TASK FINAL REPORT

on

CONSIDERATION OF SPACE APPLICATIONS TRANSFER CENTERS FOR THE NASA OFFICE OF APPLICATIONS

(Report No. BCL-OA-TFR-76-3)

by

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FOREWORD

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OBJECTIVE

The major task of the Office of Applications is to carry out research and development on space-related applications. A corollary responsibility, and one which has been receiving increasing attention in recent years, is that of seeing that the results of the research and development are transferred to the nonaerospace community, so that the potential benefits of the R&D can be maximized. Another corollary responsibility is that of directing the R&D into those areas which provide the best match between NASA capabilities and user requirements.

As one of its activities in support of these responsibilities, the Office of Applications is considering a new technology transfer device: a group of Space Applications Transfer Centers. In general terms, these would be regional facilities devoted to: (1) promoting awareness of NASA technology on the part of users and potential users, (2) providing assistance to users in applying the technology to their own purposes, (3) providing a mechanism whereby user needs and attitudes can be transmitted to NASA to assist in managing the R&D itself, and (4) developing new applications and expanding existing ones.

The purpose of this paper is to examine the concept of Space Applications Transfer Centers, to consider the design of the first of these facilities, which would be experimental in nature. The questions to be considered include:

- Would a group of Space Applications Transfer Centers enhance technology transfer?
- Where should the initial center be located?
- What should it be designed to accomplish?
- How should it be organized?
- What criteria should be used in evaluating its performance?

APPROACH

The study begins with an examination of the technology transfer process in general, and a review of similar activities which have been carried out by various industrial and governmental organizations.

Next, the question of the sphere of activity for the initial center is addressed. The principal element of this is a review of the current activities of the Office of Applications from the standpoint of a regional center activity.

Finally, the characteristics of the initial center are developed, based on the foregoing material. It is realized that, in a brief review of this kind, not all questions can be answered fully. However, the major considerations are addressed, and the major factors in center configuration are outlined.

THE TECHNOLOGY TRANSFER PROCESS

Technology transfer or technological innovation is not a new process, nor is it a new field of study and activity. There has been a substantial amount of research devoted to this area, and a number of activities have been initiated for the purpose of fostering technology transfer.

Figure 1 shows the steps in the innovation process. All steps have to be completed in order to effect an innovation. Past studies have shown that the mortality rate at each stage is quite high, and the fraction of concepts which survive through to market acceptance is of the order of one in a hundred. In the later stages, however, where heavy investments are required, the survival rate is of the order of 50 percent. Nevertheless, in many ways the first step, the invention, is perhaps the most critical. This is a recognition of a match between a technological possibility and a requirement of some kind; a need or a desire. This recognition usually takes place in the mind of a single individual who is acquainted with both the needs and the technology. Sometimes the concept is generated by a multidisciplinary group, though this is a rather recent development. Studies of the process of invention have shown that there appears to be a strong element of chance in this step. It is also known that certain individuals perform this function far better than most. Thomas Edison accounted for about 0.1 percent of all patents issued by the U.S. Patent Office during his active life. There is some question as to whether invention can be managed effectively, but if it can, it appears that the route is one of bringing together diverse streams of influences (technological and marketing) in a single individual or a small group.

After an idea has been conceived, it usually requires some demonstration, before product development can be initiated. This demonstration necessitates some resources, and these resources tend to be limited, so there is a requirement for screening a number of conceptualizations to see which should be pursued through the demonstration phase. This decision is, or at least should be, strongly influenced by market considerations, as well as technical ones.

The area within the heavy dashed box of Figure 1 is the typical region of activity for NASA. The lighter dashed box is the area of user involvement. Within NASA the principal problems seem to be (1) bringing market needs and economic factors to bear on the conceptualizing

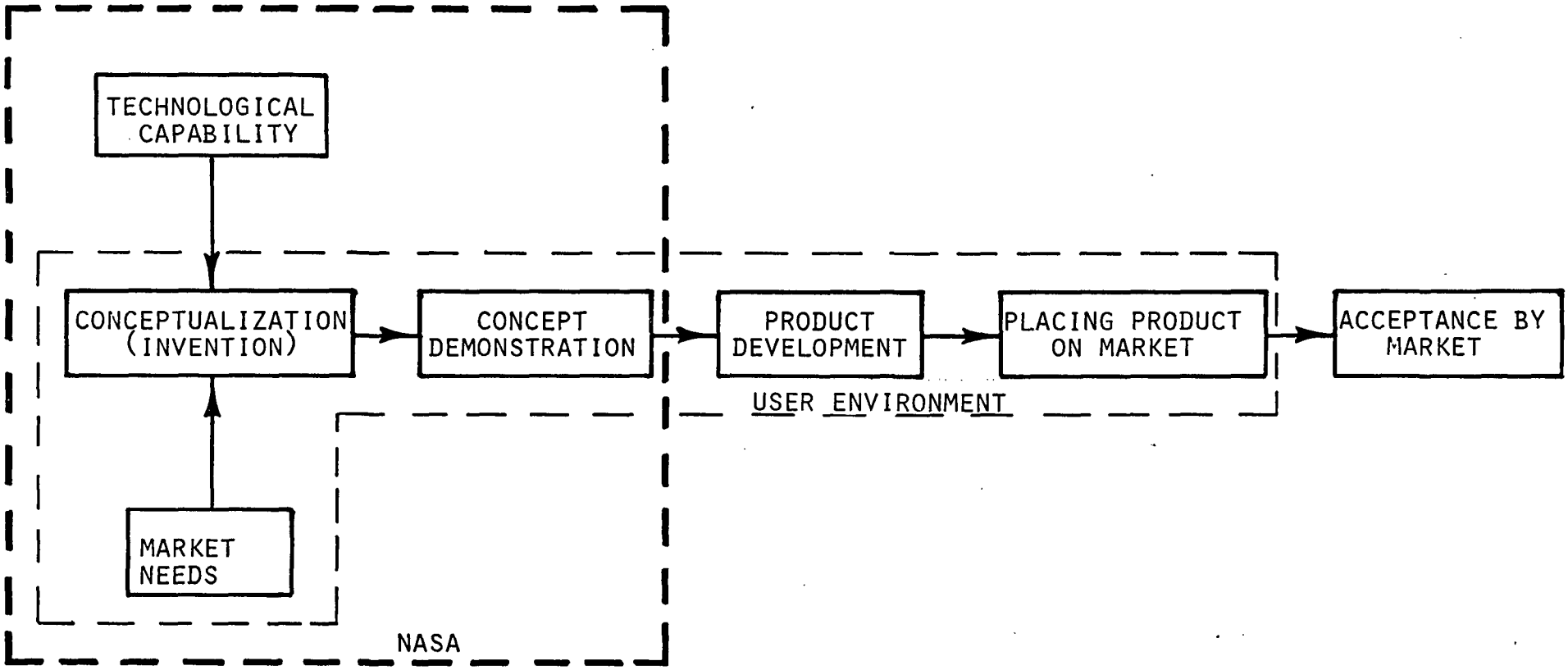

FIGURE 1. SCHEMATIC OF PROCESS OF INNOVATION

process,) (2) fostering the conceptualization, and (3) making the proper decisions about which concepts warrant demonstration (market forces and economic factors are important here also). The principal questions to be answered in this study revolve around the relationship of a Space Applications Transfer Center to this process of innovation, and especially to the areas of overlap between NASA and user concerns.

EXAMPLES OF TECHNOLOGY TRANSFER ACTIVITIES

It is of interest here to review selected examples of how other organizations have approached problems of technology transfer. None of the examples represents exactly the same situation as that facing NASA, but there are at least some points of similarity in all of them.

The Agricultural Technology Transfer System

Perhaps the most successful example of a technology transfer mechanism is the one developed about a century ago to support U.S. agriculture. It consists of local agents, typically one to a county, who reside permanently in the region they serve. These county agents are backed by a system of state agricultural experiment stations, and the Agricultural Extension Service of the U.S. Department of Agriculture. State Universities, especially the land grant colleges, carry out needed research, and the results are disseminated to the farmers by the county agents. The system is funded jointly from Federal, state and local tax revenues.

This system is widely viewed as having played a major role in the present unparalleled productivity of the U.S. agricultural sector. It is used by a major segment of farmers, especially operators of smaller farms, and is well regarded by the community it serves. There is a possibility that the system may play less of a role in the future than it has in the past. Because of the tendency toward larger farms and large agri-business organizations, with their own specialists and means of reaching farm managers, the need for a publicly supported system may decline. Be that as it may, the system has played a major role for over a century, and has helped build one of the strongest and most efficient sectors in the American economy.

The Urban Technology System

The Urban Technology System (UTS) is a national experimental program to support the use of new technology by urban governments. Sponsored by the Public Sector Office of the Experimental R&D Incentives Program of the National Science Foundation (NSF) and conducted by Public Technology, Inc., UTS is an instrument for local government self-help. It focuses on urban communities selected by the National Science Foundation and Public

Technology, Inc. (PTI). Twenty-seven cities or counties have been chosen, and each is host to a Technology Agent. The role of the Technology Agent is to join local officials in defining problems susceptible to technological innovation; to review experiences in other jurisdictions for techniques and tools to solve these problems; and to help initiate research and development for new solutions and products. Additional expertise is being provided by Resource Centers (universities, private companies and other R&D organizations), who become integral elements of the UTS by means of a formal agreement spelling out mutual commitments and requirements. Each community has been assigned its own Resource Center.

UTS is jointly funded by the Federal government, the selected local governments, and other participating organizations. Initial estimates are in the range of 9 million dollars, of which NSF will provide over 4 million. It is expected that these activities will generate significant additional resources to carry out specific development and demonstration activities.

The UTS experiment is being conducted over a 51-month period (beginning July, 1973). Each Technology Agent will have on-site program responsibilities for 3 years. The remaining time will be used for program planning, acquisition of base data, data analysis, and preparation of recommendations dealing with a long-range national policy of support for technological innovation in local government.

The Urban Technology System has been designed to merge the planner, the management specialist and the researcher, the public official and the private businessman, for a major effort to break through the barriers that have prevented technology from making its full contribution to modernizing local government. It is envisioned that the conduct of an experiment on such a scale over more than 4 years, with careful data gathering, analysis and evaluation, will provide significant insights for the development of national policies to increase the ability of our public and private sectors to develop and use technology for the benefit of all.

The Battelle Regional Centers Program

The Battelle Regional Centers Program (BRCP) was initiated in 1971 as a commitment to assist decision-makers in both the public and private sectors who are concerned with rational regional development. The Program brings a wide range of R&D capabilities to bear on social, economic, and technological problems at the state, regional, and local levels. The primary goal of the Program is to stimulate the development and use of scientific methods to: seek solutions to priority regional-development problems; identify regional-development opportunities; promote cooperation between technical resources in addressing local problems; and simulate the transfer of science and technology to help solve priority regional and local problems.

The Battelle Regional Centers Program functions in partnership with public and private agencies that focus on regional development. A major feature of the Program is the provision of selected services by its own full-

time professional staff at no cost to an agency. Each Regional Center is generally staffed with one or two professionals, who work with local decision-makers to help identify priority problems, point up opportinities for development within the region, and structure approaches that respond to these problems and opportunities. Projects evolving from contacts of Regional Center staff with local decision-makers are often conducted at one of Battelle's major laboratories, thus utilizing the specialized capabilities and skills of Battelle's organization.

The Program currently concentrates its activities in the southeast and mid-south regions of the United States. Professionally staffed centers are located in Atlanta, Jacksonville, New Orleans, and Lexington. Additional offices are being established in other states, along with a network of BRCP affiliates that will assist the Program staff in completing its mission--to serve as a catalyst and implementation agent in the region.

The Battelle Regional Centers Program was organized to fill what the National Academy of Sciences/National Academy of Engineering called "... a need for a new type of R&D institution ... to encourage the technological and economic development of the region in which it is located". Has the Program fulfilled its objectives/goals? This is a venture program funded by Battelle over a 10-year period. Now in its sixth year, the Program can perhaps best be evaluated on the basis of financial growth. During the period 1970-1974, Battelle's business base with state and local governments in the BRCP region has increased 2680 percent, while its business volume with state and local governments outside the BRCP region has increased 131 percent. As a statistic, however, the 2680 percent increase in the BRCP region should be viewed with caution, for Battelle had conducted virtually no business in the BRCP region before 1970; conversely, Battelle had a fairly well established business base outside the BRCP region before 1970.

A Transfer Center For Electronic Business Machine Technology

A major manufacturer of computers and electronic devices uses a headquarters-location technology transfer center in its marketing of high-technology, high-ticket systems to industry and government.

Field representatives continually call on upper management in a variety of industries that could benefit from advanced electronic technology in the form of point-of-sale data devices, computer systems, and so on. Depending on the level of interest shown, the potential customer may be invited to participate in a company-sponsored seminar on one of a variety of particular subject areas:

Computers in the medical field
Accounting applications in local government
Central information systems and financial auditing.

These seminars are intensive learning programs varying in length from one to several days. The objective is to make the executive aware of what the technology can do as applied to this need, and gather his ideas for marketing and product development purposes. At the center, whole rooms are dedicated to specific product lines, where the executive can see the equipment demonstrated, and in some cases use it, and review other successful applications which are analogous to his needs.

Once a commitment has been gained from the potential customer to seriously consider a particular system, the potential customer's staff participates in an intensive project development effort at the center, where all the variables surrounding the potential application are addressed. Finally, if the customer commits to the system, the center is available to his staff for initial training and ongoing support. The investment in the center has been viewed by the manufacturer as highly successful.

Additional examples could be cited, but it should be clear from these that: (1) based on past experience a regional center has a good chance of furthering technology transfer and (2) this possibility has been recognized, and is currently being employed by other organizations.

This, of course, does not assure success for the Space Applications Transfer Center concept, but it does suggest that it is a reasonable and potentially successful approach to the technology transfer problem.

REVIEW OF USER INTERFACE CHARACTERISTICS FOR OFFICE OF APPLICATIONS INITIATIVES

The activities of the Office of Applications could include any or all of the many fields in which NASA is active. This implies a very wide possible spectrum. In considering the problem of the first of the Space Applications Transfer Centers, however, primary emphasis should be placed on the current activities of the Office of Applications, and the associated user interfaces. In this section, these activities are reviewed in a very general way, for the purpose of identifying those which lend themselves to a Transfer Center approach.

Also, there is brief mention of some of the other areas of work which NASA might be called on to undertake in the near future. In the following section, a more detailed examination is given to those user interfaces which appear to be best served by a Transfer Center.

Communications and Data Management Programs

ATS-6 and CTS

The user communities for these communication satellites consist of principal investigators. There are a limited number of these and their degree of technological sophistication is comparatively high. It does not appear that the training center would assist in these programs.

Monitoring Foreign and Commercial Communication Satellite Activities

The user communities in these programs are very limited for the most part, comprising only a single organization. Furthermore, OA does not have primary responsibility for working with the users on these programs.

Monitoring Communications Navigation and Data Handling Activities

OA plays a coordinating role in a number of programs such as NAVSTAR, IPAD, INMARSAT, and AEROSAT. NAVSTAR could have substantial user community if the DOD decides to make this system available to civil users. If that decision is made, then NASA might play some role in working with the civil users, though the time scale of the NAVSTAR system falls outside the range of interest here. IPAD could also have a substantial user community consisting of a broad spectrum of high-technology design and manufacturing firms. These are widely distributed, with primary concentrations east of the Mississippi and in California. NASA Langley* has undertaken some efforts to develop nonaerospace users for IPAD, but this has been limited. Based on an earlier Battelle study for NASA Langley, it appears that an intensive one-on-one approach is appropriate for marketing IPAD technology to industrial users.

The rest of these activities involve very small user communities and thus fall outside the scope of this study.

Initiation of New Programs

OA is presently at work on developing several new initiatives in its area of responsibility, such as Search and Rescue and Mobile Communications. Transfer Centers could play a role in developing user requirements in programs such as these, while they are in the formative stages.

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* L. E. Hulbert, "A Preliminary Investigation of the Potential Applicability of the IPAD System to Non-Aerospace Industry", NASA CR 2603, Oct., 1975.

In addition, there are a number of other ideas in various stages of consideration in which EC might play some role, such as operation of an educational satellite, or satellite relay of data from remote data collection platforms. Inasmuch as communications represents probably the most significant application of NASA technology to date, it would be surprising if substantial new initiatives did not emerge in this field. A Transfer Center could assist in defining what these new initiatives should be by assessing needs and potential benefits. The center could also play a role in matching user requirements with commercially-provided satellite communications facilities.

Earth Observations Programs

Weather and Climate Programs

There is a substantial amount of activity here under the NIMBUS, TIROS, ITOS, and GOES programs. These relate to small user communities, either NOAA or groups of principal investigators. However, there are several cases in which dissemination of satellite-generated information to private meteorological organizations (airlines, agricultural services, offshore operators) could be beneficial. Real-time cloud-cover data from SMS could, for example, be valuable in local special-purpose forecasting.

LANDSAT Programs

LANDSAT data are currently being generated and disseminated to a large number of users. It is expected that this data flow will continue with the launch of LANDSAT C. Thousands of organizations and individuals have been identified as users of LANDSAT products, and the sale of these products currently amounts to [c. $1,500,000] annually. Many of the users have limited technical capabilities. It appears that LANDSAT data utilization could be materially improved by application of the Transfer Center concept.

The location and nature of the users will depend on the particular application area. The areas which have been identified are discussed in greater detail in a subsequent section.

Special Programs

GEOS-C, LAGEOS

Both of these programs have a primarily scientific orientation, and their user communities are principal investigators. These have been relatively numerous but their high degree of technical sophistication and geographical diversity suggests that a training center would be of limited

assistance in developing new users. However, even for programs of this type, the Transfer Center could help in developing a general awareness of the scope and quality of NASA efforts.

SEASAT A

SEASAT A is an experimental program targeted for launch in 1976, with a nominal 1-year life span. It will generate meterological products which should be of use in local weather and wave forecasting, and it will be equipped with an imaging radar which will have possible applications for both ocean and land areas. These uses are currently being explored as part of the SEASAT program, but it seems quite possible that new uses of SEASAT products can be found through the medium of a Transfer Center.

MAGSAT

Again, this is a science-oriented program, with a user community of principal investigators. However, the data would be of potential interest to the extractive industries for assessing large-scale features of the sub-surface structure.

Shuttle Payloads

There are many ways in which OA programs could impact shuttle payloads. Two are considered here.

Space Processing

The users of space processing are expected to be high technology industrial firms. Battelle's recent study of the problem of marketing space processing suggests that the proper means of dealing with a user community is an intensive one-on-one relationship in which NASA would work closely with each of the participating industrial firms on their particular problem. This type of relationship is not greatly enhanced by a Transfer Center.

Earth-Viewing Applications Laboratory (EVAL)

The sensors for EVAL have not been completely specified, but it seems clear that the user community will be some combination of the users for meteorological data, LANDSAT data and SEASAT data. The Transfer Center could assist in developing requirements for EVAL, as well as in disseminating the products, once EVAL is operational.

Technology Applications Programs

Vascular Aquatic Waste Water Treatment

The user community associated with this concept consists of the smaller waste-water treatment facilities in the southeastern United States. In a Battelle study of the market for this concept, it was concluded that the total market size was of the order of $165 million over the next 25 years. Present indications are that the concept is most promising for approximately the southern half of Florida. With some additional development, it could be used along the Gulf Coast. Because of the sharply localized geographical applicability of this concept, a Transfer Center in the region could speed dissemination of the technology.

Activated Carbon Treatment System

This concept is potentially applicable to treatment of municipal waste waters anywhere in the country, with special emphasis on the larger facilities. More specifically, the market consists of the design engineers at the major A&E firms. There are probably better ways of reaching this community than through the Transfer Center, though if a center existed for other purposes, it could perhaps be used to further the dissemination of this technology.

Water Quality Monitoring System

The market for this system is very similar to that for the activated carbon system mentioned above and would have the same characteristics.

IR Scanning

This concept has potential applicability to a large number of industrial and governmental organizations. It is potentially useful throughout the nation but is perhaps of more critical importance in the colder climates. An Information Center or Transfer Center might be quite helpful in disseminating this technology.

Air Pollution Source Identification

The principal market for this concept seems to be environmental enforcement agencies. The number of such agencies is quite limited and there are more effective ways of reaching them than through a Transfer Center.

Summary

It appears, then, that for an initial Transfer Center, the following existing programs would have some degree of application (listed in decreasing order of priority): LANDSAT, SEASAT A, Meteorological Data Programs, IR Scanning, Activated Carbon, Water Quality Monitoring and Vascular Aquatic Plants (given a southeastern location). The LANDSAT applications are discussed in more detail in a following section.

In addition to expanding the user communities for these programs, the center would provide a means of getting user inputs into these programs, and in guiding NASA in the selection of future programs.

REVIEW OF INDIVIDUAL TECHNOLOGY MARKETS

Introduction

Each of the current technological activity areas identified above has its own universe of potential users; in each area, some of these have become actual users while others have not. There are a number of influences at work on each potential user which will determine whether or not he buys the product. Some of these are:

- Nature of user's needs
- Technical characteristics of the product
- Cost of the product
- Availability and timeliness of the product
- User's level of technological sophistication
- User's financial situation
- User's competitive position within his industry
- Inadequate information about the product.

In this section we identify to the extent possible the relative magnitudes of these influences in each of the applications areas. From this analysis it will be possible to form an estimate of the possible impact of a Transfer Center.

Analysis of LANDSAT Technology Market

In analyzing the needs for the types of training and assistance activities required to facilitate Earth resources survey data (using LANDSAT data) use throughout the user community (private and public sectors), five integrated factors must be considered. The five elements that must be analyzed both singularly and in combination in terms of their current status

include: (1) user community factors, (2) use/application factors, (3) space data capability factors, (4) area/regional factors, and (5) applications transfer factors. Table 1 shows the individual components that are considered relevant to each of the factors. In this analysis, user factors are considered as the most significant since such items as user needs, capabilities, resources and current space data use, experience and awareness are extremely critical to ascertaining the need for and defining the type(s) of applications transfer centers required. The second most significant factor involves the technical characteristics of the space data, especially in terms of the opportunities and limitations associated with using the data products being generated and subsequently disseminated. The third factor involves specific data use considerations to date. This factor has two aspects: one addresses the specific data applications and/or uses (within a discipline framework); the other addresses the current operational status or use level, varying from possible/potential application to routine use. The remaining two factors (area and applications transfer factors) are mainly important in terms of identifying and assessing the optimum types and locations of space applications transfer centers.

In the following discussion, these factors will be considered as appropriate to (1) assessing the need for space applications transfer centers, (2) determining the nature and type of centers required, and (3) selecting locations for pilot/future center establishment.

Applications Transfer Centers - Need Assessment

Formal training on the application of remote sensing techniques has been the most effective catalyst in promoting the use of satellite Earth resources survey data in foreign countries. To date, over 100 foreign data users from over 40 countries have participated in international remote sensing training programs held at the USGS EROS Data Center. Foreign participants who have attended the 4-week "hands-on" training workshop, interviewed during a Battelle survey for NASA/OA, were united in their views as to the value of such training programs. Several stressed, however, that added benefits would be gained by in-country training where user problems, data needs, and capabilities could be more effectively linked (Battelle Survey of Users of Earth Resources Remote Sensing Data, March 31, 1976, for NASA/OA, Contract No. NASw-2800, Task 6, page 109).

Because of the past success of the international workshop effort and existing needs throughout the satellite data user community, the EROS Data Center has implemented a series of data applications training programs ranging from 2 to 4-day orientation sessions to structured, discipline workshops of one or more weeks duration. Unfortunately, these courses are established on an as-needed basis, and plans and schedules as of September, 1975 were not being met, suggesting that the growing need will not be met by EROS Data Center training efforts alone.

TABLE 1. FACTORS SIGNIFICANT TO ESTABLISHING SPACE DATA APPLICATIONS TRANSFER CENTERS

1. USER STATUS

- Data needs
- Capabilities
- Resources
- Institutional Strengths and Weaknesses
- Conventional Practices
- Data Use Awareness

2. DATA STATUS

- Spectral Capabilities
- Spatial Capabilities
- Data Delivery
- Repetitive Coverage
- Geographic Coverage
- Data Quality
- Format Options
- Cost

3. USE STATUS
(For Each Application Area)

- Possible Applications Exist
- Experimental Utility Demonstrated
- Cost Effective/Cost Beneficial Uses Demonstrated
- Quasi-Operational Application Systems Under Development
- Routine-Operational Use in Being

4. AREA/REGIONAL STATUS

- Rational Activities
- Current User Activities
- Current Uses
- Regional Area Capabilities/ Centers of Technology

5. APPLICATIONS TRANSFER OPTIONS

By Level of Sophistication:

- Basic Facility to Improve User Awareness
- "Hands On" Facility to Evaluate/Demonstrate Uses
- Major Facility to Support ASVT Program

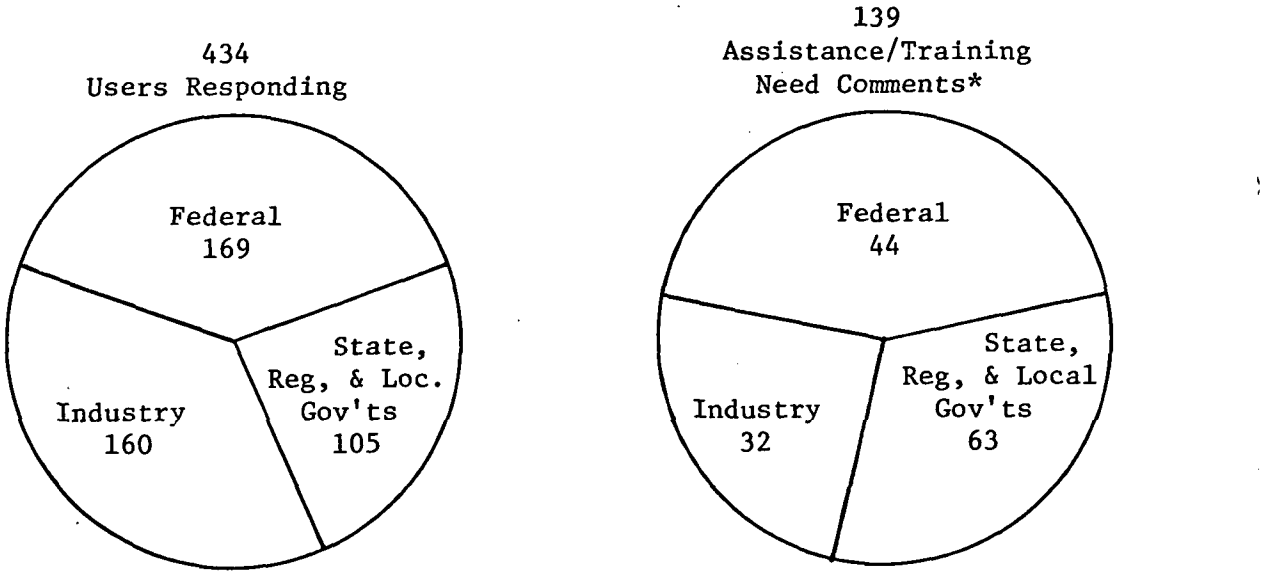
By Function:

- User Awareness
- User Assistance
- User Relations
- Market Development

Staff members of all three federal satellite data centers (EROS, USDA, and NOAA) routinely involved in direct interactions with satellite data users are of the common opinion that most of the users and potential users seeking satellite data are very unfamiliar as to how to actually use the data. Current procedures involving telephone conversations and/or letter correspondence are not adequate in communicating this critical information, which in almost every instance involves special technical considerations.

Other more formal educational efforts, represented mostly by short courses of the type offered on machine analysis of remotely sensed data by Purdue University (Laboratory for Applications of Remote Sensing), have done much to upgrade the technical capabilities of participating Earth resources survey data users. However, once again, such formal academic opportunities are too few and too infrequent to meet the growing needs of ERS data users currently estimated (based on data center use) to number tens of thousands.

Perhaps the most important means for deciding whether or not a real need exists involves viewing the need for additional assistance in using satellite Earth resources survey (ERS) data from the user perspective. The recently completed Battelle survey clearly documents the user community expression of need. Figure 2 shows the results of contacts with 434 actual current users of ERS data, distributed as shown among the three user communities. Of those, 139 indicated a need for additional assistance and/or training. Among <u>potential</u> users, the fraction requiring training would undoubtedly be higher.



* Specific user comments written in response to question requesting how ERS data applications can be improved by discipline.

FIGURE 2. NUMBER OF USERS INDICATING ASSISTANCE/TRAINING NEEDS ON BATTELLE SURVEY

Battelle survey results show that all user groups have voiced concern as to the need existing for specialized assistance and training in satellite data use. The strongest concern came from the state, regional, and local governmental users; federal users were a close second, and private sector users were third. A contemporary GAO survey of state LANDSAT investigators found 87 percent of respondents indicating a need for training in LANDSAT data use. (Study by the Staff of the U.S. General Accounting Office of NASA's Land Satellite Project, January 30, 1976.)

In evaluating all user-recommended options for strengthening current data use resulting from the survey, Battelle concluded that more education and training, including 'hands-on' training, represented one of the three most promising opportunities, and recommended, accordingly, that NASA give high priority to establishing such training centers on a regional basis (Battelle Survey Summary, p. 121; Table 16, p. 125, and Recommendation No. 2, p. 129.)

Applications Transfer Centers - Nature and Type Assessment

The Battelle survey found that current ERS data applications among the various disciplines are fairly uniform, with small peaks occurring in land use and geological applications and a considerably lower effort indicated for environmental data uses (see Figure 28, p. 120).* This suggests, from an overall use perspective, that applications transfer centers could be equally effective in all discipline areas. However, looking at the discipline use status from the standpoint of user data needs, LANDSAT data adequacy, and data use maturity (i.e., level of use from experimental, demonstrational to operational), it is clearly indicated that the best current data use opportunities are highest in the areas of land use and geology and related geoexploration uses (see Table 2).

However, based upon information available and experience, Battelle feels that the Space Applications Transfer Centers should clearly have a two-fold purpose. First, the center(s) should clearly be the regional focus for promoting/supporting space data use, and second, the center(s) should maintain an allegiance to being responsive to the total needs and users of the region(s) involved. Anything less or more specialized will confuse and possibly discourage potential user involvement. This is not to say that centers should be established without current and potential applications/uses in mind. On the contrary, the center(s) should be established with initial emphasis on promoting the most established uses compatible with regional user needs and priorities, but clearly maintaining an image of expertise broad enough to expand as appropriate to other space data application areas--both within and outside the framework of Earth resources survey data use.

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* "Survey of Users of Earth Resources Remote Sensing Data", Battelle Columbus Laboratories, for NASA Office of Applications, February, 1976.

TABLE 2. OVERVIEW OF FACTORS CONSIDERED IN SPACE APPLICATIONS TRANSFER CENTER ANALYSIS

	APPLICATIONS STATUS ASSESSMENT								
	USER NEED			LANDSAT DATA ADEQUACY			DATA USE STATUS		
	Industry	Fed. Gov't.	State Gov't.	Industry	Fed.Gov't.	State Gov't.	Industry	Fed. Gov't.	State Gov't.
Agriculture/ Forestry/ Range Resources	Moderate	Extensive	Moderate	Inadequate	Adequate	Inadequate	Potential/ Experimental	Experimental/ Demonstrational	Potential/ Experimental
	Required for the assessment of available natural resources and crop yield	Required for nationwide survey of crops/forests and damage to crop/forests and range lands	Primarily for inventorying forest and range resources				Forest inventories	Crop and forest inventories	Agricultural land and forest inventories
Land Use	Moderate	Extensive	Extensive	Useful	Useful	Useful	Demonstrat./ Routine	Demonstrat./ Routine	Demonstrat./
	Primarily used by service-to-user agencies who process data for other users	Required for planning, monitoring purposes on national scale	Continuous need for information on cultural growth and depletion or growth of land cover				Data preperation for state and local users for land cover maps	Used primarily to demonstrate usefulness of data and technique to other users	Used for mapping of urban growth, growth patterns and trends
Geological Surveys/ Mineral Resources	Extensive	Extensive	Extensive	Very Useful	Adequate	Useful	Routine	Demonstrate/ Routine	Demonstrational
	Worldwide data required for finding new sources of energy and minerals	Needs nationwide data for mapping geological structures, terrain, earthquake areas, etc.	Need statewide data for mapping monitoring, inventorying, highway construction				Data purchased and used in operational mode for locating and developing areas containing minerals and fossil fuels for site selection	Used primarily to show usefulness for locating geological hazards, minerals, fossil fuels, mapping geological structures	
Water Resources	Moderate	Extensive	Extensive	Adequate	Adequate	Adequate	Experimental	Demonstrational	Demonstrational
Environment	Moderate	Extensive	Extensive	Inadequate	Useful	Useful	Experimental	Demonstrational	Demonstrational

TABLE 2. (Continued)

	TRAINING IMPLICATION ASSESSMENT						FACILITY SITING ASSESSMENT	
	TRAINING NEED			TYPE OF CENTER			Based on	Based on Current LANDSAT
	Industry	Fed.Gov't.	State Gov't.	Industry	Fed.Gov't.	State Gov't.	Regional Discipline Interest	Data User Distribution
Agriculture/ Forestry/ Range Resources	Moderate	Extensive	Moderate	"Hands on" Facility	ASVT	Basic User Awareness Facility	St. Louis or Kansas City St. Louis or Kansas City Seattle San Francisco	Washington, D. C. Houston, Texas Seattle Atlanta
Land Use	Moderate	Moderate	Extensive	"Hands on" Facility	ASVT	ASVT	Houston Washington, D. C. Chicago or St. Louis San Francisco	Washington, D. C. Atlanta Houston Chicago
Geological Surveys/ Mineral Resources	Extensive	Moderate	Moderate	"Hands on" and ASVT	ASVT	Basic User Awareness Facility	Houston Colorado Pittsburgh, Columbus	Washington, D. C. Houston, Texas San Francisco, Calif. Denver, Colorado
Water Resources	Moderate	Moderate	Extensive	"Hands on" Facility	ASVT	Basic User Awareness Facility	Houston Chicago San Francisco	Washington, D. C. Atlanta, Ga. Houston, Texas San Francisco
Environment	Moderate	Extensive	Extensive	Basic User Awareness Facility	ASVT	Basic User Awareness Facility	Washington, D. C. Houston, Texas San Francisco	Washington, D. C. Atlanta Chicago, Illinois San Francisco,Calif.

Definition of the characteristics of the Space Applications Transfer Center that would be most responsive to explicit user community needs requires inputs as to what constitutes current user views relative to the type(s) of assistance and/or training needed to improve satellite data use.

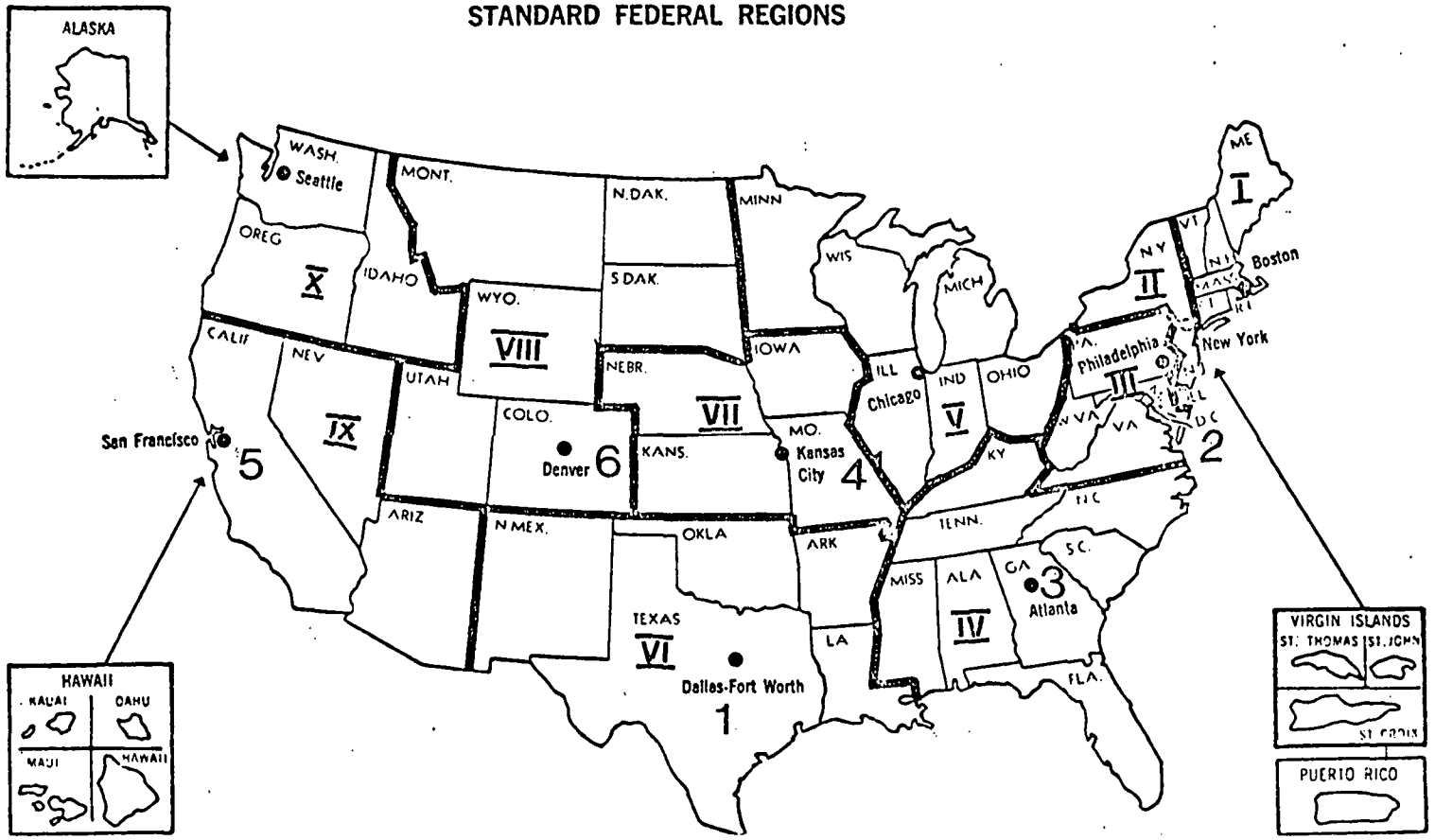
State, Regional and Local Government Users. Battelle Survey results show that this group strongly advocates the need for establishing regional ERS data application assistance centers containing trained personnel and data analysis facilities (which are within a day's drive from the capital). They feel the current need is to direct more of the effort (and resources) toward applications development as opposed to research. Specifically requested are improved user awareness procedures whereby users are more effectively kept up to date on space technology developments and plans which could be significant to current and future data use possibilities. The mechanism must include "anytime" opportunities for users to exchange information/data with NASA application specialists relative to user needs and space data use possibilities. They clearly see the need for more formal education and training programs for both current and potential users. They are much in favor of specialized application workshops for administrators and decision-makers.

Federal Government User Community. During the Battelle Survey, federal users expressed a strong desire for regional data centers, equipped with state-of-the-art data analysis equipment, which would receive ERS data for their geographic area on a timely basis. This user group has a great need for basic information on data applications, and data availability; this especially holds for federal agency field staff located outside the Washington, D. C. area. They desire to be kept informed of new technological developments through improved communication/coordination links with NASA. They feel that NASA should provide the space data application leadership by making data analyses programs available and providing trained discipline specialists for consultation on an as-needed basis. They request more training/educational opportunities for direct involvement with data interpretation techniques and more workshops, seminars, and symposia in which only state-of-the-art advances are addressed.

Private Sector Users. Industrial users contacted during the Battelle Survey also indicated a strong current need for more EROS-type application assistance facilities, especially in terms of providing required, up-to-date browse files and sophisticated equipment to aid space data analysis and use. Users in this category indicated a need for more educational material on data use, data availability, and end products. They clearly want more user-oriented conferences and workshops such as the Pecora and Houston ERS symposia.

Applications Transfer Centers - Facility Siting Assessment

Figure 3 shows the ten federal regions which have been considered as candidates for an initial or subsequent Space Applications Transfer



1. Houston/Dallas, Texas (Region VI)
2. Washington, D. C. (Regions I, II, III)
3. Atlanta, Georgia (Region IV)
4. St. Louis, Missouri (Regions V, VII)
5. San Francisco (Regions IX, X)
6. Denver, Colorado (Region VIII)

FIGURE 3. REGIONAL OPTIONS FOR LOCATING NASA DATA APPLICATIONS TRANSFER CENTERS

Center(s). Table 3 shows the results of viewing these regions from the standpoint of major discipline(s) interest and available organizational expertise to promote space data use.

Table 2, shown earlier, gives the results of linking the status of LANDSAT data applications (by discipline) with training/assistance requirements existing for participating LANDSAT data users (viz., industry, federal government, and state government) with logical regional facility siting options. The last column in Table 2 lists regional application center options based soley on the apparent distribution of current LANDSAT data users (by discipline interest) identified in the Battelle Survey.

Applications Transfer Centers - Summary and Conclusions

This brief analysis of the status of LANDSAT data use as viewed in relation for establishing Space Applications Transfer Centers has indicated that:

(1) A definite need, explicitly expressed by both public and private sector users, exists for establishing technically sophisticated (staff and equipment) regional application centers for assisting users in evaluating and developing procedures for using space-acquired data.

(2) The center(s) should be tailored to emphasize proven LANDSAT data applications that are responsive to the regional needs, while presenting an image of comprehensive technical competence to promote all satellite data use possibilities.

(3) The center(s) should serve as (a) regional facilities for access to satellite data (initially ERS/LANDSAT data), (b) training centers, both formal and informal, (c) advisory centers to assist users in evaluating and developing programs for routinely using satellite data, (d) facility centers for providing sophisticated equipment to assist users in analyzing satellite data, and (e) libraries for user education and familarization with satellite data applications technology, and (f) a means for putting users in touch with commercial services and equipment suppliers.

(4) The center(s) should be active in seeking out regional use/users. Accordingly, links should be established with all technology transfer-type agents (e.g., agricultural extension, community development, and others) and all technology transfer-type programs and organizations in the region. The possibility should be given to using mobile data analysis facilities and computer terminals to insure a center's involvement throughout the region.

TABLE 3. REGIONAL DISCIPLINE INTERESTS AND AVAILABLE SPACE DATA APPLICATION ASSISTANCE ORGANIZATIONS

	Major Regional ERS Data Application Disciplines	Current Technical Application Assistance Organizations
Region I	Water Resources	U. S. Army Corps. of Engineers
Region II	Land Use and Ecology/ Environment (Coastal Zone)	Cornell University of Delaware
Region III	Geology and Land Use	Penn State University, University of Maryland General Electric and Earth Satellite Corporation Goddard Space Flight Center
Region IV	Agriculture and Ecology/ Environment (Coastal Zone)	Kennedy Space Flight Center and Marshall Space Flight Center Tennessee Valley Authority USGS Earth Resources Laboratory University of Tennessee and Georgia Tech
Region V	Ecology/Environment Geology and Land Use	Lewis Research Center Battelle, Bendix and ERIM Purdue University, Michigan State University University of Michigan, University of Wisconsin
Region VI	Geology and Ecology/ Environment	Johnson Space Center and Associated Industries Texas A&M, University of Texas and Louisiana State University
Region VII	Agriculture	University of Nebraska, University of Kansas, Washington University
Region VIII	Agriculture and Geology	EROS Data Center Denver Research Institute South Dakota State University
Region IX	Water Resources	NASA Ames, Jet Propulsion Laboratory Stanford Research Institute, TRW, Inc. ESL, Incorporated University of California, University of Arizona
Region X	Agriculture and Ecology/ Environment	Battelle Northwest Oregon State University University of Alaska

(5) Aggregating all LANDSAT data use/user information with federal regional factors (such as existing facilities, capabilities) indicates a need for the establishment of at least six regional Data Applications Transfer Centers. Figure 3 shows the recommended sites, which include, in order of priority:

- Houston/Dallas, Texas - To serve users in Region VI
- Washington, D. C. - To serve users in Regions I, II, III
- Atlanta, Georgia - To serve users in Region IV
- St. Louis, Missouri - To serve users in Regions V and VII
- San Francisco - To serve users in Regions IX and X
- Denver, Colorado - To serve users in Region VIII.

CHARACTERISTICS OF THE INITIAL SPACE APPLICATIONS TRANSFER CENTER

On the basis of the background developed above, the design of the initial Transfer Center can be addressed. In this section, the last four of the questions raised in the first section are discussed: (1) where should the initial center be located, (2) what should it be designed to accomplish, (3) how should it be organized, and (4) what criteria should be used in evaluating its performance.

Requirements

Before answering these questions, it is necessary to consider certain additional aspects which underlie the establishment of the initial center. First, the experimental nature of this activity should be reasonably clear. There is no verified methodology for carrying out technology transfer. Indeed, there are those who believe that no methodology is possible, and that it is necessary to rely on chance.

Accordingly, it is necessary to proceed in an experimental fashion. Beginning with a single center, rather than setting up several of them initially, is a recognition of the experimental aspect. The initial center will be predicated on the best possible hypotheses, but it will also be designed to test those hypotheses, so that they can be modified for subsequent centers.

With the initial center, it is desirable to begin as small as possible consistent with maintaining a viable operation. There is some "critical mass" below which chances of success are diminished, but the size of the center should be kept to a minimum until experience is gained.

Also, in keeping with the experimental nature of the problem, it is desirable to select a location in which there are a variety of problem areas from which to choose. However, it would be advisable to limit initial efforts to a reasonably well-defined and verified applications area.

In association with keeping the risk small, and maximizing the information to be obtained, there is also a requirement to design the center in such a way as to maximize its probability of success. It should build on market areas which are known to be strong.

The timing of the initial center is also significant. Both LANDSAT D and SEASAT A have operational dates that require the earliest practical initiation. If users are to be provided with training and assistance in time to make use of these programs, a start in FY 1977 is required.

Evaluation Criteria

Perhaps the simplest approach to evaluating a technology transfer organization would be to keep an account of the number of successful transfers for which the organization was responsible, and to keep a corresponding account of the costs. There are several difficulties with this, but perhaps the most serious is the time that elapses between the original conceptualization and the final adaptation by the marketplace. Periods of 10 to 20 years are by no means uncommon for major innovations, such as the Xerox process, though minor advances occur more rapidly.

Accordingly, it seems that it will be necessary to evaluate completions of activities nearer the beginning of the process, i.e., those activities within NASA's area of concern in Figure 1. It is not possible to develop full details of an evaluation procedure within the scope of this study, but it is suggested that a combination of the number of these activities completed, the estimated economic impact of those which are completed (amount of money which can potentially be saved if the concept it implemented, etc.), and the cost of the activities would be appropriate. With publicly funded activities, some form of cost/benefit evaluation would be desirable. However, in this case, it would be potential benefits rather than actual ones, until such time as implementation is achieved.

There is another criterion for evaluating performance of the centers which is non-quantifiable, but nonetheless very important. The general standing of NASA with the industrial and state and local user communities is not high. For the most part, these groups do not perceive that NASA's activities, or technology in general, are benefitting them. Operation of the Transfer Centers should help to change this climate of opinion by providing both the substance and the appearance of technology applied for the benefit of the user.

Location of the Initial Transfer Center

There are two aspects to the location problem: (1) in what part of the country should it be located and (2) within the selected region, what type of location should be sought. Considering the second question first, we would suggest that the Transfer Center should not be located at either an existing NASA field center or at a university. Most potential users of the types being sought would probably feel uncomfortable with the high-technology space orientation of a NASA Field Center or with the research/intellectual atmosphere of a college campus. A more typical business location would be preferred, which would present at least a neutral image to the users. Convenience of access, both for intercity travel and for local travel would be significant.

In finding and working with users, the Transfer Center will be viewed by most users as representing all of NASA, and in many cases as a representative of the Federal Government in general. Questions may be raised by users which fall outside the scope of OA activities, or even outside the scope of NASA. In such cases, it is highly undesirable for Transfer Center personnel to indicate that the question is outside their area of concern.

Because of this, it will be necessary that (1) the Transfer Center develop working relationships with other NASA organizations, as appropirate and (2) that relationships be worked out with other Federal agencies. This latter consideration bears on the problem of location because there is already established a network of Federal Regional Councils, one for each of the ten Federal regions. These Councils have a responsibility for coordinating the regional activities of the various Federal agencies, and it seems probable that they would also play some role in the Transfer Centers. From the standpoint of the Transfer Centers, it seems that the Federal Regional Councils would provide the most logical mechanism for responding to user concerns which fall outside NASA's sphere of responsibility.

Accordingly, there is some merit in co-locating the Transfer Center with the Federal Regional Council. It is quite important that a relationship be developed with the FRC, but there are other considerations in locating the Center than the location of the FRC. Principal among these considerations is the location of concentrations of users or potential users.

Turning now to the question of the region in which the initial center should be located, it does not appear possible to make a definitive selection without further study. Every portion of the country offers some benefits and some disadvantages. The main considerations, of course, are the locations of users and potential users. In a previous section, the location of current users was reviewed, and it was found that, in order of user concentrations, the leading candidates are (1) Houston/Dallas, (2) Washington, D. C., (3) Atlanta, (4) St. Louis, (5) San Francisco, and (6) Denver. These users were primarily industrial, and Federal Government users, with a comparatively small number of state and local users.

It is hard to be definitive about locations for the potential users, since they have yet to be identified. In this connection, however, it is natural to focus attention on highly populated regions because these represent the concentrations of economic activity, and offer the greatest potential for economic impact. On the other hand, the Pacific Northwest (Federal Region X) is perhaps the most enthusiastic in terms of support of the LANDSAT program, the forest and range management, to which remote sensing can make a major contribution, is very significant in the regional economy.

To some extent, the question or regional location is tied up with the discipline to be emphasized. If one is interested in forest and range questions, it would be Regions VIII and X. If land use mapping is the focus, probably the midwest and northeast. If environmental problems are paramount, the northeast would be selected. If surface mining monitoring is the subject, Regions III, IV, and V would be selected. For other extractive industries, probably Regions IV and VI would be emphasized.

In the Battelle survey of LANDSAT users, it was found that state and local users were a rather small fraction of the whole. It could be argued that the Transfer Center should be aimed at developing this application. Land use and environmental monitoring would be the most relevant disciplines in that case and midwestern or northeastern locations would be indicated. However, it seems somewhat risky to predicate the initial center on a market which is comparatively weak.

All things considered, it appears to us that Regions IV and VI represent the most attractive areas, based on a combination of concentration of current users of LANDSAT data, and an opportunity for a variety of applications, governmental and industrial. These regions contain almost all the types of terrain, urban concentrations, industrial activity and environmental problems to be found in the country as a whole. On this basis, they would provide for many possible types of Transfer Center activities.

However, a more complete analysis of the interaction between regional location and Transfer Center design (primarily disciplines to be emphasized) should be undertaken before a recommendation is formulated.

Staffing and Operation

If technological possibilities and needs are to be brought together, the first question is that of where this meeting should take place. Are potential users to come to a technology center, or should technologists go to the potential users? Both have been tried, but it is our opinion that the technologist should take the active role, certainly in the initial stages. This appears to have been more successful in the past than leaving the initiative to the user.

The Space Applications Transfer Center, then, should seek out opportunities in the region it serves. A major share of the personnel should be engaged in this function. These market development representatives would be analogous to the county agents of the Agricultural Extension Service.

They would locate opportunities, and assist in the iterative process which would have to take place between users and technical specialists to create a concept for new applications. Of course, it follows that technical specialists would also be a part of the center organization, or they would be readily available to the center from some other source.

The market development representative, who is both marketing oriented and technically conversant, should:

- Be aware why the technology area being developed has been selected for this user community
- Understand the specific match of technology to the user's need
- Know why the user should be interested (technical and economic benefit)
- Be familiar with the cost benefit, economic assessment and market projections made for the user's case
- Know the applicable technology history and status
- Know the user, be familiar with the user organization's financial and business profile or agency profile
- Understand the entry point being made at the user's organization (why it was selected and role in authority chain)
- Be familiar with the general acceptance/resistance to be anticipated from the user community (user community profile)
- Assure that informational material is tailored to user
- Make the presentation to the user and <u>listen</u>, since the user contact must be an <u>exchange</u> of information and ideas
- Be responsive to user ideas, questions, need for more data
- Be capable of providing or coordinating technical backup (research history/results/status)
- Be able to identify and implement the next step.

The technical specialists associated with the center should be versed in those disciplines with which the center is most concerned. For example, in the case of the initial center, a prime focus would be on remote sensing, so there should be remote sensing experts associated with the center. They should be full members of the remote sensing technical community, and should keep abreast of, and contribute to, that technical discipline.

In the course of its activities, however, any center is going to deal with a wide variety of technologies. It is not reasonable to expect each center to have technical specialists in all possible fields. Accordingly, other personnel need to be on call, as in the Agricultural Extension Service or the backup centers for the Urban Technology System. In any case, the technology specialists must also be somewhat user-oriented, and be able to cooperate with industrial or governmental users.

It is important that not all services of the Transfer Center be free to the user. Most industrial and governmental users would feel more comfortable with arrangements in which something is expected from them in return for value received. Setting rates for such services would require a study in itself, but some preliminary suggestions can be made. Initial contacts with potential users would be free, as would initial discussion of possible areas of mutual interest. Once an idea has been identified, and it is being developed jointly, it is reasonable to expect that the user would contribute services of his technical staff required to carry out the development. Experimental use of Center computer and library facilities could be priced at marginal cost, or perhaps somewhat below, while routine use of such facilities could be priced at full cost. This would maximize the motivation of the users to transfer to a commercial supplier of such services, at that point.

The center should have certain facilities, such as a library, meeting and training facilities, access to technical data systems, and some computational and data analysis capability, to the extent that these facilities will assist in getting new users involved.

As a minimum, it appears that the staff should include five or six market development representatives, two or three technology specialists and a support staff of two or three. Including facilities and operating expenses, the total cost would be somewhere in the range of $1 million to $1.5 million annually. A minimum operational period of 3 years would be required to permit any reasonable evaluation of results, and 5 years would be more desirable.

The center should be contractor-operated, so as to permit the flexibility and responsiveness necessary for an experimental program. As noted above special combinations of skills are required, and personnel should be recruited specifically for this endeavor.

SUMMARY AND CONCLUSIONS

After analyzing the current and possible future activities of the Office of Applications, it appears that a contractor-operated Space Applications Transfer Center, employing a staff of from 10 to 15 persons, together with appropriate support equipment, should offer the best opportunity for

evaluating this type of technology transfer mechanism. The best location for the initial Transfer Center and the disciplines to be emphasized will require further study, but it appears that there are some advantages to locating it in the same metropolitan area as one of the Federal Regional Councils.

The cost of operating this facility would be of the order of $1 million to $1.5 million annually, though this could be offset to some degree by user charges. It would require from 3 to 5 years of operation to obtain a reasonable evaluation of results.

Because of the timing of existing OA programs, such as LANDSAT D and SEASAT A, it is desirable to start the initial Center as soon as possible, certainly in FY 1977. Both systems involve substantial new capability for which user involvement prior to launch is highly desirable.

If the Center is operated in a proactive manner, in which Center personnel seek out opportunities for applications and seek out market needs, it can provide not only a means for furthering applications of NASA technology, but it can provide guidance to NASA for applications-related R&D.

In addition, successful operation of the Centers could go a long way toward dispelling the elitist image that NASA currently has with most user communities and with the general public. Generation of concrete and comprehensible economic benefits is the best way to justify NASA's activities, and high technology in general.

Centers of the type suggested would be in the interest of NASA, in the interests of the users, and (through users) in the interests of the public. Commercial suppliers of space-related goods and services should also benefit through the increased levels of activity developed by the Centers. NASA's efforts would be concentrated in early phases of application development which frequently do not attract private investment. Finally, the economy as a whole should benefit from increased productivity of the segments affected by Transfer Center operation. For these reasons, it is desirable for the Office of Applications to undertake implementation of the Transfer Center concept in FY 1977.