

ARAC

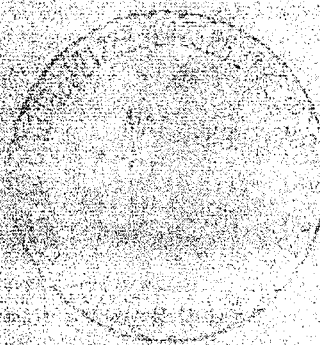
FINAL FIVE-YEAR REPORT
EXPERIMENT TO TRANSFER TECHNOLOGY
FROM A UNIVERSITY-BASED CENTER

NASA Contract SC-NASr-162

by

Joseph DiSalvo
Director

February, 1968



Aerospace Research Applications Center
Indiana University Foundation
Bloomington, Indiana

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INTRODUCTION

This is the final report on the basic five year contract between NASA and the Indiana University Foundation involving the experimental efforts at attempting to transfer technology from a University-based information center. The report is divided into four sections. The first section is a summary of activity at the Center for the fourth quarter of 1967.

The second session discusses the efforts made with various transfer mechanisms, shows various charts which indicate successes and failures of the mechanisms explored, and summarizes the transfer activity over the five year period. The third section discusses activity levels, trends in activity, company renewal data, and various other indicators from the point of view of meeting the market test. The fourth section is a summary of the five year experiment.

I. Highlights of Activities for Fourth Quarter, 1967

During this quarter, and through January 15, 1968, thirteen company memberships came up for renewal. All thirteen companies renewed their memberships with the Center under the new unit-cost fee schedule. There have been no membership terminations for seven consecutive months.

In addition to the thirteen renewals, six new firms became members with the Center. These firms are:

1. Ashland Oil Refining Company
2. Hobart Brothers Technical Center
3. Clark Equipment Company
4. Delco-Remy Engineering Center
5. NIBCO, Incorporated
6. The Steelcraft Manufacturing Company

As of January 15, 1968, the Center maintained membership with a total of 70 firms. Additionally 14 other firms and organizations are using the services of ARAC on a pay-as-you go basis or under a special arrangement which does not include payment of the conventional \$150.00 annual membership fee. These firms pay fees to the Center in accord with the rate for non-members. The present ARAC fee schedule heavily favors a membership arrangement in that the cost for each service element is one-third less.

On January 1, 1967, ARAC had 48 regular member companies. Throughout 1967 as the anniversary date for membership renewal approached, each of these 48 companies was asked to renew their membership in accord with the current ARAC fee schedule which has been designed so that the fee for each service element would cover the cost of providing that service. Stated otherwise, each individual service element was forced to stand on its own merit as people in the ARAC member firms had to make a decision on whether or not to renew that particular service element. Because of this flexibility, gross changes in the amount and mix of service elements were made

as each company renewed. However, only three of the forty-eight companies did not continue their membership with ARAC in 1967. Additionally, twenty-five new firms became members of ARAC to bring the total number of member companies to seventy as of January 15, 1968.

Figure I-1 shows the summary of activity highlights for the fourth quarter 1967. It is apparent from this table that all firms have now renewed under the new unit cost fee schedule. The decrease in activity which had been observed during previous quarters (as more of the member firms were operating under the new fee schedule) did not appear during this quarter. In several of the services the trend has been reversed and activity is once again increasing. This is encouraging because the Center has the capability at its present staff-level to handle approximately three times the amount of activity as is presently in the system (see previous quarterly report for discussion). Now that the decrease in activity level has ceased and increases are being observed there is every reason to believe that the Center will reach a point at some time in the future where it will generate enough income to carry on all of its operations from this source of revenue.

In an effort to create a national image for Technology Utilization through an RDC and in effort to encourage new membership, ARAC continues to perform various promotional activities. Also, the number of persons interested in learning about the activities of our Center continues to grow as persons from various organizations and firms continue to visit the ARAC installation in order to inspect our operation first hand. A list of visitors to ARAC and the center's promotional activity for the fourth quarter, 1967, is shown in Table I-2.

TABLE I-1

ACTIVITY SUMMARY

<u>Type of Service</u>	<u>1966 Quarterly Average</u>	<u>First Quarter 1967</u>	<u>Second Quarter 1967</u>	<u>Third Quarter 1967</u>	<u>Fourth Quarter 1967</u>	<u>1967 Quarterly Average</u>
1. Retrospective Searches	193	83	66	64	50	66
2. Subscriptions to SDS Custom Interest Profiles	296	178	173	114	167	N/A
3. Subscriptions to SDS Standard Interest Profiles	N/A	111	217	324	342	N/A
4. Document Requests from 1, 2, and 3	3,896	3,888	2,849	2,090	3,151	2,995
5. Industrial Applications Service						
(a) Tech Briefs Disseminated	136	145	113	111	127	124
Requests for Supplementary Information	26	33	64	31	39	42
(b) ARAC Industrial Applications Reports						
Abstracts Announced	104	104	104	104	104	104
Requests for Full Copy	2,483	2,137	1,560	1,556	1,527	1,695
6. Technical Marketing Information Service						
Requests for Documents	574	860	484	522	572	610
7. Computer Information Service						
(a) Requests for Documents	48	94	24	39	56	53
(b) Copies of Programs	139	175	60	36	37	77
8. Extrapolated Annual Rate of Document Requests (all sources)	30,948	28,748	20,164	17,092	21,528	21,883

TABLE I-2
VISITORS TO ARAC AND PROMOTIONAL ACTIVITY
FOURTH QUARTER, 1967

Visitors

Mr. John Jundt	State of Ohio Technical Services	10/2-10/5/67
Mr. Steve Buttress	State of Ohio Technical Services	10/2-10/5/67
Mr. Robert Duffy	NASA/TUD	10/19/67
Mr. Richard Barnes	NASA/TUD	10/19/67
Mr. George Howick	NASA/TUD	10/19/67
Mr. Donald R. Booze	Donald R. Booze and Associates	10/25/67
Mr. E. Vanlommel	University of Ghent, Belgium	12/6/67
Mr. Henri Muller	University of Ghent, Belgium	12/6/67

Promotional Activity

October

Presentation at Indiana Manufacturers Association	A. M. Weimer
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November

ARAC Fall Meeting, Indiana University	J. DiSalvo/Staff
Illinois State Technical Services Conference (Peoria)	R. W. Counts

December

Planning meeting with DISC re: Urban Studies	C. Mullis/R. Hall/ A. M. Weimer
Trial Memberships for 11 Illinois Firms	J. DiSalvo/Staff

II. Transfer Mechanisms Employed

Throughout the five year history of ARAC various approaches have been taken toward meeting the primary objective of transferring the results of government-sponsored research to the private industrial sector. Some of the transfer mechanisms attempted have not lived up to expectations and are no longer employed by the Center. These include attempts such as conducting seminars in special areas, formation of "brainstorm" teams to solve particular problems and other similar activities. Although these "people intensive" type of transfer mechanisms did achieve good results on occasion, it turned out that this type of activity is extremely expensive. The general feeling of participants in these programs is that information transfer mechanisms of this type are better received when conducted by a professional society or other similar agency that deals with a very specialized segment of technology.

However, a number of transfer mechanisms tested did indeed seem to be successful and were well received. As these mechanisms were perfected, they were brought "on line" and included as a regular ARAC service. Listed below is a brief description of each transfer mechanism (or service) currently employed by ARAC along with some comments which serve to put the reason for its existence, its acceptance, and its continuation in proper context.

ARAC RETROSPECTIVE SEARCH SERVICE

This service is used by a company in an attempt to locate information that may supply a complete (or at least partial) answer to a particular technical, managerial, or marketing problem. In an attempt to find the answer to a search question, all the resources of ARAC are brought to bear on each particular problem submitted. These resources include the technical and managerial staff of the Center, the computerized and manual information file sources of the Center, and the national network of specialized information centers, government laboratories, university specialists and other sources with which ARAC personnel have built rapport throughout its five years of existence.

The service has a problem solving focus seeking to isolate information relevant to specific company problems. Subjects range from broad "state of the art" surveys to specific, well-defined narrow problem situations. The reader is referred to Table II-1 for a selected listing of search titles that serves to indicate the broad spectrum of problems submitted.

Search results are analyzed and evaluated by an ARAC specialist in the appropriate discipline and a short, "semi-interpretation" report is always included along with copies of pertinent report abstracts, names of knowledgeable individuals, and other information deemed relevant to the solution of the problem. The entire process is characterized by inquiry in depth and by direct interaction between the ARAC specialist and the company's staff.

Table II-2 is a five year summary of all services offered by ARAC. As shown in the table, a total of 3,000 separate and individual custom

TABLE II-1

SELECTED LIST OF RETROSPECTIVE SEARCH TITLES

Failure Theories
Energy Absorbing Devices
Methods of Training Technical People
Stereoscopic Display Systems
Human Environmental Effects
Ripper Design
Percussive Welding
Apparatus for Learning Research
Methods of Monitoring Sewage Flow
Birthdate and Place of Wernher Von Braun
R & D Decision Making
Moisture Detection in Wood Veneer
Underwater Sound Detection and Propagation
Properties of Radon and Xenon
Power Screws
Non-Stick O-Ring Seals
Results of AF Contract AF-33/615/3747
Survey of Fluid Amplifiers
Non-Destructive Testing
Synoptic Vesicles
Fiber Optics
Plastic-to-Metal Bonding Techniques
Dental Health Survey
Reconnaissance
Numerical Analysis of Heat Transfer
Design of Permanent Magnets
Relaxation ~~Phenomena~~
Chicken Eater's Survey
Techniques of Information Retrieval
Plant and Laboratory Location Theory
Flame Retardant Paint
Pyrolysis of PVC
Biomedical Ultrasonics
Zero-Gravity Fuel Measurement
Artificial Heart Physiology

TABLE II-2

ARAC FIVE-YEAR ACTIVITY SUMMARY

<u>Year</u>	<u>Qtr.</u>	<u>RSS, No. Requests</u>	<u>SDI</u>		<u>No. Member Firms</u>	<u>RSS Requests/ Firm</u>		<u>SDS Profiles/ Firm</u>		<u>MIS Documents</u>	<u>CIS Programs</u>	<u>IAS Docs.</u>	<u>Total Docs.</u>
			<u>Standard</u>	<u>No. of Profiles</u>									
			<u>Total</u>										
				<u>Custom</u>									
1963	1	18			29	0.62							12
	2	52			29	1.79						43	51
	3	44	30	30	29	1.52	1.03					203	293
	4	62	60	60	29	2.14	2.07					470	582
1964	1	77	101	101	30	2.56	3.37					832	1,056
	2	174	121	121	31	5.62	3.91					983	1,431
	3	210	189	189	33	6.27	5.73					1,119	1,938
	4	218	207	207	33	6.62	6.27		23	5		1,603	2,992
1965	1	226	216	216	38	5.95	5.84		102	3		1,977	3,192
	2	223	237	237	42	5.30	5.63		207	17		2,850	3,585
	3	225	261	261	42	5.36	6.22		263	41		2,095	4,411
	4	226	305	305	44	5.13	6.94		325	50		2,536	3,746
1966	1	263	333	333	44	5.97	7.58		408	67		3,070	4,669
	2	313	323	323	48	6.52	6.94		604	95		2,934	4,113
	3	262	308	308	48	5.46	6.42		613	154		2,715	5,298
	4	129	297	286	48	2.69	6.19		935	76		2,351	5,123
1967	1	83	111	289	55	1.51	5.25		860	175		2,303	7,189
	2	66	217	390	58	1.14	6.72		484	60		1,624	5,041
	3	64	324	494	64	1.00	7.72		522	36		1,587	4,274
	4	65	342	509	70	0.72	7.28		572	37		1,556	5,382
Totals		3,000	28,020 (SDI Searches)		N/A	N/A	N/A		5,917	826		32,878	64,364

retrospective searches have been conducted by ARAC in its first five years of existence. It is interesting to note that just prior to introduction of the unit charge fee schedule, this service had swelled to the point where ARAC received 6.52 search requests per company, per quarter in the second quarter of 1966. Even with adoption of the unit fee schedule, this service has fared quite well although the average number of requests per company by quarters is down substantially now that each request involves a \$70 fee. Other factors played a role in reducing the volume of activity for this service. First, many of the new ARAC members are small firms and do not require this service frequently. Secondly, after January, 1967, all searches performed for government agencies, university faculties and other RDC's were not included in the total. Both of these factors tended to lower the figure for average requests per company, per quarter.

There is no doubt that this service is a significant one in transferring technology and companies seem to be willing to pay a fee sufficient to cover the cost of the service, although they tend to be more selective in submitting requests when this criterion is applied. A recent audit of ARAC users also indicated that this service received the highest value rating of all services provided by ARAC.

SELECTIVE DISSEMINATION OF INFORMATION - CUSTOM PROFILES

The primary purpose of this service is to keep company people aware of new reports appearing in the literature in their specified area of interest. As such this service serves both a current awareness and an idea generating function. In order to use this service a company person (or group of people) define their area of interest to an ARAC specialist in the appropriate discipline. As ARAC receives its periodic updates to its information warehouse, the ARAC specialists monitors and searches (with the aid of a computer) the new material and selects those reports relevant to the interest profile as defined by the company person. The company person is alerted, via abstracts, to the existence of the newly received relevant reports at convenient intervals (usually twice-monthly).

This service was also well-received by ARAC users. The data in Table II-2 show that in the second quarter of 1966, there were 323 custom profiles in the ARAC system for an average of 6.94 profiles per member company. As ARAC member companies were forced to renew under the unit-cost fee schedule, those custom profiles of only marginal value were deleted. The reason is that the cost for this service ranges from \$200 to \$1,300 annually per profile, depending primarily on how broad an interest area is defined.

In spite of the high cost involved for this customized current-awareness service, 167 custom profiles are still active in the ARAC system. This is true even though a number of these profiles were being supplied to other RDC's which have since drastically reduced the amount of this service they were taking. The number of custom profiles per member firm is down to 2.38, due in large part because most of the new firms added are smaller and have potentially less use for this relatively expensive current-awareness service. Nevertheless, this service is held in high regard by a number of ARAC users and continuation of it is certainly essential.

SELECTIVE DISSEMINATION OF INFORMATION - STANDARD INTEREST PROFILE (SIP)

As ARAC developed a larger and larger base of customized interest profiles, the Center's specialists became aware of the emergence of many areas of government report literature which experienced a high index of interest. Accordingly a group of Standard Interest Profiles (SIP) were defined by the ARAC staff and then developed in those areas of high interest. Thus these SIP's are essentially operated in the same manner as custom profiles except that an ARAC staff member defines the interest area rather than a company person. Another difference between the two is that the output of a profile may be sent to numerous places rather than to a single mailing point thus allowing a member company to serve those interests which fall in these general areas at a cost much less than that for customized profiles. The three major disadvantages of custom profiles are:

- (1) high cost
- (2) time requirement on the part of the user to define interest
- (3) limited ability of the Center to provide custom profiles due to time demands on the staff

All three of these are overcome with the standard profile approach only at the expense of a user possibly taking a profile which is approximately his area of interest, but is not his custom stated interest.

As of January, 1968, a total of 56 SIP areas have been defined and are available from ARAC. The title of each SIP area and a brief description of the 56 areas now available are listed in Table II-3.

The data in Table II-2 indicate that the Standard Interest Profiles have been very well received and accepted. In just one year of availability, there were twice as many subscriptions to SIP's as there were for custom profiles. Recently the base of coverage for the standard interest profiles has been increased to include most government report literature (STAR, IAA, NSA, and USGRDR) as well as selected open literature sources. It is anticipated that this will significantly enhance the value of this service as no other source at the present time is able to offer as complete a coverage of government report literature for \$80.00 annually.

As a final thought, it should be noted that the combined result of both standard and custom profiles is that ARAC has run 28,020 individual current awareness searches in its first five years of existence.

INDUSTRIAL APPLICATIONS SERVICE (IAS)

As members of the ARAC technical staff sort through the 8,000 - 9,000 new reports each month in their SDI and retrospective search activities, certain reports are identified which seem to have a very high potential for industrial application. The ARAC staff takes note of these reports, writes abstracts for them if none exists, and then announce ten each week in the Industrial Applications. Each week ten to twenty Tech Briefs are also sent with this service. Thus the service represents a combination of technology

TABLE II-3

Notes on The

STANDARD INTEREST PROFILES

SIP-02 CRYSTAL GROWTH. Most of the work reported deals with growth of crystalline materials for lasers or for electronic components.

SIP-03 CARBON AND GRAPHITE. Production and application of carbon, graphite and carbide materials, usually for structural use.

SIP-04 PHYSICAL METALLURGY. This was designed for the metallurgist engaged in examination of the microstructure of metals, particularly laboratory analysis. Much material concentrates on methods of analysis.

SIP-05 POWDER METALLURGY. The profile is thought to be useful to persons designing parts made from powdered materials and to firms engaged in the manufacture of powdered metals and products formed from them.

SIP-06 HIGH TEMPERATURE APPLICATIONS OF METALS. The reports identified have been found useful to engineers designing or constructing high-temperature process equipment.

SIP-07 MATERIALS JOINING TECHNOLOGY. Design engineers usually find this of most benefit. Welding and brazing techniques are discussed in most reports, but reports on structural adhesives or unique joining methods are also included.

SIP-08 MATERIAL FORMING AND MACHINING. Chemical milling, laser machining, ultrasonic drilling and cutting, electron beam machining, and lathe operations. Explosive forming, magnetic forming and other novel forming techniques. The profile is of most value to designers or to machinists working with difficult-to-fabricate materials.

SIP-09 MICROANALYSIS AND PROPERTIES OF ENGINEERING MATERIALS. This profile identifies reports on properties of materials which should be of interest to metallurgists and design engineers. Typical reports discuss crack propagation, creep, fatigue, plastic deformation and effects of thermal or mechanical loads on materials properties.

SIP-10 NON-DESTRUCTIVE TESTING. This area is growing in popularity. Organizations deriving the most benefit from the profile are those which must test expensive items of equipment, whether these items be products sold or equipment used in processing. Reports are found relating to both electronic and mechanical equipment.

SIP-11 CORROSION AND PROTECTIVE COATINGS. This SIP includes all forms of metallic corrosion, corrosion mechanisms and corrosion detection. Most protective measures involve coatings, both

Table II-3 Con't.

organic and inorganic. Many reports are an excellent source of ideas for dealing with corrosion measurement and prevention.

SIP-13 BEARINGS AND LUBRICANTS. All kinds of bearings and lubricants which are developed by federal programs are discussed. Most reports deal with problems in unusual environments and they are a source of ideas for bearing design and lubricant selection in very difficult applications.

SIP-15 FLUID FLOW ANALYSIS. The profile is intended for persons taking an analytical approach to problems of fluid flow. Gaseous, liquid, and two-phase flow. Flow measurement problems. Techniques of mathematical analysis. Applications in fuel flow, hydraulic systems and pneumatic controls. Includes reports on fluid amplification and fluid logic system.

SIP-16 HYDROCARBON FUELS AND COMBUSTION. Fuel composition and blending, storage properties, contamination--sometimes by micro-organisms, and analysis of combustion products. Combustion studies and instrumentation used. Most reports are on aviation fuels, but do not discuss exotic rocket fuels.

SIP-17 AIR-WATER POLLUTION AND INDUSTRIAL SAFETY. Detection and measurement of foreign substances in air and water, water reclamation systems, radiation hazards and chemical toxicity studies. Most studies refer to environmental purification and safety requirements in small systems, aircraft and submarines, for example, and a few deal with pollution of industrial complexes.

SIP-18 ANALYTICAL CHEMISTRY. Both instrumental analysis and wet chemistry methods are discussed in reports, but the best reports describe instrumentation for making analyses either more accurately or more quickly than has previously been done. Reports are selected for the analytical chemist.

SIP-19 REINFORCED COMPOSITE MATERIALS. All types of reinforced materials are discussed--metallic, ceramic and plastic; but most of the writing is on reinforced plastics. Analysis of properties, preparation and testing. Reinforcement material selection and manufacture.

SIP-20 POLYMER TECHNOLOGY. This profile identifies all reports dealing with polymer technology except those appearing in SIP-19, REINFORCED COMPOSITE MATERIALS. Reports usually discuss polymers developed and tested for difficult applications, structural adhesives, membranes, dielectric materials, etc.

SIP-21 TEMPERATURE MEASUREMENT. Techniques and devices for temperature measurement, probes, thermocouples, thermistors, pyrometers. Errors in measurement and problems of data acquisition under difficult

Table II-3 Con't.

conditions. Reports should be of most interest to persons working at cryogenic temperatures or at temperatures above 2000° F.

SIP-22 VACUUM TECHNOLOGY. The profile is particularly valuable as a continuing survey of the properties of materials in a vacuum, and of the instrumentation used for vacuum work.

SIP-24 LASER DEVELOPMENTS. Applications of lasers. Intended for the reader who wants to stay informed of what lasers can be used for without reading detailed research work in the field. New applications for lasers, state-of-the-art reports, surveys and bibliographies.

SIP-25 LASER RESEARCH. Exhaustive coverage of theory and experimentation related to lasers. Together with SIP-24, complete coverage of unclassified government reports on lasers is obtained, and there is excellent coverage of foreign work.

SIP-26 CRYOGENICS AND SUPERCONDUCTIVITY. Liquefaction processes, handling of cryogenic fluids, usually fuels or oxidizers. About half the reports identified deal with theory or applications of superconductivity.

SIP-27 LOGIC CIRCUITS. Reports deal with both electronic and fluidic circuits of the type being used in digital computers and, more broadly, in digital control systems.

SIP-28 INFRARED INSTRUMENTATION. A device-oriented profile which cites reports on instrumentation making use of the infrared portion of the electromagnetic spectrum. The profile has value for providing ideas for instrumentation in many areas--whether infrared radiation is employed or not.

SIP-29 PHOTOGRAPHY. The profile is designed to service people engaged in the development or modification of photographic equipment. Most applications are the visual records of testing, and also aerial photography. Photography appears to be used more in government-sponsored scientific work than is generally true in industry.

SIP-30 DISPLAY SYSTEMS. A profile to cite reports about the design and development of display systems, and also the unique materials used. Reports are usually concerned with reports employing cathode ray tubes, but systems for data printing, xerography, or optical projection are also discussed. Manufacturers of display equipment may be particularly interested.

SIP-31 DATA TRANSMISSION. Reports are selected for their general applicability to data transmission problems, and they generally discuss the transmitting of experimental data from remote locations, usually by telemetry, but sometimes by wire.

Table II-3 Con't.

SIP-33 RECORDING SYSTEMS. Data recording is the subject of most reports, and all kinds of recording instrumentation are discussed; magnetic systems predominate, but some reports also discuss graphic recording.

SIP-34 SEMICONDUCTOR DEVICES AND MICROCIRCUIT FABRICATION. This profile is primarily intended to service persons engaged in the design and fabrication of microelectronic components and devices. Reports discuss materials used, fabrication methods, and reliability testing.

SIP-35 MICROWAVE SYSTEMS. Development and design of microwave equipment, particularly for communication and radar. Microwave transmission technology.

SIP-36 RADIO ANTENNAS, TRANSMISSION AND PROPAGATION. The profile is intended to be of maximum benefit to persons concerned with commercial radio communications. Attenuation, noise, reflection, antenna design, refraction, information theory, signal reception and related topics.

SIP-37 RADIO COMMUNICATIONS EQUIPMENT. Most of the reports discuss components used in r.f. communications equipment, and the profile is intended to service persons designing and producing radio equipment.

SIP-38 RELIABILITY. The majority of reports discuss reliability in the design of products with a few reports on quality control in production. Electronic equipment is usually involved.

SIP-39 OPERATIONS RESEARCH. This profile is intended to service professionals in this field. Most reports are mathematical, and they are selected because they describe quantitative techniques of current interest in operations research.

SIP-40 COMPUTER INFORMATION SERVICE. Actual computer programs are announced by this profile. There are three to five per month selected for generality of application and completeness of documentation. Besides the programs, abstracts of reports on software are announced. All programs announced are available from the ARAC program library on cards or on tape.

SIP-41 PERSONNEL MANAGEMENT AND BEHAVIORAL SCIENCE. There are many reports pertinent to the behavior of man in an industrial work environment--both managerial and non-managerial. Most reports are at an advanced level so that persons deriving benefit are usually industrial psychologists.

SIP-43 BIOMEDICAL TECHNOLOGY. Instrumentation for medical uses, computer simulation of physiological processes, analyses of biomedical

Table II-3 Con't.

test data. The profile is intended for persons designing biomedical equipment or making extensive use of it.

SIP-44 RADIOBIOLOGY. The medical effects of radiation. Effects of radiation on tissue. Radiation therapy and use of radiation for diagnosis. Health physics. Chiefly intended for medical researchers.

SIP-45 TURBINE TECHNOLOGY. All reports dealing explicitly with gas or steam turbines and their basic components.

SIP-47 PROPERTIES OF CERAMIC MATERIALS. Physical properties, structural phenomena, and analytical methods for ceramics. Most reports deal with basic research, and the profile should chiefly interest firms doing development work with ceramic materials.

SIP-49 CONTROL SYSTEMS ANALYSIS. The theory and design of control systems, mathematical analysis techniques. Intended for scientists and engineers developing control systems for moving bodies.

SIP-52 SENSORY DEVICES FOR INSTRUMENTATION. Devices used to detect, observe or measure a physical property or quantity. Reports are excellent suggestions for ways to obtain measurements more accurately, more quickly or under more extreme conditions than has previously been possible. The profile is for those interested in instrumentation.

SIP-55 INDUSTRIAL SYSTEMS MANAGEMENT. Planning and control of manufacturing operation with emphasis on the use of computerized information systems. Articles are taken from both open and government literature. The result is a selected program of current reading directed toward managers in manufacturing firms. Minimum of mathematics.

SIP-56 RESEARCH AND ENGINEERING MANAGEMENT. Oriented towards managers of scientific and engineering activities. Articles are taken from both open literature and from government reports to provide the manager with a selected program of the best in current reading.

SIP-60 SPACE-AGE ENERGY SOURCES. A continuing review of the latest work on battery developments, fuel cells solar cells, thermionic power conversion, etc. The purpose of the profile is to keep the reader abreast of the latest developments in power sources and provide reports concerning directions of future work.

SIP-63 INDUSTRIAL MATHEMATICS. Reports will cover differential equations, applied complex variables, functional analysis, numerical analysis and statistics. Its purpose is to provide reports on mathematical techniques most applied in scientific and engineering work, and the persons most likely to benefit are mathematicians who are consultants to research or engineering groups.

Table II-3 Con't.

SIP-68 HEAT TRANSFER. The profile is intended for specialists in heat transfer problems. Theory and analyses of heat transfer, the interrelationships between materials properties and heat transfer, and heat transfer problems of unique nature.

SIP-70 HOLOGRAPHY. This area is growing in both popularity and volume of literature. Most reports are still basic research, but applications are increasing.

SIP-71 HUMAN FACTORS ENGINEERING. Reports are selected for the design engineer, discussing man-machine interaction, human responses to control systems, prediction of performance, error possibilities, and physical capabilities. The emphasis is on designing systems to fit human limitations.

SIP-73 ADVANCES IN GEOPHYSICS, GEOLOGY AND OCEANOGRAPHY. The profile is intended to service geologists engaged in work--either research or practice--related to oil and mineral exploration. Instrumentation is discussed, and the interpretation of subsurface structures by physical and chemical analysis.

SIP-74 MARKETING INFORMATION SERVICE. Most of the reports announced are from open literature. The profile provides a monthly review of selected reading for marketing executives and analysts, particularly those who are concerned with marketing technical products.

SIP-75 STRUCTURAL ANALYSIS TECHNIQUES. Reports are selected for mechanical and civil design engineers. Effects of mechanical and thermal loads on structures, stress analysis, creep and deflection of structure, computer-assisted design, and safety analysis.

SIP-76 PSYCHOPHYSIOLOGY. The profile is intended to service researchers interested in the interrelationship between physiological conditions and psychological reactions in humans. Testing systems for intelligence, fatigue, learning. Effects of drugs on psychological processes. Visual and auditory responses, perception, etc.

SIP-77 NEUROCHEMISTRY AND BIOCHEMISTRY. Of interest to research workers concerned with metabolism and biochemistry of the brain, blood chemistry, protein composition of man, or the effects of drugs on neural processes.

deemed to be of high potential for industrial application by both NASA and ARAC technical people. The purpose of this service is to generate new ideas and to expose company technical people to a broad cross-section of technology where industrial application seems imminent.

In terms of volume of reports requested, this service has been the Center's most productive one accounting for 32,878 requests for full reports. The service is particularly popular with smaller firms and the extent of usage of this service was hardly affected when ARAC switched from a blanket fee schedule to a unit cost fee schedule. Each mailing point for this service is \$50.00 annually with reports available at \$1.85 each.

MARKETING INFORMATION SERVICE (MIS)

Through the monthly abstracts, New Dimensions in Marketing Technology, outstanding articles are reported to member firms for help in problem-solving and in identifying new marketing opportunities. Full articles are supplied upon request, and additional, personal assistance is provided as needed.

Staff marketing specialists continuously search literature for new developments. Their inquiries cover such subjects as pricing, consumer behavior, credit, advertising, distribution, inventory, transportation, and forecasting.

Special emphasis is given to survey methods in market research and to quantitative techniques.

This service also fared quite well even though a charge of \$1.85 for full copies of reports is now included as well as a charge of \$80.00 for the announcement service.

COMPUTER INFORMATION SERVICE (CIS)

The Computer Information Service is designed to transfer the technology of new computer program developments to member firms.

An extensive range of computer programming activities operate continuously within the group of NASA contractors, other government sources, and numerous individuals that are willing to share programs they have developed for various reasons. From this vast source, only those programs are selected which seem to have potential for industrial application and are of a more practical nature.

A description of the programs considered most worthwhile by the Center's technical staff are sent to member firms each month. This announcement typically includes five programs and a number of abstracts of computer-oriented reports.

Throughout this process, the Center's computer systems group works directly with computer experts of member firms.

To date, a total of 826 programs, worth millions of dollars in developmental cost, have been disseminated to ARAC users.

III. Meeting the Market Test

There are a number of quantitative indicators that can be used in an attempt to access the success of a university-based Center at transferring technology. These indicators include such factors as number of profiles on line, number of retrospective searches performed in a quarter, number of document requests, etc. In attempting to measure the success of a university Center at meeting the market test, the task is not quite so straight-forward. Once again there are a number of "quasi-quantitative" indicators that may be used. These include number of user companies, and the willingness of member companies to renew their membership arrangement annually with the Center. An additional factor is introduced in accessing the success in this area in that originally the Center was established as an experiment in technology transfer which would charge users a fee to help cover the cost of providing service to them. Throughout the five-year history of the Center, the yardstick for measuring success underwent several changes. Finally the definition which has evolved is one which implies a Center that carries on transfer activity with a group of users such that enough income is generated to maintain its company operations and cover all costs incurred by the Center in all of its day to day operations including direct transfer activity, cost accounting functions, billing and invoicing, development of new transfer mechanisms, marketing activity, and promotional and public image type activities. This section of the report discusses a number of factors which influence the ability of a center, such as ARAC, to meet the market test according to the finalized definition stated above. It also discusses the particular successes experienced in the five-year history of the Center, a number of problem areas are identified, and some suggestions for future operation are also made.

One of the more quantitative ways of measuring success at meeting the market test is to look at the renewal record for member companies of ARAC. Table III-1 is a composite history of ARAC member companies throughout the five-year period concerned. It can be seen that during this time span a total of 85 different companies were at one time or another (or in fact still are) member companies of the Center. Of the 85, seventy still retain their membership with the Center. Fifteen firms have discontinued their membership arrangement over the first five years.

The data in Table III-1 are summarized in Tabel III-2. It can be seen in Table III-2 that ARAC started its operation in April, 1963, with 29 charter members. Of the original 29 charter members, 24 are still member companies with ARAC. In 1964, seven new firms became members of the Center. During that same year, three of the original 29 firms discontinued their membership leaving a net gain of four member companies during 1964. Overall, a 90% retention of member firms was experienced during company renewals that occurred in 1964.

In 1965, the Center added thirteen new firms. During that same year, two of the older members did not renew their membership giving the net result of 11 firms gained and a retention of 94% of the member firms. In 1966, eleven new members were added. However, in 1966 there were seven

TABLE III-1

COMPOSITE HISTORY OF ARAC MEMBER COMPANIES

FIRM NAME	1963	1964	1965	1966	1967	1968
1. ABBOTT LABORATORIES	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJ
2. AIR PREHEATER CO.					SXXXXX X	
3. ALLISON DIVISION - GMC	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	SXXXXXXXXXXXX	X
4. ANDREW CORPORATION	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	SXXXXX	XXXXXT	X
5. ARVIN INDUSTRIES	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
6. ASHLAND OIL REFINING CO.	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	SXX X	
7. BALL BROTHERS RESEARCH CORP.	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
8. BELL & HOWELL COMPANY			SXXXXX	XXXXXXXXXXXX		
9. BORG-WARNER CORPORATION					SXXXXX X	
10. BROOKSIDE CORPORATION			SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
11. CARBORUNDUM COMPANY	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
12. CINCINNATI MILLING MACH. CO.					SXXXXXXXXXXXX	X
13. CITIES SERVICE COMPANY			SXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
14. CLARK EQUIPMENT COMPANY					SX X	
15. COATS & CLARK INC.					SXXXXXX X	
16. CUMMINS ENGINE COMPANY	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
17. DALTON FOUNDRIES, INC.				SXXXXXXXX	XXXXXXXXXXXX	X
18. DELCO-RADIO DIVISION - GMC					S	
19. DELCO-REMY ENGINEERIG CTR.			SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
20. DELCO-REMY PROCESS ENGRG.			SXXXXX XXXXT	XXXXXXXXXXXX	XXXXXXXXXXXX	X
21. DIAMOND ALKALI COMPANY	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
22. DODGE MANUFACTURING CORP.				SXXXXXX XXXT	XXXXXXXXXXXX	X
23. ELI LILLY AND CO.	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
24. ESSO RESEARCH AND ENGR. CO.	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
25. ESTERLINE ANGUS INSTRUMENT CO.					SXXXXX X	
26. FRANKLIN ELECTRIC COMPANY		SXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
27. GENERAL ELECTRIC COMPANY		SXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
28. GENERAL TIRE & RUBBER CO.	SXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	X
29. GLIDDEN COMPANY	SXXXXXXXX	XXXXXXXXXXXX	XXXXXT			

S = Beginning of membership, X = Continuation of membership, T = Termination of membership

Table III-1 (Cont.)

COMPOSITE HISTORY OF ARAC MEMBER COMPANIES (Cont.)

FIRM NAME	1963	1964	1965	1966	1967	1968
20. B. F. GOODRICH COMPANY	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJ
31. GOODYEAR TIRE & RUBBER CO.			SXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
32. HARRIS INTERTYPE CORP.		SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
33. HARSHAW CHEMICAL COMPANY			SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
34. HEWLETT-PACKARD COMPANY			SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
35. HOBART BROS. TECHNICAL CTR.					SXX	X
36. HOFFMAN SPECIALTY MANU. CO.	SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
37. HOWARD W. SAMS, INC.	SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
38. INDIANA BELL TELEPHONE CO.	SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
39. IND. INSTRU. & CHEM. CORP.					SXXXXXXXX	X
40. INLAND CONTAINER CORP.	SXXXXXXXXXX	XXT				
41. INTERNATIONAL HARVESTER CO.		SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
42. INT. TEL. & TEL. - FED. LAB.				SXXXXXXXXXX		X
43. INT. TEL. & TEL. - IND. LAB.	SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
44. JENNAIR PRODUCTS CORP.			SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
45. KERR-MCGEE OIL INDUSTRIES			SXX	XXXXXXXXXX	XXXXXXXXXX	X
46. KIMBERLY-CLARK CORPORATION	SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
47. KURFEES PAINT COMPANY				SXXXXXXXXXX		X
48. LINK BELT COMPANY				SX	XXXXXXXXXX	X
49. MEAD JOHNSON & COMPANY	SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
50. MID-CONTINENT CARTON CO.	SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
51. MOBIL OIL CORPORATION	SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
52. NEW CASTLE PRODUCTS, INC.	SXXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	X
53. NIBCO, INCORPORATED						S
54. NORTH AMERICAN AVIATION, INC.			SXXXXXXXXXX	XT		
55. NUCLEAR-CHICAGO CORP.					SXXXXXXXXXX	X
56. OWENS-ILLINOIS, INC.			S	XXXXXXXXXX	XXXXXXXXXX	X
57. PENN CONTROLS, INC.				SXXXXXXXX	XXXXXXXXXX	X
58. PERFECT CIRCLE CORP.	SXXXXXXXXXX	XXXXXXXXXX	XT			

S = Beginning of membership, X = Continuation of membership, T = Termination of membership

Table III-1 (Cont.)

COMPOSITE HISTORY OF ARA-C MEMBER COMPANIES (Cont.)

FIRM NAME	1963	1964	1965	1966	1967	1968
59. POLLAK & SCAN	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJ
60. POTTER & BRUMFIELD DIV. - AMF	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXX X
61. P. R. MALLORY COMPANY	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
62. PROCTER AND GAMBLE CO.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXX	XXXXXXXXXX	XXXXXXXXXX
63. PUBLIC SERVICE INDIANA	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
64. PULLMAN STANDARD	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXX	XXXXXXXXXX	XXXXXXXXXX X
65. QUAKER OATS COMPANY	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
66. RADIO CORP. OF AMERICA	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
67. REGAN INDUSTRIES	XXXXXXXXXX	XXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
68. ROBERTS BRASS MFG. CO.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
69. ROBINSON-HOUCHIN, INC.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
70. SARKES TARZIAN, INC.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
71. SIGNAL OIL & GAS CO.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
72. SINCLAIR RESEARCH, INC.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
73. SKELLY OIL COMPANY	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
74. STEEL INDUSTRIES, INC.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
75. STEELCRAFT MANUFACTURING CO.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
76. STREETER-AMET DIV. MANGOOD CORP.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
77. SUN OIL COMPANY	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
78. SYSTEM SCIENCES, INC.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
79. TEXAS GAS TRANSMISSION CORP.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
80. TEXSCAN CORPORATION	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
81. UNION CARBIDE CORPORATION	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
82. WELCO INDUSTRIES, INC.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
83. WESTINGHOUSE ELECTRIC CORP.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
84. WHEEL-HORSE PRODUCTS, INC.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X
85. XEROX CORPORATION	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX X

S = Beginning of membership, X = Continuation of membership, T = Termination of membership

TABLE III-2

SUMMARY OF ARAC COMPANY MEMBERSHIPS

	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967*</u>
Member Companies at beginning of year	0	29	33	44	48
New Members added	29	7	13	11	25
Memberships terminated	0	3	2	7	3
Member Companies at year end	29	33	44	48	70
Net gain in Member Companies	29	4	11	4	22
Percent of Companies renewed	**	90%	94%	68%	94%

* Includes January, 1968

** 24 of the original charter members are still member companies.

CATEGORIZATION OF REASONS FOR MEMBERSHIP TERMINATION

CATEGORY	STATEMENT NOS.	TOTAL
Technological mis-match	9, 11, 12, 15	4
Firm changed to internal or other source	2, 5, 13, 14	4
Poor internal organization in firm	1, 7, 10	3
Company dissolved or sold out	4, 6	2
Financial reasons	3, 8	<u>2</u>
	TOTAL	15

DATA ON MEMBERSHIP LIFETIME FOR FIRMS TERMINATING

MEMBERSHIP DURATION	NO. FIRMS	
Less than 12 months	0	Average length of membership for 15 terminated firms was 20.1 months.
12 - 17 months	7	
18 - 23 months	2	
24 - 30 months	3	
More than 30 months	<u>3</u>	
TOTAL	15	

terminations of memberships resulting in a net gain of only four companies. It was during 1966 that most of the planning and cost-accounting to be used in formulating a new unit-cost fee schedule was accomplished. By this time, it had become obvious that a blanket-type fee schedule with a rather high entrance fee was not very acceptable to small and intermediate size firms. There was strong indication that these firms needed a unit-cost type of fee schedule that would allow them the flexibility to pick and select those services which would be of immediate importance and reject the majority of the older blanket package which had been designed primarily for larger, more technically sophisticated firms.

The unit-cost fee schedule designed on sound cost-accounting principles was put into effect during 1967. The results of the new fee schedule were rather dramatic. It allowed a total of twenty-five new firms to become members of the Center, more than double that in any previous year. Of the twenty-five new firms, the majority fell in the small firm category. Also, during 1967, forty-five of the forty-eight members in January of 1967 renewed their membership under the new fee schedule resulting in retention of 94%, which was also higher than any previous year. The composite history shows that 70 of the 85 members still retain their membership for an overall rate of 82% retention.

It is of interest to examine the reasons given by these fifteen firms for not renewing their memberships. These reasons are listed in Table III-3. Interestingly, not a single firm indicated it was unhappy with the quality of the service. The reasons for terminating seemed to fall into five different categories. These categories are listed in the second part of Table II-2 on page 22. The last part of Table II-2 gives data on the membership lifetime for firms terminating membership.

The reasons given for firms terminating provide some insight into problem areas where additional effort needs to be placed. Also, a number of other areas have been identified which seem to influence the ability of a university-based Center to meet the market test as an information Center dealing primarily with government report literature. These factors are discussed below.

User Education: Perhaps the most conspicuous factor which has bubbled to the surface during the five years of this experiment is the general lack of knowledge on the part of potential industrial users concerning the possible value or even the existence of services that may be obtained from outside sources. In an effort to combat this, ARAC has taken the following action over the past five years:

1. ARAC has answered some 2,741 mail inquiries from 1,907 different firms and organizations.
2. ARAC has given seminars, technical papers, or promotional presentations at 43 professional meetings, technology conferences, workshops, and similar meetings.
3. ARAC has sent unsolicited promotional information to some 4,000 different firms.

TABLE III-3

BRIEF SUMMARIES OF REASONS GIVEN BY FIFTEEN FIRMS
FOR TERMINATING MEMBERSHIP WITH ARAC

1. Insufficient engineer hours internal to the company to utilize ARAC output. Company very satisfied with ARAC services.
2. Corporate reorganization and establishment of a company "library" rather than technical information services.
3. This company maintained that taxes had already paid for the information and that they should not have to pay again. Stated otherwise, they either refused to recognize or could not recognize that the payment of fees was for the value added to the information by ARAC.
4. Upon death of the owner, this company was dissolved according to his last will and testament.
5. This company gained access to essentially the same data base as ARAC through government contracts in their Aerospace Division.
6. This company was bought out by another firm.
7. The person who coordinated the ARAC membership at this firm was retired from the firm and used by the firm on a quasi-consulting basis. This arrangement for retired managerial persons in firms is becoming more common. The coordinator was very far removed, both in interest and distance, from the actual users of the ARAC services. He decided not to continue the membership even though in several instances he had been informed via carbon copies of letters from users that the services had been of some value. An additional factor was involved because the primary users were in a subsidiary firm while the budget for information services is controlled at corporate headquarters.
8. Profits in this firm were down, there was a severe cutback in engineering staff, and the firm was exercising all possible economy measures.
9. Technological mis-match for this firm. The research center of the firm may renew later.
10. The coordinator and management at this firm refused to exploit and/or apply ARAC services. The interests of this firm are in areas where great potential for assistance by ARAC services exist.
11. No engineering talent in the firm. Technological mis-match.
12. This firm liked the type of services provided but wanted access to a more chemically oriented data base.
13. This firm felt that they might obtain similar services through their State Technical Services Agency.
14. This firm developed their own internal system with access to NASA tapes. Ironically, ARAC supplied the retrieval programs.
15. Insufficient technological mis-match was the reason given by this firm. Interestingly enough, a competitor of this firm recently gained a significant technical advantage because they were able to exploit a NASA innovation.

4. ARAC has held 17 meetings on the Indiana University, Bloomington Campus.
5. ARAC has had 12 open literature publications describing its operations and objectives.
6. ARAC has registered 34 reports in the government report literature.

However, these efforts by ARAC combined with those of NASA at headquarters still do not seem to be sufficient. A mechanism is needed whereby the technology transfer efforts of all organizations and agencies are publicized in a recurrent manner to create a national image for the RDC's and the concept of technology utilization and technology transfer.

Expansion of Data Base Used in Transfer Mechanisms: The original charter of ARAC called for the specific objective of transferring aerospace technology to the industrial sector of the economy. The technology generated from aerospace sources is certainly significant and a number of transfers from this source have been documented. There is no doubt, however, that certain disciplines or areas of technology are essentially non-existent in the aerospace literature. This is a natural consequence since in spite of the broad spectrum of aerospace technology there are still many areas of little or no interest to aerospace researchers and developers. Many of these missing areas, however, are of vital interest to the industrial sector. It was found that many firms like to be able to come to a single source, such as ARAC, for all of their technological information problems. Several firms listed the limited information base of ARAC as the reason for terminating their memberships (see Table III-3, page 24). Many firms have informed ARAC that this was the primary reason for not expanding their membership any further than had been done. Thus it turns out that in order to transfer aerospace technology effectively, ARAC needs to have a broader information base so that the broad spectrum of technology could be dovetailed with the aerospace portion and the confidence of the users would be gained. ARAC has addressed itself to this problem by expanding the base of coverage to include USGRDR and NSA in its regular transfer mechanism. Attempts are underway at the present time to gain access to some of the non-government files such as those of the American Chemical Society and Engineering Index, Inc.

University Environment: In general, some significant advantages have accrued in operating ARAC from a University environment. In the early stages, alumni and friends of Indiana University played a significant role in helping to identify and make connections with the original twenty-nine charter members. Throughout the history of the Center, the faculty and graduate students have been a vital source of technical manpower to ARAC. Conversely ARAC has helped to support graduate students on a part time employment basis, has helped serve the technical information needs of many faculty, has trained graduate students as information application engineers upon which several have based their careers, and is now playing an important role in providing automated library services to the university community. In many respects the ARAC experiment has been a textbook case of organizational symbiosis.

Quantitative Measures of Effectiveness: One of the problems which has been identified is that of attempting to put a dollar sign or other quantitative measure on the value of ARAC like services to a firm. Unlike a piece of hardware or a service contract, a firm must buy the services of a Center like ARAC strictly on the belief that there is a chance of gaining a real pay-off. Firms with progressive management recognize the value of "knowledge chunks" which ARAC can provide and, therefore, tend to retain ARAC services regardless of the particular profit cycle of the firm. Firms with less progressive management have a tendency to feel that the services of ARAC are not needed if profits are good at the moment. When profits are down, services such as those from ARAC, are usually the first to be eliminated from the budget of a conservatively managed firm. Unfortunately, this is the very time when this kind of service is needed most in order to stimulate new or better product, process, and development. In situations such as this, ARAC personnel are at a complete loss on how to quantitatively affix a value to the firm for retention or expansion of the service. Almost all firms agree that the services are a good thing to have, but the question of how much effort should be made still exists. A case very similar to this exists for libraries. Almost everyone agrees that libraries are useful and are necessary, but no one can do a meaningful cost/benefit analysis on operating a library or on retaining the services of an ARAC-like Center.

Reliability of the Source: Another comment which is sometimes heard from firms is that the government report literature does not constitute a so called "trusted source" in the eyes of many industrial scientists. The author is not in a position to judge the quality of government report literature, nor does he wish to pursue this point in any qualitative fashion. ARAC does not share this view point and can usually defend the quality of government reports to skeptics by producing a high-quality report in the specialized area of the critic.

Proliferation of Sources with Similar Services: During the five-year history of ARAC, a number of sources of services resembling those of ARAC have appeared. These include efforts of federal government agencies, especially those under the State Technical Services Act in the Department of Commerce. Eight other RDC's patterned after ARAC are now also offering similar services primarily regionalized to their section of the country. The prime market for ARAC-like services appears to be with firms that do extensive government contracting. However, these firms are not likely to come to ARAC since they receive similar services free because of their contractual relationship. During the past two years a number of commercial firms and several publishers have entered into new business ventures which closely resemble many of the ARAC operations. Much of this is desirable because it helps in the educational effort described above. However, each of these sources is vying for the same group of users. Experience has shown that the potential user of information services is indeed becoming a more sophisticated buyer. The only approach to take in this competitive spirit is to be certain that the ARAC staff maintains its position at the very forefront of technology and management in running a meaningful information center. Most recent additions to the ARAC list of users have elected to become associated with the Center after a careful review of the services available from a number of different sources.

Integration of ARAC with a Firm's Technical Information Center: Surprisingly, even moderate-sized firms find it necessary to maintain some sort of information facility to assist the firm's technical and managerial personnel in locating information relevant to current interests of the firms. These operations range in size from a portion of a single man's time to a multi-million dollar operation depending on the size of the firm. The approach taken by ARAC is to attempt to coordinate and integrate the Center's services with those of the firm's information center. In most cases, excellent rapport is established and the results obtained are substantial. A recent interview of ARAC users revealed several ingenious uses of ARAC services fashioned by people in various information centers of firms. These cases are being studied and documented by ARAC and will be made generally available to all ARAC users pending permission of the firms involved. Occasionally, however, the head of a firm's information Center views the availability of ARAC-like services as a threat to his position rather than an asset. An example of this is seen in the firm that made Statement No. 5 in Table III-3 (page 24). Approximately twelve months after this firm terminated their ARAC membership, they were contacted again by ARAC personnel with the specific objective of attempting to obtain cost figures concerning buying from ARAC vs. operating information services from the same data base on their own. The person responsible in this firm admitted that the direct cost of providing this service on their own was approximately seven times as much as the annual fee previously paid to ARAC. He further admitted that when indirect costs were included, the figure might be as much as eleven times greater. Yet he still refused to obtain these services from ARAC since it tended to dilute his position within the firm. Obviously, there are few rational arguments that can be made with a person who adopts this attitude.

IV. Summary

During the course of this experimental effort of transferring technology from a university-based center, two primary objectives have crystallized. The first objective was to transfer technology. A number of quantitative figures can be cited to indicate that at least reasonable success has been achieved. These include the following:

- 3,000 Custom retrospective searches performed
- 28,020 Current-awareness searches performed
- 32,878 Industrial Applications Reports disseminated
- 64,364 Technical reports disseminated
- 826 Computer programs transferred
- Numerous individual transfers confirmed and documented
- 133 Firms, organizations, and universities have used the services of the Center

The second general objective of the Center was to be able to meet the market test, i.e., generate enough income through its activity to support all of its operations. Once again, numerous data may be cited to indicate a reasonable amount of success toward meeting this objective. The most significant is that of the 85 firms with which the Center has had a formal membership arrangement, 70 still retain their memberships.

While both of these objectives certainly deserve merit, experience has shown that the two are not necessarily 100% consistent. Rather, it was found that some degree of overlap exists between the two major objectives and that in order to achieve optimum results, the Center has found it necessary to follow a path midway between the two. Examples of this can be seen in Table IV-1 and Table IV-2. For the first three and one-half years of this experiment, the primary effort was made at transferring technology. All services were very highly personalized (and thus expensive) and the tables indicate that activity skyrocketed.

In the middle of 1966, as the experiment drew to a close, greater and greater emphasis was placed on becoming self-sufficient. A cost-accounting study was done and fees were raised to a level that would cover all costs, assuming that activity remained at the previous level. The effect on the transfer activity level of the Center was drastic. Table IV-1 depicts the decrease in retrospective search activity during 1967 as the new fee schedule was introduced. The number of custom profiles (see Table IV-2) also decreased drastically. However, the simultaneous introduction of the lower-cost, less personalized Standard Interest Profile allowed this type of service to hold its own, and to some extent, even increase. Unfortunately, there was no low-cost replacement for the retrospective search and the numbers of requests decreased significantly. Essentially the same type of decrease was observed with other ARAC services.

Thus, users of ARAC services, to some extent, seemed to be willing to pay a fee sufficient to cover all costs involved but made only very reserved use of the personalized services at this price. It is unfortunate that the yardstick of self-sufficiency need be applied to this transfer experiment.

TABLE IV - 1

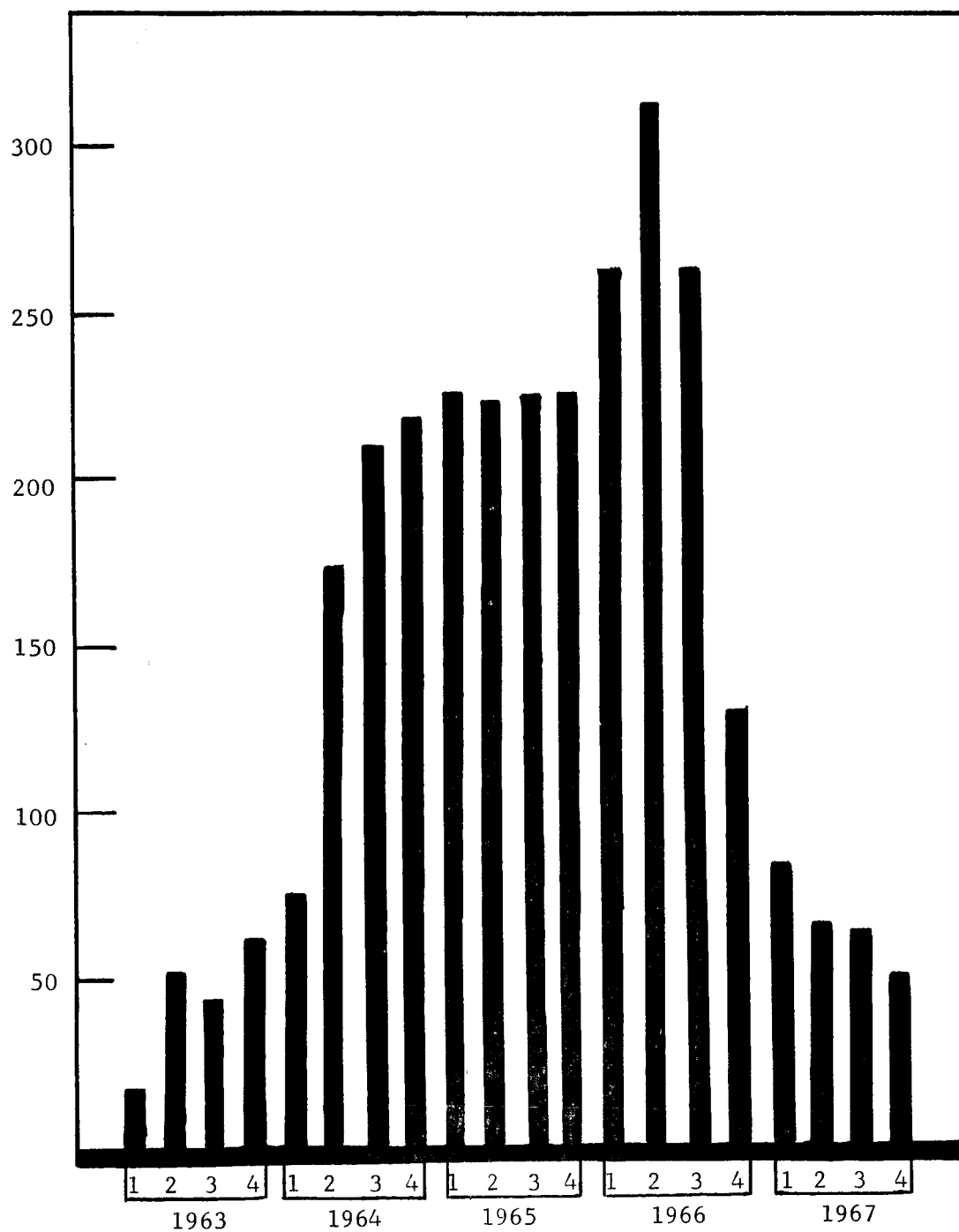
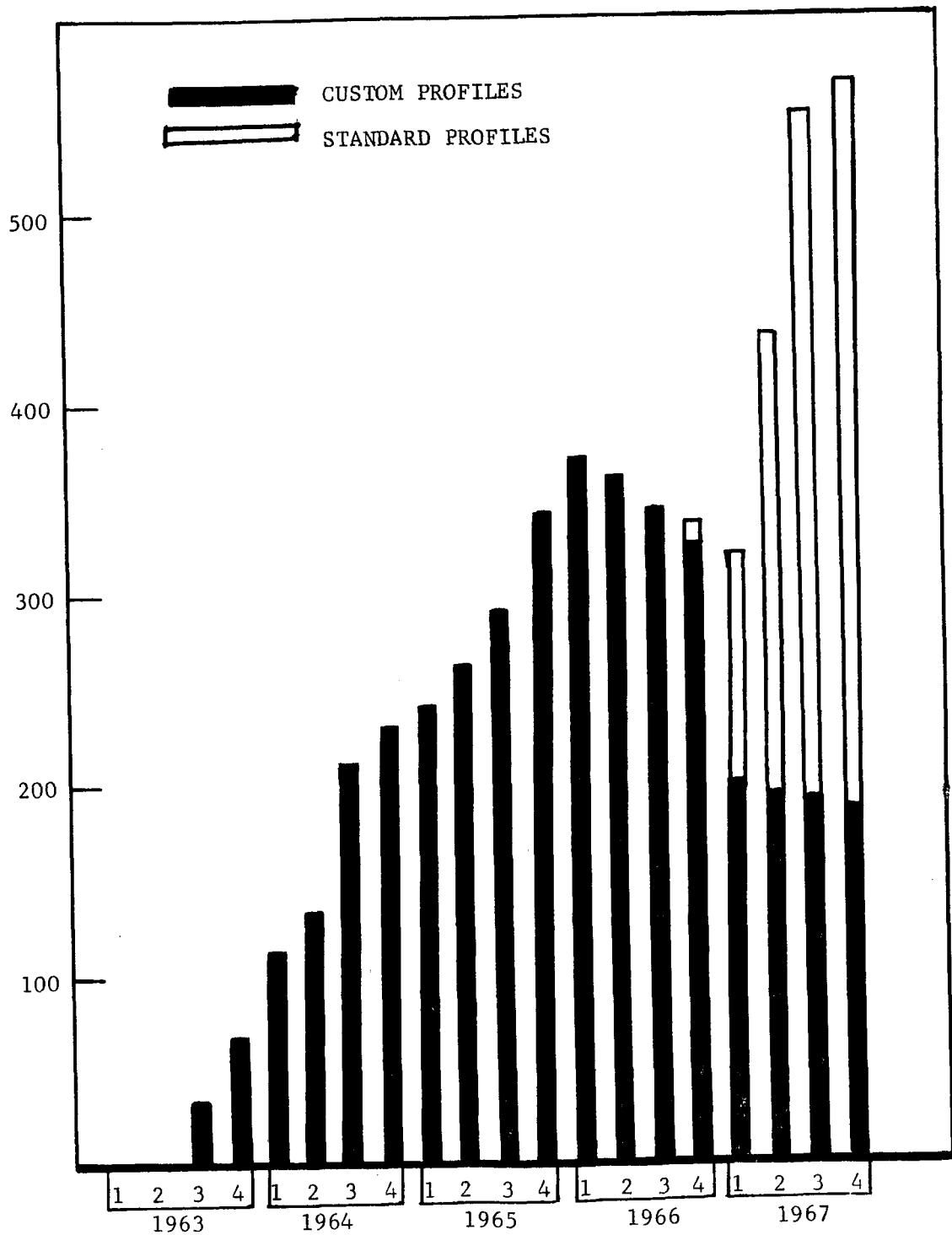
RETROSPECTIVE SEARCH REQUESTS
by Quarters

TABLE IV - 2

CURRENT AWARENESS PROFILES ON DISTRIBUTION
by Quarters



Evidence for this statement may easily be found by examining its effect on activity levels in Tables IV-1 and IV-2. There is certainly significant merit to the program, enough to warrant continuation and further effort based on what has been learned during the first five years. If the yardstick of self-sufficiency were applied to all government services and only those which met this criterion were continued, a large number of extremely useful services would no longer exist (the U. S. mail system for example).

The answer to meeting both the objective of transferring technology and becoming self-sufficient seems to lie in expanding the user base and in the use of standardized services. Naturally, customized, personal services should always be available for those that want them. But the lower-cost standard services are able to reach many more users.

As might be expected, the cost involved in serving an individual user is sensitive to the total number of users of the Center's services at any one time. Table IV-3 shows that the average cost per quarter to serve each firm decreased significantly during the five-year period. Part of the decrease was due to increased skills on the part of the Center's technical staff and management. The majority of the decrease must be attributed to the expansion of the number of users. On the other hand, the number of dollars that firms put in their budgets for the purchase of ARAC-like services tends to remain relatively constant regardless of the cost for such services. The slight decrease in average fee paid per company per quarter can be attributed to the increasing percentage of small firms that subscribe to ARAC services. These smaller firms require smaller memberships with correspondingly smaller fees. Nevertheless, the plot which depicts the average fee paid per firm per quarter is remaining relatively constant (lower curves in Table IV-3). The plot (upper curve in Table IV-3) which depicts the average cost for ARAC to serve each firm per quarter continues to decrease as the number of users is increased. Unless an unexpected perturbation occurs in either of the two plots, the curves will eventually intersect each other at some point in the future when the user base has been sufficiently expanded. Obviously, when this crossover occurs, the Center will be completely self-sufficient.

TABLE IV - 3
TREND TOWARD SELF-SUFFICIENCY

