

OPERATION OF A NASA TECHNOLOGY UTILIZATION
REGIONAL DISSEMINATION CENTER

Regional Utilization of NASA-Generated
Space Technology

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FINAL REPORT

VOLUME I

Task Order Contract Nos. NASr-63(03) and
NASr-63(12)

MRI Project Nos. 2563-M and 3064-E

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MRI

MIDWEST RESEARCH INSTITUTE

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by

Paul C. Constant, Jr.

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PREFACE

This report summarizes the activities conducted over a period of nearly seven years from 5 November 1961 to 15 October 1968 on the ASTRA programs, sponsored by NASA under Contracts Nos. NASr-63(03) and NASr-63(12). The report consists of two volumes. Volume I, this report, summarizes the ASTRA program in three major sections: (a) Section I is an introduction covering the purpose of this review, scope of the review, and historical background; (b) Section II is the history of the program described in three principal phases: Phase I: Feasibility of Regional Dissemination Proved; Phase II: Operation of a Regional Dissemination Center--100 Percent NASA funded; and Phase III: shifting to self-supporting basis; cost sharing of companies and then cost responsibility assumed by the company; and (c) Section III is MRI's evaluation of ASTRA in a retrospective view.

Volume II, a separate document, describes in detail the organization, business and operational procedures, management and technical services of ASTRA, a regional dissemination center conducted by Midwest Research Institute. Volume II is in essence a manual on the operation of a NASA technology utilization regional dissemination center.

Initially, the program was organized under special management supervision with Drs. Charles Kimball, President, and M. H. Thornton, Vice President and Technical Director, directing the program and with H. M. Gadberry serving as the Project Leader. Principal investigators on the program during this period were H. M. Gadberry, John Loser and Eldon C. Sneegas. During the seventh quarter (August 1963) ASTRA was formally made the responsibility of the Economic Development Division under James Alcott, Director, and Mr. John C. McKelvey, Assistant Director, with Eldon C. Sneegas as Project Leader. Mr. Sneegas remained project leader on the ASTRA program until the end of the nineteenth quarter (October 1966). During this period, the principal investigators on the program, in addition to Mr. Sneegas were: William Anthes, Dr. Louis Burmeister, Dr. William E. Clark, Clayton C. Craghead, Arsen J. Darnay, Jr., William E. Franklin, Richard Fetter, Galen M. Ford, Dr. William B. House, James A. Houston, George J. Howick, Albert L. Kimmel, John B. Loser II, Kenneth D. May, Henry L. Munde, Michael Noland, Greta E. O'Keefe, Charlton R. Price, Glenn Seay, Dorothy Simcoe, Ralph Simonson, Mason Thompson, James Tice, Henry H. Young, and other MRI personnel as needed.

In January of 1967, ASTRA was made the responsibility of the Engineering Division under Mr. Harold L. Stout, Director, and became the technical responsibility of Mr. Paul C. Constant, Jr., Assistant Director of the Engineering Division and Manager of Technology Utilization.

Mr. Constant was acting Director of ASTRA until August 1967 when Mr. Lawrence Rosine assumed the position of Director of ASTRA until June 1968. Then Mr. Constant resumed the position of Acting Director until the completion of the program on 15 October 1968. Contributors to this latter portion of the ASTRA program include Messrs. Galen F. Ford, Wilbur E. Goll, Billy L. Rhodes, Area Technologists; Messrs. Edward T. Fago, Jr., and James Green and Mrs. Jody Alexander in search strategy and computer aspects; Mr. Ron Williams in ASTRA Office Management; and Dr. Florence Metz and Messrs. Al Kimmel and Fred Rollins in User-Producer Conferences.

Approved for:

MIDWEST RESEARCH INSTITUTE

A handwritten signature in dark ink, appearing to read "Harold L. Stout". The signature is fluid and cursive, with a long horizontal stroke at the end.

Harold L. Stout, Director
Engineering Division

14 October 1968

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I. INTRODUCTION

A. Purpose of this Review

This report was prepared to:

1. Provide basic information in summary form for historical record.
2. Document operating experience for the benefit of other regional dissemination centers sponsored by NASA, such as ASTRA* (and other similar institutions); and
3. Provide bases of judgment for the success and limitations in the approaches taken to technology transfer by Midwest Research Institute (MRI).

B. Scope of Review

The program was initiated on 5 November 1961, under Task Order (03) of Contract No. NASr-63(00) and continued for nearly six years (by eight contractual amendments) through 15 October 1967. Further continuance is under Contract No. NASr-63(12).

The general scope of work initially was to aid and encourage industries of Arkansas, Iowa, Kansas, Missouri, Nebraska and Oklahoma to participate in the technology-transfer program. Starting 1 February 1963, Minnesota was added, and the scope of work enlarged to include (1) participation in NASA's Industrial Application Program; and (2) the identification of innovations resulting from NASA's research and development work having potential value in (nonaerospace) industry.

On 1 February 1964, ASTRA activities were extended outside the seven states. On 1 October 1964, the scope was changed as defined by the following four tasks: (1) selective dissemination of NASA-generated technology to mid-western industry; (2) evaluation of NASA-generated technology with regard to its potential use by midwestern industry; (3) evaluation of transfer techniques used in the program; and (4) preparation, for publication by NASA, of state-of-the-art reviews of technical areas to which NASA has made significant contributions.

* The acronym ASTRA stands for Applied Space Technology - Regional Advancement, and is the name of the program MRI conducted under the subject contract.

On 1 February 1965, the program philosophy changed significantly. The program became a highly selective, user-oriented one to be conducted for a limited number of industrial firms. Some degree of cost-sharing or payment for services was required of participating firms. Closer and more continuous contact was required with the smaller group of firms best equipped and motivated to accept and apply technical information which was new to them. Exploration of new channels for the dissemination of NASA-generated technology was required.

On 1 May 1966, the scope of the program reverted to that covered by Tasks 1, 2, and 3 given above for the period 1 October 1964 through 31 January 1965.

On 1 March 1967, work started under Contract No. NASr-63(12). The objective of this work was to expand ASTRA activities and improve its effectiveness in helping industry utilize the technological information created by aerospace research and development. This was to be accomplished by Midwest Research Institute soliciting fee-paying subscribers for ASTRA services, and for ASTRA to become self-supporting by this means after three years of operation.

C. Historical Background

By Public Law 85-568, National Aeronautics and Space Act of 1958, NASA was charged, under Section 102(C), with the responsibility for securing "the most effective utilization of the scientific and engineering resources of the United States," and for disseminating information about "the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes."

Among the many responsibilities of NASA, the two cited above are among those of greatest importance to the six-state area,* whose educational institutions and industries were not heavily involved directly in the nation's space effort. Thus, the region was not benefiting heavily from the space effort in either a technical or direct economical sense.

The educational institutions of the six-state area comprised considerable scientific potential, yet they were not developing at the rate required to meet the future space-technology needs of a nation. Similarly, the region's industries had good technical capabilities; but they, too, were

* Arkansas, Iowa, Kansas, Missouri, Nebraska, and Oklahoma.

deficient in their participation in the space program itself, as well as being relatively unaware of the many technological results coming from NASA's scientific findings, which could be gainfully employed in nonspace, industrial applications. This lack of participation in the national space effort meant that the six-state region was falling behind in building the intellectual and industrial base on which the future economic growth of those states would depend.

For nearly a quarter of a century, MRI had been transferring the results of its own contract research and technology to 1,000 corporate clients and some 200 public agencies. Midwest Research Institute had considerable visibility here, and was known by hundreds of midwestern companies and businessmen who were to become those logically, initially served in the technology utilization effort. In their view, MRI was a trusted source of information.

II. HISTORY OF THE PROGRAM

A. Phase I: Feasibility of Regional Dissemination Proved

1. Initial Problems

Initially, three major problems confronted MRI. Although all three were not apparent upon initiation of activities, they were recognized readily:

- (1) The newness of technology utilization at NASA;
 - (2) The supposition that transfers applied directly to hardware;
- and
- (3) The newness of the concept of technology transfer to most of the audiences of ASTRA.

At the start of the pilot program in November 1961, NASA was only a few years old, and there was no Technology Utilization Division. Although there was considerable momentum to the Space Program, there was no NASA system in existence to permit MRI to easily retrieve NASA-developed technology space-related items of potential use to industry. The absence of such a system required ASTRA to seek such information from selected NASA installations, to provide it to and stimulate interest in it by industry.

Initially, program personnel operated under the assumption that only minor modifications of NASA-developed hardware would be required to permit the use of the hardware elsewhere. This narrowed the scope of activities and placed a restraint on the rate at which transfers could evolve, since NASA technology included material, material process, design, measurement techniques, computer programs, etc. as well as hardware.

2. Principal Mode of Operation

The basic philosophy or concept under which ASTRA was organized and operated called for identification of industrially useful aerospace information and dissemination of it to those (1) who had technical problems that could be solved by the proper application of this information, or (2) whose needs* could be satisfied through acquisition and understanding

* Needs are differentiated from problems, i.e., a company may need information that would serve as a basis for the decision to enter a new technical area of activity.

of the information. To operate under this philosophy, it was recognized that the market (potential recipients of results of aerospace research and development) would need to be educated in the potential benefits of the new technology. Management would need to understand and better appreciate the meaning of innovation and invention. Education was an integral part of all contacts with industry.

The initial plan of operation appeared to be straightforward. Space-related items* would be identified. Next, the industrially useful ones would be sorted out, and information about them conveyed to industrial organizations.

Information to help industry was obtained from four principal sources:

1. Research centers and field installations of NASA;
2. Technical reports of NASA;
3. Patent and invention disclosures of NASA; and
4. Technical and trade journals (or professional meetings) which reported developments of NASA aerospace contractors.

During the winter of 1961-62, visits were made to NASA centers for information. At that time, many of the people at these centers did not fully understand our mission; NASA's in-house Technology Utilization (TU) effort was just being organized. In many cases, ASTRA personnel used cameras to obtain ready documentation of unreported research results. The information gained from these visits was studied and documented so that its potential use for industry might be identified. In many cases, of course, use could not be determined until ASTRA personnel were confronted with industrial problems that seemed to lend themselves to solution by such previously identified technology.

As a result of extensive technical discussions during the visits to NASA centers, ASTRA personnel obtained a detailed, overall picture of the fields of specialization of each center and the types of industrially useful developments to expect from each. ASTRA identified 120 discrete ideas resulting from NASA research and development. Ninety of these held relevance to industrial applications, but required that ASTRA describe the ideas to industry in a different context from their aerospace uses, or suggested appropriate nonspace uses.

* Any device, material process, design, or technique which has a nonspace use, and has either resulted from or received impetus from aerospace effort.

These ideas represented a variety of concepts ranging from useful developments to more general principles. They were typically as follows:

Areas of Concrete Concepts

New materials
Novel uses of materials
Fabricating techniques
Mechanical devices
Instruments and transducers
Electromechanical devices
Electronic devices and circuitry
Lubrication, friction and wear
Surface treatments
Corrosion control
Auxiliary power sources

Areas of Broad Concepts

Information handling
Data display
Adaptive controls
Human engineering
Systems analysis
Quality assurance
Valve engineering
Program management
Reliability
Long-life equipment

Thirty of the ideas were selected for use in displays used to introduce industry to TU. The ideas were "processed" by ASTRA personnel, who collected descriptions, photographs, performance data, and where possible, the devices or components themselves; then integrated the information and hardware into the design or exhibits. (See Appendix A).

Concurrent with visits to NASA centers, plans for the promotion of ASTRA were organized, and criteria were established to permit the selection of participants for meetings. Appropriate lists of companies by geographic areas were prepared. A questionnaire was prepared to register the technical activities, capabilities, and interests of firms that could be served on a "field of interest" basis. (See Appendix B.)

NASA inventions that appeared to be industrially useful were selected for presentation and discussion at meetings with potential users of ASTRA services.

ASTRA started to receive NASA reports in February 1962. They were reviewed by MRI staff members. Consideration was first given to subject matter, level of technical presentation and inclusion of practical details to obtain an overall understanding of the material and for basic familiarization. Then reports containing ideas potentially useful to industry were analyzed in detail to permit encouragement of potential application. Some documents were prepared for industry, and mailed to thousands of potential users of our technology. A few gained popularity; for example, "The Arc Tunnel Heater" was given a sixth mailing by the end of the feasibility phase. NASA flash sheets (short digests of inventions and innovations) entered the picture about midway through the feasibility study phase; MRI evaluated and helped to document the technology reported by flash sheets.

The technology that resulted from the screening process was disseminated in special meetings to more than 2,200 businessmen representing over 600 firms in the midwestern area, and through visits to plants and offices of 250 of these companies.

Pertinent information obtained from the screening process and that processed by the classification scheme was sometimes repackaged for effective use by industry. Repackaging was done principally in the case of ideas having unusual economic importance. Although this task was time-consuming, it proved worthwhile. Through synthesis and organization, a new description of an idea, derived from a concept that had been separated from its original context, became translated into the language of industrial application.

3. Reaction of Industry

It is not always easy to assess the value of a service in a relatively short time. Many attributes of a service are not always readily known, and known ones are not always easily measured. There were, however, sufficient indications of the feasibility of the basic concept upon which ASTRA, as a pilot program, was originated. Measures used during this stage of the project are listed below.

a. Number of companies involved: In the geographic region covered, there were about 18,000 manufacturing firms, representing 45 major SIC groups. However, only about 3,000 of them were real potential users of aerospace-generated information.

ASTRA's initial sample was slightly over 1,000 firms, or 33-1/3 percent of the market. By the end of the feasibility period, 461 firms were being served by ASTRA. This population was principally from the 1,000 firms originally solicited. However, some came from outside that supplementary group on their own initiative after having heard of ASTRA.

b. Attendees at regional ASTRA meetings: Over one-half of the firms contacted sent representatives to ASTRA special or regional meetings. Nearly 100 percent of these attendees responded favorably to requests made of them in the form of filling out questionnaires, etc. (See Appendix B). The keen interest and excellent participation at the meetings signified understanding and a high degree of acceptance of the basic idea of technology utilization.

c. Requests: Requests for technical information came from those who attended the special meetings as a result of personal visits to firms, and from mailings of ASTRA. During the feasibility phase, 675 technical requests were made requiring ASTRA action to transfer information. (This information was over and above that disseminated by periodic mailings.)

d. Group cooperation: There was willing acceptance and eagerness by regional industrial groups to assist in setting up the initial, special meetings and to participate as required.

e. Company visits: ASTRA personnel visited 250 companies. In nearly every case, a genuine interest was shown. Problems or needs were defined on the spot or, more frequently, at a later date. In most cases, the result was the transfer of some technology.

f. Visits to MRI: In many cases, users visited MRI to discuss technical problems and to seek aerospace-related technology.

g. News coverage: Excellent coverage by local newspapers was given to ASTRA meetings and the importance of the TU objectives. Numerous articles appeared in 22 different newspapers, 2 technical publications, and in-company house organs.

h. Unprompted company and individual action: The Kansas Power and Light Company funded MRI to present ASTRA to small towns in the State of Kansas. This action made it possible for 130 persons to learn of the TU program.

Requests were received from firms on the ASTRA mailing list for a change of address because of a move, and for a change of address because of a person relocating. Further, some requests were made to have a firm's name added because a man with knowledge of ASTRA would join the firm and describe to its management the potential of aerospace-related technology.

4. Results to Guide Future Activity

Once the feasibility of a regional dissemination center (RDC) experiment had been proved, the major task was that of establishing the proper organization and procedures so that ASTRA could efficiently transfer NASA-generated technology to midwestern industry.

The most useful criteria for evaluating in advance the response of a firm appeared to be (a) the degree to which the business is technically based; (b) specialization in a particular market area; (c) prosperity, profitability and growth; and (d) the fact that the firm has reached a "critical size" for its particular type of business. (The personality and attitudes of key company personnel are equally important, but in most cases not easily determined in advance.)

Interests of the larger companies fall into four general categories: (a) long-range technical trends; (b) specific details of commercial technology;

(c) economics and market intelligence; and (d) NASA basic research activities and findings.

Two inherent factors in large companies differentiated their approach to NASA technology from that of smaller firms: (a) high-volume production of established products made their primary interest a technology that would prove useful in lowering the production costs of existing products; and (b) they lacked flexibility in adapting their capabilities to do new things or to use their present production arts in new ways.

Large, technically-sophisticated companies excel in taking raw scientific data from basic research reports and applying it. No "repackaging" or translation to a lower technical level is necessary. There is, however, a distinct need to repackage and distill NASA technology for the production and management groups of the larger firms.

The "patent question" arose in about one-third of the discussions held during plant visits. In almost every case, a patent of any type was a negative factor. The firms did not view the possibility of royalty-free use of government-owned patents as an opportunity. They foresaw red tape, delays, and possible trouble.

Industrial groups and trade associations were more responsive to technology utilization than were professional societies; and consequently, had greater influence and provided more support in the dissemination of the new technology and educating industry in general about the potential value of TU to industry.

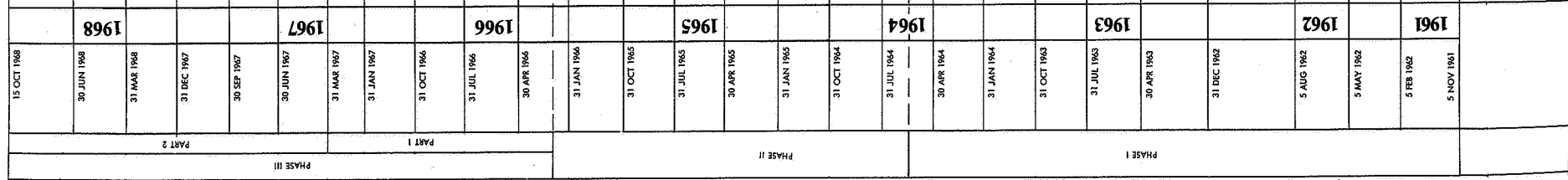
B. Phase II: Operation of a Regional Dissemination Center--100 Percent
NASA Funded

The operation of ASTRA, in the form of a Regional Dissemination Center (RDC), commenced in September 1962. Its philosophy of operation was quite similar to that during the latter part of Phase I, the feasibility period. The specific modes of operation were based upon the results outlined in Section II-A-4, and are discussed subsequently in this section. (A summary is given in Figure 1.)

1. Service to Clients

The general-service philosophy was to respond to a company's technical fields of interest (see Appendix B for Field-of-Interest form) by knowing its technical profile. The response was to seek in NASA's bank of

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information all information relevant to the company's needs as indicated in its fields-of-interest form, and send this information to the company. Consequently, after initial promotional visits, most of the technology transfer was by mail and telephone calls.

A company's field of interest would form the basis for the information sought and sent. ASTRA personnel were assigned companies to match their technical capabilities with the companies' needs. Then, as the ASTRA personnel found what they believed to be relative information through their review of NASA documents or by specific searches of NASA computer tapes for specific technical information, the information found would be duplicated and sent to the company. (If documents were available, these would be sent rather than duplicated.) This method of transfer meant that the recipients could receive a voluminous number of documents. To enhance this service, ASTRA prepared publications for industry and conducted seminars or workshops. The publications included fact sheets, monographs, information announcements and bibliographies, Tech Surveys and proceedings of seminars.

Between February 1962 and November 1963, NASA-fact sheets (see Appendix C) were made available to midwestern companies through ASTRA mailings and through regional presentations. These fact sheets are in essence a synopsis of documents, and were used as the forerunner of NASA documents for public distribution.

Between April 1963 and July 1964, ASTRA prepared special monographs to cover the expanding aerospace technology. These monographs were prepared for dissemination to fill a gap in the documentation. As such, they summarized the essential features of new technology in a way that could be used by the midwestern industrial audience. A total of 20 different monographs were prepared. (A list of these are given in Appendix C.)

As a further step in closing the gap between growing technology and the availability of information on this technology, ASTRA began in April 1964, to prepare "Innovation Announcements" (See Appendix C for an example). These announcements contained an abstract of the innovation with a coupon to be returned by firms interested in receiving additional information.

In April 1964, ASTRA began receiving NASA Tech Briefs, which described aerospace developments of interest to ASTRA's audience. These Tech Briefs were immediately integrated into the dissemination system and mailed to participants.

In January 1965, ASTRA started a series of bulletins called "Information Announcements" (see Appendix C for an example) which were similar to the innovation announcements except that they described new technology

available in formal NASA documents. Companies interested in receiving hard copies of these documents could request them directly through ASTRA by returning a coupon as in the case of Innovation Announcements.

It became apparent during Phase I that effective transfer of aerospace technology could be achieved through specialized seminars or workshops, bringing together midwestern firms and specialists in selected fields. The first seminar, however, was not undertaken until April 1965 (Phase II). This seminar was on "Industrial Applications of Solid Lubricants." It featured presentations by NASA Research Center specialists, industrial representatives and MRI staff members.

The second seminar, "Advanced Valve Technology," was held in October 1965. A third seminar, "High Velocity Metalworking," was held in October 1966.

All seminars accomplished their mission very well. They attracted considerable attention in the trade press.

A comprehensive document termed a Tech Survey was prepared by MRI in each of the following areas: advanced valve technology, solid lubricants, and high-velocity metal forming. The source of information was the result of NASA's research and development efforts. These three documents were widely acclaimed as extremely useful, and requests are still being received for them.

2. Ties with Other Regional Dissemination Centers

In July 1964, ASTRA began to provide bibliographic searches in response to industrial inquiries. These searches were first performed by NASA's Analysis and Research Unit, Scientific and Technical Information Division by interrogating NASA computer tapes using a predetermined search strategy.

Subsequently, during the Fall of 1964, a formal tie was made between ASTRA and the Aerospace Research Applications Center (ARAC) (see Figure 2) facilities at Indiana University, for the purpose of obtaining bibliographic searches of NASA's computer tapes. At this time, ASTRA established procedures for handling bibliographic searches for firms on an individual basis. More than 300 individual bibliographic searches were made by ARAC for ASTRA.

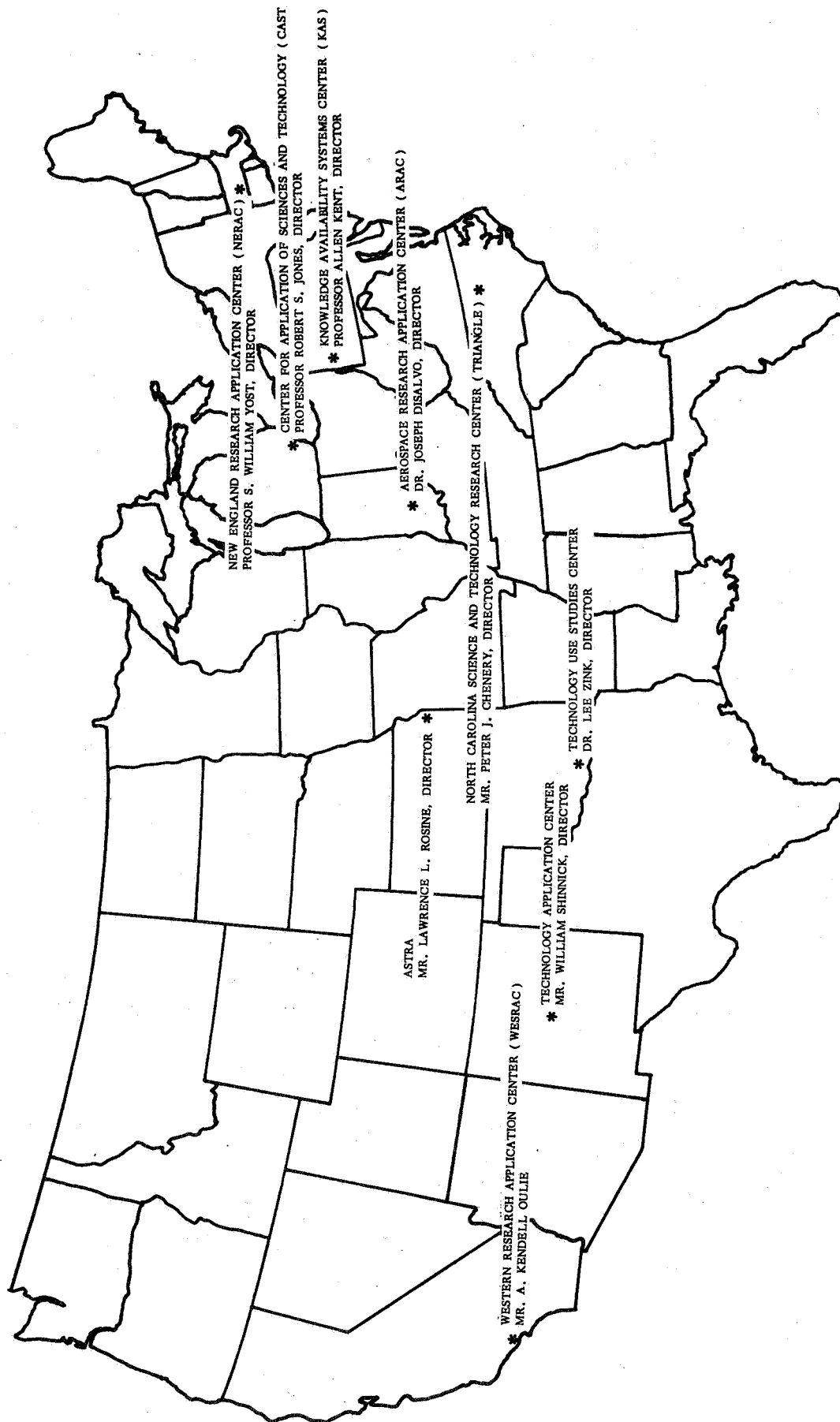


Figure 2 - NASA Established Regional Dissemination Centers

Subsequently, and as other RDC's were established (see Figure 2), ASTRA's association was that of a sister organization. Exchange of requested information between RDC's was accomplished through personal visits, telephone conversations, correspondence and annual RDC meetings. There was exchange of information regarding services, costs, promotion, marketing, organization, management, cooperative needs, etc.

3. Promotion

Promotion was achieved basically through formal presentations to groups, as was done in Phase I, and by individual visits to users and potential users of NASA's technology. Group presentations were continued through October 1963. At this time, promotional emphasis was placed on personal visits to industrial firms.

The personal-visit approach became more effective because ASTRA had become known in a general sense. Industry knew ASTRA's purpose and its potential. What was left was to educate potential users of the potential usefulness of NASA-generated aerospace technology through ASTRA's services. This was accomplished most effectively by a face-to-face discussion of an organization's problems at its location where ASTRA personnel could get a first-hand view of the problem.

The visits were set up by telephone calls and correspondence. At that time, the specific technical areas of concern were generally determined. This information enabled ASTRA to send the proper technical disciplines to a company to discuss problems on an intimate and constructive basis, resulting in a good appraisal of a company's technical profile.

A summary of the results of ASTRA's promotional efforts from the initiation of the program through Phase II is given below.

<u>Introduced to ASTRA</u>		<u>Firms</u>	<u>Items of Aerospace</u>	<u>Responses to In-</u>
<u>No. of People</u>	<u>No. of Firms</u>	<u>Visited</u>	<u>Technology Disseminated</u>	<u>dustrial Inquiry</u>
6,299	1,101	629	623,900	10,555

4. Reaction of Industry

The reaction of industry was quite favorable. The principal bases for this conclusion are:

- (1) Number of firms (clients) that used ASTRA services;
- (2) Percentage of clients to those solicited;
- (3) Cumulative service to clients in client years;
- (4) Industrial inquiries;
- (5) Items of aerospace technology disseminated; and
- (6) Number of technology transfers.

The number of firms introduced to ASTRA during Phase II were 1,101 of which 840 were clients (or users of NASA technology); i.e., more than 76% of the firms solicited became clients. These firms represented 25 different S.I.C. codes, research and development, universities and non-manufacturing companies, as indicated in Figure 3. (A classification of these firms according to number of employees is given in Figure 4, to further describe the client companies.)

ASTRA served the 840 clients for a total of 3,692 client years, as indicated in Figure 5. This indicates that on the average, ASTRA served a client for 4.4 years. The client-years service certainly indicates acceptance of ASTRA's services on a no-fee basis.

The 840 clients over three and one-half years made 10,555 inquiries for information to which ASTRA responded. The total response resulted in 623,900 items of aerospace technology being disseminated to the clients. This is the dissemination of approximately 180,000 items per year; 15,000 items per month; or 700 items per working day.

A considerable amount of technology was transferred during the period of this program. The technology transferred proved to be of direct value to industry. Specific transfers related, in varying degrees of benefit to the recipients, to components, instruments, subsystems, systems, techniques, designs, and approaches to problems. In some cases, the transfers were made essentially without the need of modification or adaptation. In other cases, the transfers were again of significant value, but the information disseminated was a link in the evolution of an innovation or a catalyst in motivating the recipient.

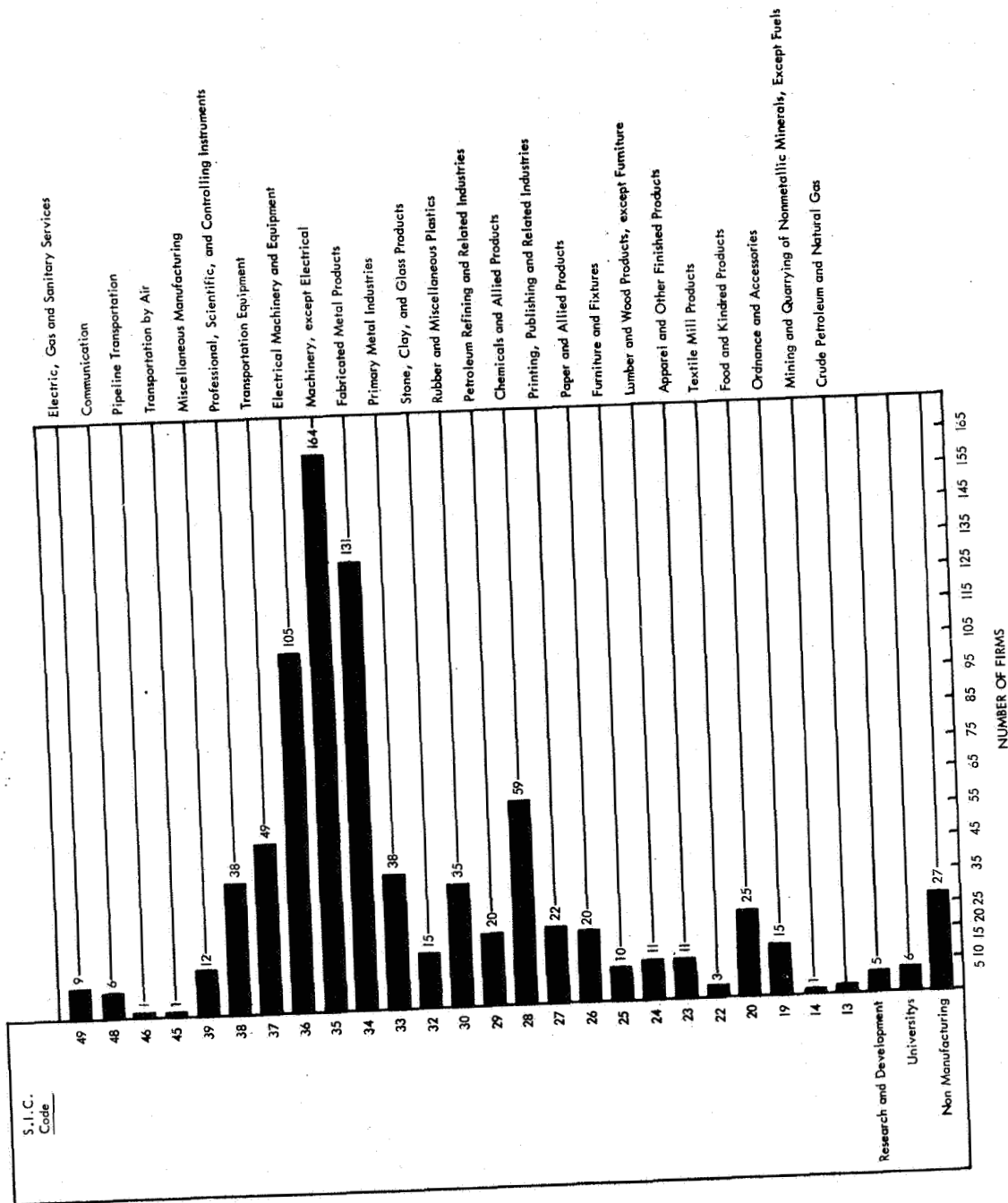


Figure 3 - Number of Firms Served Listed According to Technical Areas

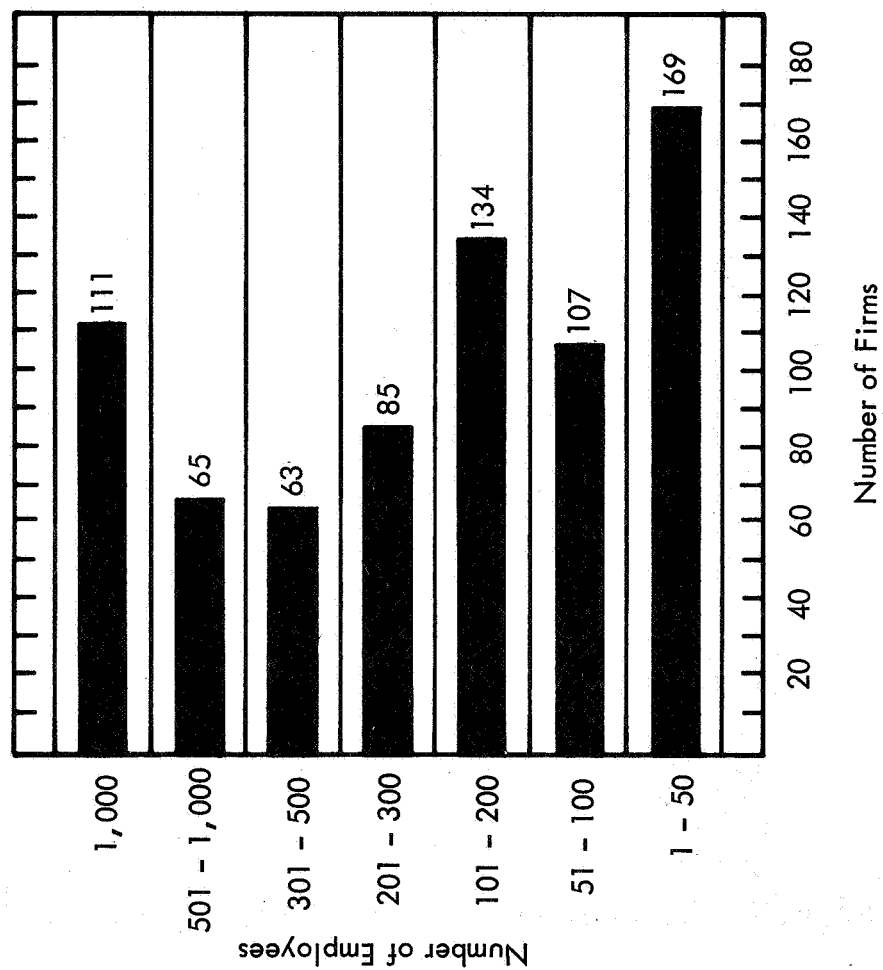


Figure 4 - Client Firms Characterized According to
Number of Employees

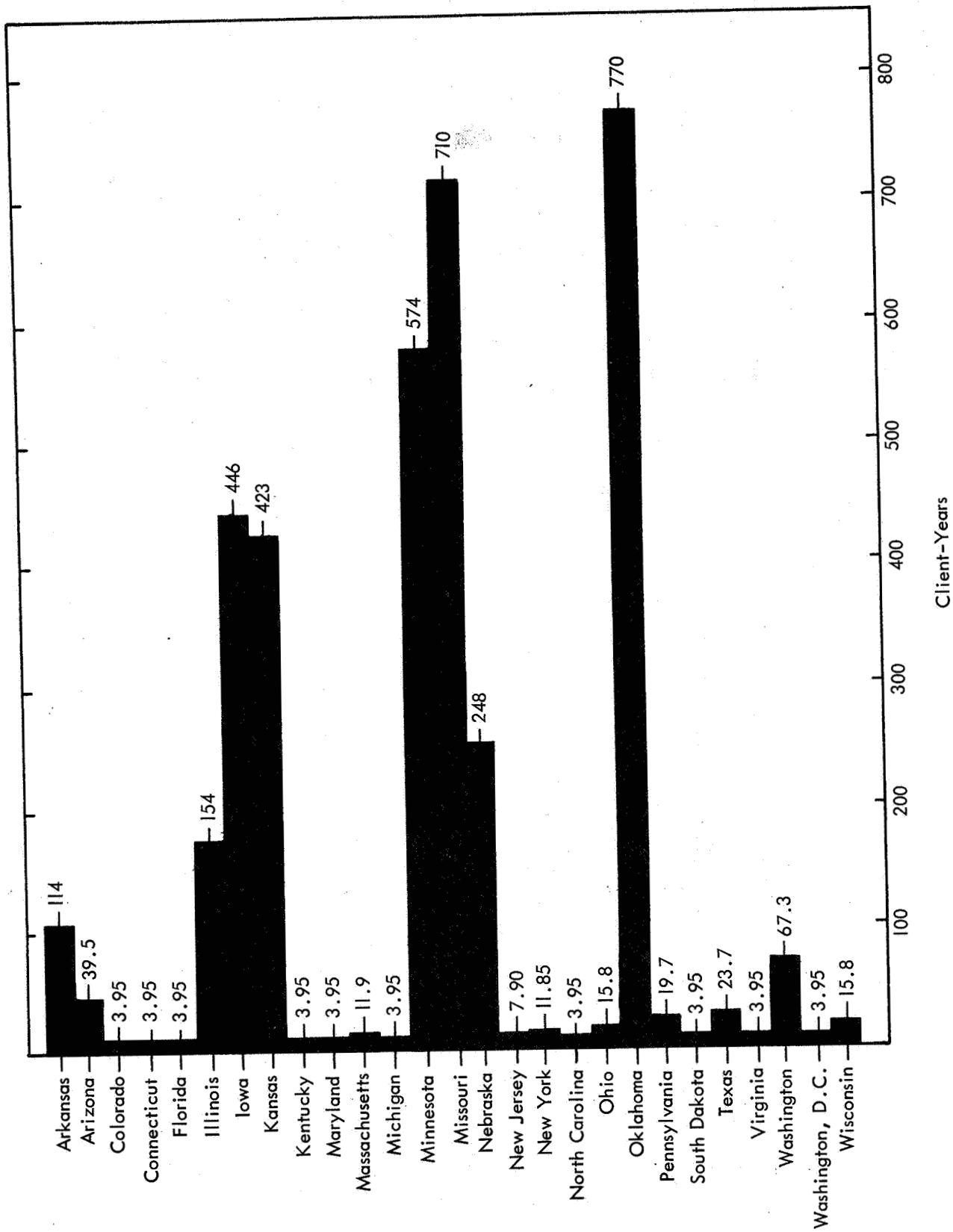


Figure 5 - Client-Years of Service According to Geographic Location of Clients

During Phase II, 120 transfers were made. A description of each of these is given in Appendix D. A conservative estimate is that these 120 transfers, or less than 25 percent of the total number of transfers, were made through the efforts of ASTRA. Information regarding technology transfers was difficult to obtain primarily because of the privileged nature of industrial-company information.

C. Phase III: Shifting to Self-Supporting Basis

1. Cost Sharing by Companies

During ASTRA's growth from its inception to April 1966, dissemination efforts were carried out at no cost to the participating companies. In 1965, policies of the NASA Technology Utilization Program were modified, which in turn necessitated that ASTRA's basic philosophy of operation change to one of cost sharing by companies to be served by ASTRA.

Operation under this new concept started for ASTRA in February, 1966, with a program designed to provide those services which had proved to be most useful to clients under past operations. Generally speaking, those services were of three types: information acquisition, consultation, and seminar participation.

Of prime importance were the promotion and marketing of these services. The first two months were devoted to planning; preparing material (brochures, contracts, mailing lists, etc.); and servicing during the transition period. Then in April, 1966, an intense promotional and marketing program was undertaken, with the first client under contract on April 1, 1966.

During subsequent months and until December 1966, the ASTRA program was promoted and marketed. The clients under contract (45 by January 1, 1967) received ASTRA services for \$500 per year. However, during late November 1966, it became apparent that this fee was too low, and further subscriptions were suspended--only those pending were accepted after December 1, 1966, and none were accepted after January 1, 1967.

The 45 companies which subscribed to ASTRA were served by ASTRA for the one year of their contract. The principal services provided consisted of:

(1) Visits with key representatives for orienting the clients with the ASTRA program and determining their technical fields of interest (or profiles);

(2) Consultation through visits and letters or telephone inquiries;

(3) Retrospective searches relative to fields of interest (these were done by ARAC since MRI did not have NASA computer tapes of information); and

(4) Screening and reviewing technical literature and sending clients documents (or copies of documents) which reviewers believed contained information relative to a client's field of interest.

A summary of these services to the 45 clients is given in Table I. This summary shows:

(1) There were 225 inquiries from clients (194 by letter and 31 by phone), or on the average 5 inquiries per client per year;

(2) The 45 clients requested 260 retrospective searches and received 1,524. On the average, a client requested approximately 6 searches a year and received on the average the results of approximately 34 searches per year. (The reason for the difference in searches sent to those requested is that ASTRA was working on the basis of the company's field of interest and would include searches on its own in behalf of the client.)

(3) There were a total of 10,212 documents sent to the 45 clients, or on the average 227 documents per client per year. Of the 10,212 documents, 10,006 or 98 percent of the documents were NASA-generated. Of the 10,212 documents, 7,099 or approximately 70 percent, were NASA Tech Briefs.

(4) Twenty-three representatives of clients attended the seminar on High-Velocity Metal Working that was conducted by ASTRA in the fall of 1966. A total attendance of 80 indicated considerable interest by non-clients. (The seminars were a means of promoting ASTRA, and industry in general was invited.)

The adaptive handling of considerable amounts of technical, NASA-generated technology for clients proved to be of direct benefit (value) to them. Examples of how the transfer of information has benefited clients other than by implication from the efforts summarized in Table I are given below as five technology transfers accomplished during Phase III.

Sinclair Oil and Gas Company

NASA Tech Brief 66-10062, FORTRAN Flowchart is Automatically Produced, permitted this company to cancel a computer course they had scheduled for some of their personnel, and simplifying their procedure.

TABLE I

SUMMARY OF ASTRA CLIENTS AND SERVICES RENDERED UNDER COST SHARING (\$500 CONTRACT)
(April 1967 through January 1968)

	Client	City	State	Date	Consulting (hr.)	Inquiries		Searches		Items Sent			Seminar ^{a/} Attendees
						Letters	Phone	Requested	Sent	Tech Briefs	Other	Other	
1.	Sinclair Oil & Gas Co.	Tulsa	Okla.	April	9	-	2	-	53	273	85	5	1
2.	Hallmark Cards, Inc.	K.C.	Mo.	April	9	4	-	-	50	755	112	8	2
3.	Geeco, Inc.	St. Joseph	Mo.	April	14	1	1	1	15	65	42	1	2
4.	McKally-Pittsburg Manufacturing Corp.	Pittsburg	Kans.	April	18	-	1	5	35	151	72	2	-
5.	The Vendo Co.	K.C.	Mo.	April	7	-	1	4	62	233	73	8	1
6.	Stainless & Steel Products Co.	St. Paul	Minn.	April	10	5	-	-	16	74	34	1	1
7.	Instruments, Inc.	Tulsa	Okla.	May	7	8	-	4	60	231	83	13	-
8.	Monsanto Chemical Co.	St. Louis	Mo.	May	16	2	-	3	65	248	85	2	1
9.	Black, Sivalls & Bryson, Inc.	K.C.	Mo.	May	8	-	-	-	19	92	30	1	-
10.	Halliburton Oil Co.	Duncan	Okla.	May	20	20	1	7	58	252	181	44	1
11.	The Bendix Corp.	K.C.	Mo.	May	27	50	11	98	130	212	185	11	1
12.	Honeywell Corporate Research Center	Hopkins	Minn.	May	10	14	-	16	31	198	82	6	-
13.	The Gates Rubber Co.	Denver	Colo.	May	14	39	2	8	101	253	181	3	-
14.	Watlow Electric Co.	St. Louis	Mo.	May	8	12	-	2	18	55	49	7	-
15.	Midwest Research Institute	K.C.	Mo.	May	-	-	-	47	47	-	-	-	1
16.	Philips Laboratories	Briarcliff Manor	New York	May	7	2	-	2	55	27	40	2	-
17.	Trans World Airlines	K.C.	Mo.	May	9	-	-	-	40	141	94	6	1
18.	Alco Valve Co.	St. Louis	Mo.	June	8	-	-	3	32	149	41	2	-
19.	Pan American Petroleum Corp.	Tulsa	Okla.	June	10	22	-	17	56	776	96	-	-
20.	J.F. Pritchard & Co.	K.C.	Mo.	June	11	-	1	1	24	151	68	2	-
21.	T.D. Williamson, Inc.	Tulsa	Okla.	June	23	3	1	-	25	110	33	2	1
22.	The Fleming Co., Inc.	Topeka	Kans.	June	11	-	-	-	1	8	1	6	-
23.	Burgess Battery Co.	Freeport	Ill.	July	10	1	-	6	35	89	25	9	-
24.	Reda Pump Co.	Bartlesville	Okla.	July	18	-	-	-	20	56	23	3	1
25.	Northern Natural Gas Co.	Omaha	Nebr.	Aug.	4	2	3	3	41	162	48	11	-
26.	Whirlpool Corp.	St. Paul	Minn.	Aug.	7	-	-	-	40	124	50	3	-
27.	General Mills, Inc.	Minneapolis	Minn.	Aug.	7	2	-	1	28	146	34	2	-
28.	Omnitronics Manufacturing, Inc.	Omaha	Nebr.	Sept.	5	-	-	-	10	37	25	12	-
29.	Butler Manufacturing	K.C.	Mo.	Sept.	3	-	1	-	19	143	71	1	1
30.	Inland Chemical Co.	Warrensburg	Mo.	Sept.	6	-	-	1	5	7	6	-	-

^{a/} High Velocity Metalworking seminar - 80 attendees total

TABLE I (Concluded)

SUMMARY OF ASTRA CLIENTS AND SERVICES RENDERED UNDER COST SHARING (\$500 CONTRACT)
(April 1967 through January 1968)

	Client (Cont.)	City	State	Date	Consulting (hr.)	Inquiries		Searches		Items Sent			Seminar ^{a/} Attendees
						Letters	Phone	Requested	Sent	Tech Briefs	Other	Other	
31.	Atlas Chemical Industries	Valley Forge	Pa.	Sept.	5	3	2	6	40	161	119	-	1
32.	Beech Aircraft Corp.	Wichita	Kans.	Sept.	3	-	-	-	46	183	103	-	1
33.	Burns & McDonnell Engineering Co.	K.C.	Mo.	Sept.	3	-	1	1	11	120	88	1	-
34.	Westclox/Div. of General Time Corp.	LaSalle	Ill.	Sept.	3	-	-	-	20	109	41	8	1
35.	Mid-west Metal Products, Inc.	K.C.	Mo.	Oct.	3	-	-	-	34	130	67	-	2
36.	Rabco, Inc.	K.C.	Mo.	Oct.	3	-	-	-	19	61	59	-	2
37.	Ethyl Corporation	Ferndale	Mich.	Oct.	3	10	-	3	28	122	129	-	-
38.	W.A. Sheaffer Pen Co.	Ft. Madison	Iowa	Nov.	3	-	1	12	41	141	78	-	-
39.	Crimco, Inc.	K.C.	Mo.	Nov.	3	-	2	5	33	456	71	1	-
40.	Parmalee Plastics Co.	K.C.	Mo.	Nov.	3	1	-	1	10	26	14	1	-
41.	American Bosch Arma Corp.	Columbus	Miss.	Nov.	5	-	-	1	19	124	49	2	-
42.	First National Bank of Joplin	Joplin	Mo.	Dec.	4	-	-	-	-	-	6	6	-
43.	Olin Mathieson/Windchester-Western Division	East Alton	Ill.	Dec.	6	-	-	2	9	70	38	-	-
44.	Omark Industries, Inc.	Portland	Ore.	Jan.	8	1	-	-	13	62	83	2	1
45.	Torotal, Inc.	Grandview	Mo.	Jan.	4	-	-	-	10	113	20	12	-
TOTAL					375	194	31	260	1524	7099	2907	206	23

^{a/} High Velocity Metalworking Seminar - 80 attendees total.

Geeco, Inc.

Information from NASA Tech Brief 66-10385, Inflatable O-ring Seal Would Ease Closing of Hatch Cover Plate, is being applied to their vacuum-forming operations.

Halliburton Oil Company

Document N64-29598, Studies of Chelate Polymers, changed the direction of one of the company's in-house research programs.

Halliburton Oil Company to T. D. Williamson, Inc. (Inter-Client Transfer)

Information on linear-shaped charges for cutting steel was obtained from the Halliburton Oil Company and sent to T. D. Williamson, Inc. This information had been requested from ASTRA. T. D. Williamson, Inc., is now applying the information to their problems.

Trans World Airlines, Inc.

The Training Section of the Maintenance Division of Trans World Airlines, Inc., obtained 12 additional copies of NASA TM X-53432, Welding Procedures for Titanium and Titanium Alloys, to use as a class textbook.

It was not always possible to assess the value of ASTRA's adaptive handling of information. Nevertheless, the number of inquiries for consultation, documents, searches, etc., is certainly indicative of ASTRA's value to its clients. Quite often clients are reluctant to provide information on the usefulness of the information ASTRA has provided them since their work is considered to be of a privileged nature. In some cases, there are no tangible measures of the value of ASTRA's transfer service. In other cases, the principal benefits will be derived at a future date, and cannot be assessed until that time.

Four contracts for research and development have resulted for MRI from ASTRA's service to its clients. In each case, the contract has been with MRI. In two cases the company (one company, two contracts) desires to remain anonymous. The work for Geeco, Inc., involves the design of air cargo shipping containers; the work for Black, Sivalls and Bryson, Inc., relates to pollution control and waste disposal.

2. Cost Responsibility Assumed by the Company

2.1 Introduction

During the first five years of ASTRA's growth, dissemination effort was carried out at no cost to the participating companies. In 1966, policies of the NASA Technology Utilization Program were modified, which in turn necessitated a change in ASTRA's basic philosophy of operation to one of cost sharing by companies to be served by ASTRA. The initial effort under this new concept is discussed in the previous section (Section II-C-1).

Accomplishments at the end of ASTRA's first year under the cost-sharing basis are quite significant (see Section II-C-1 for details). The principal accomplishment was the success attained in marketing activities. Forty-five companies contracted with MRI for ASTRA services at an annual fee of \$500. This clientele was solicited principally by mail with a special comprehensive brochure covering ASTRA. The cost of the services provided, however, exceeded the actual cost by the client by an order of magnitude, and in some cases, even more.

During the latter part of 1966, NASA desired that ASTRA (as well as other RDC's) become self-supporting. This was to be accomplished by ASTRA after three years of operation. This requirement of self support by fee-paying clients necessitated a significantly different philosophy of operation for ASTRA.

Operation under this new concept raised the following questions for ASTRA: What is the true market for its services? Is the market large enough for a self-supporting operation? If so, how long will it take to become self-supporting? What barriers are in the way? What kind of services should ASTRA provide? What should its modes of operation be? On what basis should costs be calculated, and fees be determined for services rendered?

The management of MRI reviewed critically the ASTRA program; assessed its operation realistically and then established a plan of operation. Significant operational changes envisioned to assure ASTRA's effective growth in technology utilization encompassed the establishment of: (1) mechanization of search and retrieval operations, including computer-searching capabilities at MRI; (2) enlarged and improved services to clients; (3) a program cost accounting system; (4) a new fee structure; (5) new and viable sales approaches; and (6) trustworthy measures of performance, using these in a feedback loop for the continual improvement of operations.

A special study was made on ASTRA becoming a computer-based RDC. The results were in the affirmative. (Details of this study comprise Appendix E.)

The computer study was only a portion of the major review of the ASTRA program. The results of this review which formed the basic philosophy of operation are summarized in the ensuing subsection, Section II-C-2. Details of operational procedures comprise Volume II of this final report.

2.2 General Philosophy of ASTRA's Operation

The first requisite for successfully accomplishing a mission is to understand thoroughly the purpose of the mission. The second is to have a fundamental philosophy of operation from which realistic plans (both long and short range) can be derived to accomplish the mission. Lastly, the plans must be carried out. All three requisites hold equal weight.

The mission of ASTRA was to carry out an effective technology utilization program on an RDC basis such that (1) industry would benefit from the technological resources created by NASA's aerospace research and development, and (2) industry would become self-supporting by means of fees paid by clients of ASTRA for services rendered.

The general philosophy under which the program operated is:

- (1) Serve industry, not discriminating as to size or type;
- (2) Promote active industrial participation in the ASTRA program.
- (3) Emphasize two major activities: (a) dissemination of relevant technical information; and (b) education of recipients in its use and economic values, through ASTRA's specially developed operating methods;
- (4) Promote widespread appreciation of technology utilization nationally and specifically within regional bounds;
- (5) Allocate responsibility of ASTRA to an appropriate person who reports to a Manager of Technology Utilization for MRI;
- (6) Operate on a regional basis for active solicitation;
- (7) Divide region into appropriate areas, with a full-time ASTRA Area Technologist, having technology, information transfer, and marketing skills, responsible for a district;
- (8) Provide Area Technologists a core technical staff and a pool of consultants comprised of members of MRI's technical staff;
- (9) Establish trustworthy measures of performance to accurately assess service;

(10) Review continuously ASTRA's modes of operation, maintaining the flexibility and versatility of action needed to modify these modes to meet changing conditions and current client needs;

(11) Maintain a viable and financially sound operation that will enable ASTRA to be self-sustaining; and

(12) Maintain an appropriate staff by (a) developing appropriate attributes of individual program personnel; and (b) by staff additions and deletions, when required.

2.3 Managerial Organization

The organization under which ASTRA operated is shown in Figure 6. The program operated under a policy advisory committee made up of five members of MRI's management and senior technical staff. Dr. Charles N. Kimball, President of Midwest Research Institute, was the chairman of this committee. The primary significance of this committee was twofold: (1) it provided an active participation of MRI's top management bringing to bear not only internal effectiveness, but regional and national visibility; and (2) it gave NASA a significantly better utilization of the resources of MRI, providing the means for much broader participation and contribution on the part of all divisions of MRI.

The part of Manager of Technology Utilization was new. It brought together, under one direct management ASTRA, the Biomedical Application Team, and other special TU activities, for mutual benefit.

2.4 The ASTRA Team

The organization of the ASTRA program was that given in Figure 7. Basically, ASTRA was comprised of three functional groups: (1) Area Technologists; (2) MRI staff consultants; and (3) support staff.

An Area Technologist was a person who had a broad purview of science and engineering, skilled in more than one technical area and experienced in technology transfer. He was responsible for promoting, marketing and providing ASTRA services to clients within a defined geographic area. He had direct access to the pool of MRI staff consultants and the program's support staff, to assist him in his activities. His direct working relationship with MRI staff consultants is indicated by the dashed line in Figure 7.

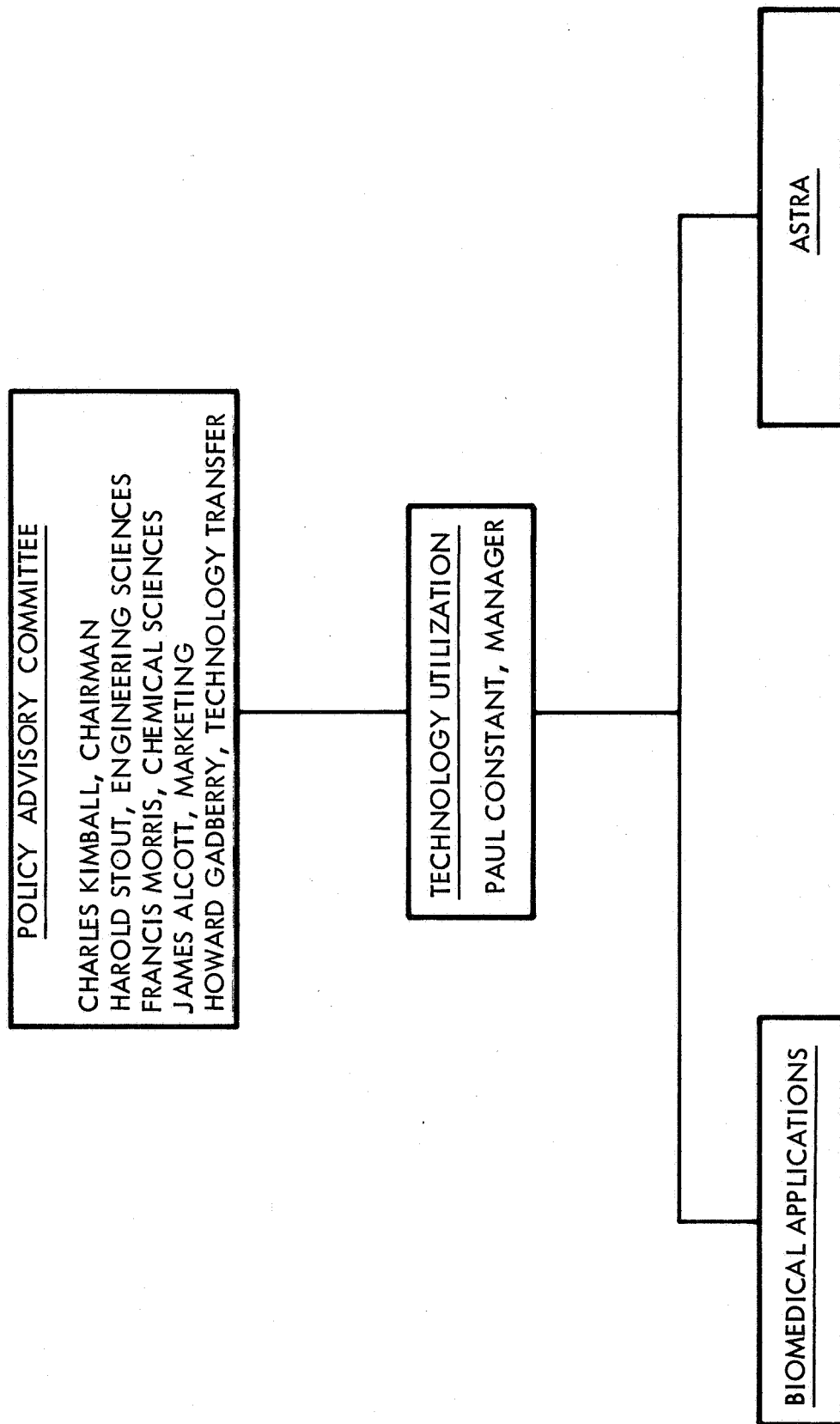


Figure 6 - Managerial Organization

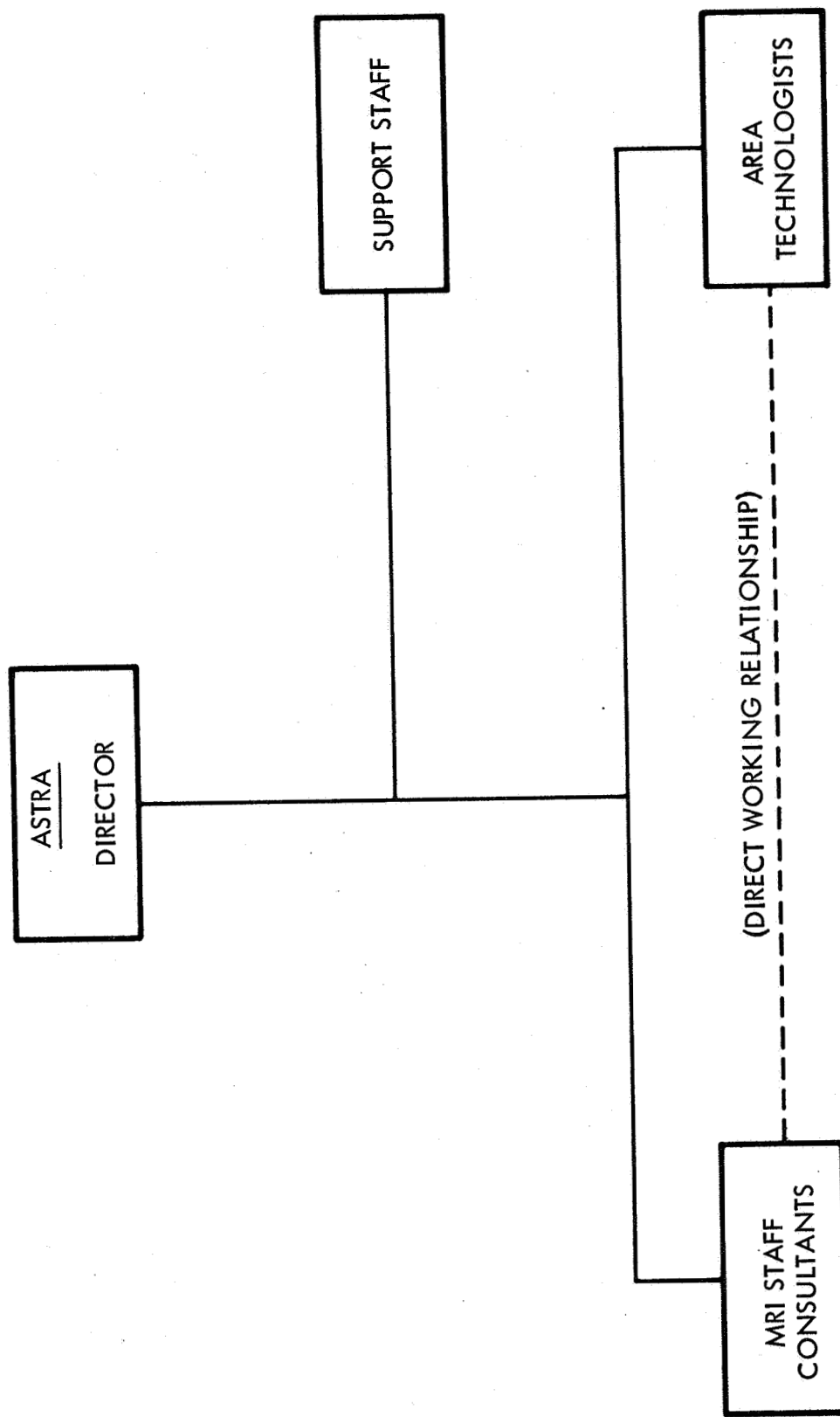


Figure 7 - ASTRA Organization

The pool of consultants are members of the senior technical staff of MRI. These men have been selected to meet projected client needs. The required talents of the pool were kept current to serve ASTRA clients more effectively.

The scientists and engineers of MRI's technical staff that comprise the pool of consultants were available to Area Technologists as and when needed to help solve client problems. The consultants serve a two-fold purpose. First, they consulted with clients on problems that are within the scope of ASTRA's services. This effort includes working on specific technical problems, and equally as important, assisting Area Technologists in the education of clients in the use of information disseminated to the clients. In the latter case, specific emphasis was placed on changing clients' attitudes, where needed, in basic management philosophy to appreciate the value of innovations and inventions, and in-house or contract research and development (R&D) efforts. Second, these consultants were the key link in effecting contract R&D between ASTRA clients and centers of excellence (among which is MRI), when this service was found to be needed.

The support staff was comprised of both administrative and technical personnel to assist in the general operation of the program. Its work covers (1) administrative, cost accounting, and contractual aspects of the program; (2) systems and marketing; (3) organization of special functions (such as user-producer conferences); (4) reporting; (5) processing of information; (6) storage and retrieval of information; (7) screening of documents; (8) special studies; and (9) special services.

2.5 Goals

The long-range goals, as well as goals for the first year of ASTRA's new operation, were sought by the philosophy of the operation set forth in Section II-C-2.2. Moreover, these goals (1) define milestones along the road to fulfillment of purpose, and (2) set forth guidelines to follow in executing the plan under which ASTRA operated.

The general long-range goals were:

(1) Improve ASTRA's services to industry through (a) development of more effective techniques of information transfer; and (b) direct access to additional sources of technology, including Government, industry, trade and professional associations;

(2) Increase the clientele for ASTRA through (a) an active and progressive service, promotional and marketing program, and (b) soliciting organizations other than industrial; and

(3) Become self-supporting financially within three years.

Immediate or one-year goals were:

(1) Determine the ASTRA market;

(2) Promote ASTRA, contracting under the new fee schedule and provide enlarged and improved services to these clients;

(3) Establish computer-search capabilities for ASTRA at MRI;

(4) Design trustworthy measures of performance; and

(5) Establish and put into effect a cost-accounting system for ASTRA.

2.6 Basic Mode of Operation

ASTRA operated on a regional basis (original regional area) for solicitation (see Figure 8). Appropriate contiguous states were included where MRI has long established relationships with organizations in these states. The region was divided into sub-geographic areas. The operation of ASTRA within an area was the responsibility of an Area Technologist.

Area Technologists worked under the philosophy of operation and plan established by the Manager of Technology Utilization and the Policy Advisory Committee, and reported directly to the Director of ASTRA. The Area Technologist established a plan of operation for his activities which is commensurate with the ASTRA program plan.

Each Area Technologist had available the technical staff needed to serve his assigned area. Initially, this staff consisted of himself and personnel of the Support Staff (see Figure 7). In addition, he had direct access to the pool of MRI staff consultants or any member of MRI's technical staff.

The consultants assisted the Area Technologist in the solution of a client problem. This work came under the category of consulting services (see Section II-C-2.7). However, if the problem was one that required considerable research, development or design, the client was served by separate contractual agreement. ASTRA kept informed of progress and results of all contract R&D efforts, insofar as a company cooperated.

ASTRA was centrally located within the Institute. This location provided for efficient operations, including working with the MRI computer center and library, as well as working with the technical divisions of the Institute in serving clients.

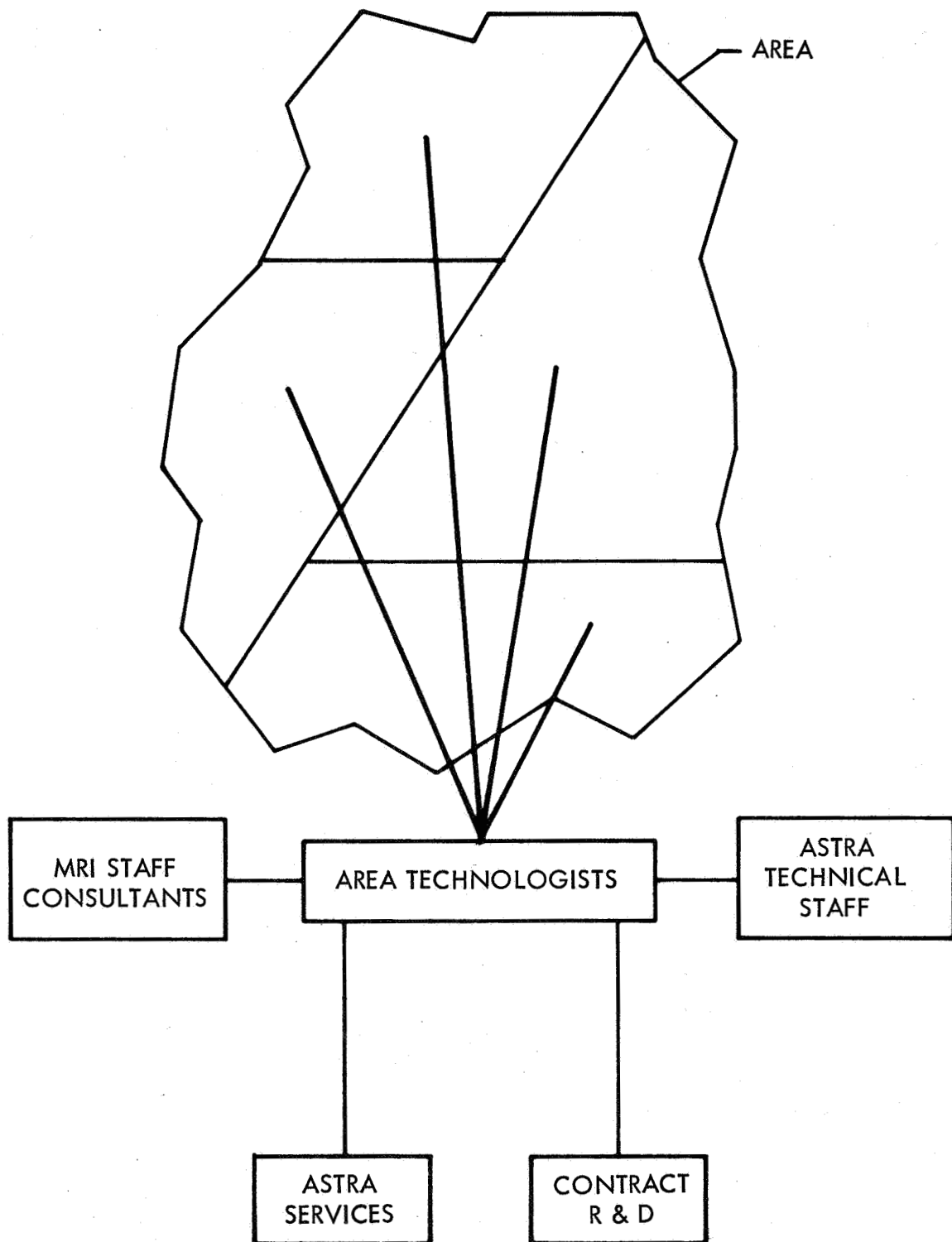


Figure 8 - Basic Mode of Operation.

There were regularly scheduled meetings of the program team (Consultants, Area Technologist, Support Staff) to provide the communications necessary to keep all team members informed of pertinent aspects of the program. Such meetings (as well as special meetings) with technical management personnel of the Institute enabled Area Technologists as well as others on the the ASTRA team to be well informed on current technical capabilities of the Institute. The ASTRA team kept apprised of current technical capabilities of other centers of excellence.

2.7 Services Offered

The four primary services of ASTRA were (1) interpretive retrospective search; (2) interpretive current awareness surveillance; (3) non-interpretive retrospective search; and (4) non-interpretive current awareness surveillance. A summary description of these is given in Figure 9.

Other ASTRA services included:

(1) Consultation in clients' plants or at MRI for assistance on specific problems or for more efficient usage of information obtained from specific services rendered;

(2) User-producer conferences covering specific technical fields to fit clients' needs and conducted annually by leading experts;

(3) Telephone problem inquiries for dissemination of information, readily available to the technical staff of MRI, immediately upon inquiry;

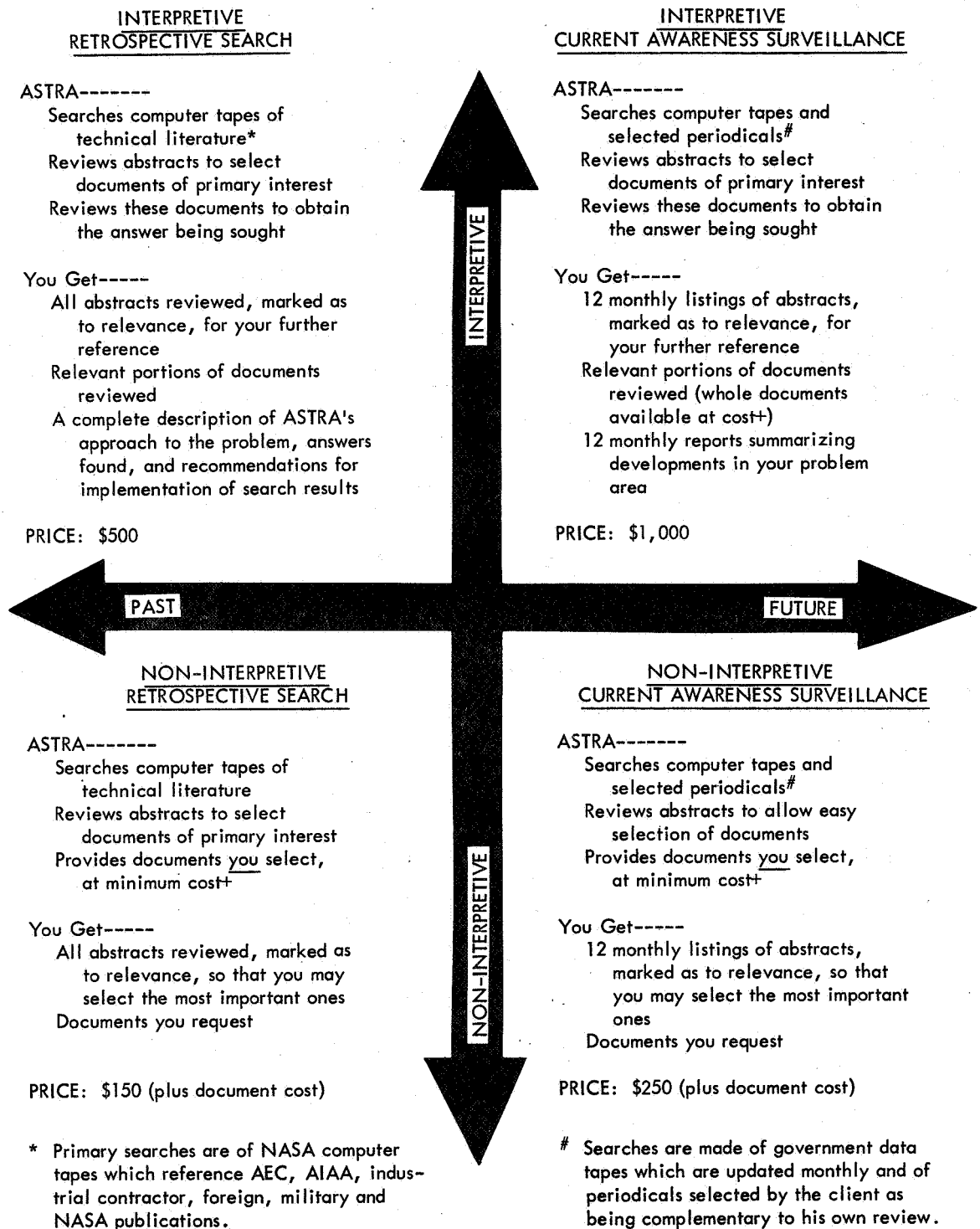
(4) Computer programs available through NASA's EOSMIC program;
and

(5) Special services covering exhaustive literature searches, residence work at client's facility, long-range planning, reports on technical conferences and contract R&D.

2.8 Fee Schedule

The primary bases for the fee structure to be used the first year of ASTRA's new operation are covered by two philosophical aspects: (1) all industry within ASTRA's regional bounds has an opportunity to contract with MRI for ASTRA services; and (2) the fee paid by each client is commensurate with the service received. Other significant factors considered in structuring a fee schedule are: (1) ASTRA should become self-supporting in three years on a cost-sharing basis by the clients served; (2) the services offered must be adequate to serve the market within the region; (3) past fee structure; (4) a new fee structure that can be built on easily without jeopardizing future sales.

BASIC ASTRA SERVICES



* Primary searches are of NASA computer tapes which reference AEC, AIAA, industrial contractor, foreign, military and NASA publications.

Searches are made of government data tapes which are updated monthly and of periodicals selected by the client as being complementary to his own review.

+ You are charged only our document or reproduction costs. At present these are:

1. Many government reports at no cost
2. Some government reports at \$3.00 each
3. Xerox copies at \$.10 per page
4. Microfiche copies at \$.20 per page

Cost quotations are available on request.

Figure 9 - Basic ASTRA Services

Each of these factors has ramifications of its own. Some of the consequences of each cannot be foretold or even anticipated because of lack of sufficient background information, e.g., characterization of the regional or district market. Moreover, this set of conditions, and ramifications therefrom, may not comprise a compatible set. When this is determined to be the case, the fee was to be revised accordingly.

A special time and cost analysis was undertaken to establish a realistic fee structure that would allow ASTRA to serve its clients properly and to become self-supporting. All available and pertinent historical program information was used to arrive at the two fee schedules established and used. These fee schedules are summarized in Figure 10, and were part of the contract ASTRA had with its clients.

The time-and-cost analysis comprised the application of known information to the particular and specific tasks required to perform a service, such as an interpretive current awareness surveillance. Principal tasks analyzed to obtain a mean value of time and materials requirements (with the variation or spread in the data) included: define client's problem; characterize problem (preparation of strategy with which to interrogate the computer); check strategy; interrogate computer; retrieve relevant documents; review documents; reproduce relevant parts and transmit to client; prepare summary of findings; and fixed business costs.

The cost formulas for the four principal services of ASTRA that were derived from the cost-and-time analysis task, are given in Appendix F.

2.9 Results of Final ASTRA Efforts

During the first portion of the final effort of the ASTRA program (April through August 1967), the principal activity was that of establishing the new ASTRA organization which comprised:

- (1) Management operations--market analyses, program evaluation and review techniques, program staff, legal items, intra-organizational relations and public relations, scheduling and monitoring of operation, communication with NASA, etc.;
- (2) Business practices--general and cost accounting, office procedures, privileged information, property, purchasing, forms, records, contract administration, travel, etc.; and
- (3) Technical operations--computer search procedures, promotion and marketing, services, conferences, consultations, etc.

\$500 SUBSCRIPTION

Basic Annual Subscription

\$ 500

This covers a retrospective search for one field of interest (F.O.I.), one full day of in-plant consulting, telephone inquiries, and ASTRA program publications.

The client company may purchase additional services as listed below:

Additional Services:

Interpretive current awareness surveillance per F.O.I.	\$1,000
Interpretive retrospective search per F.O.I.	500
Current awareness surveillance per F.O.I.	250
Retrospective search per F.O.I.	150
Consultation per day	200
User-Producer Conference per registrant	75

\$2,000 SUBSCRIPTION

Basic Annual Subscription:

\$2,000

This covers interpretive current awareness surveillance for one field of interest (F.O.I.), a retrospective search for one field of interest, one full day of in-plant consultation, telephone inquiries, and ASTRA program publications.

Up to \$500 of the basic annual subscription fee may be used by the client company to purchase additional services listed below.

Additional Services:

Interpretive current awareness surveillance per F.O.I.	\$1,000
Interpretive retrospective search per F.O.I.	500
Current awareness surveillance per F.O.I.	\$ 250
Retrospective search per F.O.I.	150
Consultation per day	200
User-Producer Conference per registrant	75

These rates are also applicable for any additional services over and above those services included in the basis annual subscription which the client may desire during the ASTRA service period.

Figure 10 - Fee Schedules

In late August, ASTRA initiated its promotional and marketing plans. This effort continued through December 1967, with ASTRA attaining eight clients. ASTRA continued to serve clients who contracted under the initial cost sharing program (see Section II-C-1) as well as the new clients.

In January 1968, NASA informed MRI of its decision to discontinue ASTRA as an RDC. ASTRA was to stop the marketing of ASTRA, but was to continue serving existing clients.

A summary of program activities during the latter portion of the ASTRA program is given subsequently in this subsection.

Results of a market analysis are given in detail in Appendix G. This analysis (1) indicated that ASTRA's initial approach should be to concentrate promotional and marketing efforts in a few major metropolitan areas such as St. Louis, Minneapolis and Kansas City; (2) characterize the markets in the three major metropolitan areas; and (3) further work in analysis of the regional market needs to cover more comprehensively factors such as company size, markets, orientation (viz. R&D, sales, manufacturing) and product line in an effort to evaluate the characteristics of a given company that make it most receptive to utilization of the ASTRA services.

The results of the market analysis assisted in promotional work, which was undertaken in establishing the new ASTRA organization. Promotional aids included:

1. ASTRA slide presentation: The slide presentation contains some 65 slides and is accompanied by a 30-minute script. The presentation covers various aspects of technology utilization, search procedures, and MRI capabilities. While this marketing tool is able to stand alone, it was augmented by the 16-minute film, "By-products of Space Research." The slide presentation is an impressive means of demonstrating the ASTRA program in cases where firms cannot visit Midwest Research Institute and are not familiar with ASTRA and MRI's capabilities.

2. Sales presentation book: A sales presentation book was written, designed, illustrated and produced. It presents in outline form the need, purpose, and services of ASTRA. The book is done in two-color Diazochrome and mounted in a ring binder for easy addition and substitution of pages. The length is 24 pages.

3. ASTRA promotional brochure: The ASTRA brochure describing ASTRA and RDC was prepared as a hard-sell piece.

4. Technology utilization newsletter: A monthly newsletter for the promotion of ASTRA was planned for use during the 1968 marketing year.

5. ASTRA user's manual: An ASTRA user's manual was prepared. The manual describes the services of ASTRA in detail and assists in further promotion of the basic TU concept.

6. TU program description: A description of the TU program was prepared. This document is to be used in conjunction with the new MRI brochure to promote the capability of the Institute in all aspects of technology utilization.

7. Marketing package: A marketing package was prepared for mailing to possible clients contacted by telephone and who expressed interest in a personal call by an ASTRA technologist. This package contains a brief description of the ASTRA program services, reprints of articles on technology transfer, a brochure describing the Institute, and in some cases, tech briefs or other NASA literature specifically aimed at the recipient.

ASTRA integrated computer search techniques into its operation and became a computer-based RDC. This integral function increased the efficiency of operation and improved service to the client, from technical results to speed of operation.

A User-Producer Conference on corrosion problems and control was held 13-14 September 1968 in Kansas City, Missouri. The program was basically a workshop organized around a need of industry in the Middle West. (This subject resulted for a comprehensive survey of the geographic area.) The attendance of 62 formed an ideal size group from the standpoint of idea exchange and interaction between attendees. Proceedings of the conference were published.

A summary* of the services rendered the eight new clients are:

Items of Aerospace Technology	4,257
Searches Performed	97
Client Inquiries by Letter or Phone	13
Consulting Hours	75

* These data do not include services to the 45 companies served under the efforts toward cost sharing (see Section II-C-1 for these results.)

III. MRI'S EVALUATION OF ASTRA: A RETROSPECTIVE VIEW

A. Philosophy of ASTRA

The basic concept of ASTRA, or that of technology utilization, interlaces such parameters as:

- (1) The intellectual capabilities of those directly involved in the transfer of the technology;
 - (2) The attitudes of the technical man, the manager, and the "ultimate recipient" of the transfer, whoever he may be;
 - (3) The environments in which transfer activities are undertaken;
- and
- (4) The tools available to the transfer agent, or technologist.

The first two parameters cited are educational or philosophical in nature; the latter two are concerned with mechanisms or tools (discussed in Section III-D).

ASTRA observed that in many instances industrial companies were not aware of the fact that new aerospace technology is available to them. As a consequence, the companies do not realize the potential value of putting this technology to their use--adapting it to meet their need. The results of ASTRA's activities during a seven-year period indicated that management must understand and better appreciate (1) the meaning of innovation and invention; (2) that the pace of technology is accelerating, and the development-to-product cycle is getting shorter; (3) that survival in a competitive business demands high-quality research and fast action (which are related directly to the development-to-product cycle); and (4) the cost of research and development can, and will, continue on an incline.

ASTRA, in the business of technology transfer, provided an education of technology utilization to potential users of its services through general, business-like promotional and marketing techniques. This was essential in attempting to change the attitudes of the manager, the technical man or whoever or whatever the restraint was in a company's reluctance or refusal to use ASTRA's services.

ASTRA was helpful in the educational aspect throughout the program. Substantial help is required which is of fundamental nature. In general, the amount of help required, or the effort needed to change attitudes was

related to the cost of technology utilization to a company. On a full subsidy basis by NASA, companies accepted ASTRA quite quickly. However, when the total cost or a large percentage of this cost was to be borne by the company, the company would, in most cases, require a rigorous economic justification.

Technology transfer is still in an early phase of its evolution. There is a potential market for it on a self-supporting, RDC basis, but this market needs to be developed through education of the potential users as well as the technologists themselves. The heart of the "watermelon" has not been reached--i.e., any continued efforts should place greater emphasis on interpretive and adaptive aspects of information transfer--put the information accumulated during searches into action for the benefit of the client through technologists who have the wisdom, imagination and experience of doing just that.

B. Organization and Operation

ASTRA's organization during the last year and one-half of its existence (see Section II-C-2 and Volume II of this first report) provided the greatest potential for a viable business organization. The operation of ASTRA under this organization was efficient from management, business and technical aspects of an RDC. It provided for potential success under the restraints of its "charter." The major restraint was that of the amount of time in which to become self-supporting. This restraint is a direct function of the attitudes of companies relative to the "value" of technology utilization, through ASTRA, to their operation. ASTRA believed that it would take five to ten years for the market in its geographic area to completely support ASTRA; and three years for approximately 50 percent of the financial support.

The significant improvements achieved in ASTRA's evolution which formed the bases for a successful organization and operational RDC are:

(1) All technology utilization efforts at MRI were under one manager;

(2) This manager of technology utilization reported to a Policy Advisory Committee comprised of top management and technical personnel of MRI;

(3) The ASTRA staff had direct access to the technical staff of MRI;

(4) The geographic region served by ASTRA was subdivided into areas each of which was the responsibility of a full-time ASTRA Area Technologist for information transfer, promotion, marketing, etc., under the general program philosophy and plan of operation;

(5) ASTRA became a computer-based RDC;

(6) The services of ASTRA were designed to provide the transfer of maximum pertinent information in NASA's bank of information to the client with dispatch and economy, and in a form that presented this information in the most adaptable way for expedient use by the client--the adaptive and interpretive handling and transfer of information by technological experts.

(7) Trustworthy means of performance to accurately assess service were established;

(8) ASTRA's management exercised a continuous review of ASTRA's modes of operation, maintaining the flexibility and versatility of action needed to modify these modes to meet changing conditions and current client needs; and

(9) Business procedures were established and practiced which included cost accounting and controls.

C. Kinds of Services

During Phases I and II of ASTRA's evolution, the principal service to clients was that of seeking information relative generally to rather broad technical areas of sponsor interest. Basically, ASTRA personnel continuously reviewed NASA documents. When information believed to be of interest to a client was recognized, the documents (or a copy made by ASTRA, if additional published copies were not available) were sent to the client. The results of this general mode of operation were that the client received a voluminous number of documents which required a considerable amount of time on its part to screen and digest--quite an expenditure of time and funds on its part.

This basic service, which was complemented by consulting services at MRI or at the client's establishment and special seminars, served 1,101 clients and brought about 120 technology transfers (see Appendix D). These services were of value to industry in the midwestern area covered by ASTRA, as indicated by the 120 transfers, the 623,500 items of Aerospace Technology disseminated to these 1,101 clients, and the responses ASTRA made to the 10,555 industrial inquiries. (A large part of the inquiries resulted in

computer searches of NASA tapes by other RDC's. Also, a significant portion of the items sent resulted from searching NASA's bank of information via the computer.)

The basic philosophy of service changed during the latter part of the program to that of interpretive and adaptive handling of information for optimal benefit to the client. Moreover, the service sought to help the client more with specific problems, rather than to provide it with vast amounts of information. In addition, the User-Producer Conference was born. The consultation and telephone inquiry services were continued.

The interpretive and adaptive handling of information was accomplished by interpretive and noninterpretive retrospective searching and interpretive and noninterpretive current awareness surveillance. The appropriate technical talents were directly associated with a problem from its definition (ASTRA working directly with the client), through preparation of search strategies, review of abstracts and documents, weighing relevance of information, and preparing summary reports for client. This system proved to be extremely valuable to the client, since the client was involved a minimum for a maximal return from NASA's bank of information. Consequently, the value to the client increased by orders of magnitude over previous services.

D. General Comments--Looking into the Future

The tools of ASTRA as a computer-based RDC were built around the IBM 360/30 digital computing machinery, storage media such as magnetic tapes and microfiche, abstracts of results of NASA's research and development efforts, and published documents covering these efforts.

A client's needs initiate action. A search was performed. It is apparent that only a general method of performing a search, man-to-machine-to-man, can be established in advance; each search is usually handled in a "custom manner" to provide a maximum benefit to the client. Consequently, the exact mix of man and the machine for a particular search can only be determined after the fact.

Today, the technologist is principally seeking documents through a weighted or a Boolean descriptor search technique of NASA tapes. He retrieves documents identified through this discretionary system and submits them to the client or requestor. This is called the transfer service. Optimization of encoding tapes is assumed to be in effect, as well as the optimization of retrieval and reproduction techniques for documents. Nevertheless vast improvements can be made in the services to the users--through a system approach; through improved means of storage; and through maximum use of the technically talented.

Technology transfer is believed to be in early stages of its evaluation. There is a potential market for it. Only a small portion of this market is being served. The total market needs to be educated relative to the value of technology transfer (see Section III-A). The technologists require further education. Technology transfer needs to encompass more than NASA's technology to enhance its value to the potential user. The "tools of the trade" are not adequate at present to accommodate the potential explosion of technology transfer.

What is envisioned, based upon projected needs, is given in subsequent remarks.

Predicted developments in microelectronics will feed a continuing revolution in communications and data handling. Some examples of what will happen are: (1) computer speeds will increase about three hundred-fold; (2) cost per million additions (as a measure of computer costs) will drop about eight hundred-fold; and (3) access speeds of memories will catch up to processing speeds and mass random access memories will be used increasingly. Other forecasts, made by experts, indicate rapid change in techniques of communicating among man-to-man, man-to-machine, and machine-to-machine. Communications-based computer systems will become cheap, plentiful, and easy to use.

This "hardware" of the future cannot be used most effectively unless the entire transfer system is netted together properly. Consequently, technology transfer must be considered as and operated as a system. This system should be established for optimization of all transfer techniques, and applied to the total universe of technology. Consolidation is needed of all activities similar to NASA's technology transfer. Ways of amalgamating available nongovernmental information into the system is needed. Standardization of methods and procedures to maintain a high degree of efficiency must be a major factor in the design and implementation of this system. Centralization for decision-making is essential.

With this management philosophy of operation, the actual system would have a central control point from which regional dissemination centers (RDC's) would operate. Then in turn, these RDC's would have the necessary satellites that would have proper terminal devices. These devices would permit technologists to have direct access to the major computer of an RDC. Time-sharing techniques would permit this method of acquiring information to become economical. Thus, the RDC's and the satellites would apply their own proprietary search strategies in interrogating data banks. Graphic displays would be driven by the central computer to permit rapid distribution of large quantities of scientific and technical information. Reports from a dissemination center to customers would be on-line through secured communication links and displayed on screens (or presented by other selected means)

on the client's premises. (Holographic images are one means of storing techniques for displaying devices and image displays of processes on products which could replace many of the printed abstracts and reports used today.)

The potential capability of man himself must be developed much more rapidly than ever before. Man's potential in action is necessary to the success of information transfer.

Society, in general, and managers of industrial concerns, in particular, need to be educated in technology transfer--the technical man requires it also. The impetus of preparedness can be, and certainly is in numerous cases, self-motivated. However, to attain a high degree of confidence that those needing it will indeed be prepared, necessitates that leaders in educational, government, industrial, and professional spheres initiate and sustain the action required for this perpetual preparedness through the increase of the human capability.

The basic aspects of increased capability need to be incorporated in our educational system--in the academic curriculum (physical sciences, biological sciences, economics, business management, etc.) for the long-range view; and through continuing education in the university, or in the factory, or self-style for the short-range or immediate aspects.

There must be "champions of the cause" other than at NASA to initiate the proper action and sustain the follow-through. These champions need to be on the peripheral as well as the internal aspects of technology transfer. Statesmen and industrial and educational leaders need to become deeply involved. More entrepreneurs are needed with considerable depth of technical perception and anticipatory ability.

Recommendations for the enhancement of the field of technology utilization in the future are:

1. Man's learning process must be studied more intensively. The human mind has a tremendous capacity for storage of information; for reasoning; for perception. Man himself is the answer to "giant steps" of progress in technology transfer. Potential hardware advancements are infinitesimal compared with that of man.

2. We must learn how to characterize current and historical information (documents) more efficiently, fully, and scientifically for the future recall for problems or needs which are not yet foreseeable.

3. We must learn how to better characterize a problem or client's technical profile (search strategy) so that we may interrogate the computer data banks more intelligently.

4. Emphasis should be placed on in-depth study of knowledge retrieved in the transfer process to increase benefits for the client--creating a new dimension in technology transfer.

5. An intensive study must be made on the identification of the pertinent factors and parameters associated with technology transfers; characterization of technology transfers through models is needed. Evaluation of these models as they pertain to the different environments from which they were derived must be made for input in the design of educational approaches to be taken and to determine measures of effectiveness of technology transfer as an entity.

A final recommendation is that since technological progress of the future is ultimately dependent upon human beings--individuals rather than machines--we need to do more than ever before to define the sources of creativity, and encourage it wherever and whenever we find it among our scientists and engineers.

APPENDIX A

DISPLAY BOARDS

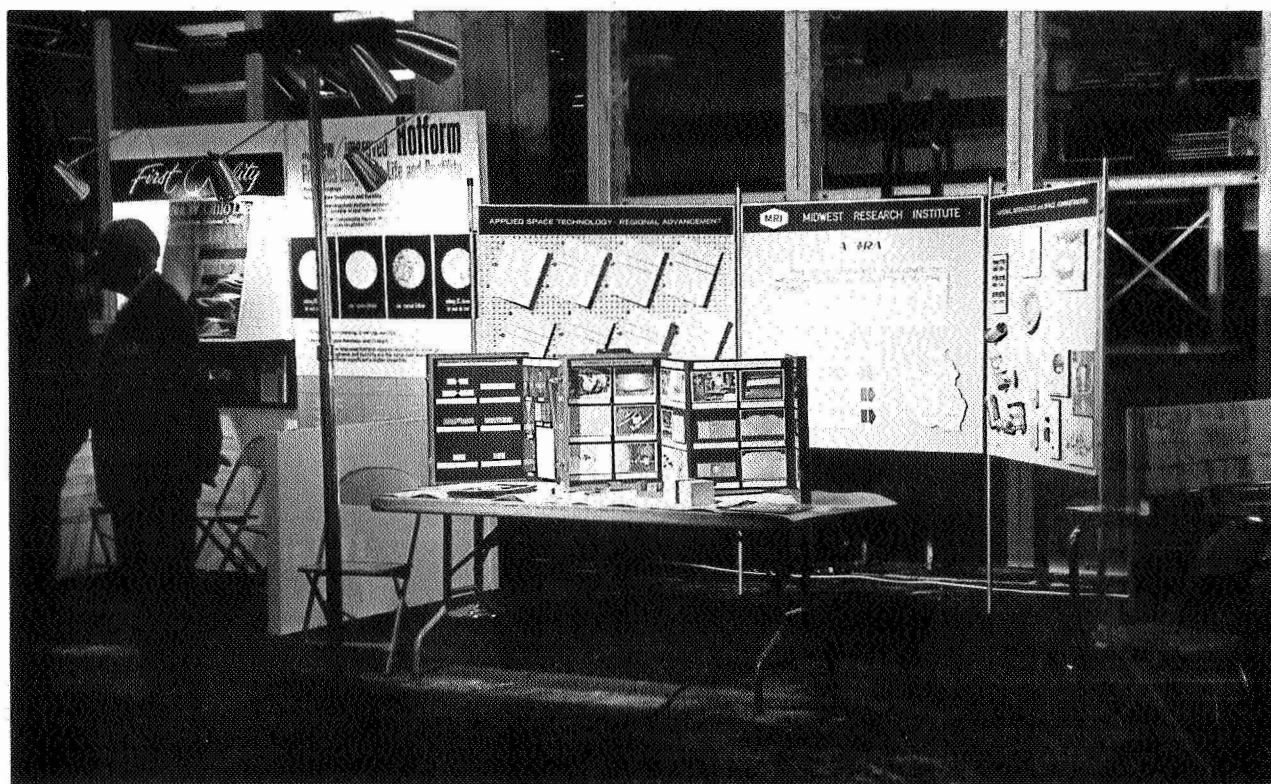
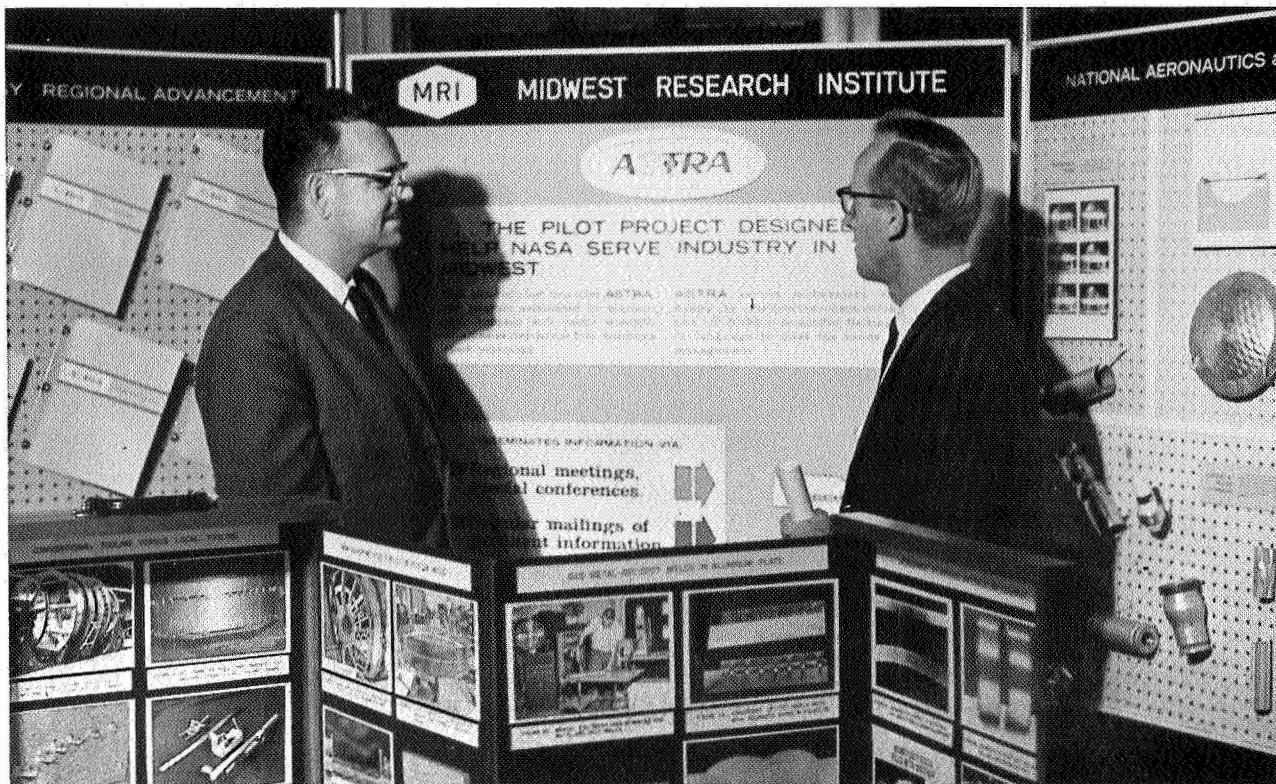


Figure A-1 - Display Booth for ASTRA Orientation

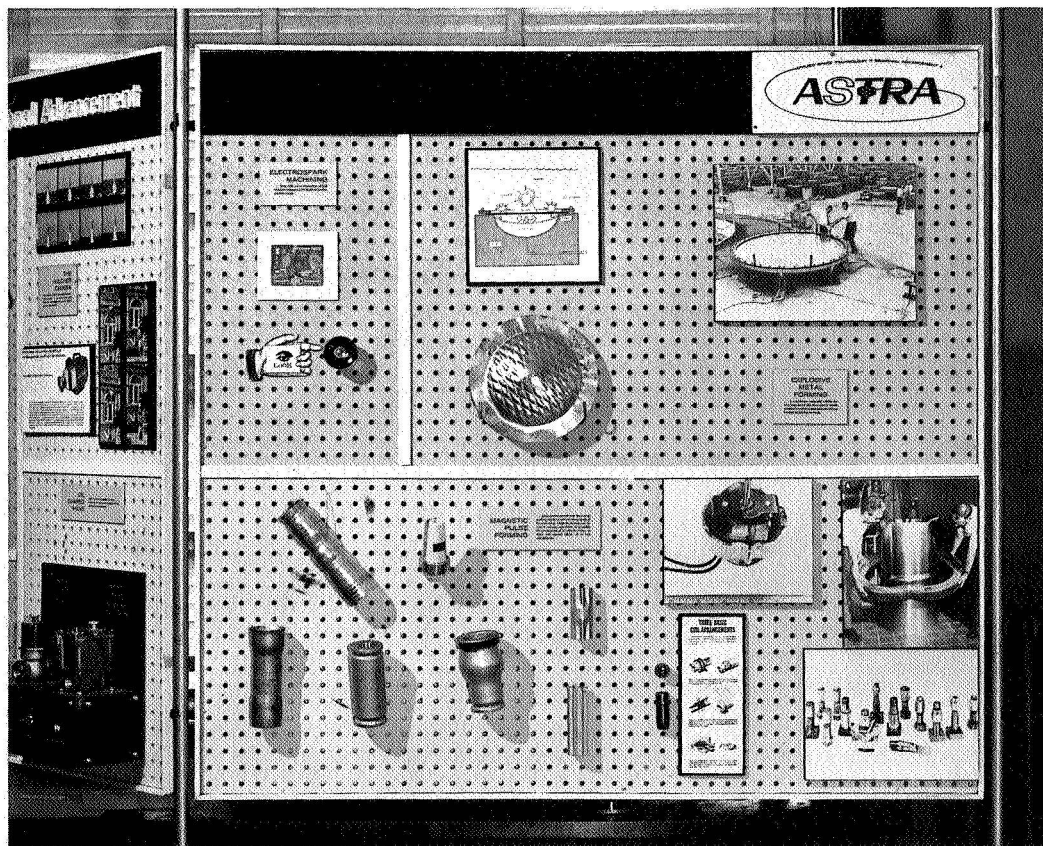
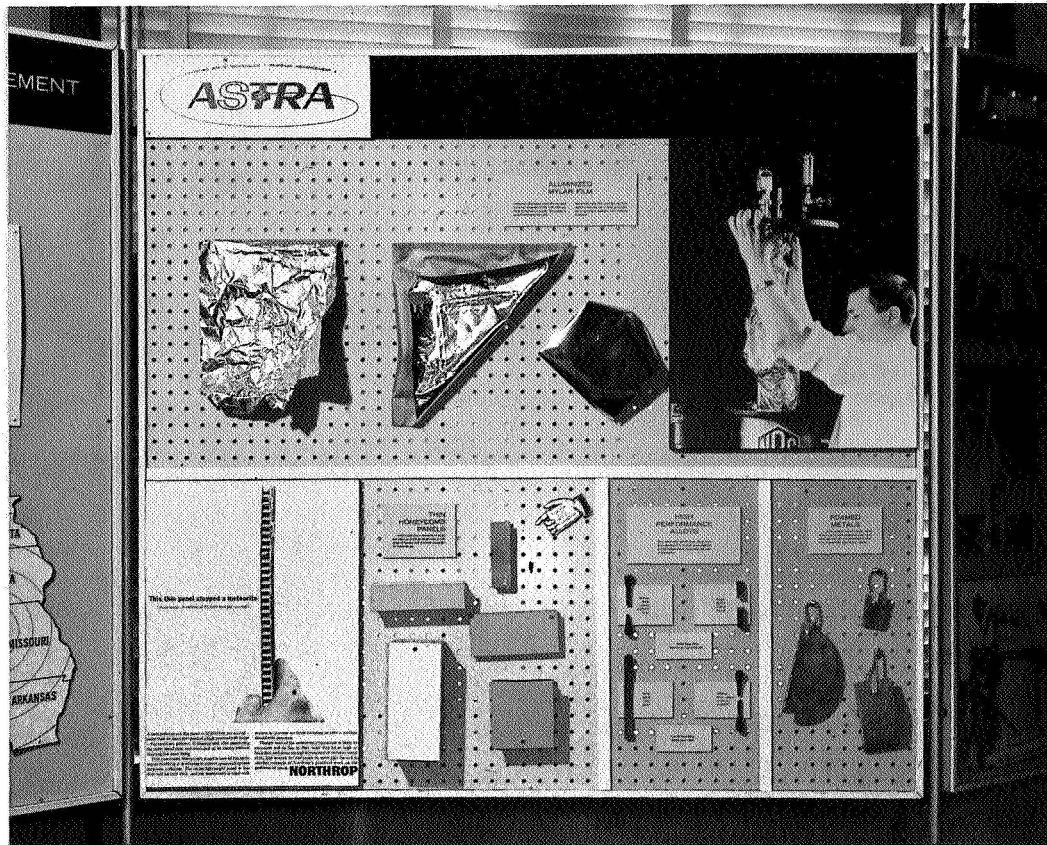


Figure A-2 - Close-ups of Display Boards

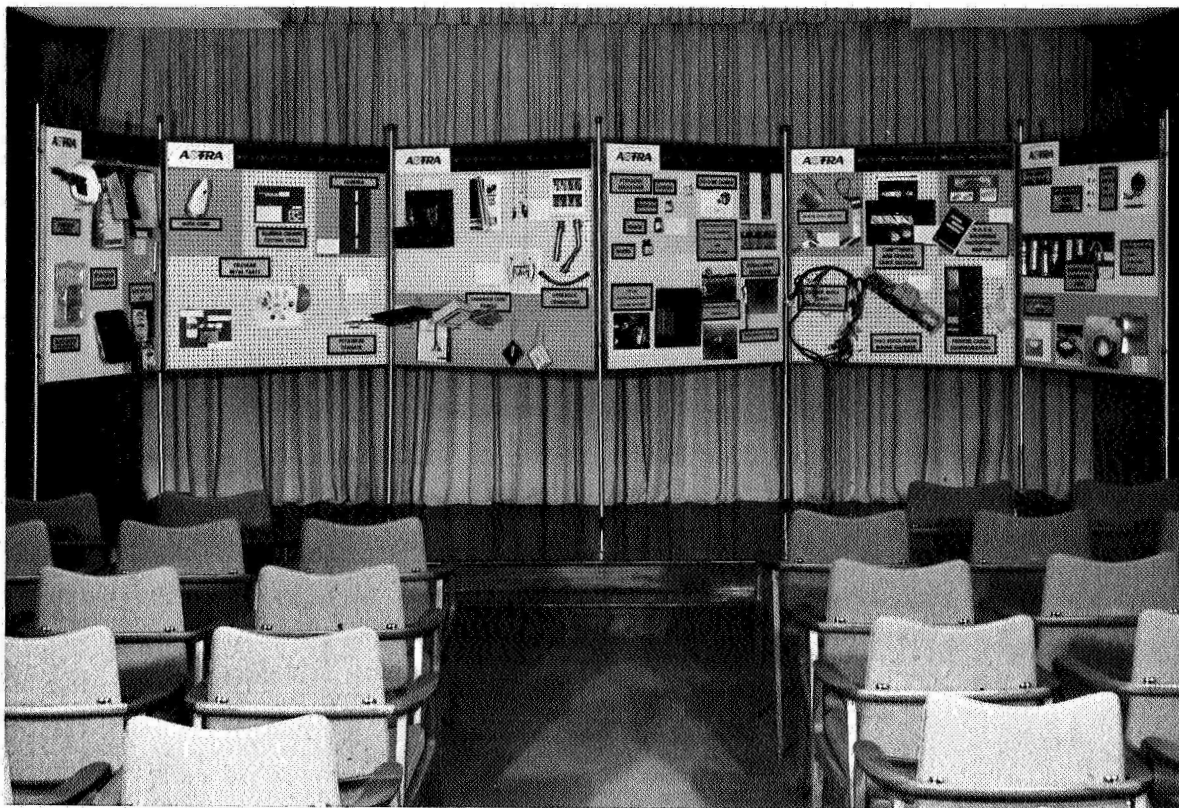


Figure A-3 - Promotional Display Boards at Special
Sectional Meeting

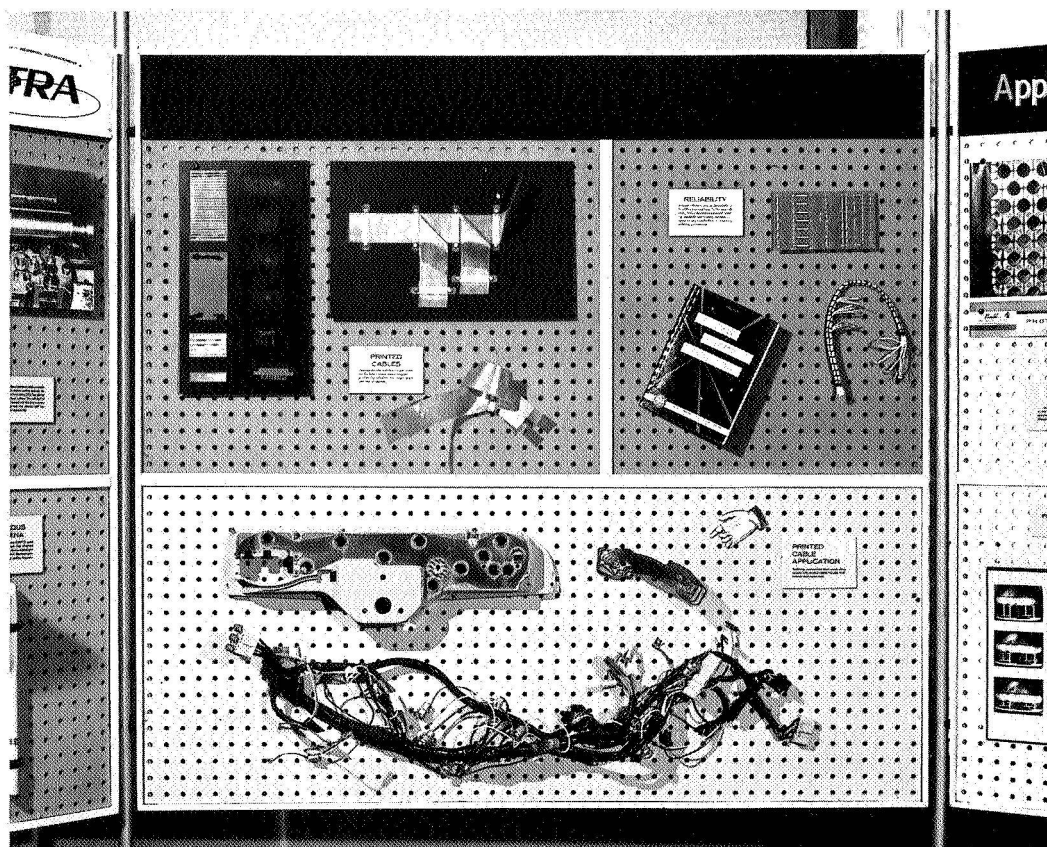
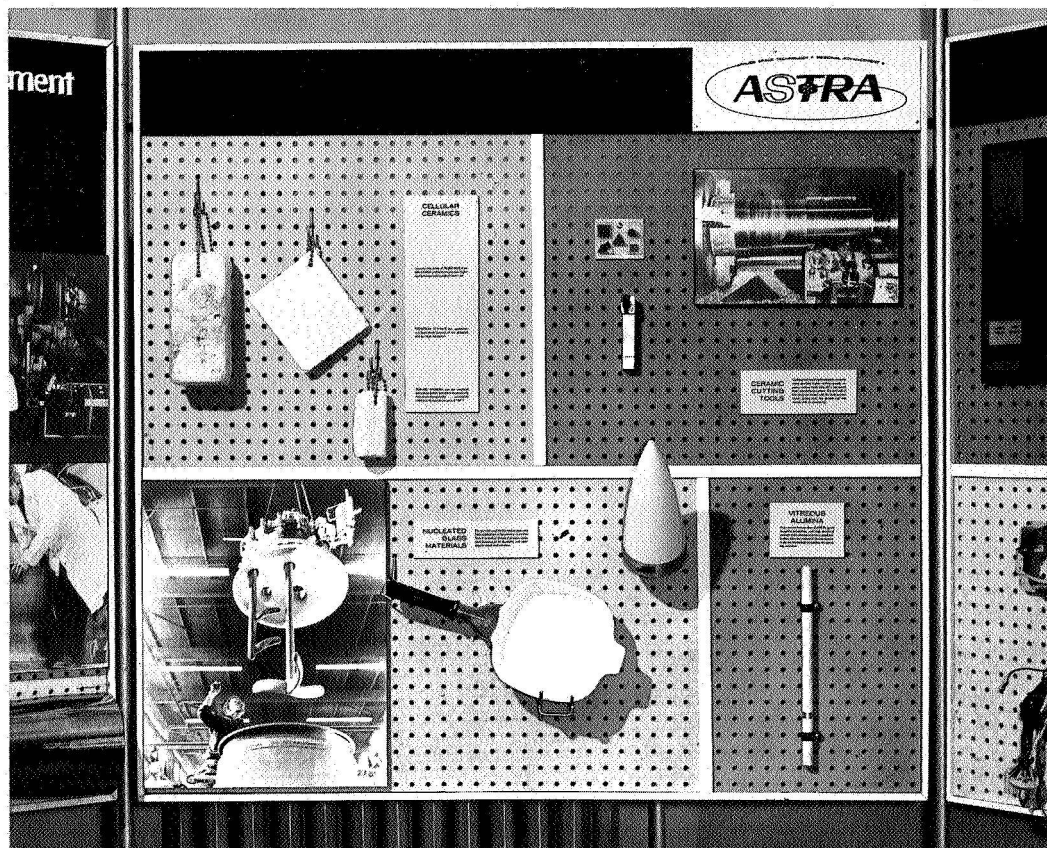


Figure A-4 - NASA Technology Display for ASTRA
Initial Promotional Efforts

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APPENDIX B

OPERATING FORMS

To aid ASTRA in the proper dissemination of continuing information, please check, in the boxes provided, the fields of technology of greatest interest to your firm.

<u>Materials Sciences</u> ☐ ☐ Ferrous Alloys ☐ Nonferrous Alloys ☐ Physical Metallurgy and Heat Treating ☐ Powder Metallurgy ☐ Strength of Material ☐ Testing Methods ☐ Ceramics, Refractories, Glass ☐ Cement, Lime, Gypsum Products ☐ Abrasives ☐ Rubber and Elastomers ☐ Textiles, Fabrics, Fibers ☐ Wood, Paper, Cellulose ☐ Others (Specify) _____	<u>Electrical/Electronic Technology</u> ☐ ☐ Components ☐ Solid State Devices ☐ Miniaturization/Microminiaturization ☐ Molecular Electronics ☐ Printed Circuitry and Cables ☐ Circuit Design ☐ Commun. Equipment and Techniques ☐ Telemetry ☐ Ground Support Equipment ☐ Motors, Gener., and Rotating Equip. ☐ Power Generation and Distribution ☐ Batteries, Fuel Cells, Secondary Power ☐ Thermoelectric and Thermionic Devices	<u>Life Sciences</u> ☐ ☐ Medicine and Biochemistry ☐ Pharmaceuticals and Biologicals ☐ Human Engineering ☐ Bacteriology ☐ Fertilizers and Plant Growth Regulators ☐ Pesticides ☐ Food Additives ☐ Cereal, Bakery and Confectionery Products ☐ Meat, Fish, Dairy, Poultry Products ☐ Vegetable and Animal Oils and Fats ☐ Animal Feeds and Nutrition ☐ Food Technology and Processing ☐ Others (Specify) _____
<u>Fabrication Technology</u> ☐ ☐ Materials Cutting, Shaping, Forming ☐ Welding, Brazing, Soldering ☐ Surface Finishing (inorganic-organic) ☐ Adhesive Bonding and Other Joining Methods ☐ Electroplating and Anodizing ☐ Composite Structures ☐ Melting and Casting ☐ Temporary and Special Tooling ☐ Processing Methods ☐ Packaging ☐ Filament Winding ☐ Reclamation and Salvage	<u>Instrumentation</u> ☐ ☐ Recorders ☐ Timing Devices and Programmers ☐ Automatic Controls and Regulators ☐ Sensing Devices (I.R., U.V., Optical, etc.) ☐ Transducers (press, T°, level, etc.) ☐ Digitizers and Readouts ☐ Test Equipment ☐ Laboratory Instruments ☐ Medical Instrumentation	<u>Engineering Mechanics</u> ☐ ☐ Machinery ☐ Gas Turbines ☐ Refrigeration and Air Conditioning ☐ Internal Combustion Engine ☐ Mechanisms ☐ Stress Analysis ☐ Power Transmission ☐ Bearings ☐ Pumps ☐ Nozzles and Sprays ☐ Servomechanisms ☐ Nonlinear Controls
<u>Chemical Sciences</u> ☐ ☐ Fuels and Combustion ☐ Corrosion and Protection ☐ Lubricants and Fluids ☐ Explosives ☐ Adhesives ☐ Molding Plastics and Polymers ☐ Laminating and Reinforced Plastics ☐ Coatings, Paints, Inks ☐ Soaps, Detergents, Cleaners ☐ Others (Specify) _____	<u>Data Handling and Display</u> ☐ ☐ Computers ☐ Information Storage and Retrieval ☐ Presentation and Display Techniques ☐ Signaling and Warning Devices ☐ Printing and Other Graphic Arts ☐ Learning Processes and Teaching Devices	
<u>Physical Sciences</u> ☐ ☐ Optical Devices ☐ Photography ☐ Sound and Noise ☐ Ultrasonics ☐ Radiation and X-Rays ☐ Magnetic Devices ☐ Thin Films ☐ Vacuum Technology ☐ Cryogenics ☐ Heat Transfer and Thermodynamics ☐ Seismic and Geophysical Prospecting ☐ Spectroscopy	<u>Management and Control</u> ☐ ☐ Program Mgt. (PERT, PERT/COST) ☐ Value Analysis/Value Engineering ☐ Reliability and Long Life ☐ Quality Assurance/Quality Control ☐ Statistics and Decision Making ☐ Safety and Maintenance Engineering ☐ Economic Analysis ☐ Economic Study	

Fields of Interest

Figure B-1 - Form: Fields of Interest



INDEX OF TECHNICAL CAPABILITIES AND INTERESTS

for

MRI INDUSTRIAL PROGRAM

In order for ASTRA to serve your firm more effectively, we ask you to cooperate by recording your specific technical capabilities and your fields of interest.

1. Name of Firm _____
Address _____
City _____ County _____ State _____
Telephone _____

Company
Name

2. Please designate one person to receive and handle the information which this program provides.

Name _____
Title _____

3. Does your company presently sponsor a research program?

Research and
Development

4. Number of technically or scientifically trained personnel assigned to research and development or future technical planning. _____

5. Total number of employees _____

6. Principal products (in order of volume)

a. _____	f. _____
b. _____	g. _____
c. _____	h. _____
d. _____	i. _____
e. _____	j. _____

Company
Products

7. Unusual or unique industrial capabilities (describe below). _____

8. What major technical advance within the next two years would be most beneficial to your firm?

Figure B-2 - Form: Index of Technical Capabilities and Interests

PLEASE CHECK, IN BOXES PROVIDED, THE JOURNALS YOU ARE NOW READING

	<u>Seldom Read</u>	<u>Often Read</u>
1. Modern Plastics	☐	☐
2. Product Engineering	☐	☐
3. Food Technology	☐	☐
4. Electrical Design News	☐	☐
5. Missiles and Rockets	☐	☐
6. Aerospace Engineering	☐	☐
7. Space and Aeronautics	☐	☐
8. Industrial Research	☐	☐
9. Machine Design	☐	☐
10. Materials in Design Engineering	☐	☐
11. Chemical and Engineering News	☐	☐
12. Others (specify) _____		

Technical
Reading List

Return to:

ASTRA
Midwest Research Institute
425 Volker Boulevard
Kansas City 10, Missouri

Figure B-3 - Form: Technical Reading List

APPENDIX C

SUPPLEMENTAL ITEMS FOR CLIENTS

SUBJECT: FILAMENT WINDING

The combination of light-weight with high-strength has always been a prime criterion for materials used in space hardware of all kinds. Much of present-day filament winding technology stems directly from space research which sought better ways to produce strong, light-weight pressure vessels and rocket cases for space vehicles.

Basically, filament winding is simple in concept. A continuous tensioned strand of glass fiber is wound onto a mandrel in a pattern. Plastic resin is introduced either by running the glass roving or yarn through a resin bath before putting it on the mandrel or by using a pre-impregnated roving. When winding is completed, the structure is then cured, usually by heating in an oven. In some cases, room temperature cures can be made with an appropriate catalyst system. No pressure is applied during the curing cycle. So successful has filament winding become in the aerospace industry that commercial uses are now being developed rapidly by such firms as Brunswick, B. F. Goodrich, Goodyear Aircraft, Hercules Powder, Thompson Ramo Wooldridge, Black, Sivalls and Bryson, Inc. and others.

SPACE USE:

As mentioned above, filament winding has been widely used in the aerospace industry for pressure vessels and rocket motor cases. Recently, high-temperature radomes have become a major application for filament-wound structures in space applications.

INDUSTRIAL APPLICATIONS:

Lamtex Corporation, which filament-winds booster cases for NASA, are now the world's largest supplier of filament-wound brassiere supports. The Kansas City firm of Black, Sivalls and Bryson, which gained much of its knowledge of filament winding from experience gained in winding parts for Minuteman and Polaris missiles, recently produced the first filament-wound, reinforced-plastic railroad tank car. With a capacity of 22,500 gallons, it weighs nine tons less than a conventional tank car of the same capacity. Additional commercial uses foreseen for the near future are truck brake systems, fire extinguisher pressure containers, chemical tanks and grain storage bins. A Cincinnati firm, Justin Enterprises, Inc., has recently pioneered an "on-site" filament winding technique. In unusual applications, they take filament winding equipment out to tank-erecting sites for out-size tanks which can't be handled in the shop or shipped by ordinary transportation media. Recently a 46,000-gallon tank 28 feet in diameter and 10 feet high was successfully spun in the field.

List of ASTRA Monographs

1. JPL Products and Techniques From Space Research
2. High Temperature Nickel Alloy
3. Magnetic Metal Forming
4. Innovations in Electroforming
5. NASA Shop Hints
6. Cold Galvanizing
7. Arc Tunnel Heater
8. The Retrometer
9. Cryogenics: Industry's World of Super Cold
10. How To Get Your Products Into Orbit
11. How Companies Have Turned Space Technology Into Industrial Profits
12. NASA Patents
13. LOLA (Lunar Orbit Landing Approach Simulator)
14. Orbital Photography
15. Digital Solar Aspect Sensor
16. Black Body
17. Fused Amorphous Silica
18. Silent Chain Friction Drive
19. Dissemination of Industrially Useful Space Technology
20. Beryllia - Space Age Gem

Figure C-2 - List of ASTRA Monographs Distributed



MIDWEST RESEARCH INSTITUTE

ASTRA INNOVATION NO. 95

Title: Tunnel Diode Monostable Multivibrator

Abstract: The high and low voltage stable states of a tunnel diode are utilized to improve the circuit performance characteristics of a monostable multivibrator. A semi-detailed discussion of the circuit operation is given in the text of the related NASA disclosure.

Three outstanding features are:

1. Rise and fall times of less than 0.2 microsecond.
2. A 95% duty cycle can be obtained with this circuit.
3. The fall time is totally independent of the duration of the quasi-stable state.

These combined features might be of particular interest to the design engineer who is concerned with pulse and timing circuits.

For further information about
this innovation, mail coupon to:

No. 95

Mr. Clayton C. Craghead
Project ASTRA
Midwest Research Institute
425 Volker Boulevard
Kansas City, Missouri 64110

Name _____

Title _____

Company _____

Address _____

City _____ State _____



MIDWEST RESEARCH INSTITUTE

Information Announcement No. B-90

Title: ELECTROMECHANICAL TRANSDUCERS

Summary: We are pleased to announce the availability of a new bibliography resulting from a thorough retrospective literature search for documents pertaining to the subject of electromechanical transducer devices, techniques and applications.

These documents include reports originating in the various government laboratories and research centers, and in research conducted by industry, universities and other institutions for the federal government.

Each listing includes the title, author, and a short abstract of the text.

No. B-90

For a copy of this bibliography,
mail coupon to:

Mr. Eldon Sneegas
Director, Project ASTRA
Midwest Research Institute
425 Volker Boulevard
Kansas City, Missouri 64110

Name _____

Title _____

Company _____

Address _____

City _____ State _____

Figure C-4 - Sample Information Announcement

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APPENDIX D

TECHNOLOGY TRANSFERS

There was a considerable amount of technology transferred during the period of this program. The technology transferred proved to be of direct value to industry. Specific transfers related, in varying degrees of benefit to the recipients, to components, instruments, subsystems, systems, techniques, designs, and approaches to problems. In some cases, the transfers were made essentially without the need of modification or adaptation. In other cases, the transfers were again of significant value, but were the dissemination of information, which for example, were links in the evolution of innovations or catalysts in motivating the recipients.

Although all transfers made are not known to program personnel, and therefore, cannot be reported, one-hundred twenty-five (125) are known and reported below. A conservative estimate is that these constitute less than 25 percent of the total made through the efforts of ASTRA.

No. 1

Use of company name not permitted

In the production of farm machinery, this firm must machine the edges of two channel pieces before they can be welded into a box beam on an automatic welder. A representative of the firm visited MRI to learn whether the weld seam tracker (developed at the Marshall Space Flight Center) would eliminate the necessity of machining on these parts. Subsequently, he visited Marshall to obtain detailed information on their seam tracker. The firm is currently seeking a commercial version of this device.

No. 2

Use of company name not permitted

Immediately after the ASTRA meeting in Kansas City, this firm, one of the nation's leading producers of industrial cooling towers, requested information about an inactivated patent case covering a system for cleaning cooling towers. This system uses no electric power and is ideal for remotely located, atmospheric towers. It also promises economies of installation and operation for regular industrial use.

MRI provided the firm with a copy of the patent application and made arrangements for the firm to get in direct touch with the inventor at the Langley Research Center. A newly revised application incorporating new claims has been prepared by the inventor for submission to the patent office.

The firm evaluated this cleaning system for possible use in their line of cooling towers.

No. 3

Use of company name not permitted

This firm is an A.E.C. prime contractor, producing electrical and electronic circuitry, meeting the highest standards of reliability. On learning from MRI of the special NASA course and handbook on Reliable Soldered Connections, the firm requested 48 copies of the manual which the Marshall Center supplied. MRI suggested that the firm could best obtain full benefit of NASA's experience by sending one of their production

supervisors to the NASA training school. Through the cooperation of the Quality Assurance Division at Marshall, the firm will send one man to the school during October.

No. 4

Use of company name not permitted

In the production of miniature precision wire-wound resistors, the firm was encountering about 25 percent breakage of the small steatite ceramic rods when the terminal caps were pressed on the ends. MRI suggested the use of stronger ceramics and requested the advice of Lewis Research Center. Following these suggestions, the firm has successfully located a commercial source of a 95 percent alumina rod and tell us that "breakage has ceased to be a probelm."

No. 5

Use of company name not permitted

This firm, an aircraft manufacturer, expressed considerable interest in the frangible tube energy absorber for possible use on one of their helicopters. In this application, it would serve as an emergency overload absorber to prevent damage to the airframe in the event of a hard, auto-rotation landing.

MRI supplied the firm with complete information on the frangible tube, including a copy of NASA's TN-D 975. The firm's engineers are making a design study to evaluate the concept for possible inclusion in the landing gear structure of their new helicopter.

No. 6

Use of company name not permitted

This firm produces jet aircraft for private use. Up to the present all structural elements have been of conventional aircraft aluminum alloys. For their new aircraft design they wished to employ titanium in certain critical parts, and needed to obtain up-to-date information on the selection of alloys and the best shaping, drawing, and forming processes.

MRI had told them about McDonnell Aircraft's successful use of heated ceramic dies for "Creep Forming" of double curved titanium sections on the Mercury capsules. For further production know-how, MRI arranged for one of the firm's representatives to spend one day at the Defense Metals Information Center and to receive special information from Titanium Metals Corporation.

No. 7

Use of company name not permitted

In the production of men's hats, this firm employs a phenolic impregnated stiffener which is heat set in the final hat blocking operation. Sticking of the phenolic resin to the aluminum heater blocks was a frequent occurrence, sometimes resulting in tearing of the finished hat.

Although invited to the Oklahoma City ASTRA meeting, their representatives were unable to attend. However, the president of the First National Bank of Lawton was there and he knew of Moore's production troubles. He telephoned MRI and asked whether the F.E.P. Release Coating found to be useful in curing solid propellants might prevent the sticking problem. MRI furnished technical information on the properties and application procedures needed, and also suggested several custom coaters equipped to apply F.E.P. or Teflon Coatings. The firm had their aluminum hat presses coated and have reported that adhesion no longer is a problem.

No. 8

Use of company name not permitted

In the production of germanium semiconductors, this uses a number of precision micro-balances. Building vibrations caused by stamping presses interfered with delicate weighings.

On learning from MRI about the use of air bearing vibration isolators, the firm borrowed the MRI air bearing assembly to try out as a mount for their micro-balances. The isolation was so satisfactory that the firm's engineers have prepared specifications for their own design of balance platforms and have requested quotations from the Astro Space Laboratories Company of Huntsville.

No. 9

Use of company name not permitted

During a plant visit MRI suggested the use of beryllia ceramic heat sinks in place of the insulated aluminum heat sinks previously employed. Physical properties, cost and sources of supply were furnished.

The firm has adopted a molded beryllia part and are able to effect great savings in the number of man-hours needed to produce their electronic assemblies.

No. 10

Use of company name not permitted

This firm, a leading wire-rope producer, recently decided to enter the business of making large diameter dished tank heads. These heads would be up to 20 ft. in diameter and 1 in. thick. The company determined that a 4 million dollar facility would be required to make these heads by conventional spinning means.

MRI furnished several NASA reports on explosive metal forming and put them in touch with one of the NASA contractors actively engaged in this type of work.

The firm is now planning toward making these heads by explosive forming, since their preliminary estimates show this will save 1-1/2 to 2 million dollars over the proposed conventional method.

No. 11

Use of company name not permitted

This firm expressed immediate interest in a high temperature foam insulation to apply to structural steel as a replacement for concrete in building construction. This foam insulation was employed in the protective coating of the astronaut escape vehicle used at the Atlantic Missile Range.

During the initial visit to the firm, MRI left information on this insulation, including a sample and sources of supply. More recently the

supplier, the Swedlow Company, has been asked by MRI to supply the firm with larger samples and complete engineering information.

No. 12

Use of company name not permitted

A major Kansas City manufacturer approached MRI relative to the use of the Arc Tunnel Heater as an adjunct to their present gas-fired heaters. We have ascertained for them that units of the power rating they need can be operated continuously and are capable of raising temperature of combustion gases by several hundred degrees, thus assuring independent control over the gas flow rate and temperature. Technical representatives of this firm have had discussions with Westinghouse to explore a cooperative testing program.

No. 13

Use of company name not permitted

This producer of large furnaces and heating equipment learned from MRI about the fiberglass weld backup tape used on Saturn tankage at the Marshall Space Flight Center. They are now evaluating samples of the tape. If the tape proves applicable to this firm's operations, it will allow a 50 percent reduction in their total welding cost.

No. 14

Use of company name not permitted

MRI first responded to a request from this plastics fabrication firm for data on the thermal insulation values of various flexible, thin fabrics, felts and foams capable of withstanding hospital autoclave sterilization. These leads enabled the firm to carry on and develop a specialty product for the hospital market.

On a subsequent call, the firm's president saw considerable market possibilities in the use of the Goddard devised floating honeycomb fastener in conjunction with their styrene bead-board products. The firm is now considering applying for a license to employ this design concept.

No. 15

Use of company name not permitted

The firm's president saw immediate product opportunities for his firm to produce and market inflatable items patterned after the life raft and life vest developed at the Manned Spacecraft Center. In the absence of written description, the firm has borrowed the prototypes MRI uses in the exhibits in order to study patterns and construction details. Matthew Radnofsky furnished information about the neoprene coated fabric, Velcro, Mylar-Nylon laminate and the adhesives employed in the fabrication. The firm is proceeding toward production on both the flotation vest and a modified raft.

While the electronics section of the firm was anxious to produce the compact video tape recorder developed by Goddard, they were dismayed that it has not been possible for NASA to determine the rights or patent status of this innovation.

No. 16

Use of company name not permitted

This firm is noted for its quality line of camping equipment. Since nylon rope is used extensively, they are faced with the problem of rope end attachments that do not slip.

MRI suggested the use of an aluminum or brass swaged fitting, applied by magnetic metal forming. MRI supplied technical information on magnetic metal forming and put the firm in direct touch with General Dynamics Company, a commercial supplier of magnetic metal forming equipment. The firm's engineers are presently determining the suitability of magnetic swaging for their production use.

No. 17

Use of company name not permitted

The chief engineer of a large company in the heating and ventilating equipment business said that the bearing technology survey book arrived at exactly the right moment for them. Their advance development engineer was "ecstatic" about it, since it gave them highly relevant state-of-the-art information they needed for a radical new approach they are making in a water-cooled bearing where they had not been able to solve certain problems in performance over a wide temperature range, difficulties with seals, etc., until the ASTRA information came along.

The device they are working on is an attempted breakthrough in a packaged liquid chilling unit for air conditioning. Instead of using a reciprocating engine, they are working on a centrifugal principle, and propose to use the freon itself as a lubricant. The bearing technology survey was useful because they had to find a way of lubricating their bearings which would not introduce a contaminant. The preliminary design studies were very favorable and they are now building test hardware.

He was most interested in our plans for seminars and other services. He said they would like to attend some of these, and he was assuming that a fee would be involved.

No. 18

Fairfield Engineering & Manufacturing Company, Fairfield, Iowa

A manufacturer of livestock equipment, Fairfield Engineering & Manufacturing Company of Fairfield, Iowa, is using cold galvanizing on their steel livestock equipment. It is used on areas where the hot dip galvanizing has been burned by welding and also is used as additional protection for the remaining galvanized steel.

This same company is now in the process of designing air bearing pads and compatible floor surfaces for use in their warehouse operations.

This company learned of both of these innovations, for the first time, at the ASTRA presentation in Davenport, Iowa.

No. 19

Diversico Industries, Minneapolis, Minnesota

Diversico Industries, Minneapolis, Minnesota, will place on the market, within three to six months, a commercial product which will incorporate the regulating valve for flexible tubing. The product is proprietary information.

Diversico Industries first learned of this valve through ASTRA Innovation Announcement No. 102, sent out in one of our selective mailings.

No. 20

Rosemont Engineering Company, Minneapolis, Minnesota

An instrument manufacturer, Rosemont Engineering Company of Minneapolis, Minnesota, is using beryllium oxide in the manufacture of their temperature sensors.

Information obtained from the ASTRA program stimulated their interest in this thermally conductive, electrical insulating material.

They are currently in the process of designing this material into a number of their other instrumentation products.

No. 21

Crimsco, Inc., Kansas City, Missouri

Crimsco, Inc., Kansas City, Missouri, a manufacturer of hospital, airline, and restaurant food-handling equipment, reported as follows: "We have not directly utilized ASTRA information into a product, but we have used the ASTRA information as a 'springboard' in some instances. For example, we are seriously considering a similar approach to driving a hospital tray conveyor as used in Tech Brief 63-10009. We are considering fused amorphous silica (ASTRA monograph) in lieu of quartz in aircraft heating elements. In addition, we have, on occasion, mailed Tech Briefs to technical contacts at the major airlines where we felt that it might be beneficial."

No. 22

Modern Engineering Company, St. Louis, Missouri

The Modern Engineering Company, St. Louis, Missouri, manufactures butterfly valves used in breweries. As a direct result of reviewing information from Project ASTRA, they modified the process used to manufacture the butterfly flapper in their larger valve.

Prior to adopting the process described in Tech Brief 63-10008, the part was made of one stamped piece and one machine-turned piece, welded together.

Modern Engineering asked their supplier, the Hitchner Molding Company, to make the part for them using the precision casting technique described in the Tech Brief for making wind tunnel models. The resulting part is smooth, is held to a tolerance of ± 0.003 in., requires no cleaning and is a one piece casting. This change of manufacturing process has several definite cost-saving advantages, including the complete elimination of several broaching operations that were previously required.

No. 23

Modern Engineering Company, St. Louis, Missouri

The Modern Engineering Company, St. Louis, Missouri, learned about magnetic metal forming from Project ASTRA. They conducted a thorough investigation of the applicability of this process to the swaging of oxy-acetylene welding tips. They determined that this swaging operation is just beyond the capacity of existing commercially available equipment. They are actively monitoring developments in magnetic forming and intend to adopt the process as soon as suitable commercial equipment becomes available.

No. 24

Use of company name not permitted

A large manufacturer of office and school supplies requested and received from ASTRA a number of reports and recommendations on magnetic metal forming. The company followed up on these recommendations and posed

their manufacturing problem to the manufacturer of the magnetic forming equipment. This particular application did not materilize, due to the size of the parts involved. However, the company is very much interested in the forming process and is looking into other applications.

No. 25

Use of company name not permitted

A medium size (125 employees) company in the pipeline equipment business reports they read, circulate and file all ASTRA information. Although there are not, as yet, any specific cases of their use of the information, the chief engineer stated that ASTRA is a very valuable service in that it is educational and is a good thought stimulant.

"This service benefits our firm by giving our engineers a broader view of other people's solution to problems -- some of which may be similar to our problems."

No. 26

Eagle-Picher Company, Miami, Oklahoma

The Miami Research Department of the Chemical and Metals Division of the Eagle-Picher Company receives ASTRA publications which are circulated to their staff. Several applications of NASA technology are being considered. A specific example concerns a problem at Eagle-Picher in the cutting of infrared windows. At present, Eagle-Picher is using diamond core drills and a pantograph to hold the tool for the cutting operation. This arrangement has not been completely satisfactory. An ASTRA mailing of "NASA Shop Hints" included a description of an automatic cutter-holder device developed at Lewis Research Center. This device greatly reduces the setup time and the cutting time required by previous methods, such as the one employed at Eagle-Picher. Round holes, without ragged edges, are produced; and breakage of the part being cut practically is eliminated. Mr. Joseph Powderly of Eagle-Picher contacted ASTRA for further information, and an ASTRA engineer obtained a picture of the jig design and a letter explaining its operation from Lewis Research Center. This information was transmitted to Eagle-Picher, and Eagle-Picher now is considering application of this new technology in its operations.

No. 27

Northern Natural Gas Company, Omaha, Nebraska

Northern Natural Gas Company has distributed a number of Tech Briefs and Special Reports to their Area Development Department mailing list of 2,200 firms. In some cases (NASA SP 5006 and SP 5007), the reports were distributed selectively to 50 companies they knew to be interested in that subject matter.

Northern Natural Gas Company reports that the NASA T.U. program "has been excellent, and I hope that we will continue to receive these (Tech Briefs) and be able to pass them on to the manufacturers in our area."

No. 28

Western Electric Company, Kansas City Works, Lee's Summit, Missouri

Project ASTRA furnished the Western Electric Company with a NASA bibliography on ceramic to metal seals, in connection with a product development program they are conducting. Western Electric's letter states the usefulness of this information. (See Figure D-1).

No. 29

Use of company name not permitted

Many companies find the information supplied by ASTRA useful in keeping abreast of the state of the art in many areas. For example, a manufacturer of disposable hypodermic needles cements the needle to a plastic hub with an epoxy resin. The process, which has remained unchanged for a number of years, requires 100 percent inspection under the microscope to be certain that the resin has not plugged the bore of the needle. The company has ordered the bibliography on structural adhesives, which is available through ASTRA, and will search that bibliography for clues to possible improvement of their process. The same company also has found the Tech Briefs of use in the development of special equipment for their manufacturing processes.

Western Electric Company

INCORPORATED

KANSAS CITY WORKS

777 NORTH 50 HIGHWAY

LEE'S SUMMIT, Mo. 64063

AREA CODE 816 LA 4-4000

64063

C O P Y

August 27, 1964

AUG 28 RECD

MR. ELDON SNEEGAS, Senior Engineer
Midwest Research Institute
425 Volker Boulevard
Kansas City, Missouri 64110

Dear Eldon:

The reports and references on ceramic-metal seals you have forwarded recently from NASA have been very useful.

We are in the first phase of the cost reduction effort to which this information applies. It is important to us that we acquire the most recent knowledge available from all possible sources in order to do the best development job. To avoid duplication of effort is also significant cost avoidance.

This project on one of our existing microwave tubes was begun to investigate the current technology which might lead to product performance improvement and lower production cost. The work is currently authorized on the basis that foreseeable savings could be obtained on materials and processes alone.

We appreciate the help you have been to us and look forward to further contacts that may be desirable.

Bill

WHA:CG

W. H. ASHLEY - 2410

Copy to:
E. D. Long
W. F. Pell
H. L. Scott

Figure D-1 - Letter From Western Electric



MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

No. 30

Use of company name not permitted

A steel fabrication company in Nebraska receives the ASTRA information and routes it to their engineering personnel. Each new input of information is considered for its relevance to the current operating processes and to the long range planning they are engaged in. Several NASA welding techniques are under active investigation, although none has as yet been adopted.

No. 31

Electric Machinery Manufacturing Company, Minneapolis, Minnesota

The Electric Machinery Manufacturing Company screens the ASTRA material they receive and circulates the applicable material to their technical staff. They report the material has been very useful and will most certainly result in improving their manufacturing processes. In particular, the welding clamp (Tech Brief 63-10376) stimulated much discussion and may have been adapted to their use, but it is impractical at this time to trace it down to determine positively that it has been used.

No. 32

Ed Marling Stores, Inc., Topeka, Kansas

The service department of Ed Marling Stores, Inc., Topeka, Kansas, a large home appliance concern, routes the ASTRA information to their technical staff. Information contained in the booklet Selected Welding Techniques (SP 501) was put to use in their refrigeration system welding operations.

From one of the Tech Briefs, an electronic oscillator circuit was incorporated in some of their electronic test equipment.

No. 33

Weatherbuster Corporation, Camden, Arkansas

The Weatherbuster Corporation, Camden, Arkansas, a manufacturer of air conditioning equipment, screens, circulates and files the Tech Briefs and other documents they receive from ASTRA. Of most interest have been those dealing with electronics and temperature controls. Although none has yet been put in actual use, three Tech Briefs were cited as being under study and "very interesting for our operations." They are Tech Briefs Nos. 63-10567, 64-10150, and 64-10158.

No. 34

Flour City Architectural Metals Division, Huff Corporation, Minneapolis, Minnesota

Flour City Architectural Metals Division of Huff Corporation, Minneapolis, Minnesota, saved considerable cost by using cold galvanizing as a substitute for hot dip galvanizing on 800,000 pounds of steel curtain wall supports on the Republic National Bank of Dallas, Texas.

In addition to the cost savings, the cold galvanizing permitted easier fabrication of the curtain wall because the hot dip process causes distortion of the steel and, therefore, creates fabrication difficulties.

No. 35

Spencer Chemical Division, Gulf Oil Company, Merriam, Kansas

ASTRA mailings to Spencer Chemical Division of the Gulf Oil Company go to the Leader of the Process Development Section who screens them for possible company interest and forwards those which appear applicable to company operations to the appropriate people. This Section Leader has had no feedback on the use made of this information; but he considers the small amount of his time required to screen the mailings well spent, in consideration of the amount of worthwhile information obtained.

No. 36

Inland Chemical Company, Warrensburg, Missouri

The Inland Chemical Company, Warrensburg, Missouri, is typical of the smaller companies contacted by ASTRA. The company packages and distributes charges for several different types of fire extinguishers. Mr. L. J. Culp, the president, became interested in the ASTRA program through attendance at a Regional Conference sponsored by ASTRA. He is seeking to reduce his operating costs and improve or add to his product line. As a result of discussions with ASTRA personnel, Mr. Culp received detailed information on several NASA developments which, such as rescue equipment, could possibly be added to his production line. He has decided not to use any of the developments so far suggested; but he desires to maintain close contact with ASTRA because he finds the information of interest, and he is convinced that eventually his business will be helped by technology developed in the space effort.

No. 37

Combustion Engineering, Inc., St. Louis, Missouri

Combustion Engineering, Inc., St. Louis Division, has found the Tech Briefs mailed by ASTRA useful. Mechanical and electrical maintenance personnel find hints in the Tech Briefs which can be adapted to their plant operations. A file is being made up of the Tech Briefs for reference in the future.

No. 38

Mid-Continent Engineering, Inc., Minneapolis, Minnesota

Mid-Continent Engineering, Inc., of Minneapolis, manufactures rubber components. In the precision molding of a part, a pressure transducer must operate at 320°F and 2,500 psi. Lubrication of this transducer was a problem. In a routine mailing from ASTRA, Mid-Continent Engineering received a copy of "Advanced Bearing Technology," NASA SP-38. From this publication they learned that silicone lubricants should perform better than conventional lubricants in this particular application. They switched to silicone lubricants and although lubrication still is not perfect, operation of the transducer is much improved.

No. 39

Southwest Electric Company, Oklahoma City, Oklahoma

Southwest Electric Company of Oklahoma City is engaged in the manufacture and repair of electrical equipment such as transformers, motors, and welders. A problem encountered is the welding or bonding of two dissimilar conductors such as aluminum and copper. After a visit to the plant by an ASTRA engineer, information on diffusion bonding and explosive or percussive welding was sent to the company. These methods did not appear economical for their operation, but their thinking was stimulated along new lines and they now are using an impact cold welding technique to join dissimilar metals.

No. 40

Hawkeye Steel Products, Inc., Council Bluffs, Iowa

Hawkeye Steel Products, Inc., of Council Bluffs, Iowa, manufacturers of automatic livestock watering and feeding equipment, first learned of cold galvanizing at the ASTRA meeting at Cedar Rapids, Iowa.

They are now recoating their galvanized steel products by cold galvanizing to protect the welded areas and as extra protection on the remaining sheet metal areas.

No. 41

Western Supply Company, Tulsa, Oklahoma

Western Supply Company of Tulsa, Oklahoma, is a manufacturer of heat exchange equipment. Their interest in innovations from NASA primarily involves welding and fabricating techniques for heavy equipment. As a result of the ASTRA presentation in Tulsa, and subsequent visits at the company by ASTRA personnel, they have adopted the use of fiberglass back-up tape in welding operations where that technique can be applied, especially for bevel welds with lighter weights of metal, including stainless steel. Mailings by ASTRA have provided additional information of use to the company. Cold galvanizing has been used to protect structural supports welded in the field. Some information, such as that on temperature-indicating paints, has been passed on to customers. Other information,

although not applied as yet, has been useful in indicating possible future changes in the operation of their plant. Examples are information on magnetic and explosive forming, filament winding techniques, and honey-comb structures. At present, information on Belleville springs (NASA Tech Brief 63-10247), a vacuum back-up bar (NASA Tech Brief 63-10384), and the upsetting of butt edges to increase weld-joint strength (NASA Tech Brief 64-10164) are being studied for possible application to their operations.

No. 42

Armour Pharmaceutical Company, Kankakee, Illinois

Personnel at the Armour Pharmaceutical Company in Kankakee, Illinois, receive the routine mailings from ASTRA and file those pertinent to the plant operations. Information on new materials and new methods of fabrication has been applied to their plant, and they consider the ASTRA file a valuable source of information.

No. 43

American Cyanamid Company, Stamford, Connecticut

The Central Research Division of American Cyanamid Company, Stamford, Connecticut, has found that the Tech Briefs sent through ASTRA are very helpful. Their instrumentation group has used the Tech Briefs in the development of new instruments and new techniques for process control and research studies. The information in the Tech Brief seldom is used directly, but it provides background information and information which can be adapted for their particular needs. A bibliography on structural adhesives recently was sent by ASTRA to American Cyanamid and this bibliography apparently will fill a need of the Research Division.

No. 44

Minnesota Rubber Company, Minneapolis, Minnesota

The Minnesota Rubber Company, Minneapolis, Minnesota, learned of sintered metal oxide cutting tools through the ASTRA presentation in Minneapolis. They requested further information from ASTRA and obtained

tools for testing in their plant from leads supplied by ASTRA. The tools have not proved satisfactory for their particular application, but the technological know-how remains available within the company for possible future application. From a routine mailing by ASTRA, the company learned of the book, "Advanced Bearing Technology," NASA SP-38, and obtained a copy through ASTRA. This book has enabled the company to improve the bearings supplied on its equipment, and especially to develop a quieter bearing. Information in Tech Briefs distributed by ASTRA has been especially useful. A specific example is Tech Brief 64-10113, which helped the company solve a problem in bonding an elastomer to aluminum.

No. 45

Paxton-Mitchell Company, Omaha, Nebraska

One of the special capabilities of the Paxton-Mitchell Company, Omaha, Nebraska, is the design and development of electrical power conversion units. One unit in particular involves DC-AC-DC inversion/conversion for a railroad company. Mr. C. H. Petersen, Vice President - Marketing, says that they were able to reduce the temperature derating factor on their power transistors by using the heat sink material and technique of NASA Tech Brief 63-10033, "Indium Foil with Beryllia Washer Improves Transistor Heat Dissipation."

They are presently looking to NASA and the ASTRA office for power inversion and conversion circuit ideas to improve on their present design.

No. 46

Kansas Gas and Electric Company, Newton, Kansas

Mr. Maurice E. Clark, Division Manager of the Kansas Gas and Electric Company, Newton, Kansas, says, "We have learned of new ideas (electronically, etc.) to fit our business. For instance, better control of heat, new ideas on insulation for walls and dry state rectifiers."

He feels that some of the techniques and materials of NASA origin will be a significant factor in their long-range plans for providing more home comfort to their customers at a reduced cost.

No. 47

Blackhawk Industries, Dubuque, Iowa

Mr. K. D. Rose, Vice President and General Manager of Blackhawk Industries in Dubuque, Iowa, says, "We couldn't be more pleased with, or enthusiastic in, support of a program. We were having some problems with faulty and non-uniform welds in our die and jig making department. By implementing the technique described in Tech Brief 64-10058, our people were able to improve the quality of weld to an acceptable level."

Mr. Rose also said, "I want to thank your office (ASTRA) for the prompt attention and excellent response you have given to our requests for specific information. We certainly look forward to the continued use of the technical information service provided by your program."

No. 48

Auto Crane Company, 1214 South Norwood, Tulsa, Oklahoma

Auto Crane of Tulsa manufactures and markets hoists, winches and cranes. (Goddard Space Flight Center uses one of their cranes.) According to Mr. A. H. Wilkinson, Chief Engineer of Auto Crane, brush wear on the motors associated with their product line has been a big problem. The motor brush compositions used at Marshall Space Flight Center and discussed in NASA Tech Brief 63-10479 prompted him to contact the ASTRA office for further information regarding commercial source of procurement and life test data. We responded with the more recent supplemental information on B63-10479 from NASA Marshall entitled, "Molybdenum Disulfide-Metal Brushes for High Vacuum Operation." In a recent telephone conversation, Mr. Wilkinson indicated that they intend to procure and install some of these brushes. Also, as a total solution to their brush wear problem, he is very much interested in the various NASA developments on brushless motors.

No. 49

Fan-Tron Corporation, Little Rock, Arkansas

The Fan-Tron Corporation of Little Rock, Arkansas, is a small firm engaged in the design and development of electronic subsystems and special circuits to meet the requirements and needs of their customers.

Mr. Thomas H. Burgess, project engineer for Fan-Tron, says that the circuit technique of Tech Brief 63-10553, with minor alteration, was employed in the development of a "black box" for one of his customers. Two other NASA circuit techniques which were brought to his attention by the ASTRA office "look quite promising" for direct application on some current contract development work.

No. 50

Fife Manufacturing Company, Inc., Oklahoma City, Oklahoma

Mr. B. A. Feiertag, Chief Engineer of Fife Manufacturing Company, Inc., Oklahoma City, Oklahoma, states that their employees have referred quite often to the handbook from NASA Marshall Space Flight Center, entitled "Reliable Electrical Connections." He and Mr. Jerald L. Brown, Project Engineer, feel that this publication will be used even more extensively by them in the near future as they diversify into electronic product development.

They are quite enthusiastic about the recently established retrospective search (of the literature) service which is available through the ASTRA office. Mr. Brown, who is currently concerned with reliability and quality assurance of their products, has submitted a request to the ASTRA office for a literature search on this subject.

No. 51

Square "D" Company, Cedar Rapids, Iowa

The Square "D" Company of Cedar Rapids, Iowa, manufactures molded case circuit breakers. Mr. J. S. Vaughan, Vice President, reports that NASA Tech Brief 63-10567 "alerted us to a need on one of our processes which is resulting in an alarm system check of thermocouple conditions in our furnaces."

Mr. Joseph M. Khalid, Project Engineer, and also of Square "D", stated that the ASTRA monograph entitled "Beryllia - Space Age Gem," had introduced him to the desirable properties of beryllia, i.e., high thermal conductivity and high dielectric strength. As a result, Mr. Khalid is currently investigating the use of beryllia in a new product development, and says that "it looks quite promising."

No. 52

A. B. McMahan Company, 693 Raymond, St. Paul, Minnesota

The A. B. McMahan Company of St. Paul, Minnesota, had a quantity production contract on a transistorized digital read-out device which they had designed and developed. In order to minimize unit rejects due to faulty electrical connections, and to insure a high quality of fabrication, it was necessary that they train and educate their assembly line workers on soldering technique. This need prompted their management personnel to use the handbook entitled, "Reliable Electrical Connections," from the NASA Marshall Space Flight Center as a standard training reference on soldered electrical connections. They feel that the detailed descriptions of techniques provided in this handbook shortened the training time considerably, and resulted in their reaching peak production much earlier than had been expected.

No. 53

Watervliet Arsenal, Watervliet, New York

The Watervliet Arsenal, Watervliet, New York, makes most of the heavy artillery for the United States. In the course of their work, they oftentimes need to design and assemble special test equipment for conducting laboratory evaluation of new items prior to proving ground testing.

According to Mr. Richard Muller, they have employed the "high power Square-wave oscillator" of Tech Brief 63-10554 in the design of a test unit.

Further, Mr. Muller commends the concise, interpretive presentation of technology items coming from NASA via the ASTRA office. Even in the case where the item does not serve an immediate need or application, this method of disseminating information tends to engrave the potential user's

memory for future retrieval, whereas the many items appearing in the trade press do not.

No. 54

Star Manufacturing Company, St. Louis, Missouri

The Star Manufacturing Company, St. Louis, Missouri, makes commercial cooking and food serving equipment. Their plant manager stated that they circulate all the ASTRA information to their technical staff. Although no specific items have been adopted, they think "the ASTRA concept is great, the information triggers our own thinking, and we cannot help but benefit from the service."

No. 55

Use of company name not permitted

A large manufacturer of firearm ammunition learned of magnetic metal forming from Project ASTRA. We suggested that they use the magnetic forming process to swedge a brass ring on one of their standard sizes of ammunition. They investigated the process and found it to be completely satisfactory. Tests on the new process indicate that it will eliminate a long standing serious manufacturing problem. The company is proceeding to design the automatic feeding equipment that will be used with the magnetic forming machine.

No. 56

J. Z. Company, Inc., Kansas City, Missouri

A small manufacturer of precision parts for instrumentation and electronics needed small high speed lathes (100,000 rpm) to maintain proper cutting speeds. Commercial equipment, capable of such high rpm, was not available. An example of their products is a 0.005 in. diameter shaft, 0.250 in. long, turned on 1/16 in. diameter stock. Using ASTRA data, this company was able to design small lathes with gas journal bearings that permitted them to obtain the required high speeds.

No. 57

Use of company name not permitted

Two small Midwest firms are currently considering the use of an item of NASA information transfer to jointly develop and market a new product. Their combined capabilities, resources and facilities make the venture look quite promising. (For the present, these two firms have asked the ASTRA office not to disclose their identity nor the identity of the information.)

No. 58

The Kartridg-Pak Company, Davenport, Iowa

Mr. James Steffen, Chief Manufacturing Engineer of The Kartridg-Pak Company, reports that the handbook entitled, "Reliable Electrical Connections" from the NASA's Marshall Space Flight Center has become a standard reference for their fabrication people.

Kartridg-Pak is also preparing to use the device and technique of NASA Flash Sheet M-FS-107 (an instrument for accurate determination of squareness or perpendicularity) in their operation of designing and fabricating aerosol and packaging machines. (This information was disseminated by the ASTRA office in the form of an abstract with back-up information derived from the Flash Sheet.)

No. 59

Raven Industries, Sioux Falls, South Dakota

One of the specialties of Raven Industries, Sioux Falls, South Dakota, is the design and development of telemetry for high altitude research balloon systems. (They are doing some work for the NASA's Goddard Space Flight Center.)

Generally, the requirements of these telemetry systems include the minimization of size, weight, and power consumption. According to Mr. D. M. Thon, Manager, Electronics: "We recently had a crying need for a compact high input impedance solid-state amplifier circuit for use in a

telemetry system. The circuit of Tech Brief 64-10143 was the ready-made answer to our problem and we were able to apply it without any alteration."

No. 60

Olson Brothers, Omaha, Nebraska

Olson Brothers, Omaha, Nebraska, are metal fabricators and contractors. They have no technical group; Mr. Myran Olson, Vice President, screens ASTRA material and passes it directly to the shop. They have been helped in various ways by the information on (1) jibs and fixtures, (2) welding, and (3) galvanizing. Two specific applications:

1. They have had very good results using the cold galvanizing technique in getting better protection of welds on counter tops, window louvers and shop tables which are subject to either hard wear or weathering. They have also been able to do this in the shop rather than send out for galvanizing, resulting in cost saving. Previously they used various types of protective paint, none of which was really satisfactory.

2. He mentioned an "electric razor" method of etching or roughing metal. (Flash Sheet LeRC-32.) They have used this in a variety of situations to get into tight spots and avoid removing too much material.

They appreciate knowing of our eagerness to hear from them with specific questions and problems. They are handling some complicated jobs, e.g., Minuteman work which involved special materials, but also a lot of bread-and-butter fabrication.

No. 61

The Hussmann Refrigeration Company, St. Louis, Missouri

The Hussmann Refrigeration Company, St. Louis, Missouri, was seeking an improved means of controlling the speed of a condenser fan motor in proportion to a change in temperature. The temperature sensitive circuit described in NASA Tech Brief 63-10537 appeared to be applicable and prompted Mr. L. A. Faharsky of Hussmann to call the ASTRA office for suggestions on the type of temperature sensitive diodes to be used. A diode type (Transitron's S320G's) was suggested by cognizant ASTRA personnel and this circuit is now being employed by Hussmann Refrigeration in the laboratory model of a temperature control system.

Mr. Faharsky also thinks that the "multiple post pressure scanner" of Tech Brief 64-10031 will be implemented soon as a part of some in-house test equipment.

No. 62

Garland Y. Smith, P. E., Engineering Consultant, Riverside, Illinois

An Engineering Consultant has been able to use information concerning an inflatable seal for butterfly valves (a NASA patent). This consultant also tells us that the information he receives from NASA Tech Briefs, through the ASTRA mailing program, is providing him a most useful background for his consulting work; information that he has not been able to obtain from any other known source.

No. 63

Witte Engine Works, Kansas City, Missouri

From information obtained from ASTRA (Innovation No. 106), the Witte Engine Works, Kansas City, Missouri, a medium size manufacturer of engines and machines, has made instruments to measure perpendicularity or squareness that greatly improve the accuracy of their machined parts.

No. 64

Use of company name not permitted

A large consulting firm has specified cold galvanizing on parts of two large steel river bridges, resulting in appreciable cost saving. This firm became familiar with cold galvanizing through information mailed to them on the ASTRA program.

No. 65

Use of company name not permitted

A large manufacturer of heavy industrial equipment built and tested a piece of equipment using a NASA bearing design. They reported that "Your help on the bearing design was very useful. I am sure it would not have worked without your help."

The Chief Engineer keeps a complete file of all NASA publications for future use. He also reported, "Your service is worthwhile to us by keeping us posted on what is going on."

No. 66

Harris Manufacturing Company, St. Louis, Missouri

Several engineers of the Harris Manufacturing Company, St. Louis, Missouri, peruse the NASA technology information received via the ASTRA office. Further, they have, on several occasions, requested additional information on items of special interest. Although, to date, there has not been a "straight across the board" application of the NASA item, the various techniques, devices and ideas of NASA origin have provoked and stimulated their thinking in the general areas of future product development, manufacturing processes and "building blocks" for engineering design.

"We are counting on and looking forward to a continued participation in the program."

No. 67

Rouge Electronics Company, Oklahoma City, Oklahoma

Rouge Electronics Company of Oklahoma City, Oklahoma, has special capabilities in the design and development of subcarrier oscillators and small, compact RF transmitters. They have also done some development work in the field of biomedical electronics.

The biotelemetry unit developed at Ames (NASA Tech Brief 64-10171) was of much interest to Rouge engineers in their efforts to

broaden their knowledge and capabilities in biomedical electronic design techniques and requirements. They have "looked quite closely" at the design and packaging of the transmitter section of this biotelemetry unit and feel that they will find application for it, at least in part. In particular, the ultra-low power design technique used in the transmitter was quite interesting from the standpoint of future circuit design where minimum power dissipation is a primary requirement..

No. 68

Despatch Oven Company, Minneapolis, Minnesota

The Despatch Oven Company of Minneapolis, Minnesota, specializes in the design of equipment for metal finishing, heat treating, and drying. They manufacture conveyORIZED ovens to meet the special requirements of their customers.

An abstract on Flash Sheet GSFC-162, which was received from the ASTRA office, prompted Mr. Hans Melgaard, Manager of Research, to request additional information from NASA on the "foamed ceramic insulation" of the Goddard Space Flight Center. This additional information directed their thinking in an investigation aimed at utilizing this ceramic composition in some of their product equipment. "It looks quite promising for future use."

Furthermore, Despatch Oven has indicated that they intend to rely quite heavily on the technical subject bibliographies now available from the ASTRA office. Mr. Melgaard stated that this particular service will expedite product development research by him and his staff.

No. 69

E. I. duPont de Nemours Company, Inc., Clinton, Iowa

The experience of the Clinton, Iowa, cellophane plant of E. I. duPont de Nemours Company, Inc., is typical of many manufacturing units. They find the ASTRA mailings useful in keeping abreast of new technology, in educating personnel, and in stimulating new ideas for application in the plant.

No. 70

Iowa Paint Manufacturing Company, Inc., Des Moines, Iowa

Iowa Paint Manufacturing Company, Inc., receives the routine mailings from ASTRA. The information received has not been directly applicable to their operations, but has stimulated their thinking along new lines. As a result of the impetus provided, Iowa Paint now is supplying finishes for rocket engine components and Titan III parts. They consider the ASTRA program a valuable stimulus to their thinking, and wish to continue receiving the mailings.

No. 71

American Hoist and Derrick Company, St. Paul, Minnesota

The NASA publication entitled, "Advanced Bearing Technology," has become a standard reference source for the machine design engineers of the American Hoist and Derrick Company, St. Paul, Minnesota. Further, they have assigned one of their staff members the responsibility of channeling and routing the NASA information to the appropriate personnel. According to Mr. John Engstrom, they value this service very highly from the standpoint of possible future development.

No. 72

Jansen Electronics Manufacturing Company, St. Paul, Minnesota

Mr. Jerome V. Gilles, Chief Engineer of the Jansen Electronics Manufacturing Company, St. Paul, Minnesota, reports that the electrical/electronic circuit techniques and devices of NASA origin have been very useful to the circuit design people in that they obtained new ideas and approaches to development problems. Generation of new ideas by their own people have often resulted from reading the NASA Tech Briefs.

No. 73

Butler Manufacturing Company, Kansas City, Missouri

Butler Manufacturing Company of Kansas City, Missouri, has made extensive use of ASTRA. Approximately 38 separate inquiries for information have been handled. In most cases, further investigation of the NASA work showed it inapplicable to Butler's particular use; but at least eight areas of study remain active and could eventually lead to transfer of NASA technology to industry.

No. 74

W. S. Dickey Clay Manufacturing Company, Pittsburg, Kansas

The W. S. Dickey Clay Manufacturing Company, Pittsburg, Kansas, has developed a new method of forming clay pipe in which leads provided by ASTRA on new forming methods have played an important part. This method now is operating successfully in the laboratory and eventually will be used in plant operations. Information in other areas has not been directly applicable, at least as yet. However, the company is aware that new instrumentation and production techniques will be used in the future and considers the ASTRA mailings a valuable means of staying abreast of developing technology.

No. 75

Burgess-Manning Company, Dallas, Texas

This company manufactures filters and has the problem of bonding the filtering material so that it will remain in place under pressure. Through a selective mailing by ASTRA of Information Announcement B-87, Burgess-Manning learned of the availability of a bibliography on structural adhesives and ordered a copy of that bibliography. The company has requested copies of several items in the bibliography from ASTRA, has tested several bonding techniques in the laboratory, and expects to use structural adhesives in its manufacturing processes in the near future.

No. 76

Burgess-Manning Company, Dallas, Texas

Burgess-Manning Company, Dallas, Texas, received NASA Tech Brief 63-10251, "Helical Tube Separates Nitrogen Gas from Liquid Nitrogen," in a routine mailing from ASTRA. Burgess-Manning manufactures liquid-gas separators; and company engineers used the idea in the Tech Brief, in modified form, to design a unit for recovery of CO₂ gas from a liquid-gas mixture. The design has been used in a bid for a job and will be used in practice if Burgess-Manning is the successful bidder.

No. 77

Burgess-Manning Company, Dallas, Texas

The Burgess-Manning Company, Dallas, Texas, makes equipment for airborne monitoring of acoustic phenomena. NASA Tech Brief 63-10603, received in a routine mailing from ASTRA, suggested a circuit modification and miniaturization which it is anticipated will be substituted in their present circuit design.

No. 78

Disan Engineering Corporation, Nowata, Oklahoma

Disan Engineering Corporation, Nowata, Oklahoma, is a small electronics firm. Mr. Bill Brown, President, receives the ASTRA mailings and reports extensive use of the information provided. Two specific examples are NASA Tech Briefs 64-10069 and 64-10171. The bending brake described in Tech Brief 64-10069 will be used in their production operations; and the biotelemetry unit described in Tech Brief 64-10171 will become an addition to their product line, if present plans are realized.

No. 79

The Bendix Corporation, Pioneer-Central Division, Davenport, Iowa

The Pioneer-Central Division of The Bendix Corporation, Davenport, Iowa, has been a frequent user of ASTRA services. They circulate the

information to their technical staff, and frequently request back-up documentation on items of interest to them.

The Bendix Corporation's letter lists thirteen items currently under active investigation. (See Figure D-2).

No. 80

United States Gypsum Company, Southard, Oklahoma

The United States Gypsum Company of Southard, Oklahoma, is using the alkali silicate vehicle paint developed at Goddard Space Flight Center on the internal surface of their externally fired, steel calcining kettles. They first learned of this coating material through an ASTRA mailing of the Tech Brief (No. 64-10026). After requesting and receiving additional data, they produced a small quantity of the coating for testing. Tests included heating to 2400°F, heating to 2000°F in a corrosive atmosphere, soaking in concentrated sulfuric acid for one hour, and abrasive testing. After passing these severe tests, the coating was applied to the inside of the calcining kettles. Three months have now passed and the coating shows no visible signs of wear or degradation in the corrosive, 600° to 800°F, abrasive environment. This performance represents an appreciable saving because failure of the previously used coating required the calcining process to be interrupted every three months to descale, clean, and recoat the kettles. In addition, the company reports improvement of the product quality, resulting from the elimination of impurities, i.e., from the previously used coating.

No. 81

Omtronics Manufacturing, Inc., Omaha, Nebraska

Omtronics Manufacturing, Inc., of Omaha, Nebraska, specializes in the manufacture of precision wire-wound resistors and temperature controls. Mr. Joe Matejka, President, reports that they are presently using the amplifier circuit described in ASTRA Innovation No. 108, "A Compact DC Servo Power Amplifier," to increase the sensitivity of a standard panel mounted test instrument. "This amplifier allows us to use a more rugged instrument for production line use and still obtain the sensitivity required." (See Figure D-3).

(Note: The technical information contained in ASTRA Innovation No. 108 was taken from Flash Sheet AC-38.)

THE BENDIX CORPORATION

PIONEER-CENTRAL DIVISION - BENDIX CORPORATION, NEW YORK

January 18, 1966

JAN 20 1966

Mr. Bill Franklin
Project ASTRA
Midwest Research Institute
425 Volker Boulevard
Kansas City 10, Missouri

In answer to your recent telephone call, the plant survey shows the following.

Electronic Research:

We have made use of the NASA Tech Briefs from ASTRA in our design programs. Whereas we are generally unable to use the Tech Briefs exactly as they are presented, they have provided ideas for solution to some of our technical problems.

Flight Instrument Design:

The information is circulated to the interested engineers and is used as a background for design and knowledge. It is difficult to cite specific examples; however, the areas have been in the electrical circuits, solid lubricant and ingenious mechanical arrangements. It is my opinion that the service should be continued.

Met-Chem Department:

As reported at the time of the last query, we do not know of any specific or continued use of any of the ASTRA topics. However, the information contained may be used in one form or another at a later date. Among the 1965 topics, the following were of interest to this department: rust removal, cryogenic insulation, tester for microwelds, bender for electrical leads, brazing of titanium to stainless steel.

Bill Franklin

-2-

January 18, 1966

Master Mechanics Department:

Although we have not used any of the ideas presented in the NASA Tech Brief, we have the briefs on file for future use. The following are of considerable interest.

Brief No.	Title
65-10064	Device Measures Curved Surface Finish on Gear Teeth
65-10077	New Coupling Compensates for Shaft Misalignment
65-10060	New Alloy Brazes Titanium to Stainless Steel
65-10009	Forming Blocks Speed Production of Strain Gage Grids
65-10210	Fiberglass Dies Speed Forming of Large Metal Sheets
65-10130	Collar Positions Strip Stock Used to Form Coil on Mandrel
65-10160	Low Cost Seal Compensates for Surface Irregularities
65-10177	Epoxy-Resin Patterns Speed Shell Molding of Aluminum Parts
65-10170	Metal Parts Hydrosized by Explosive Force
65-10168	Lathe Attachment Used to Machine Elliptical Cones

Very truly yours,

THE BENDIX CORPORATION
Pioneer-Central Division

W. W. Snyder

W. W. Snyder
Supervisor
Production Engineering

WWS:jaf

Figure D-2 - Letter From Pioneer-Central Division, Bendix



OMTRONICS MANUFACTURING, INC.

2406 LEAVENWORTH STREET • OMAHA 5, NEBRASKA

January 25, 1965

JAN 26 1965

C O P Y

Midwest Research Institute
425 Volker Blvd.
Kansas City, Missouri 64110

att: Mr. Clayton C. Craghead
Project Astra

ref: your letter 1/12/65

Dear Mr. Craghead:

We are using an amplifier circuit which we obtained through one of the NASA reports and the title of this item was, " A Compact DC Servo Power Amplifier".

We do not have a record of the NASA Tech brief number, since we only have the small ticket which we send in to your company to request this information.

We are using this amplifier in conjunction with a standard panel instrument to increase its sensitivity, or use as a galvanometer. This amplifier allows us to use a more rugged instrument for production line use and still obtain the sensitivity required.

Sincerely yours,

Joe Matejka
President

No. 82

Armco Steel Corporation, Kansas City, Missouri

As a direct result of receiving Tech Brief 65-10135, this company is in the process of redesigning and adapting this lock nut for production in their plant. The Tech Brief gets full credit for providing the stimulus to manufacture the lock nut even though they will make modifications to it before going into production.

No. 83

American Oil Company, Sugar Creek Refinery, Kansas City, Missouri

This company circulates the NASA-ASTRA literature to their engineers for a "stimulating influence on people." Information from the ASTRA announcements is used "regularly" in their Mechanical Department. Information Announcements in the field of instrumentation were cited as being useful in general and NASA SP-5019, "Advanced Valve Technology" was cited as being particularly useful.

Another item cited was the NASA document, "Nondestructive Testing -- The Road to Quality." The procedures described in this paper are used in testing equipment prior to shutdown for routine maintenance and repairs as a method to obtain advance information on the extent and nature of repairs to anticipate.

No. 84

The Bendix Corporation, Kansas City, Missouri

A NASA-developed ceramic foam is under investigation. The company will make experimental runs to see if it can be adapted to their own requirements. The source for this work is ASTRA Innovation Announcement No. 88, "Ceramic Insulation" and NASA Tech Brief No. 65-10058, "Porous Ceramic Cured at Moderate Temperatures is Good Insulator." The ASTRA staff provided back-up information on this ceramic foam from Flash Sheet No. GSFC-162.

This company also reported that the NASA publication SP-5002, "Reliable Electrical Connections" is used as a standard reference and applications from it are utilized regularly in soldering operations.

No. 85

Davis Electric Company, Cape Girardeau, Missouri

This company obtained copies of NASA SP-5002, "Reliable Electrical Connections," and NASA SP-5011, "Welding for Electronic Assemblies," and passed them directly to the plant foreman who uses them as a reference manual in soldering and welding electronic assemblies. In one case a contact was to be welded on a spring of different thickness by resistance welding. The foremen were able to go back to these references and devise a satisfactory welding technique.

No. 86

Dayco Corporation, Springfield, Missouri

This company reported they have found the ASTRA information useful for "in-house applications" for improving their laboratory equipment and procedures. They have modified and are using the "Clamping Tool for Weld Alignment" which was described in ASTRA Innovation Announcement No. 109, Tech Brief No. 63-10376, and NASA SP-501.

Another apparatus in use in their laboratory is the device described in NASA Tech Brief No. 63-10338, "Optics Used to Measure Torque at High Rotational Speeds."

No. 87

Fairchild Camera and Instrument Company, Cable Division, Joplin, Missouri

This company used the information in Tech Brief No. 65-10094, "Cutter and Stripper Reduces Coaxial Cable Connection Time" to build a modified version of this tool. They use it routinely for preparing coaxial cable for terminal connections. The cutter stripper does a better job than the previous method, and has reduced the labor cost on this operation by 50 percent, which is about \$0.06 per wire end.

No. 88

Fairchild Camera and Instrument Company, Cable Division, Joplin, Missouri

This company is investigating NASA Tech Brief No. 65-10128, "Piezo Restrictive Gauge Tests Pin Connector Sockets." A test fixture will be built to evaluate this pin retention gauge. If satisfactory, the company will adapt it to their own requirements.

No. 89

Crimsco, Inc., Kansas City, Missouri

This company is currently investigating NASA Tech Brief, No. 65-10140, "Galvanic Corrosion Reduced in Aluminum Fabrication." They plan to use this approach for fastening aluminum panels on the next job on which they anticipate this type of corrosion problem -- a freezer unit for an airline.

No. 90

Crimsco, Inc., Kansas City, Missouri

This company is still actively interested in NASA Tech Brief No. 63-10009, "Chain Friction System Gives Positive Reversible Drive." The company is planning to use this concept in the near future when they redesign a driver belt system in a conveyor they use. They feel it will cut down on the present noise level and will be less costly to manufacture.

No. 91

Guarantee Electrical Company, St. Louis, Missouri

The ASTRA material this company receives is analyzed for new concepts and approaches which might be useful to them, particularly in the field of electronics. NASA Tech Brief No. 65-10178, "DC-to-AC Converter Operates Efficiently at Low Input Voltages" was cited as one which they plan to use in the near future in equipment design. The simplicity of the converter was the characteristic which stimulated their interest.

No. 92

Hallmark Cards, Inc., Kansas City, Missouri

The Photolithography Research Department of Hallmark reported they are using information from NASA Tech Brief No. 64-10249, "Instrument Adjustment Knob Locks to Prevent Accidental Maladjustment." They made five of these locking devices for use on a camera exposure mechanism to lock potentiometers. This modification resulted in better control of the exposure procedure and greater convenience in operation.

No. 93

Hallmark Cards, Inc., Kansas City, Missouri

The Photolithography Research Department of Hallmark is planning to build a test mock-up of the system described in NASA Tech Brief No. 65-10075, "Tension is Servo-Controlled in Film Advance System." This concept is expected to improve the paper tension control in one of their offset printing operations.

No. 94

Industrial Heating and Plumbing Company, St. Joseph, Missouri

This company specializes in electrical and hydraulic contract construction. They evaluate the NASA information they receive for applications on the job site. One item proved to be particularly useful for a dam construction job. They simplified and modified the beam described in NASA Tech Brief No. 63-10571, "Self-Balancing Beam Permits Safe, Easy Load Handling Under Overhang." By using this device, they were able to put piping into galleries in locks, and credit the beam with making the job both easier and safer, since they worked about 60 ft. above the ground.

No. 95

Thermoglass Company, Kansas City, Missouri

In response to a telephone request, Project ASTRA personnel provided this company with back-up information on NASA Tech Brief No. 65-10016, "Adhesive for Vacuum Environments Resists Shock and Vibration." The company is planning to test this new adhesive in their line of sealed insulated glass panels.

No. 96

Justrite Machine Works, Inc., Kansas City, Missouri

This is a very small company with fewer than five employees. The owner requested and received from Project ASTRA copies of NASA SP-5009, "Selected Welding Techniques" and the minutes of the "Aluminum Welding Symposium" from the Marshall Space Flight Center. The owner reports that he gave these books to his welder who read and studied them and now "does a better job of welding as the result of improved techniques he uses."

No. 97

Killebrew Engineering Corporation, St. Louis, Missouri

This company performs custom design and fabrication of heat exchangers and serves a variety of industrial corporations. They report that NASA SP-5013, "Precision Tooling Techniques" was useful to them as a reference during the design of several heat exchangers.

No. 98

Killebrew Engineering Corporation, St. Louis, Missouri

In their work involving the custom design fabrication of heat exchangers, this company does a great deal of welding and uses many of the so-called "space age" metals. They report that they found NASA SP-5009,

"Selected Welding Techniques," very useful to them in their titanium welding operations.

No. 99

Killebrew Engineering Corporation, St. Louis, Missouri

This company requested and received a copy of ASTRA Information Announcement No. I-37, "Bellows, Joints, Gimbals, and Clamps." This paper was one of those presented at the Marshall Space Flight Center, "Status and Trends Symposium." The Killebrew Company reports they used the information in this paper in the redesign of an expansion joint on one of their heat exchangers.

No. 100

Killebrew Engineering Corporation, St. Louis, Missouri

This company requested and received from Project ASTRA a complete bibliography on the subject of corrosion. They later ordered and received copies of a number of the references from this bibliography. They report these references have been very useful to them in specifying the best materials for certain jobs where corrosion conditions are known in advance.

No. 101

Killebrew Engineering Corporation, St. Louis, Missouri

After receiving ASTRA Innovation Announcement No. 116, "Welding Flaw Detector," the company ordered and received the available back-up information on this instrument. This back-up information is from the Marshall Space Flight Center Flash Sheet No. M-FS-237. Although the company is now using an X-ray inspection method, they plan to try this new method in the near future.

No. 102

Laboratory Construction Company, Kansas City, Missouri

This company received NASA Tech Brief No. 65-10117, "Double Gloves Reduce Contamination of Dry Box Atmosphere" in a routine ASTRA mailing. They report that this item complements their product line and they want to make it available to their customers. They are now in the process of obtaining a license through NASA to include it in their product line.

No. 103

Loose Leaf Metals, Inc., St. Louis, Missouri

This company uses ASTRA for "looking down the road" and anticipates benefits in management planning and new product development as well as benefiting their present operations. They have some unique capabilities in the metals field they would like to combine with space technology for commercial applications.

At present they are actively working on a new product, the idea for which is based on a recent ASTRA Announcement. They are not in a position to disclose information details as yet on this item.

No. 104

The Marley Company, Kansas City, Missouri

One item of current interest is NASA SP-5014, "NASA Contributions to the Technology of Inorganic Coatings." The company reports they have found this book very useful to them in their work on developing a ceramic coating for aluminum. As an example, they cite the use of "Ludox" as a noncombustible binder was one idea that had not been considered prior to seeing it in NASA SP-5014.

No. 105

Midwest Consultants, Inc., St. Louis, Missouri

After receiving NASA Tech Brief No. 65-10117, "Double Gloves Reduce Contamination of Dry Box Atmosphere," the company requested and received back-up information plus the names of two companies who had applied for licenses to manufacture the item. The company plans to make their own glove boxes for use in the manufacture of biochemicals. They anticipate needing 12 to 18 of these setups in the next five years.

No. 106

W. S. Dickey Clay Manufacturing Company, Pittsburg, Kansas

This company has budgeted funds to build an experimental unit based on the technique and hardware requirements discussed in NASA Tech Brief No. 65-10122, "Microwave Technique Measures Plasma Characteristics." This company made a search for commercially available units using this technique and found no such apparatus for sale. The company is, therefore, considering the building of these units, not only for their own use, but also for marketing to other potential users.

No. 107

Use of company name not permitted

In the repair of refrigeration systems tubing must be bent at sharp angles in some cases. This often results in a collapsed bend or even ruptured tubing. A simple approach is needed to make precise bends.

A "shop solution" approach was used. Ames Research Center had used a simple approach (not unique to the space industry) to form copper tubing to close tolerances in a specific case. This shop idea was sent to ASTRA clients through an "Innovation Announcement" and a one-page explanation sheet. It is described in Flash Sheet ARC-43.

Using this simple method, they now can make sharp tubing bends without collapsing the tubing. This is a direct application type transfer of somewhat unsophisticated technology. For this company and others

it serves the purpose well. By contrast the ARC application was quite precise and more complicated in its original use.

This process saves the subject company \$100 per year in wasted labor and material.

No. 108

Use of company name not permitted

To prevent damage to a printing press in a specialty paper manufacturing operation some type of a shock absorber would be desirable as a safety feature. However, this is not normally built in by the manufacturer.

One solution is to use a material which breaks up into small pieces as force is applied to it. This absorbs the energy of impact.

Langley Research Center developed a frangible tube shock absorber for absorbing energy of high impact landings. This was discussed in Tech Brief 63-10304, Breakup of Metal Tube Makes One Time Shock Absorber, Bars Rebound.

The company used this approach to add a safety feature to their printing machinery in a direct transfer of technology, adapting it to their own requirements.

This can be considered an "insurance policy" worth \$100 per year per machine.

No. 109

Use of company name not permitted

A shroud material was needed to connect a vibrating conveyor to an exhaust plenum in a glass bead drying and conveying operation. The material had to be flexible, tough, nonporous and withstand 550°F. The material first tried lasted only three weeks before failure.

The company asked ASTRA personnel for information which might help them. A number of information sources were furnished which contained references to both NASA advancements as well as commercial materials and

suppliers. The company subsequently selected one of the commercial suppliers cited who furnished six different materials for test purposes (Longhorn Gasket and Supply Company, Dallas, Texas).

After several tests were run a commercially available nylon cloth impregnated with a fluoroelastomer rubber was selected. The NASA information served only as a slightly beneficial piece of input but the problem was solved to the company's satisfaction.

The shroud material selected will meet all the requirements of flexibility, tear resistance and heat resistance, and will save \$600 per year in replacement costs over the previously used materials.

No. 110

Use of company name not permitted

In close tolerance fabrication work it is sometimes necessary to make several bends on standard metal bending machinery to obtain the desired shape. Cost is roughly proportional to the number of steps in the operation. Therefore, it would be beneficial to be able to make fewer but more accurate bends in fabricating any product. The company in question manufactures metal doors and frames.

Ames Research Center developed a small metal bending brake for brass, aluminum and copper sheet metal. However, they suggested it could be scaled up and used on a variety of metal bending applications. The information was made available through Tech Brief 64-10069, Metal-Bending Brake Facilitates Lightweight, Close Tolerance Fabrication.

The company was able to adapt this innovation to their own requirements in a direct transfer of the essential elements outlined in the Tech Brief. They modified their own bending device to take advantage of the ARC innovation.

They were able to eliminate two bending operations on a metal door and frame they manufacture. Estimated savings in fabrication cost are \$1,500 per year.

No. 111

Use of company name not permitted

The company needed a crack detection method for a particular problem they were having.

Tech Brief 65-10107, Crack Detection Method is Safe in the Presence of Liquid Oxygen provided a list of chemical compounds which could be used for such an application. Additional back-up material was provided to the company by ASTRA personnel using a packet prepared at NASA's Marshall Space Flight Center.

The material furnished was used in solving the problem they were having. The company is a defense contractor and did not give details of the transfer.

The dollar benefits could not be released in this case.

No. 112

Use of company name not permitted

In the design and manufacture of steel tanks and buildings the structural characteristics of the metal are very important. Careful design can lead to better fabrication methods, safer and cheaper structures.

This need for design data led the company to seek research information on the structural characteristics of thin wall short cylinders. ASTRA obtained a computer search of the NASA literature, and supplemented it with a manual search and articles supplied from current literature. A total of 375 articles were cited of which 80 were of direct value.

The company through a consultant at a nearby university found the information of direct benefit in the analysis and design of structures using "stiffened bends." They now have both production and experimental products for which the articles supplied have served as a basic reference.

The company was able to save a \$35,000 research effort that otherwise would have been necessary. New or redesigned product sales are estimated at \$50,000 per year; profits are estimated at \$4,000. Other products are in the experimental stage and will become commercial.

No. 113

Use of company name not permitted

A need arose for a motor in which the drive mechanism had to be self-contained and independent of external power sources.

The company reports that it found a NASA Tech Brief which was just the answer to their design problem. The Tech Brief is 64-10222, Compact Cartridge Drives Coded Tapes at Constant Readout Speed.

The company used the device cited in the design of the spring motor. This was a direct input of NASA technology.

It saved \$1,000 of design and test efforts. The drive mechanism is now being used routinely for its designed application.

No. 114

Use of company name not permitted

The company does research and development work for the Army Ordnance Division. Because of the sensitive nature of their work only general information could be released on this transfer.

The company was asked to prepare a bid for a feasibility study of the applicability of high density materials for a particular purpose (unspecified to ASTRA).

A brief reference was needed on tungsten powder metallurgy. This was obtained in the form of a NASA SP just released (in November 1965) entitled, Tungsten Powder Metallurgy (SP 5035).

This reference served as a direct input for the contract bid proposal to the Army. It was used extensively in the preparation of the proposal.

The preliminary feasibility study, if obtained, will be \$76,000. The proposal had just been submitted at the time of this writing.

No. 115

Use of company name not permitted

In the development of an industrial spray nozzle for a certain application, the company was faced with the problem of working with titanium. The material must be machined in a production operation.

The company found that an Information Announcement Series paper sent to them was of direct benefit in moving their development program ahead. This reference was a published NASA paper entitled, Machining and Grinding Titanium and Its Alloys (TMX-53312).

The details of the problem and its solution are not presently available.

Eventually this will lead to a new product but at the moment the information is considered proprietary. It is estimated that \$5,000 development cost was saved by having available the NASA paper just "at the right time."

No. 116

Use of company name not permitted

This company makes special and standard metal cutting and forming tools; they also specialize in grinding of all types. Customers often seek their advice on a tooling or machining problem; many of these are not routine problems. One customer who sought their help was attempting to tap titanium, but was having difficulty.

The company maintains a reference file of publications relating to metalworking. The one of value in this example was TMX-53312, Machining and Grinding Titanium and Its Alloys; it was obtained through the ASTRA information series.

Production Tool and Service reground the taps the customer had attempted to use and then used the reference above to show him how to tap the metal.

The customer averted a waste of labor and material which could have amounted to several hundred dollars had they not sought outside help. By having the file of NASA publications on hand and having the

ability to use and interpret them, Production Tool and Supply Company was able to gain (or keep) the customer's confidence in their metalworking capabilities.

No. 117

Use of company name not permitted

The product line manufactured by the company is in a highly competitive market. The company is trying to develop production machinery which will result in a unique (and lower cost) method of production. The mounting method was a major stumbling block to its successful development.

The company reports that it received a NASA Tech Brief which is the answer to their mounting problem. The Tech Brief is 65-10104 Leaf Spring Suspension System Provides Accurate Parallel Displacements.

The suspension system cited above will be used and is a direct input of NASA technology although there will be modifications made to fit the suspension requirements of the machinery.

At last report the development had not been carried to completion as yet. However, the selection of a vibration mount was the major remaining obstacle. Should the production machinery with the NASA incorporated innovation be successful it will improve the company's competitive position. The idea obtained from the Tech Brief saved an estimated \$2,000 development cost in professional time as well as keeping the project active and moving at a critical stage.

No. 118

Use of company name not permitted

When engaged in commercial photography it is necessary to work with the object to be photographed as well as the camera equipment. In such a case it would be convenient to actuate the camera shutter from a remote source rather than return to the camera for this operation.

Tech Brief 63-10560 describes a device which will operate a camera shutter by use of a rotary solenoid and a spring. The Tech Brief is entitled, Camera Shutter is Actuated by Electric Signal.

The company plans to design a similar device for use on one of its cameras; a solenoid operated shutter will be used. This will be a direct input of NASA technology derived from the Tech Brief information.

When the remote, electrically operated shutter is in use it will allow the operator to increase his efficiency by staying in the proximity of the object to be photographed. He can then either reposition, change or otherwise alter the object for the next shot. No dollar value has been placed on this transfer since it is largely intangible in nature (i.e., convenience as opposed to labor saved or product improvement).

No. 119

Use of company name not permitted

Writing instruments are commonly made of a metal inner shell with plastic bonded to it for the outer shell. A good test procedure is required to see that the bond is strong and will not break down below its designed strength.

Tech Brief 65-10173 describes a jig which will place a laminate in proper position for a continuous application of a perpendicular peel force by a standard tensile testing machine. The brief is titled, "Peel Resistance of Adhesive Bonds Accurately Measured." Radio Corporation of America developed the instrument for Goddard Space Flight Center. The firm's engineers decided to test this jig for their writing instrument laminates.

Personnel at the company constructed a test jig like the one described in the Tech Brief. Their next step was to test the procedure against the present method being used. The use of this device allowed the firm to make an accurate determination of the proper thickness and the best type of adhesive to use.

The jig gives the company a more reliable and efficient test procedure than the one previously used. This helps assure product quality.

No. 120

Use of company name not permitted

The place where the greatest wear occurs in office equipment such as file cabinets, cash drawers, etc., is in the suspension system. A lubricant will prolong the life of the suspension system (in this case roller bearing type) if it does not increase the corrosion rate of the metal significantly. It must also be clean. They were using cadmium plating at that time.

The company received an ASTRA bibliography (B-87), "Solid Lubricants." They selected two papers from this bibliography for evaluation purposes. These were supplied to them by ASTRA using microfiche from STIF.

The company ran a series of tests on solid lubricants in combination with their cadmium plated suspension systems. They verified the reference information and found that the plating they were using deteriorated and the solid lubricants "balled up."

As a result of their tests they stopped using cadmium plate and now do not use either a plating or a lubricant. This has increased the life of the suspension system but they still seek a coating for the bearings which will provide corrosion protection and lubrication.

The increased life of the suspension systems will result in better equipment performance for the customer. This should minimize customer complaints that "the equipment wears too rapidly and does not operate smoothly." A dollar value could not be placed on this equipment improvement since its benefits are intangible.

No. 121

Use of company name not permitted

One of the company's important product lines is fireproof cabinets (record housings, safes, etc.). They continually seek better insulation and protective coatings for these cabinets. A more effective insulation must also be competitive in cost with that used by other manufacturers of fireproof cabinets.

ASTRA has furnished the company a number of references on high temperature insulation. Examples are ASTRA bibliography 92, "High Temperature Insulation;" a paper "Insulation Materials" by R. E. Shannon of Marshall Space Flight Center; ASTRA Innovations 88,89,90 "Ceramic Insulation" (MSFC), Reflective Ceramics Insulation (MSFC) and Refractory Thermal Insulation (MSFC).

However, only one of those tested improved the life of the insulation. This was "Dynatherm" insulating paint suggested to the company by the ASTRA project director.

The "Dynatherm" insulating paint increased the life of the insulation by about 40 percent (under high heat tests). However, this coating is so expensive that it cannot be used and keep the cabinets competitively priced.

Since none of the ASTRA-derived information has resulted in a commercial use on the fire-resistant cabinets, the main value to date has been to stimulate their interest in evaluating new advancements in insulation technology.

No. 122

Sinclair Oil and Gas Company, Tulsa, Oklahoma

NASA Tech Brief 66-10067, "FORTRAN Program Flowchart is Automatically Produced," permitted this company to cancel a computer course they had scheduled for some of their personnel.

No. 123

Geeco, Inc., St. Joseph, Missouri

Information from NASA Tech Brief 66-10385, "Inflatable O-ring Seal Would Ease Closing of Hatch Cover Plates," is being applied to their vacuum forming operations.

No. 124

Halliburton Oil Company, Duncan, Oklahoma

Document N64-29598, "Studies of Chelate Polymers," changed the direction of one of the company's in-house research programs.

No. 125

Trans World Airlines, Incorporated

The Training Section of the Maintenance Division of Trans World Airlines, Incorporated, obtained 12 additional copies of NASA TN X-53432, welding procedures for Titanium and Titanium Alloys to use as a class text book.

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APPENDIX E

STUDY ON ASTRA BECOMING A
COMPUTER-BASED RDC

I. INTRODUCTION

In a major review of the ASTRA program, MRI has endeavored to assess the operation of this program realistically and recognize approaches to be taken for future growth. Among significant operational changes envisioned to assure ASTRA's effective growth in technology utilization is the establishment of a computer-based operation at MRI by which searches of NASA's computer tapes can be made.

The reasons why MRI believes a computer-based operation is needed are:

1. MRI, in setting goals for service to be rendered, recognizes the subjective nature of the customer's acceptance of the service as well as the environment in which the service will operate in the future. Therefore the growth and rate of growth of ASTRA, depends upon the specific banks or sources of information from which searches are made. Thus, ASTRA's information banks need to be comprised of both governmental and industrial information, encompassing agencies other than NASA, the open literature (professional and trade publications, standards, specifications, patents, etc.); centers of excellence, consultants, and manufacturers, and available systems, subsystems, components, and techniques.

2. The storage and retrieval systems must be designed specifically to serve ASTRA's market. There needs to be an optimization in the integration of manual and machine operations. The system to store and retrieve data for technical searches should present as few steps or elements as possible to eliminate the loss of fidelity resulting from transfer of information from client to technologist; technologist to machine instructions; machine output to technologist; and finally from technologist to the client. Moreover, there needs to be constantly increasing involvement toward the ultimate goal of direct man-machine relationship between the client or ASTRA's technologist and the machine system. In essence, the objective should be an on-line retrieval system in which man's knowledge, wisdom and imagination is complemented by the machine's enormous capacity for storing, relating, and retrieving data. (Display is rapidly becoming a machine accomplishment as well.)

3. Quality control in the computer search techniques as well as the form of the results of searches must be vested with ASTRA to effect efficient operational methodology and consequently superior service.

4. Control of the computer search function by ASTRA will eliminate dependency on a third party for a vital function of the program and thereby allows ASTRA to have a stronger base for its fee structure and to have greater

flexibility in scheduling and optimizing the time aspect of service. Moreover, it averts the realistic possibility that the centers now providing MRI the computer-search service (1) may need to increase their service charges significantly, or (2) may not be able to serve ASTRA for one reason or another, or (3) both. These latter items could come spontaneously, thereby jeopardizing ASTRA's operation and future success.

5. Timing of the phase-in of the computer-search capability is important to the future success of ASTRA, and it is believed ASTRA should have this capability within the next 6 to 12 months. It is extremely important that ASTRA start immediately to increase the scope of its banks of information, and in doing so, the amalgamation of this additional information with present depositories, as well as the design of methodologies should also be started immediately for economic reasons as well as technical benefits that will be derived in the future.

6. In-house, computer-search capabilities is a good promotional point.

Because of these reasons, a study was undertaken to determine whether or not ASTRA should effect a computer-search function (as a tool) in its system of operation, or in other words, to become a computer-based regional dissemination center (RDC). To obtain a basis for comparison and to better acquaint ourselves with the actual details of computer searches as performed by RDC's on NASA furnished magnetic tapes, ASTRA personnel visited several computer-based RDC's. In addition, and when the occasion warranted it, information was sought and if available obtained from RDC's by telephone discussions. Another major source of information was past experience of ASTRA with ARAC, the RDC that has performed all of ASTRA's retrospective searches (no current awareness searches have run by or through ASTRA).

The results of this study are presented in the following four sections of this report:

- II. Concept and System: ASTRA, A Computer-Based RDC;
- III. Cost Considerations;
- IV. Program Management; and
- V. Future Directions of ASTRA.

The results presented subsequently provide the justification for ASTRA to become a computer-based RDC.

MRI, therefore, recommends to NASA that ASTRA becomes a computer-based RDC during the next 12-month contract period. MRI has a digital computer center built around an IBM 360-30 computer. The Institute has numerous years of experience in the computer field and a staff of well qualified personnel to manage and operate this center. Therefore, the transition of ASTRA into a computer-based operation would be quite efficient.

II. CONCEPT AND SYSTEM: ASTRA, A COMPUTER-BASED RDC

MRI can provide the electronics data processing machinery and this machinery, in effect, would be an integral part of the ASTRA service. This capability (for both current awareness and retrospective searches) would supplement the following services that the MRI staff will provide clients through ASTRA:

1. Manual Current Awareness Service: Review of current publications, government, professional, trade, etc., screening for client fields of interest, and submission of pertinent documents, technical papers, etc. (or copies of same) to client.
2. Consulting Services: Presentation and interpretation of (1) information obtained from computer searches and screening or any special services; and (2) technical effort applied to a specific problem or area of interest presented ASTRA for this purpose.
3. User-Producer Conferences: A specific technical area is covered by leading experts to inform clients about the latest significant development.
4. Seminars and Conferences: MRI staff technical seminars and special conferences designed to meet client needs.
5. Telephone Problem Inquiries: Dissemination of readily available information immediately upon inquiry.
6. Conference Service: ASTRA personnel attendance at conferences selected by a client and the presentation of a technical summary to client's staff as desired by client.
7. Subscription to: MRI technical paper lists, MRI quarterly News Letters, and digests of medical problems generated by MRI's Biomedical Applications Team.

8. Computer Program: Acquisition of available NASA computer programs (card-decks, tapes or both) and operation information, pertinent to client needs.

9. Special Services: Any special technology utilization services that may be required and can be provided by or obtained with the assistance of the ASTRA staff; examples are (a) contract R&D efforts by MRI; (b) literature searches at Linda Hall Library of Science and Technology; and (c) residence work at a client's office to study their operations and then assist them in establishing an internal system for using ASTRA services effectively.

Substantial benefits to ASTRA users would result in several areas from the integration at MRI of analytic and machine searches for technological information. In general terms, these benefits discussed here would be improved utility of the service in quality and timeliness. In addition, a phased plan for updating methods by which this ASTRA service is provided is included in Section IV.

One measure of quality desired in this ASTRA service is the combined scope and depth of the search for pertinent documents which is the heart of the service. Fragmented approaches now in use by the joint ASTRA-ARAC approach were satisfactory as an initial approach to developing and establishing NASA generated data and translating this information for industrial or other users. Four years have passed since the program was conceived, and MRI's experience during this time has revealed basic weaknesses in the split operation of ASTRA which uses another RDC for data processing.

Specifically, these weaknesses are shown in Figure E-1 by the comparison of the current method to that proposed. One of the major changes resulting from the creation of a data processing capability at MRI would be a reduction in the number of points at which information is transferred during a retrospective search. At present, six transfers* take place from the receipt of an ASTRA user's request to the time the machine-stored data is searched by the computer (Step I). These six transfers can be reduced to four as indicated. Step II, the machine processing (presently a linear search) would be performed by MRI much as ARAC or other RDC's do now. (MRI's IBM 360-30 computer system is entirely compatible with the IBM 1401 equipment used by ARAC.) In Step III, the final process of retrieving abstracts, reviewing them, making-up of bibliography, and mailing the bibliography to the client, eight transfers occur in the present procedures. These could be reduced to four if MRI were to perform its own electronic data processing (computer research of NASA tapes) for ASTRA.

* A transfer as used here is defined as the handing over of the documents from one person to another.

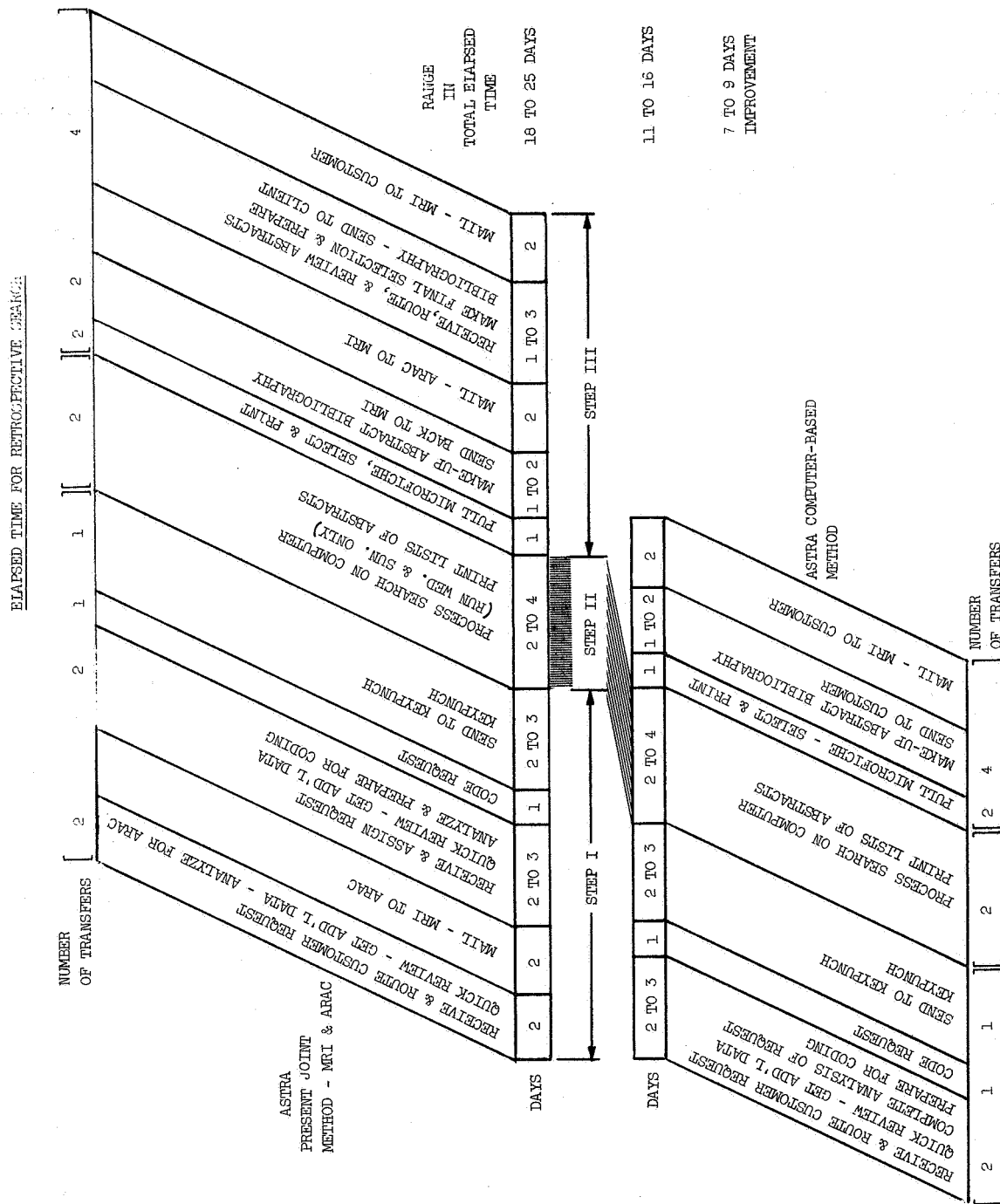


Figure E-1 - Present and Contemplated ASTRA Computer Search Methods

Two major advantages to the user of this service would emerge from the reduction of transfer points in information retrieval. Most important of these would be the higher resolution of searches in both number of pertinent documents retrieved and in the accuracy of limiting the search terms or descriptors. Such improvements in resolution would result from the change to machine data processing at MRI as follows:

1. Continuity is difficult unless the MRI technologist performs the entire analysis of a retrospective search request and the preparation for coding as one integrated process (rather than a multi-staged process). Creativity, broad familiarity with most fields of science and technology, and ability to communicate directly with user of the service are significant skills required here. Where applicable, an interdisciplinary team could be used to supplement the technologist in selecting search criteria. Fragmented steps performed by two remote organizations which are separated by time, distance, and disciplines has not produced the search resolution desired.

2. Motivational factors affecting the selection of search criteria will be more favorable if one organization performs the full preparation (or Step I) function. For example, the first selection of terms is performed by an ASTRA technologist at MRI with one orientation which results in a certain set of criteria which are revised by the second selection (now performed by an RDC analyst* at another RDC, possibly from another discipline). Such revision could be advantageous if the second analyst possessed the whole body of knowledge of the first technologist (e.g., the better knowledge of the nature of the requestor's business needs, previous requests, similar requests by other users) and other intuitive thought processes used by the first technologist. Our present state of the art in inter-personal communications does not permit a ready transfer of individual thought processes. Experience has indicated that a second review of the request at another RDC has developed these motivational shortcomings.

- a. Limits or negative weights applied on the second review cannot reflect the full thinking of the first analyst and may be too restrictive or, more serious, cancel the key terms sought by the ASTRA technologist.

- b. The first analyst may be less motivated to be thorough in his selection of terms simply because he knows another analyst will duplicate his effort.

* In the present system, this analyst needs to converse with the technologist at MRI at least one time after his receipt of a request for a search. This is necessary in more than 50 percent of the searches even though an ASTRA technologist fills out the search form supplied by ARAC.

c. Transfer of second analyst's reasons for amending the first analyst's selection of terms is not readily passed on to the first analyst when he reviews the final resulting abstracts and makes up the bibliography.

3. Elapsed time for responding to a user's request may be critical to the requestor. Figure E-1 also demonstrates that the present joint procedure (ASTRA and another RDC) takes from 18 to 25 days from the receipt of the ASTRA user's request for a retrospective search to the delivery of the printed report. These ranges, in elapsed time, shown in Figure E-1, allow for intervening weekends and staff scheduling conflicts. ASTRA, by performing the complete analysis of the user's request in-house at MRI's computer center, could deliver retrospective searches in 11 to 16 days if no improvements in methods of search were introduced other than MRI's IBM 360-30 electronic, data-processing machinery. This represents a 7 to 9 day reduction in the time a client must wait for a report from ASTRA. The time value to an ASTRA client will vary, naturally, depending upon such factors as:

a. Request for search--for a high-priority current problem or simply a long-term diversification problem.

b. Trade-off for the time required by ASTRA to perform search at current costs versus higher cost of client performing his own search. (This will vary widely from one request to another.)

c. Continuity of thought process of the client's researcher diminishes rapidly as the search time increases.

d. Opportunity to issue subsequent requests triggered by an original request (important element in information storage and retrieval systems) diminishes as the time required to perform the search increases.

It appears therefore that substantial decreases in elapsed time for searches are a significant goal for improvement of service if ASTRA is to expand and become self-supporting.

4. Current awareness service would benefit in resolution, quality and timeliness, as well, by MRI providing the machine processing rather than having this service performed at a remote RDC. Factors offering this improvement would be:

a. Reduction in the number of points at which data must be transferred from person to person.

b. Savings in elapsed time by eliminating mailing of new-client or new-profile data to the RDC performing the search for ASTRA, the RDC's second analysis, the return to ASTRA for final review before mailing bimonthly reports to clients, and the time enroute by mail by this procedure.

c. Improved quality of technical profiles of clients and therefore improved reports (from searches) from the same individual technologist or group of technologists performing all ASTRA search requests and profiles. (Continuity and motivational factors outlined above for the retrospective search would apply here also.)

Specific advantages in time are not stated here because MRI has not offered the current-awareness computer search to date. (This type computer search is a valuable service ASTRA will render clients in the future.)

A detailed flow chart of the Retrospective Search system currently used by ASTRA is shown in Figure E-2. A chart of the Retrospective Search system that would be used by ASTRA with its own computer search capability is shown in Figure E-3. Comparison of the two charts shows the increased efficiency of a computer based RDC. Figure E-4 shows a chart of the Current Awareness Search system that would be used by ASTRA in a computer-based operation.

III. COST CONSIDERATIONS

A detailed statement of the cost increase (or reduction) to NASA and to users of ASTRA for the establishment and operation of a computer-based center cannot be developed by MRI at this time. The present split method of providing the ASTRA service (ASTRA and another RDC) generates these constraints to gathering valid cost data:

1. Useful computer-processing cost factors experienced by the university RDC's are not directly transferrable to MRI because:

a. Overhead costs of the universities are not included in their search costs.

b. Presently, a university RDC processes retrospective and current awareness searches on IBM 1401 systems. ASTRA would offer the same service on the more recent but compatible IBM 360-30 system which will have somewhat different cost factors (anticipated faster running time but higher rental rate offset by more advanced programming opportunities).

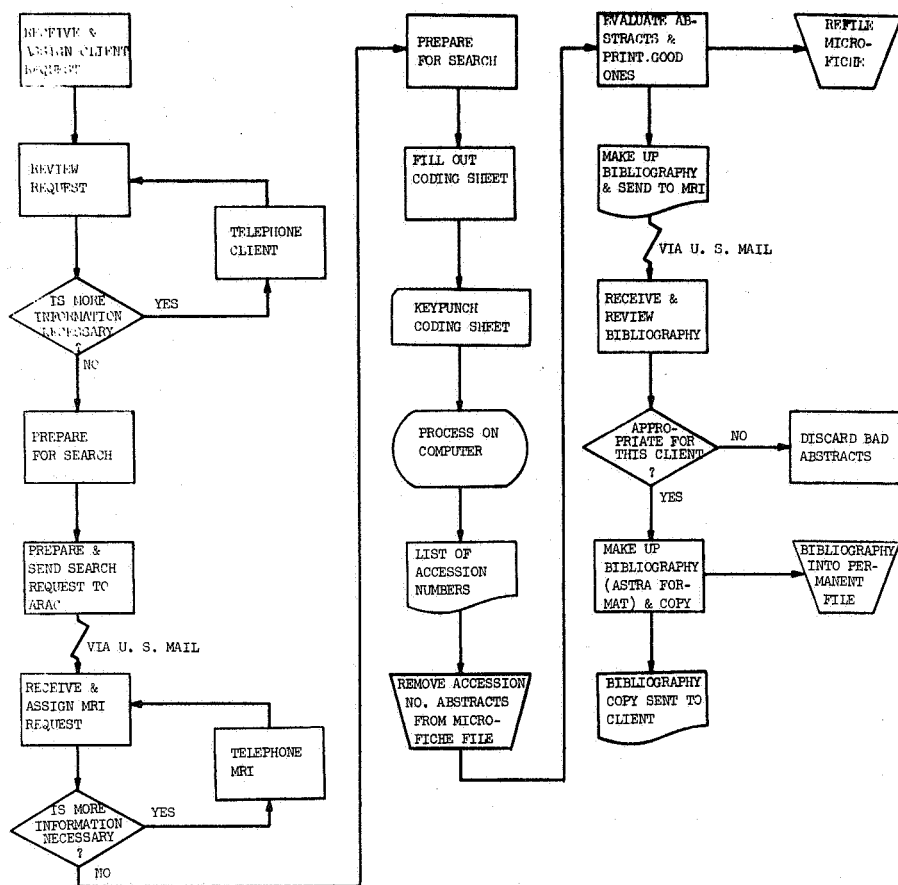


Figure E-2 - Present Retrospective Search System, With ASTRA Using a Computer-Based RDC For Machine Searching of NASA Tapes

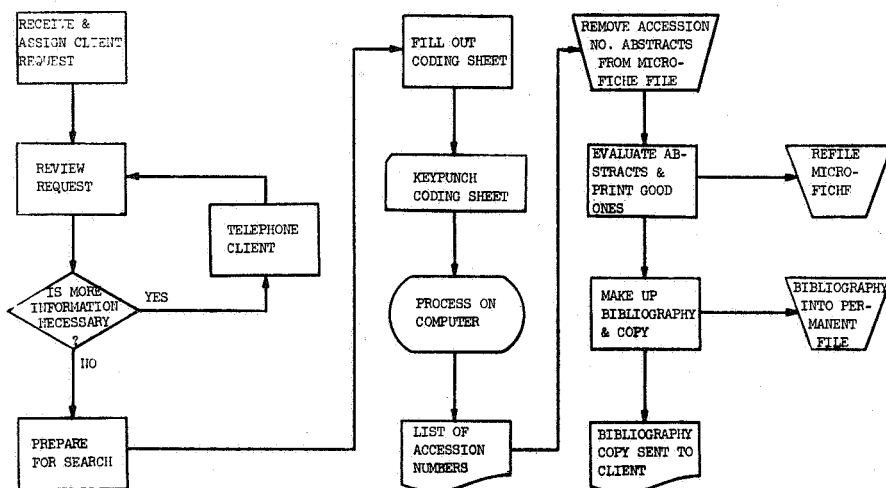


Figure E-3 - Retrospective Search System With ASTRA as a Computer-Based RDC

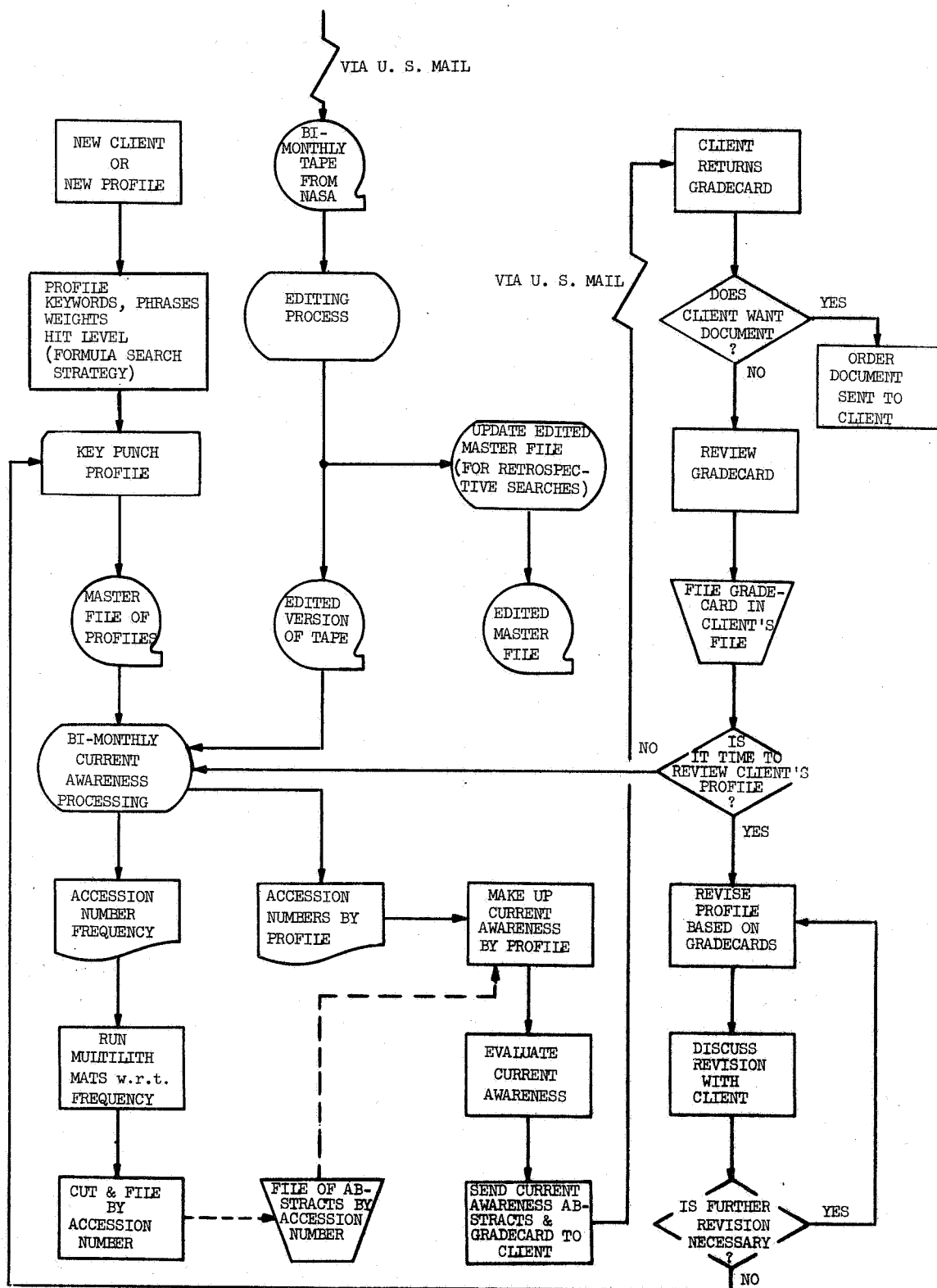


Figure E-4 - Current Awareness Computer Search, With ASTRA as a Computer-Based RDC

c. MRI's computer center is not operated as a university training tool, but as a fully-costed operation in a not-for-profit enterprise. Both the experience and skill of the MRI computer center would be expected to be equal to the university-operated computer center. MRI's overhead rate would also compare favorably, it is believed, if actual figures could be developed.

2. Actual comparison of labor rates for MRI's techno-economists to the hybrid student-professor labor rates is not possible either. If the university RDC consistently used a greater proportion of students to professors, then the university RDC rate for analytic work could be lower than MRI's. This conceivable advantage of the university RDC over ASTRA might well be offset by the permanent, experienced staff of MRI's ASTRA team who are trained in ASTRA concepts and procedures. A casual review of the university-operated RDC staff indicates a higher proportion of student labor in the winter months when teaching load is high and a reverse situation in the summer when student availability is low.

3. NASA's directive to make the ASTRA program self-supporting has and will continue to force changes in the grade (if not the types) of service rendered the user. Past cost factors are of limited value in forecasting 1967 and later year costs due to this modification in operation.

To develop the actual costs for computer searches, both retrospective and current awareness would necessitate cost accounting being applied to actual operations and integrated therein with management's philosophy regarding the future directions of ASTRA. (Discussions of program management and aspects of future directions relative to costs are given in Sections IV and V.) Cost accounting will be an integral part of ASTRA's business practices in the future. Therefore, data will be forthcoming, in 6 to 12 months, from which realistic costs can be derived.

The cost of search operations is dependent upon many factors, some of which have been previously mentioned; others in discussions that ensue. Of primary concern is to retrieve essentially all pertinent information in storage (NASA tapes) from a search and then assist the client in putting the information to use. This operation depends upon the proper interrogation of the computer; and then upon acquisition of the information from the computer, assessing it and adapting it to the client's need. The present methodology under which ASTRA works for retrospective searches and the methods that would be used for retrospective and current-awareness searches if ASTRA becomes computer-based, are given in Figures E-2, E-3 and E-4.

It is apparent that only a general method of performing a search, from man-to-machine-to-man, can be established a priori, and then each search made is handled in a "custom manner" to derive maximum benefit for the client. Consequently, the exact man and machine efforts for any particular search can only be made a posteriori.

Since the cost of a search is dependent upon unknowns, only an estimate can be conjectured at this time; and this estimate can only be a mean value representative of an average search. Therefore, based upon the search systems shown in Figures E-3 and E-4, ASTRA, as a computer-based RDC, would need to establish the fee of \$300 for either a retrospective or current-awareness search in a technical field of interest.

From the foregoing discussions and a review of the systems shown in Figures E-2, E-3 and E-4 (also see Figure E-1), it is clear that a major portion of the effort (80 to 90 percent), or cost, of a search is that for activities other than computer searching per se. Thus, the actual cost for the computer, tape-search activity is only a small portion of the total cost.

IV. PROGRAM MANAGEMENT

General

Three major trends in management as practiced by the Federal government are pertinent to ASTRA. These trends are:

1. Consolidation of similar activities under one organization for policy direction and control (e.g., Defense Supply Agency, Department of Health, Education, and Welfare, etc.).
2. Standardization of methods and procedures to improve efficiency and to reduce costs (especially in procurement in defense and NASA).
3. Centralization of information for decision making (made possible by advances in information technology).

The utility of the ASTRA program can be enhanced greatly if these trends are recognized and applied by consolidating the technologist activities under ASTRA where methods of search could be standardized. Establishment of cost control and other measures to insure the cost effectiveness of the full ASTRA program are essential if the program is to become financially independent. Split management cannot produce the cost control that a consolidated program operation can produce.

With the establishment of electronic data processing capability for ASTRA, it will be possible to take advantage of the centralization of information (at MRI) for the all-important selection of terms for retrospective searches and the creation of profiles for current awareness service. The other ASTRA services will benefit from this centralized data as well.

Staffing

One of the major advantages of the consolidation of analytical search effort by ASTRA would be superior continuity and control of search activities. MRI has and will continue to provide a permanent staff of full time technologists for ASTRA. Both the indoctrination and learning curve of the technologist benefit from the permanent, full time staffing. Increasingly, the technologist will be dealing with a larger body of NASA data, a growing list of customers, and more sophisticated techniques. The fluctuating staff of universities will be hard-pressed to provide the permanency of staff and the resources to meet the growth of the program.

Interest in technological coupling is growing rapidly in industry thereby creating a problem in collecting and keeping the high-priced skills that are essential to ASTRA. MRI believes it is best able to attract and hold such scarce talent.

Priorities

By consolidation, standardization, and centralization of ASTRA activities at MRI, management control of schedules will be improved also. Although the cooperation of the university RDC's has been excellent in serving ASTRA in the past, fragmented control of the three steps in retrospective searches, for example, was unavoidable. Conflicts in staff schedules, in computer operations, and communications with the customer can be solved best by a permanent, full-time program staff in one contractor's organization where the Director has de facto authority.

Interfaces

Both the desired growth in clients and expanding data supplied by NASA combine to further complicate the interfacing of various elements of ASTRA. Experience of today's program managers indicates that control of these interfaces is paramount to control of the program. One example is the external interface with a client in which the client wishes to prevent other

companies from knowing his areas of interest in technology. As ASTRA moves into the world of electronic communications, this security will require special attention best provided by a unified program manager.

Control of Change

The establishment of the computer capability for ASTRA during the next year and other changes in the concepts and techniques of the ASTRA program should be phased on an annual basis for two reasons:

1. Such changes take time to plan and implement and are somewhat costly.
2. System changes are of such a nature that planners usually underestimate the time and cost required to implement the changes. Therefore a time-phased approach should be used which allows for a moderate level of system analysis and design effort each year as the basis for the following year's improvements. Phases to be used might be:

Phase I (1967 - 1968): Establish computer processing capability at MRI by reprogramming university RDC's 1401 work for the IBM 360-30. In the course of reprogramming, ASTRA may be able to introduce minor improvements in machine running time. A study would be undertaken of the techniques and thought-processes used by ASTRA and the technologists of the RDC used by ASTRA for search services in selecting retrospective search terms and in creating profiles of clients for current awareness searches. Appropriate systems analysis techniques including operations search tools would be considered. From this study of the filter process for data retrieval, a plan for Phase II would be developed for submission to NASA for approval. Computer-assisted techniques in the preliminary search steps should be investigated as well.

Phase II (1968 - 1969): Refinements in the retrieval process would be implemented as approved by NASA. New studies on these subjects would be undertaken at this time:

1. Market study of ASTRA clients for cost-benefit analysis. Cost factors available from the first year's combined operations at MRI will be combined with the market study to establish revised pricing strategies designed to reach NASA's goal of a self-supporting service.

2. ASTRA would study the basic concepts originally established for ASTRA (not the goals) to determine if the services provided to clients should be modified or integrated.

3. Advances in the information storage and retrieval techniques would be examined for application to ASTRA.

Phase III (1969 - 1970): Recommendations, as approved by NASA, of Phase II studies on pricing, basic concepts of service to be offered, and of new techniques would be implemented at this point. Examination of the revolution in communications and electronic data processing would be continued. By this time, a complete review of the basic inputs of data by NASA through Documentation, Inc., would be encouraged and could lead to a complete redesign of the ASTRA program.

V. FUTURE DIRECTIONS OF ASTRA

Forecasted developments in microelectronics are expected to feed a continuing revolution in communications and data handling. In brief, we will not be performing our tasks in 1970 the same way we do today. In fact, the tasks may well be different in nature. Examples of the elements supporting such statements are:

1. Computer weight will drop more than 100-fold from 1965 to 1975;
2. Computer space requirements will drop 100-fold from 1965 to 1975;
3. Computer power requirements will decrease more than 400-fold from 1965 to 1975;
4. Computer speeds will increase about 300-fold from 1965 to 1975;
5. Cost per million additions (as a measure of computer costs) will drop about 800-fold during this decade; and
6. Access speeds of memories will catch up to processing speeds by 1972. Increasingly, mass random access memories will be used.

Similar forecasts by experts indicate rapid change in techniques of communicating between man-to-man, man-to-machine, and machine-to-machine. Lasers,

Gunn-like devices, satellites and numerous other developments will make communications-based computer systems cheap, plentiful, and easy to use in the 1970's.

NASA, as the leading force in technological research and development, is well aware of these changes. ASTRA, as a NASA service to industry, should exploit attractive developments directly rather than wait for industry to recognize, develop, and implement the breakthroughs first made by NASA. ASTRA is an attractive vehicle to short-circuit the pattern of exploiting advances in science and technology stated above. Several of the areas which ASTRA would look to support as elements of a modern technology transfer system are:

Terminal Devices: Advanced information systems depend upon integration of all elements of the system. For example, optimizing cost of inputting coded requests by the archaic argument that key punching is cheap, does not permit optimum search techniques. In other words, optimizing cost of each step in the ASTRA information search will not bring about the best, and in the long run, cheapest method of search. Present and near-term developments in terminal devices permit information specialists to have direct access to such systems as IBM 360-30. Time-sharing techniques permit this method of requesting information to be economical.

Within a few years, graphic displays driven by the central or satellite components will permit rapid distribution of large quantities of scientific and technical information.

Computer Center Organization: It is likely that between 1970 and 1975 a service such as ASTRA will be on-line to NASA computers (or a contracted service) for the types of searches now offered. ASTRA would have a satellite computer tied to NASA's massive data banks and ASTRA would apply its own, proprietary search strategies in interrogating NASA's data banks for ASTRA clients. Reports from ASTRA to customers may well be on-line through secured communication links and will be displayed on screens on the clients' premises. Holographic images are a possibility in the 1970's for displaying devices and image displays of processes on products which will replace much of the printed abstracts and reports used today.

Systems Analysis: Technologists at MRI will use computer-assisted techniques for developing search strategies and terms as well as profiles of client organizations. Various profiles of a client can be created quickly and tested for effectiveness before being entered into the current awareness system. These operations research techniques which are constrained by a large number of variables, perhaps in dynamic relationships, can be computerized in the 1970's and offer breakthroughs in dealing with the 12,000 to 14,000 terms now used in the ASTRA information search.

Communications: By 1970, computer-to-computer transfer of entire programs from ASTRA to clients will be feasible. One apparent impact will be the possibility of transferring a computer-controlled process developed by NASA (which an ASTRA user is interested in reviewing) from the NASA data bank to the client's computer for testing purposes. Our present concepts of the form and flow of information are undergoing truly revolutionary changes.

In summary, ASTRA must keep abreast of the changes in technology which offer opportunities for more responsive service. If NASA and ASTRA are unable to implement these advances, other segments of industry will step in and find ways to exploit the expanding payoffs being offered by the electronic age.

APPENDIX F

COST EQUATIONS FOR SEARCH SERVICES

The results of a time-and-cost analysis to determine the charges (fee schedules) for ASTRA search services are given below in four equations. Figure F-1 is a flow diagram showing the major tasks of the retrospective searches and current awareness surveillances (called current awareness search in the diagram). This diagram is the technical basis for the cost equations given subsequently.

Interpretive Retrospective Search

$$\text{Cost} = 2.65t_1 + 3.4t_2 + k_2 + ht_5 + f_1 + c_2$$

$$\text{Cost} = \$500$$

Interpretive Current Awareness Surveillance

$$\text{Cost} = 18.5t_1 + 4.2t_2 + h(t_3 + 12t_4) + k_1 + f_1 + c_1$$

$$\text{Cost} = \$1,000$$

Current Awareness Surveillance

$$\text{Cost} = 8.85t_1 + 3.6t_2 + h(t_3 + 12t_4) + k_4 + f_2$$

$$\text{Cost} = \$250$$

Retrospective Search

$$\text{Cost} = 3.74t_1 + 1.67t_2 + ht_5 + k_3 + f_2$$

$$\text{Cost} = \$150$$

where t_1 = Technical clerk's hourly rate

t_2 = Technologist's hourly rate

t_3 = Computer time for initial interrogation task

t_4 = Computer time for additional interrogation efforts

t_5 = Computer time

h = Computer cost per minute

k_1, k_2, k_3, k_4 = Telephone and reproduction costs

f_1 = Fixed business cost items, plus open literature documents
review costs

f_2 = Fixed business cost items

c_1, c_2 = Document review costs

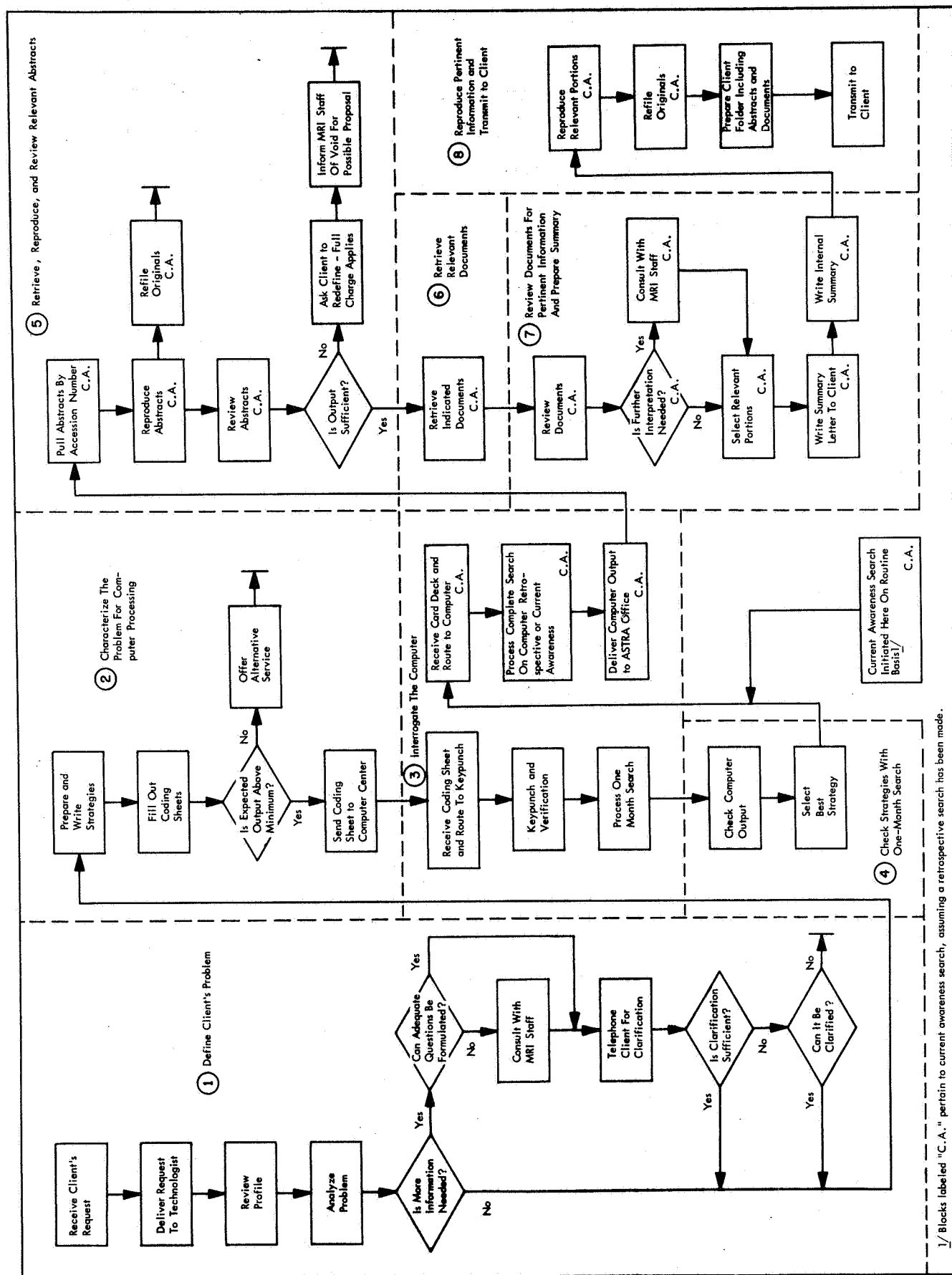


Figure F-1 - Flow Diagram of Retrospective Searches and Current Awareness Surveillances

APPENDIX G

MARKET ANALYSIS

An initial analysis of the regional market for ASTRA was designed to develop information which will allow the formulation of strategy offering maximum market penetration in the selected region. The development of this strategy involved primarily analysis of market size and its intraregional distribution. Evaluation of these factors allows the optimum development of ASTRA's product mix, i.e., the development of expertise and information in those technological fields having the greatest industrial interest. Moreover, the information derived from the study will pinpoint the major intrastate marketing areas, and serve as a guide to our initial marketing efforts.

The information generated by the study is based on a selected listing of manufacturing areas that are prominent in the region, and are technologically oriented to the spectrum of information generated by NASA. Therefore areas such as wholesaling and retailing were eliminated. Table G-I lists the SIC classifications covered by the study along with the number of firms in each classification in the region, and the percentage of the whole contributed by each. Initial consideration was given to regional market size, composition and intraregional distribution.

Figures G-1 and G-2 show the breakdown by state of the number of firms in each SIC classification, and the percentage represented by each classification of the firms surveyed in the state. Figure G-3 depicts the regional distribution of the 8,042 firms covered by the study.

The intrastate characteristics of the marketing region, as expected, show the major portion (74.3 percent) of the firms surveyed are concentrated in the larger metropolitan areas throughout the region (see Figure G-4). The degree to which manufacturing was skewed to a small number of metropolitan areas was, however, not evident in the preliminary evaluation of the data.

Also of interest because of its significance in relation to the geographical distribution of the region among the Area Technologists is the fact that 20.3 percent of the market is concentrated in four border city areas: Omaha, Nebraska/Council Bluffs, Iowa; Kansas City, Missouri/Kansas City, Kansas; Davenport, Iowa/Moline, Illinois and St. Louis, Missouri/East St. Louis, Illinois.

While random sampling of several metropolitan areas verified the fact that the distribution of manufacturing areas followed closely the distribution indicated by the statewide figures, variations in industrial activity throughout the major metropolitan areas in the region could not be ascertained through the use of the two-digit SIC classification.

TABLE G-I

SIC CLASSIFICATIONS INCLUDED IN MARKET SURVEY

<u>SIC</u>	<u>Title</u>	<u>Total Number of Firms</u>	<u>% of Total</u>
19	Ordnance and Accessories	21	0.3
25	Furniture and Fixtures	91	1.1
28	Chemicals and Allied Products	1,031	12.8
29	Petroleum Refining and Related Products	287	3.6
30	Rubber and Miscellaneous Plastic Products	327	4.1
33	Primary Metal Industries	630	7.8
34	Fabricated Metal Products except Ordnance, Machinery and Transpor- tation Equipment	1,693	21.1
35	Machinery, Except Electrical	2,115	26.6
36	Electrical Machinery, Equipment and Supplies	706	8.8
37	Transportation Equipment	626	7.8
38	Professional, Scientific and Controlling Instruments, Photographic and Optical Goods; Watches and Clocks	269	3.2
39	Miscellaneous Manufacturing Industries	246	3.1

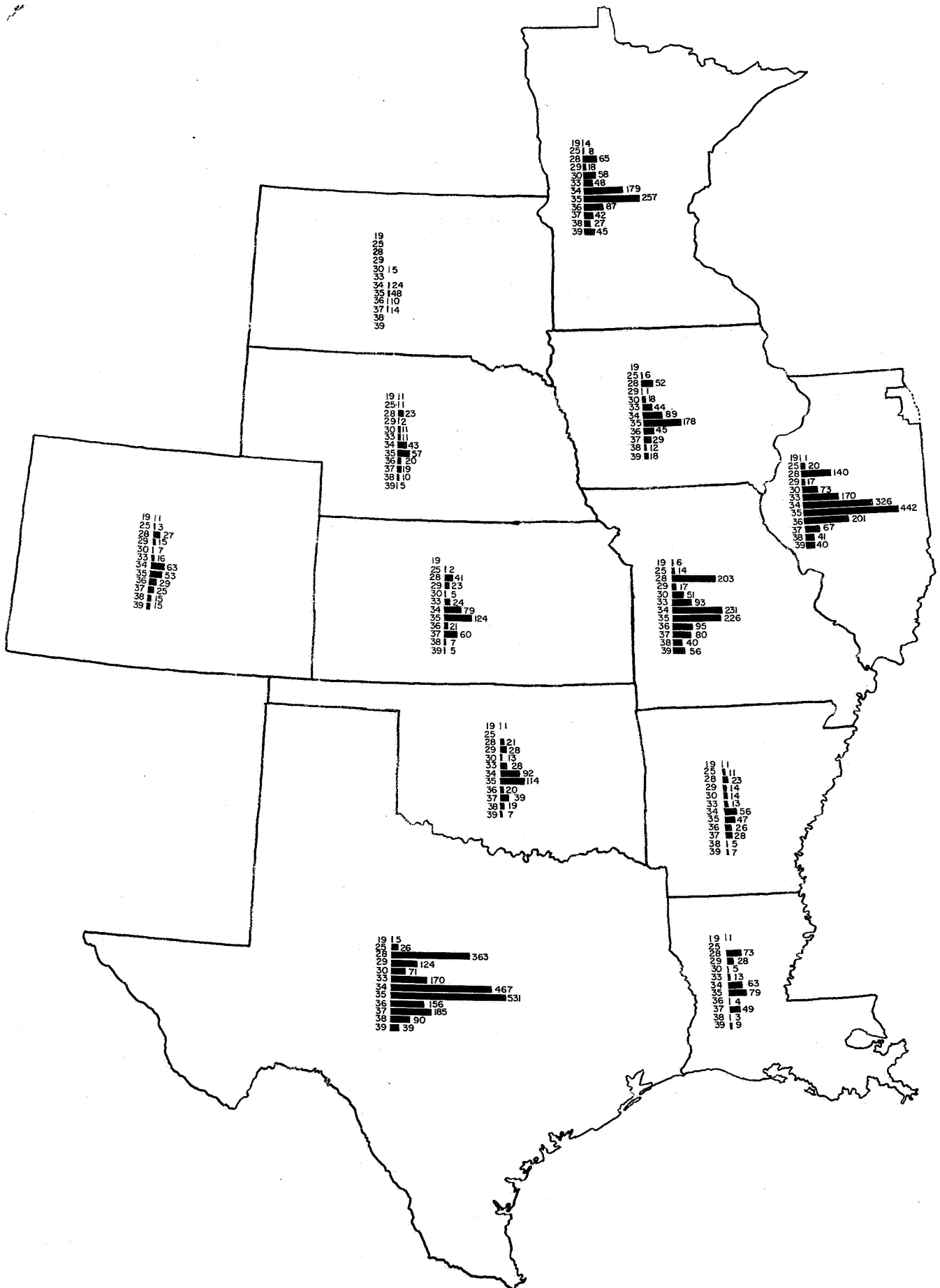


Figure G-1 - Number of Firms Per SIC Classification Surveyed by State

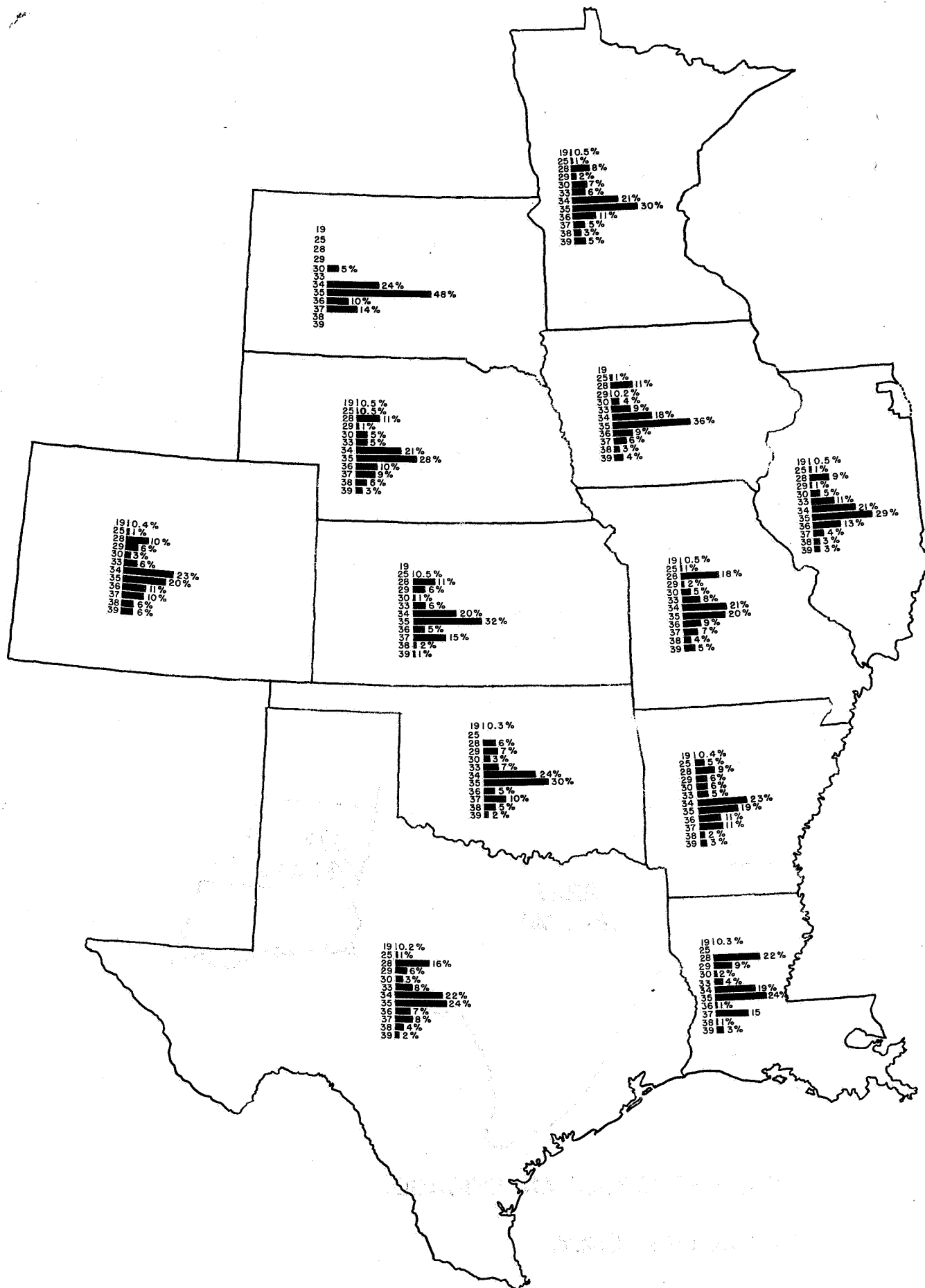
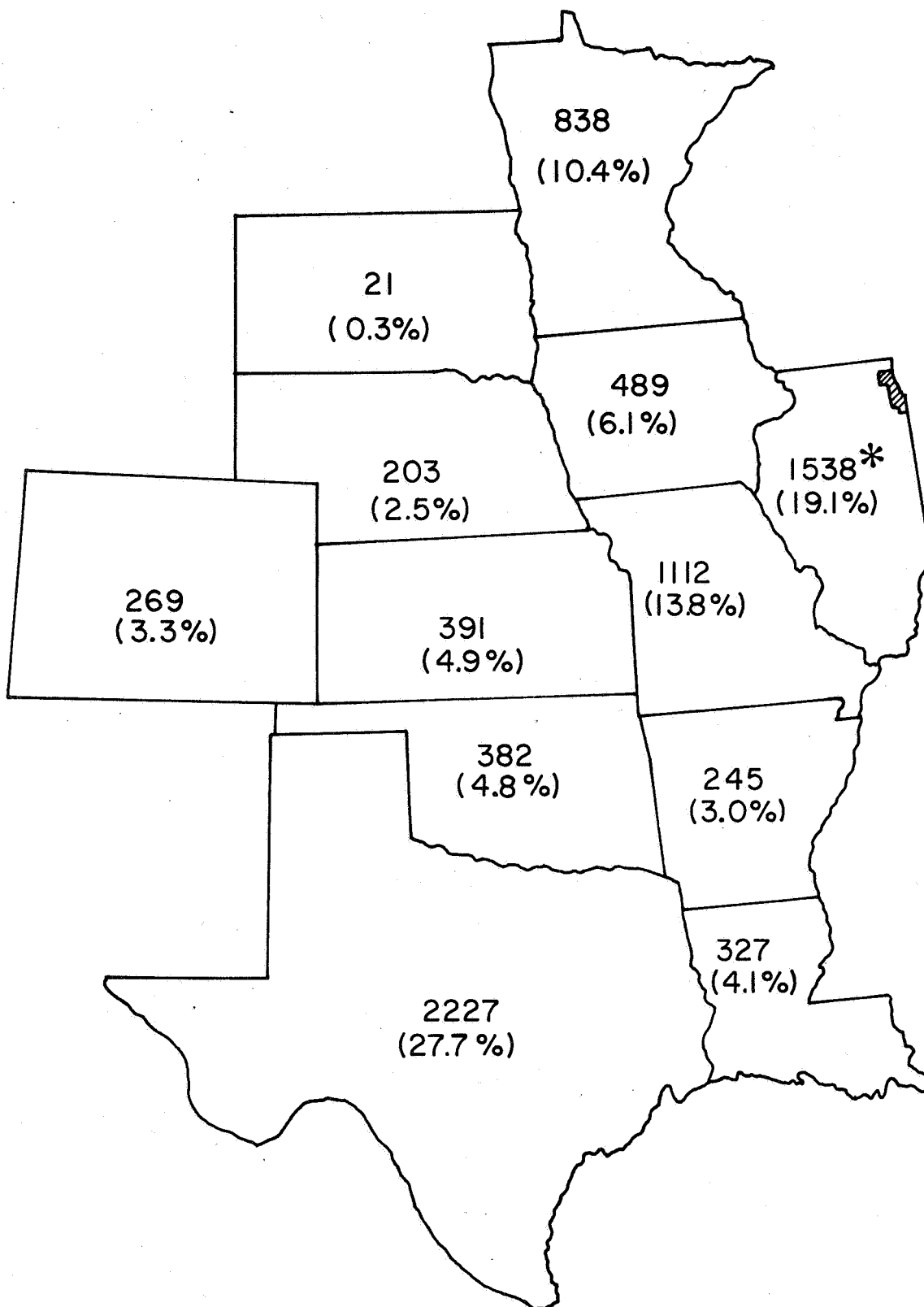


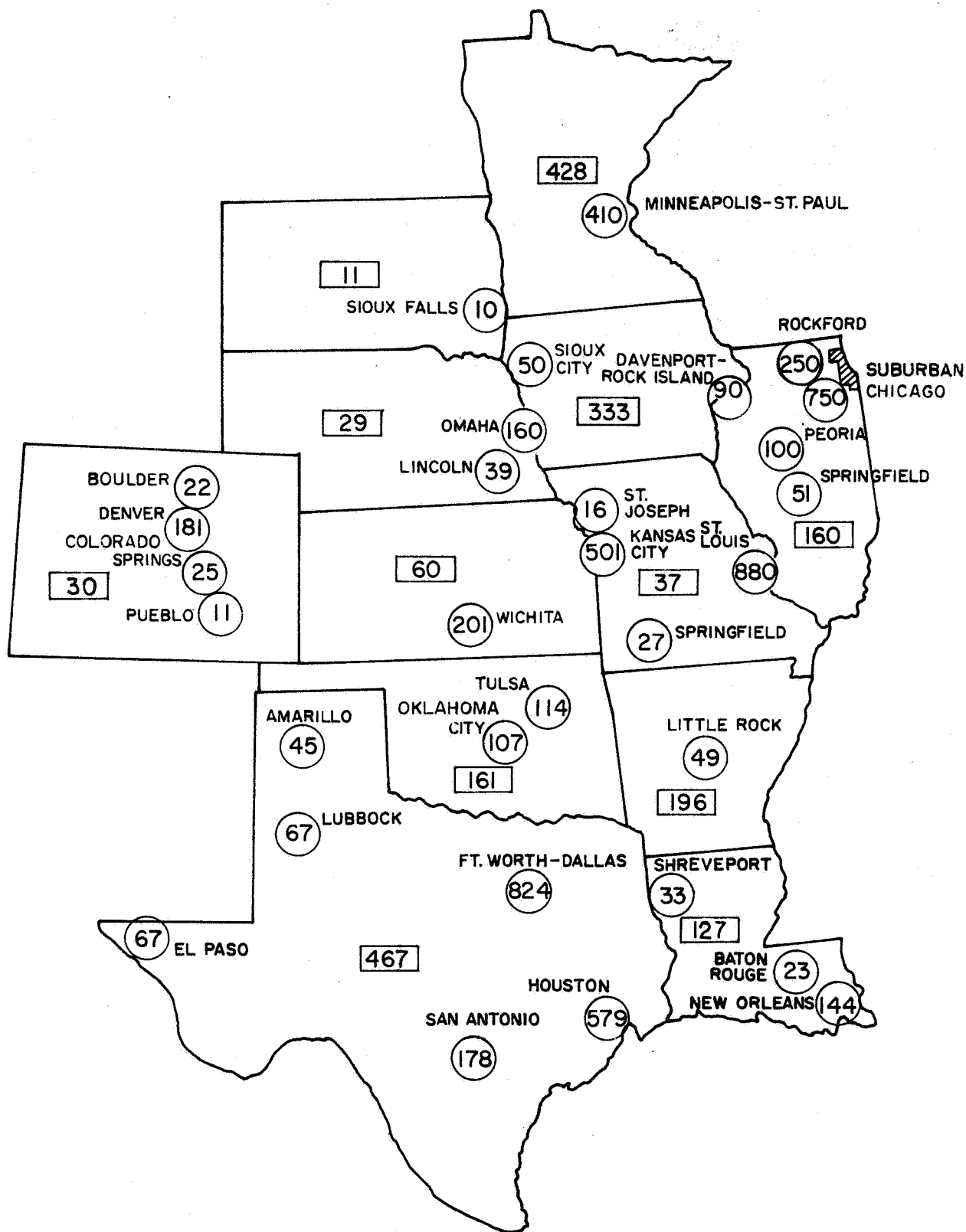
Figure G-2 - Percentage of Firms by State in Each SIC Classification Surveyed



* EXCLUDING METROPOLITAN CHICAGO.

STATE DISTRIBUTION ONLY.

Figure G-3 - Regional Distribution of Industry in SIC Classification Surveyed



○ NUMBER OF FIRMS IN METROPOLITAN AREA.
 □ NUMBER OF FIRMS SCATTERED THROUGHOUT REMAINDER OF STATE.

Figure G-4 - Intra-State Distribution of Manufacturing Firms in SIC Classifications Surveyed

The second phase of the initial portion of the study was designed to characterize the markets in three major metropolitan areas selected for input information in initial sales efforts. These preliminary results are shown in Table G-II through Table G-IV. They show the predominant industries in the area in terms of manufacturers. Also the results indicate the size distribution in terms of employment. These data are not complete as only those four-digit SIC codes that had generally six firms or plants in the area were listed. Further attention, however, needs to be given the minor groups as they may actually be a better market for ASTRA services than the groups containing more firms. Consequently, the quantity or size (number of employees) may not be the necessary and sufficient factor to be considered.

While similarities exist in the breakdowns for these metropolitan areas, significant variation was found in manufacturing emphasis between several areas. Though often in related fields, these variations produce marked differences in the major technological areas of interest which must be taken into account when planning the marketing approach and tailoring the information bank for effective dissemination.

Future work in the analysis of these regional markets needs to deal with a more comprehensive characterization of these differences, and an evaluation of other related factors including: company size, markets, orientation (viz., R&D, sales, manufacturing) and product line in an effort to evaluate the characteristics of a given company that make it most receptive to utilization of the ASTRA service. Moreover, it will encompass all four-digit SIC code groups of an area.

TABLE G-II

METROPOLITAN KANSAS CITY

<u>SIC Code</u>	<u>SIC Description</u>	<u>No. of Firms in Class.</u>	<u>Employment Code^{a/}</u>				
			<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
3544	Special Dies and Tools, Jigs and Fixtures	12	6	6	0	0	0
3441	Fabricated Structural Steel	11	4	4	3	0	0
3499	Fabricated Metal Products	9	7	0	2	0	0
2834	Pharmaceutical Preparations	9	5	2	2	0	0
3442	Metal Doors, Sash, Frames, Molding and Trim	8	8	0	0	0	0
3079	Miscellaneous Plastic Products	8	5	2	1	0	0
3993	Signs and Advertising Displays	7	4	3	0	0	0
3591	Machine Shops, Jobbing And Repair	6	3	3	0	0	0
3551	Food Products Machinery	6	4	1	1	0	0
3522	Farm Machinery and Equipment	6	3	1	1	0	1
3471	Electroplating, Polishing, Anodizing	6	5	1	0	0	0
3443	Fabricated Plate Work	6	1	3	0	1	1
2851	Paints, Varnishes, Lacquers and Enamels	<u>6</u>	<u>3</u>	<u>1</u>	<u>2</u>	<u>0</u>	<u>0</u>
	TOTAL	100	58	27	12	1	2
	% of TOTAL		58	27	12	1	2

^{a/} 3 = 20-49, 4 = 50-99, 5 = 100-499, 6 = 500-999
7 = > 1,000

TABLE G-III

METROPOLITAN ST. LOUIS

<u>SIC Code</u>	<u>SIC Description</u>	No. of Firms in Class.	Employment Code ^{a/}				
			<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
3591	Machine Shops - Jobbing and Repair	37	24	9	3	1	0
2851	Paints, Varnishes, Lacquers and Enamels	22	10	7	5	0	0
3461	Metal Stampings	21	11	5	5	0	0
3544	Special Dies and Tools, Die Sets, Jigs and Fixtures	21	17	1	2	0	1
3079	Miscellaneous Plastic Products	21	10	8	3	0	0
3321	Gray Iron Foundries	19	6	2	10	0	1
3993	Signs and Advertising Displays	18	10	7	1	0	0
3443	Fabricated Plate Work (Boiler Shops)	15	7	3	3	1	1
2834	Pharmaceutical Preparations	15	7	3	4	0	1
3441	Fabricated Structural Steel	14	9	2	3	0	0
3442	Metal Doors, Sash, Frames, Molding and Trim	<u>14</u>	<u>6</u>	<u>5</u>	<u>2</u>	<u>1</u>	<u>0</u>
	TOTAL	217	117	52	41	3	4
	% of TOTAL		53.9	24	18.9	1.4	1.8

a/ 3 = 20-49, 4 = 50-99, 5 = 100-499, 6 = 500-999, 7 = > 1,000.

TABLE G-IV

MINNEAPOLIS-ST. PAUL

<u>SIC Code</u>	<u>SIC Description</u>	<u>No. of Firms in Class.</u>	<u>Employment Code^{a/}</u>				
			<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
3591	Machine Shops - Jobbing and Repair	55	35	13	6	1	0
3079	Miscellaneous Plastic Products	30	17	7	6	0	0
3993	Signs and Advertising Displays	23	19	2	1	1	0
3461	Metal Stampings	20	7	9	4	0	0
3679	Electronic Components and Accessories	19	4	5	10	0	0
3444	Sheet Metal Work	14	7	4	3	0	0
3499	Fabricated Metal Products	14	6	3	4	1	0
3522	Farm Machinery and Equipment	14	7	1	2	1	3
3441	Fabricated Structural Steel	11	3	4	4	0	0
3442	Metal Doors, Sash, Frames, Molding and Trim	11	5	3	3	0	0
3471	Electroplating, Polishing, Anodizing and Coloring	<u>11</u>	<u>7</u>	<u>2</u>	<u>2</u>	<u>0</u>	<u>0</u>
	TOTAL	222	117	53	45	4	3
	% of TOTAL		52.7	23.9	20.2	1.8	1.4

a/ 3 = 20-49, 4 = 50-99, 5 = 100-499, 6 = 500-999, 7 = >1,000