapted technology in its own operational (e.g., processing) activities, or a firm begins to market test prototype versions of the adapted innovation. According to this paradigm, only those firms with plans to market the technology ever progress into the fourth transfer stage. In this stage, a commercial firm promotes the diffusion of an adapted technology in its sector.

When transfer activity initiated by TU publications is analyzed in different fields of technology, the progress of these adapting organizations can usually be characterized by using a "transfer profile" of the type shown in Figure 2-2. This profile aggregates the transfer experiences of organizations pursuing innovations common to a particular technical field and provides a summary of transfer progress occurring in that field.

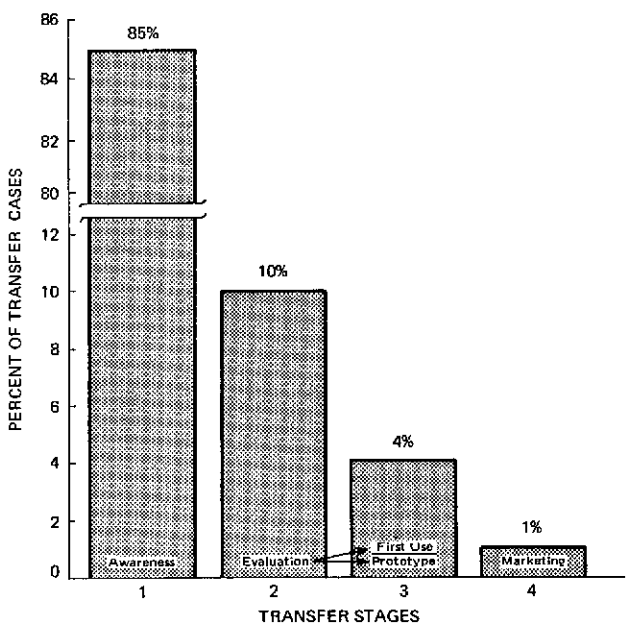

Figure 2-2. Four Stages in the Transfer Profile.

For the purposes of the following discussion, then, the primary evaluation tool will be the transfer profile, i.e., greater impact is indicated by a larger percentage of individuals in advanced transfer stages.

Objectives

While the NASA Tech Brief-TSP Program represents only one portion of the overall Agency effort to provide secondary utilization of technical capability, it is the oldest and most widely known TU transfer mechanism. Since the Denver Research Institute (DRI) has an extensive transfer data bank associated with the users of this mechanism, the NASA Tech Brief-TSP Program was chosen as the means for acquiring specific data on the characteristics of the non-aerospace user community and the progress made by this audience in adapting new technology. Specifically, the objectives of the study were:

1) To identify new patterns of Tech Brief-TSP use from an analysis of the DRI transfer data bank;

2) To investigate relationships between the nature of the technology and patterns of user behavior; and

3) To use both quantitative and qualitative judgment in analyzing the data.

Methodology

For the purpose of this investigation, a sample of 104 questionnaires covering the time period of January 1972 through March 1973 was randomly drawn from the DRI data bank. Each questionnaire was analyzed on the basis of eleven variables: three variables related to the subject technology and eight variables related to user behavior. Tables 2-1 and 2-2 differentiate and illustrate these variable interest categories.

TABLE 2-1. VARIABLES ASSOCIATED WITH SUBJECT TECHNOLOGY

VARIABLE	CATEGORIES OF VARIABLE
Technological Category	• Electronics • Electrical Systems • Physical Sciences • Materials/Chemistry • Life Sciences • Mechanics • Machinery, Equipment, Tools • Fabrication • Computer Programs
Type of Technology	• Redefines State-of-the-Art • Incremental Changes in State-of-the-Art • Consolidated
Class of Technology	• Product • Process • Manuals/Data • Sub-Assemblies/Circuits • Management • Disciplinary (Engineering)

TABLE 2-2. VARIABLES ASSOCIATED WITH USER BEHAVIOR

VARIABLE	CATEGORIES OF VARIABLE
Source of Technology	• NASA • Major Contractor • Sub-Contractor
Company Size (Employees)	• Small < 49 • Medium 50 to 10,000 • Large > 10,000
Communications Mechanism	• Interpersonal • Trade Press and Journals • Tech Briefs • Other
Management Interest	• No Interest • Slight • Moderate • Strong
Transfer Stage	• Interest • Evaluation • Trial • Diffusion
Use of Technology	• New or Improved Product • New or Improved Process • Validating New Concepts • Other Uses
Problem-Solving	• Not Problem-Solving • Problem-Solving Application
Economic Benefits	• None • Economic Benefits Identified

For each of the variables listed above, the relationship between the variable and the progress in adapting the technology (transfer stage variable) was examined in three ways. First, statistically significant differences in the transfer profile were accepted at the 95 percent confidence level; second, a qualitative assessment using transfer profiles was made; and third, where appropriate, the results of past research were included. The primary results from this study follow.

Results

Based on an analysis of the data generated from the study, certain qualitative and quantitative conclusions were reached with respect to each of the previously identified variables. However, only four of the variables which had statistically significant differences in their profiles of transfer activity will be discussed. These variables are associated with aspects of user behavior and contain, in most cases, TUO policy implications for advancing the effective transfer of technology.

Use of technology and transfer stage. A significant relationship was found to exist between each use-related variable and the maturity of transfer activity, as evidenced by profiles showing a large proportion of adapters in the later stages of the transfer process. Figure 2-3 presents the profiles of transfer activity for each use-related variable and indicates the percentages of surveyed individuals falling into each transfer stage.

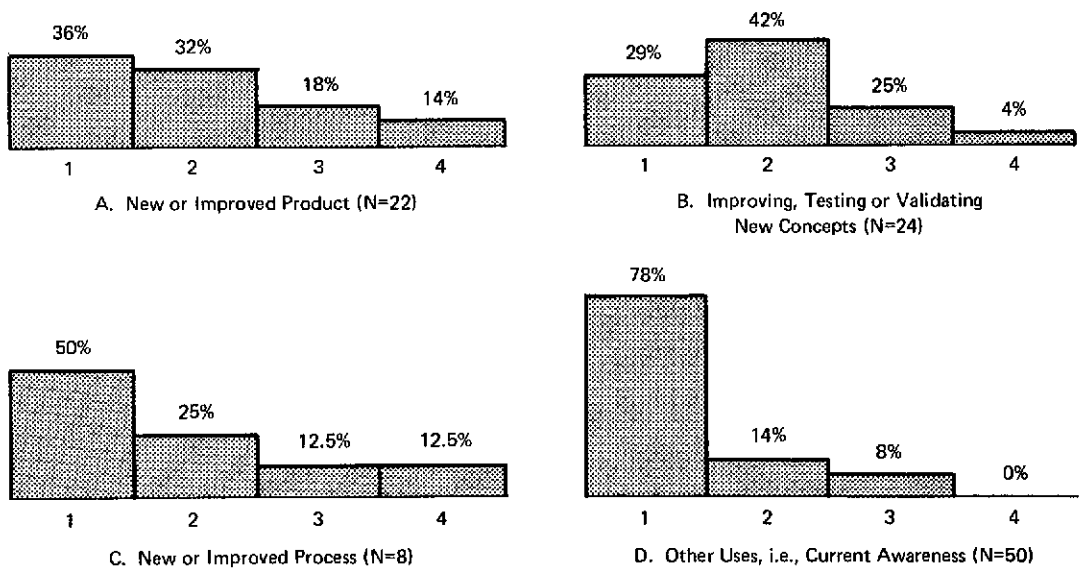

Figure 2-3. Use of Technology vs. Stage of Transfer.

User behavior concerned with new products and new concepts (profiles A and B, Figure 2-3) is significantly different from the patterns of use associated with current awareness information services (profile D, Figure 2-3). Applications of discrete technological resources are often directed to particular problem-solving situations; of equal importance, however, is the rather significant proportion (50 out of 104 surveyed) of users who acquire technical information for the purpose of staying informed or expanding the knowledge base concerning a particular field of interest.

Problem-solving capability and transfer stage. A significant relationship was found to exist between the problem-solving variable and the maturity of transfer activity. Respondents who reported that they used the technology in a problem-solving situation also indicated, for the most part, advanced stages of transfer with that technology. Figure 2-4 supports this conclusion.

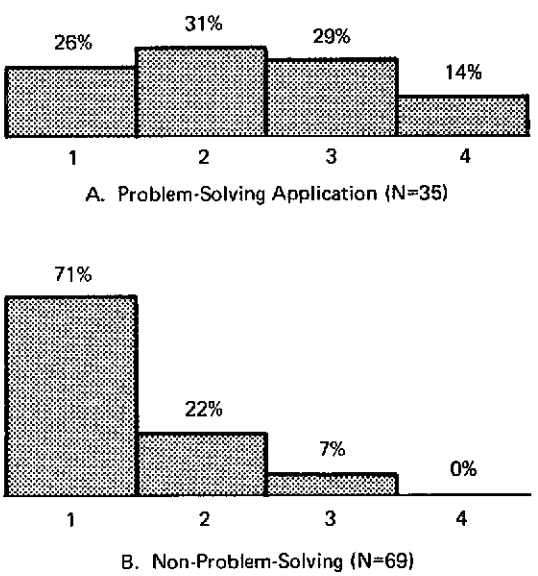

Figure 2-4. Problem-Solving vs. Stage of Transfer.

The results illustrated in the above figure were predictable based on earlier DRI analyses which suggested that TUO program effectiveness should be analyzed from the perspective of problem-solving rather than from the perspective of rapid-intact transfers.

Economic benefits and transfer stage. As expected, a significant relationship was indicated by the survey data: the greatest progress in transfer activity was associated with those individuals who indicated that certain economic benefits had resulted from the application of technical information described in the TSP. The respective profiles of the transfer stages support this judgment (see Figure 2-5).

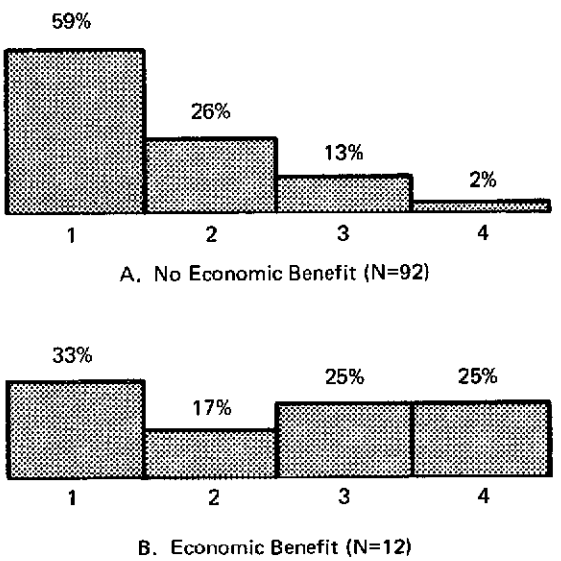

Figure 2-5. Economic Benefit vs. Stage of Transfer.

An analysis of the questionnaires showed that only a few respondents (approximately 10 percent) were able to specify any economic benefits associated with their use of NASA technology; over 40 percent, however, indicated that some kind of transfer activity was taking place. While other kinds of benefits associated with the use of Tech Briefs clearly exist, the extent of these benefits could not be identified in this study because they are not readily measurable in economic terms.

Communication mechanism and transfer stage. Although no statistically significant differences were indicated, qualitative judgments override a quantitative approach in this comparison of transfer profiles. The relative impact of "Trade Press and Journals" was clearly evidenced by the greater activity in the second and third transfer stages. The transfer profiles for the four major communication mechanisms are shown in Figure 2-6.

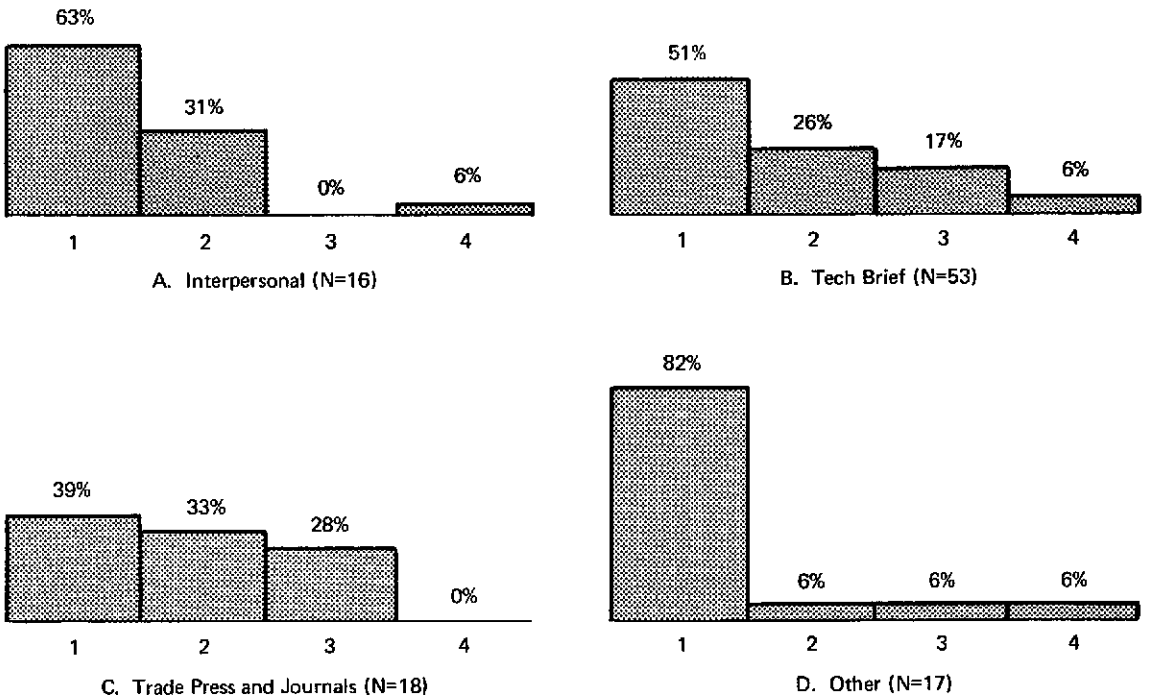

Figure 2-6. Communication Mechanism vs. Stage of Transfer.

Limitations

While the methodology maintained a degree of consistency in the available data, this study was subject to certain constraints:

- The study looked at only the characteristics of the Tech Brief-Technical Support Package Program. While this is the single most important publication program of the Technology Utilization Office, it cannot be expected to characterize all the activities, including those using transfer agents.

- Only those requesters contacting the NASA field centers directly for additional information on a NASA Tech Brief have been included in the DRI data bank and, therefore, were involved in the survey. Persons who have acquired TSP's through other dissemination mechanisms, such as Technology Utilization Compilations and Small Business Administration publications, were not included.

- The study was based on "requesters" of information rather than "users"; all requesters do not necessarily use the information they receive. As such, certain aspects of user behavior may be masked.

- The sample covered only a 15-month time frame and consisted of a small survey population chosen from over 24,000 returned TSP questionnaires in the DRI transfer data bank.

Conclusion

Based on the results of this study, further insights have been gained into the nature of technology transfer and processes for improving its effectiveness. The implications of the research continue to suggest that the development of more efficient communication techniques may be one of the integral factors in improving TU program efficiency. In particular, three aspects of the technical communications effort stand out as areas which offer alternatives for action:

1) Emphasizing special-interest communication mechanisms, i.e., formal arrangements with professional and trade publications;

2) Improving the availability of and access to sources of information, i.e., providing retrospective and timely access to NASA data; and

3) Presenting technological information which is targeted to selected user communities, i.e., packaging information according to predictable subject matter and user groupings.

While some communications media, such as NASA Tech Briefs, satisfy the general information needs of a large number of audiences, they ignore the more specific information needs of specialized interest groups. The study indicated that the most mature transfer activity was associated with technical information disseminated through the trade press and journals. Clearly, this proven channel of communication provides particular user groups with information directly applicable to their field of interest and/or current problem-solving needs.

While the results of this study showed that individuals in a problem-solving situation were most likely to utilize NASA technology, the generation and dissemination of technical information occurs independent of problems arising in the user environment. Thus, since fields of interest and user problems are always changing, it seems evident that the user must be provided with ready access to past as well as current technological developments. One possible course of action for improving the access to the information base may be the aggregation of Tech Brief-TSP information on microfilm in anticipation of individual ownership and use.

Although technological developments are not always utilized in problem-solving situations, the choice of technology to be communicated to user groups is significant to the transfer process. Research into the use of technology showed that technical information related to new or improved products and new concepts produced the most advanced transfer activity and was associated with discrete information resources.

The implications of this analysis suggest that the preceding set of alternatives could strengthen the effective transfer of innovation to the nonaerospace sector. With a greater understanding of user behavior patterns as they are associated with transfer activity, more efficient and operational communication techniques can be developed within the Technology Utilization Program. Particular attention must be paid to differentiating between specialized audiences, identifying user needs, and disseminating technical information which will best serve the needs of the nonaerospace community.