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A DDC BIBLIOGRAPHY ON

COST/BENEFITS OF TECHNICAL INFORMATION SERVICES AND TECHNOLOGY TRANSFER

DDC-TAS-68-29

JULY 1968

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DEFENSE DOCUMENTATION CENTER
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for
SCIENTIFIC and TECHNICAL INFORMATION
Cameron Station, Alexandria, Virginia 22314

P R E F A C E

1. This bibliography resulted from a special request and is a compilation of literature existing in both the government and public sectors and concerning cost-benefits of technical information services and technology transfer. The present volume cites more than 200 references reflecting the growing involvement of the research and development community in this subject area. Time prevented the assembly of a truly comprehensive listing, but numerous sources of information were consulted. It is being released now to serve as a possible starting point for a more complete survey.

2. Part I, Technical Information Services, is arranged in four sections by source.

   a. Department of Defense

   b. Federal (non-DoD) and State Services

   c. Commercial and Non-profit Organizations and Universities

   d. General

3. Part II, Technology Transfer, is similarly arranged by source.

4. Within each source, for both parts, references are arranged in chronological order by date. Three indexes, Corporate Source, Personal Author and Title, are appended to facilitate access to references.

5. With respect to the cost-benefits aspects, not only was the cost-benefit to the user reflected, but consideration was given to the initial cost of information collections, the cost of processing the information and the cost of the flow of this information to the user. Costs are incurred at every step of processing while cost-benefits result only from utilizing the system output. Cost-benefit was therefore considered as a trade-off between the expenditures for processing services and the benefit to the user. Such benefits may, of course, be either tangible or intangible. Technology transfer was considered as the communication of technology from one field to another for practical use.

6. The bibliography was developed as follows:

   a. An in-house search was made of the DDC document collection.

   b. Searches were requested of other government and non-government agencies.

   c. Discussions were conducted with key documentation or

information system personnel of several government and non-government agencies.

d. In-house searches were made of open literature available in the DDC and DSA libraries.

e. Visits were made to the Library of Congress and to Northwestern University to review their collections of open literature.

f. References were reviewed, assessed and then selected only when they were pertinent to a specific subject area. The annotations may or may not have been prepared by the Defense Documentation Center, since in many cases the quality of the author or source abstracts could not be improved.

7. References are included from the collections of NASA, AEC, CFSTI, HEW, SIE, Library of Congress, Battelle Memorial Institute and Northwestern University. The helpful and effective assistance of these organizations is gratefully acknowledged. Special recognition and thanks are accorded to Dr. Albert Rubenstein and Mr. Charles Thompson of Northwestern University, and to Mr. R. G. Bivins, Jr. of the Technology Utilization Division, NASA.

8. Those seeking copies of reports should do so from the cited agencies, corporate sources, the Clearinghouse for Federal Scientific and Technical Information, or through accession channels normally used in acquiring documents.

BY ORDER OF THE DIRECTOR, DEFENSE SUPPLY AGENCY

OFFICIAL

Robert B. Stegmaier Jr.

ROBERT B. STEGMAIER, JR.
Administrator
Defense Documentation Center

TABLE OF CONTENTS

I. Technical Information Services

A. Department of Defense

TITLE: The Value of Information in Decision Making

AUTHOR: Thornton Page

SOURCE: Proceedings of the First International Conference on Operations Research

DATE: 1957

ANNOTATION: An effort has been made to derive the value of military information empirically and semi-quantitatively by reference to decisions actually made during a large ground-air field maneuver. The timeliness of the information received was analyzed.

CORPORATE AUTHOR: The Johns Hopkins University Operations Research Office

TITLE: Defense Spending and the U. S. Economy, Volume 2, Appendices A-J and L-P

AUTHOR: Leon N. Karadbil, et al

DATE: May 1958

ACCESSION NUMBER: AD-204 086

ANNOTATION: This document contains the follow appendices: Pages

(B) Army R and D Projects Having Civilian Applicability 288

(C) Navy R and D Projects Having Civilian Applicability 127

(D) Air Force R and D Projects Having Civilian Applicability 22

(E) The Office of Technical Services, by Leon N. Karadbil 26

(F) Patents in Military in R and D, by Tupper 34

(N) Alternative Approaches To The Study of The Impact Of Military R and D Upon the Civilian Economy, by Sydney G. Winter

(O) Some Analytical Problems Concerning Defense Expenditure Costs, Benefits and Economic Impacts, by Herbert E. Striver 15

(P) The Economic Growth Stimulus and Other Ancillary Benefits Of Defense Spending, by Frank Pace

CORPORATE AUTHOR: Naval Ordnance Laboratory, White Oak, Maryland

TITLE: A Plan to Reduce Costs of Technical Library Operations in the DoD

AUTHOR: E. H. Langenbeck

DATE: 1961

ACCESSION NUMBER: NOLTR-61-102 (AD-262 935)

ANNOTATION: This document proposes the establishment of a cooperative system of cataloging DOD, NASA, AEC, and their contractors' reports (includes about 90% of the reports received by DOD libraries) at the point of origin. Thus the cost of cataloging, 60% of the total cost of handling a report, might be considerably reduced:

Cataloging cost under present practices....	$954,000.
Cost of cataloging own reports, as proposed in this plan.....	31,000.
Savings per year by elimination of duplication of effort of cataloging.....	$923,000.

The originating activities know best what is important in a report and should be in a position to do the best job. One suggestion is a standard library information page to be a part of each report originated. These costly operations will then be eliminated for the receiving libraries.

CORPORATE AUTHOR: The School of Logistics
Air Force Institute of
Technology Air University

TITLE: An Analysis of the Davis-Gram
Engineering Data Management.
An Advanced Logistics Report

AUTHOR: Frank T. Watrous, Ben F. Peake,
Barrett F. Pulham

DATE: September 1, 1962

ACCESSION NUMBER: AD297519

ANNOTATION: The purpose of this study is to weigh the advantages and disadvantages and discuss the various management objectives for engineering data, together with the various considerations involved, under a prime contractor operated depository; and the United States Air Force Central Engineering Data Depository.

Together with representatives of the USAF Central Engineering Data Depository (hereafter referred to as Depository) an attempt was made to determine the various facets of the Depository operation such as: (1) The cost to the Air Force of preparing a microfilm frame of data and related information received from a contractor for use in the master files; (2) the average cost to the Air Force to reproduce and distribute an aperture card or duplicard; and, (3) the cost to maintain the Depository files.

CORPORATE AUTHOR: Operational Applications Laboratory, Electronic Systems Division, Air Force Systems Command, United States Air Force, L. G. Hanscom Field, Bedford, Massachusetts

TITLE: Information Acquisition In A Pattern Identification Problem

AUTHOR: Susan Goldberg and Thornton B. Roby

DATE: July 1963

ACCESSION NUMBER: AD-412 275

ANNOTATION: Information acquisition is an important factor in decision making. Two experiments are reported which investigate information-seeking behavior under various conditions: (1) Information storage - the means of ''storing'' (keeping track of) information; for example: memory, pencil and paper, visual display; (2) Information density - how much information was given and how it was distributed in time and/or operations; (3) Information cost - the extent to which subjects' expected gain was a function of information seeking. Findings may be summarized as follows: (1) Individuals differ in sensitivity to conditions of cost, storage, and information demands as well as in the strategies they adopt; (2) Transmission of information of information is affected by rate of presentation. Although not statistically significant, high density presentation results in more efficient performance than low density presentation; (3) Lowering costs of information tends to increase information seeking responses up to an asymptote determined by the amount of information required; and (4) While storage seems theoretically important as a variable, storage effects were not significant for either experiment. (Author)

TITLE: DoD Scientific and Technical Information Program

AUTHOR: Walter M. Carlson

SOURCE: Proceedings of the Air Force Second Scientific and Technical Information Conference, 28 Through 29 April 1965, pp. 5-10

DATE: September 1965

ACCESSION NUMBER: AD-621 800, pp. 5-10

ANNOTATION: In the time allotted, I wish to review what we may have learned about "The Cost of Not Knowing" since I last talked to you, where we stand to day on management attitudes toward information transfer, and how we are organizing in OSD to deal with the full spectrum of scientific and technical information problems facing DoD.

As most of you are well aware, it is my firm conviction that we have entered an era in which information, must be considered as a resource in the same sense that men, money, and facilities are considered resources. This concept of information as a resource has a host of difficulties tied to it. New patterns of management thinking are required. Measuring tools must be developed and provided. Guideposts must be developed and provided. Guideposts must be erected to tell whether production and consumption of information is beneficial or deleterious to the organization's objectives, and consistent quality standards are needed for the processes by which knowledge is transferred from the person who has it to the person who needs it to improve the quality of his decisions. What is holding us back in evaluating what we already have in the way of information systems and in justifying proposals for new information systems. I think we are held back by our unwillingness to come to grips with the cost of not knowing. There is no cost sheet or accounting record in existence today to give us a handy report on the cost. We are too firmly bound in our management traditions to make the effort that is needed to create the new procedures which are essential to finding the cost of not knowing. It is time that we seek ways to break the bonds of these old accounting traditions and look at what the concept of information as a resource can do for us.

The scientist, engineer, or manager who is about to start a new research project is doing so because he does not know something and wants to find out what the answers are. In a very direct and pragmatic sense, his cost of not knowing is merely the cost of the research project. In a

broader sense, the cost of not knowing may be much higher, but let us consider only the lower and more tangible cost. In addition, to the resources of manhours, money, and facilities at his disposal, he also has a hugh information resource at his disposal, too. While he may not know the answer, there may be someone else who does, and that someone else may even have published the answer.

Now the problem becomes more complicated. How much of the research project's proposed costs should be allocated to finding out if someone already has the answer. How much of the resources being committed in the form of men, money, or facilities can be directed to finding an information resource that may or may not already exist. I suggest that there are formal methods that can be developed for engaging in this form of analysis, and I suggest that our management of research and development will become much more efficient when we approach the cost of not knowing in a more forthright manner. (Author)

CORPORATE AUTHOR: Air Force Systems Command, Washington, D. C.

TITLE: Technical Information Analysis Centers

AUTHOR: Edward Dugger

SOURCE: Proceedings of the Air Force Second Scientific and Technical Information Conference, 28 through 29 April 1965, pp. 28-33

DATE: September 1965

ACCESSION NUMBER: AD-621 800, pp. 28-33

ANNOTATION: Depending, of course, upon the state of knowledge on the operation of information centers, it may be a year or more before there is meaningful output from the center. Once the output starts, however, if the center is indeed one that meets the needs of the specialized scientific and technical community, the costs to operate will tend to increase. The reason for this is quite simple. The number of inquiries that the center receives will increase and the cost of answering them is not cheap. Let met give you three examples. The Mechanical Properties Data Center in its first year of operation had only 20 technical requests, this increased to 43 in its second year, 147 in its third, 200 in its 4th and is now at a rate of 400 per year. The cost per request has averaged between $150 to $200 during this time showing an increase of from $4000 to $80,000. The Electronics Properties Information Center in its first year of operation had 50 questions at an average of $300.000/question; in its second year, 105 questions at about the same rate and in 1964 had 250 questions at about $260/question showing a change from $15,000 to $75,000. From these two instances it can be seen that in the last three years, the inquiries have more than quintupled with either a rather constant level or slight decrease of cost per inquiry, but with a tremendous increase in total cost. The third example reflects an inhouse operation, namely the Aerospace Materials Information Center in which technical inquiries have expanded from 85 in 1962 to 277 in 1964 again emphasizing the fact that as centers operate more fully the services will be used more with consequent rise in operational costs.

These examples do not take into account other types of output that a center may produce such as state-of-the-art reports or data sheets all of which also have attendant rising costs.

In short, allowance must be made for the expanding services of any centers.

CORPORATE AUTHOR: Air Force Systems Command, Washington, D. C.

TITLE: Technical Data Management

AUTHOR: Lt. Col. V. G. Work

SOURCE: Proceedings Of The Air Force Second Scientific And Technical Information Conference, 28-29 April 1965, pp 33-37

DATE: September 1965

ACCESSION NUMBER: AD-621 800

ANNOTATION: The total costs of the NASA Selective Dissemination of Information (SDI) System are the costs of developing such a system and include much of experimentation which normally would not exist in an on-going system. Nevertheless, they are indicative of what to expect. At present the Air Force cost is about $300 per user. It would not be unrealistic to expect that an on-going system would cost about half as much or $150 per user.

This is still a tidy sum of money if one considers a service for let's say 1000 individuals; a sum of $150,000 is nothing to sneeze at and must be justified. This justification can make sense only in terms of the margin of benefits to be derived from such an investment. At the moment we don't have a good handle on this aspect; we do have, however, indications that the service can save as much as 10% of the scientists time. Translating this saving into dollars it means that an investment of $150,000 can release some $1,500.00 of productive labor to more intellectual tasks; or another way, 1% of an average salary of say $15,000 when it is spent for SDI this will save 10% of the users time.

In the world of business, a return of 20% is considered a success. A 1000 percent return on the investment in SDI, therefore, seems to be a good proposition.

Now where do we go from here. What are the future prospects.

We intend to continue exposing the Air Force to this new methodology. OAR has programmed funds to continue the SDI operation through FY 1966. During this time we intend to refine the profiles and stabilize the

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methods and operations so that a realistic cost figure can be obtained.

It is hoped that the knowledge and cost information developed will justify development of a total Air Force SDI System. More Air Force Headquarters involvement in SDI, will highlight this portion of the STINFO program, and its relation to the Scientific and Technical library. Eventually we hope the Air Force will have an SDI operation which uses a data base covering all of their interest areas.

We also hope to use the concept for a selective announcement system for our own OAR product--the research report. At present we are negotiating for the task of profiling some 3000 to 3500 individuals and 200 to 250 groups. With these interest indicator words in our data store we can match them with the keywords on the form 1473, (which as you know as the DoD bibliographic control form) this match will allow us to selectively distribute the report, a copy of the 1473, an abstract, or just titles to those needing the information.

The Air Force has had 200 scientists, engineers, and managers involved in the NASA SDI program for almost a year. I believe we are achieving the SDI objectives of 1st, demonstrating the feasibility; 2nd, building an Air Force capability; and 3rd, getting some feel for manpower and dollar costs. We have identified the major problems as getting hard copy and profile maintenance. The program in general is well accepted, and shows definite promise for continued development.

That's the picture of Air Force involvement with NASA on SDI, and though just a prelude to better things to come, it is working, it is being used, and it is thwarting paper pressure now.

TITLE: System Effectiveness Assurance in Response to DoD/NASA Requirements

AUTHOR: Leslie W. Ball

SOURCE: Society of Automotive Engineers, Aeronautics and Space Engineering and Manufacturing Meeting, Los Angeles, California

DATE: October 1966

ANNOTATION: Outline of the technical segment of cost, schedule, and technical assurance in regard to DOD/NASA requirements. The major techniques for assuring that the resources, in the form of documented technology, facilities, and qualified people, are available for each critical activity. Program management techniques for assuring that these resources are applied to each project in accordance with cost effectiveness principles are summarized.

CORPORATE AUTHOR: Bunker-Ramo Co., McClean, Virginia

TITLE: A Parametric Approach To The Evaluation Of Military Information Systems

AUTHOR: J. C. Grimberg

DATE: November 1966

ACCESSION NUMBER: AD-652 692

ANNOTATION: This report documents the second part of a research study about a parametric approach to military information systems evaluation by cost-effectiveness analysis.

In this approach, the effectiveness of such an information system measured by its impact on the military operation using it.

Five significant parameters through which an information system affects the effectiveness of military operations are defined parametrically. Part I is the first of three and covers the general approach and two of the significant parameters in detail. This report covers the remaining three parameters and the synthesis of all five into a composite effectiveness measure.

Both Parts I and II restrict the discussion to an unsophisticated military operation to simplify the exposition. Part III will extend the application to any type of military operation.

In performing the work it has been found necessary to define five significant parameters, viz, promptness, dependability, brevity, perspicuity, and discriminance in order to make them unambiguous and measurable. They roughly substitute for the more commonly discussed characteristics of timeliness, accuracy and completeness to which sometimes is added relevance, which were not found as manageable to this type of treatment.

CORPORATE AUTHOR: Tactical Planning Division, Directorate Of Planning And Technology, Electronic Systems Division, Air Force Systems Command, United States Air Force, L. G. Hanscom Field, Bedford, Massachusetts

TITLE: Phase II. Final Report On Use Of Air Force ADP Experience To Assist Air Force ADP Management. Volume I

AUTHOR: Alan J. Gradwohl, et al

DATE: December 1966

ACCESSION NUMBER: AD-646 867

ANNOTATION: The handbook would be used by high-level Air Force management in reviewing proposals for new automation. These proposals would contain requirements for the new ADPS, expressed in terms of workload descriptors, and estimated costs and development times. Relevant costs and development times from Air Force ADP experience would be retrieved from the handbook with the aid of the workload descriptors from the proposed ADPS. The proposed costs and development times would be compared with retrieved costs and development times to determine whether relevant evaluations and problems would be retrieved from the handbook and factored into the comparison. Results of the comparison would then be weighted against Air Force criteria for acceptance or rejection of new automation.

CORPORATE AUTHOR: Tactical Planning Division Directorate Of Planning And Technology Electronic Systems Division, Air Force Systems Command, United States Air Force. L. G. Hanscom Field, Bedford, Massachusetts

TITLE: Phase II. Final Report On Use Of Air Force ADP Experience To Assist Air Force ADP Management. Volume 3. Concept And Plan

AUTHOR: Wolford O. Wootan and Alan J. Gradwohl

DATE: December 1966

ACCESSION NUMBER: AD-646 868

ANNOTATION: Four areas are discussed and can be classified broadly as scope; information flow; personnel requirements, both at Headquarters, USAF, and in the field; and computer requirements for operation of the system.

Presented is the over-all information flow of the proposed ADP Management Information System. The great bulk of data enters the system in the form of periodic reports from ADP users in the field. The frequency of reports should be monthly for most items, but could be stretched quarterly (and even semiannually or annually) for some of the less volatile items. The content of the experience reports will require an additional effort of 100 man-years per year (over and above that to be expended in 1968) at Headquarters, USAF, by 1973.

This effort will be required to handle the growing workload of reviewing and approving ADPS proposals; budgeting, reviewing, and controlling current developments and operational systems; and preparing special reports.

Figure 7 presents a summary of the benefits and costs of the proposed ADP Management Information System. It can be seen that development of the MIS could result in a reduction in personnel costs of some $600,000 per year by 1973. This, of course, must be balanced against the cost of developing and operating the Management Information System, as discussed in the next subsection.

MIS Development and Operating Costs: The cost of developing the MIS, including initial training and orientation of appropriate Air Force personnel, would be approximately $480,000 spread over calendar year 1967 and the first half of 1968. This includes $465,000 for implementation and training efforts and $15,000 for

computer time for program checkout and system test. As shown in Figure 7, the cost of operating the system (operations beginning in mid-1968) will rise from about $101,000 in 1968 to about $293,000 in 1973. The operations cost includes data base maintenance at Headquarters, USAF; experience reporting efforts by ADP systems in the field; and asset reporting efforts by data processing installations in the field.

The total development and operating cost over the next 7 years is, then, approximately $1,847,000. The estimated cumulative saving over the same period is about $1,990,000. In other words, the system should pay for itself in less than 7 years, not even considering the more intangible benefits resulting from increased quality and better controls over ADP system development. The big payoff of the MIS, however, will come in the field, where the dollars saved by the Headquarters personnel reduction could be absolutely dwarfed by the dollar induction achieved through better ADP measurement.

Cost Detail: Table 7 shows the cost detail used to arrive at the figures presented previously. Included are the costs of development and operation of the Air Force ADP Management Information System and benefits of a resulting personnel reduction at Headquarters, USAF. All costs, of course, must be considered only as budgetary estimates, and are subject to the assumptions made.

CORPORATE AUTHOR: Planning Research Corp., Los Angeles, Calif., Information Systems Div.

TITLE: Air Force ADP Experience Handbook (Pilot Version)

DATE: December 1966

ACCESSION NUMBER: AD-646 863

ANNOTATION: The Experience Handbook is used to evaluate a proposed ADPS in two major steps. The first step involves the comparison of proposed cost factors such as man-months of development effort with estimated cost factors obtained through use of cost estimation iso-graphs. These iso-graphs are graphical representations of cost estimation equations derived from sampled data on 18 Air Force ADP systems. Subsection I.A. describes the use of these iso-graphs.

The second step for use of the handbook involves reviewing the proposed hardware, software, development plan, file conversion plan, etc., in light of experience gained by the Air Force in the development and operation of 18 ADP systems. The experience information is retrieved from 18 system descriptions through the use of 12 indexes. Subsection I.B. describes use of these indexes for retrieval of experience information, while subsection I.C. describes the format and contents of the experience information in the system descriptions.

Cost Estimation

I. Description of Iso-Graphs

Five sets of iso-graphs representing the five cost estimation equations and their respective intervals are available for cost estimation. These sets of iso-graphs are identical in structure and are contained in Section II. Each set is used for determining three expected values for a cost factor. Cost factors that may be estimated are as follows:

Development Cost
1. Man-months of development effort

Operations Cost
2. Number of program maintenance personnel
3. Number of operations personnel
4. Dollars per month of hardware cost for application production
5. Dollars per month of hardware cost for program maintenance

The workload descriptors from the ADPS proposal are used for determining cost from the iso-graphs.

CORPORATE AUTHOR: Air Force IDEP Office, Los Angeles, California

TITLE: Interagency Data Exchange Program Cost Savings Report: 1966

DATE: January 1967

DISTRIBUTION/AVAILABILITY STATEMENT: Copies available from Army/Navy IDEP Office (AMSMI-RBP), Redstone Scientific Information Center, Redstone Arsenal, Ala. 35809.

ANNOTATION: This document lists the savings realized by organizations through the use of the Interagency Data Exchange Program during calendar year 1966. Cost avoidances include man-hours converted to dollars and all other savings. Due to the possibility of the money being put to use on other project requirements, these savings may not result in an over-all project reduction.

CORPORATE AUTHOR: Office of Aerospace Research, Arlington, Va.

TITLE: The Office of Aerospace Research Scientific & Technical Information Program

AUTHOR: Currie S. Downie, Thomas T. Luginbyhl, Alexander G. Hoshovosky & Carlton M. Smith

DATE: March 1967

ACCESSION NUMBER: AD-656 694

ANNOTATION: The document outlines the mission and organization of the Office of Aerospace Research (OAR), then describes how its principal product, scientific and technical information is disseminated through its various publications. The magnitude of OAR's research in Information Sciences (approximately 15% of total Federal expenditures in this area) is compared to that of other governmental agencies. Savings of over $3.5 million, resulting from an effective technical information program, are documented by examples. The role of the Office of Scientific and Technical Information within OAR as performed by the 16 personnel assigned is described in terms of its four divisions; Publications, Information Studies, Programs, and Executive. It is suggested that the most pressing problem facing the DoD Technical Information Program is the absence of integrated, DoD-wide planning efforts with the active participation of the three services and various DoD agencies. Planning conferences are needed to improve the organization structure and co-ordinate the future activities of the program. The classical functions of Management -- planning, organizing, etc. -- should be reviewed to determine whether they are being adequately emphasized and implemented throughout DoD in the Scientific and Technical Information Program. (Author)

CORPORATE AUTHOR: U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Virginia

TITLE: An Approach To Cost Effectiveness Of A Selective Mechanized Document Processing System

AUTHOR: Carlos O. Segarra

DATE: March 1967

ACCESSION NUMBER: AD-651 486

ANNOTATION: The purpose of this project was to identify and define the parameters of an economical and practical information system for the U. S. Army Engineer Research and Development Laboratories. The program included four phases: data requirements definition; cost analysis and system definition; hardware selection; system test and evaluation; and development of software. The method of approach for each phase is given, and the procedures used and decision criteria developed are discussed. Results of decision to mechanize operations in the information center lead to the selection and installation of four machines, all components of the IBM 870 Document Writing System, within a rental budget of $7,000 per year. Results of mechanizing, after operation for one year, included: reduced processing costs by rejecting reports having no relevancy to on-going tasks; eliminated the need for overtime required under manual conditions; reduced actual processing costs of documents; reduced processing time per report from 75 days to 5 days; and relieved staff of routine clerical workloads, thereby extending their capacity to optimize other information functions.

CORPORATE AUTHOR: Air Force Systems Command, Washington, D. C.

TITLE: Cost Reporting For Development of Information Processing Systems

AUTHOR: Edward A. Nelson

DATE: April 1967

ACCESSION NUMBER: AD-657 793

ANNOTATION: This report describes a system for the collection and reporting on data on the resources expended in the production of computer programs. The system is intended to: (1) provide information to facilitate management control during the progress of a computer programming effort; (2) build a data bank from which better cost-estimating relationships and planning tools can be developed; (3) accomplish the above with a minimum of interference with operating personnel. The report was designed to provide sample materials necessary for the implementation of cost reporting in any organization in which computer programming is performed; it includes a description of the steps that constitute the computer programming process, the kinds of personnel who would be involved in the cost-collection and -reporting system, a recommended work flow and suggested forms for use in data collection and reporting, a work breakdown structure for associating costs with activities, and a brief discussion of the relationship of this system with several existing Department of Defense management procedures. (Author)

CORPORATE AUTHOR: Office of Aerospace Research, Arlington, Virginia

TITLE: Selective Dissemination of Information In Practice: Survey of Operational and Experimental SDI Systems

AUTHOR: Alexander G. Hoshovsky and Currie S. Downie

DATE: September 1967

ACCESSION NUMBER: AD-668 072

ANNOTATION: The primary purpose of the report is to present an overview of the operational and experimental systems established for the selective dissemination of scientific and technical information. Secondarily an attempt has been made to identify the trends which may shape the future development of the selective dissemination procedures. The report is based in part on the existing SDI literature and in part on the results of two recent surveys. The combined results indicate that there are approximately 45 SDI systems in various stages of operation, serving an approximate population of 30,000 users. The largest system processes as many as 30,000 entries per month, while the smallest runs no more than 150. AEC, NASA and DoD are the three largest processors. Operating costs are in the vicinity of $100 per user with the degree of literature coverage. There seems to be no correlation with the precision of matching. The observable trends are toward the efforts of capitalizing on products from large systems, toward an increased use of group profiles and toward commercial subscription services. (Author)

CORPORATE AUTHOR: Defense Ceramic Information Center
Battelle Memorial Institute,
Columbus, Ohio

TITLE: Value of the Databook Engineering Properties of Ceramics

AUTHOR: Winston Duckworth

DATE: January 1968

ANNOTATION: A sample of 40 recipients of the primary distribution of the Databook was surveyed to obtain an indication of the book's value. A 95% response was obtained to the survey questionnaire. The respondent's estimates of time conserved in information retrieval through use of the Databook totaled over 5,000 manhours each year, which are worth approximately $60,000. Considering that 1680 copies of the Databook have been distributed, an extrapolation of this savings gives a value of $2.5 million for the book and an annual return of over $33 per dollar spent. For DoD programs alone, the estimated return on investment is at least $6 per dollar spent.

CORPORATE AUTHOR: Army/NASA IDEP Office, Redstone Arsenal, Alabama

TITLE: Interagency Data Exchange Program Valuation Report - 1967

DATE: 1968

ANNOTATION: This report describes the participating members IDEP valuation during calendar year 1967.

The following excerpts from other benefits reported by participants are listed: (1) Establish vendor capability and selection; (2) General application information; (3) Failure mode information; (4) Very useful for non-standard parts approval; (5) Weed out potentially weak parts/components; (6) Monitoring contractors parts selections; (7) Select reliable parts when no test money or facilities are available; (8) Engineering and design information; (9) Guide to test planners and test methods; (10) Assistance in writing specifications; (11) Assistance in system analysis prior to design definition; (12) Selection of alternate vendors; (13) Verification of results of own testing; (14) Materials and process information; (15) Assistance in failure analysis and corrective action; (16) Backup data for proposals; (17) Information on new techniques and technology; (18) Inter-contractor contracts through the IDEP-CDCs; (19) All inquiries provide information (including absence of reports); (20) Report listing valuable, immediate knowledge of available test data; (21) In house data retrieval system strongly influenced by IDEP experience and methods; and (22) Valuable in preparation of Engineering Manual.

B. Federal (non-DoD) & State Services

CORPORATE AUTHOR: Auerbach Corporation

TITLE: Information Storage and Retrieval: A State-Of-The-Art Report

AUTHOR: Lawrence Berul

DATE: September 1964

ACCESSION NUMBER: AD-630 089

ANNOTATION: Described is the economics of information center operations for two major government information centers. The comparative economic analyses of alternate approaches to (1) the index operations function and (2) the document management function are also presented.

Very few information centers have adequate cost accounting systems and, as a result, there is not much data available on the costs of information center operations. Fortunately, cost accounting data has been obtained from two information centers, which shall be referred to as Center A and Center B.

Neither Center A nor B can be considered to be ''typical.'' For that matter no information center can be considered typical. They are both primarily document centers which involve that group of functions designated as System 7 - origination, acquisition, surrogation, announcement, index operation, document management, and end-use.

Center A utilizes a general-purpose computer for index operation, including bibliography preparation and other request processing, whereas Center B performs these functions manually with the aid of a catalog card file. Both centers supply copies of documents from printed inventories as well as by reproducing full size blow-back copies from roll microfilm on demand. Center A does most of its own printing, whereas Center B contracts out all of its printing to another organization.

The annual operating costs are compared for Center A and Center B by system function. Three separate aspects of the cost of each system function are presented: unit cost, total dollars, and percent of over-all center costs. The unit costs are based on the number of titles processed, copies prepared, document requests handled bibliographies handled or catalog cards handled. The actual workload or number of units processed varied within each function.

CORPORATE AUTHOR: Report of the Select Committee On Government Research of the House of Representatives, 88th Congress, Second Session

TITLE: Documentation and Dissemination of Research and Development Results Study Number IV

DATE: November 20, 1964

ANNOTATION: The study deals with federal scientific and technical information programs, their efforts to achieve efficacy and timeliness, their present scope, prevailing practices, access to and utilization of foreign information problems that face them, and proposals for dealing with them. Costs are presented of federal funds for technical and scientific research information.

CORPORATE AUTHOR: Battelle Memorial Institute and Oak Ridge National Laboratory

TITLE: Proceedings of 1st Ad-Hoc Forum of Scientific and Technical Analysis Center Managers, Directors, and Professional Analysts

DATE: November 1965

ACCESSION NUMBER: CONF-651131 (TID-4500)

ANNOTATION: Talks included are: (1) The DASA Data Center; (2) Information Research at ESSO; (3) Organization of a New Information Center on Nuclear Fuel Technology; (4) Training Manpower for Technical Information Centers--First Considerations; (5) Procurement of Information Analysis Center Staff; (6) Financing Information Analysis Centers; (7) Management of Information Analysis Centers; (8) Panel Discussion: "How Can Effectiveness of Analysis Centers Be Measured"; (9) Information Analysis Center Communications; (10) Inter-Center Problem Areas; (11) Automation; and (12) The National Documentation Handling System.

TITLE: Recommendations For National Document Handling Systems In Science And Technology. Appendix A -- A Background Study -- Volume II -- COSATI -- Federal Council For Science And Technology

DATE: November 1965

ACCESSION NUMBER: AD-624 560, PB-168 267

ANNOTATION: The estimated R and D cost to the Federal Government for 1964 is $15.1 billion. For the same year an estimated $200 million will be spent for scientific and technical information. Two-thirds of this total will be attributed to the activities of DoD (31%), Commerce (17%), and HEW (18%). Our judgment, based on experience over the years and on the impressions gained from interviews during the course of the present study, is that there are many unreported costs, such as overhead and other indirect costs, that should be attributed to information activities. These costs together with those that are overlooked or deliberately not reported (e.g., classified costs) approximate the costs that are reported. Hence, we feel that $400 million is a more accurate figure. It is difficult to substantiate a figure of $400 million, but we feel it is closer to the actual costs for scientific and technical information than the $200 million figure which is the total of reported costs for such activities in the Federal Government. For indicating trends, the distribution of this reported $200 million is significant. For example:

Publication and distribution	40.0%
Bibliographic and reference services	40.0%
Scientific symposia and technical meetings	12.5%
R and D scientific communication and documentation	7.5%

Another distribution shows that the Federal Government performed 65% of this work in-house (intramurally) and obligated 35% of these funds to non-Government organizations (extramurally). Approximately $3 million was spent by the Federal Government (outside the intelligence community, for which figures are not available) in 1963 for translations of foreign scientific and technical literature.

CORPORATE AUTHOR: U.S. Atomic Energy Commission, Oak Ridge, Tennessee

TITLE: The Role of Information Centers: Evaluation of Their Effectiveness

AUTHOR: Francois Kertesz

DATE: 1965

ACCESSION NUMBER: ORNL-TM-1339

ANNOTATION: During initial stage of establishing an information center, overall production cost figures should be determined, including number of documents put into system and number of individuals involved in operation.

Potential evaluation methods considered are unit cost of the input and saving of money that would be possible if previous work were known.

Evaluation of effectiveness is done on three levels:

1. Whether the information center is worthwhile in context of the entire technical community it serves.
2. Whether total product of information center is useful to each individual user.
3. Whether retrieval system provides proper amount of exhaustivity and selectivity per dollar and per request.

TITLE: System Effectiveness Assurance in Response to DoD/NASA Requirements

AUTHOR: Leslie W. Ball

SOURCE: Society of Automotive Engineers, Aeronautics and Space Engineering and Manufacturing Meeting, Los Angeles, California

DATE: October 1966

ANNOTATION: Outline of the technical segment of cost, schedule, and technical assurance in regard to DOD/NASA requirements. The major techniques for assuring that the resources, in the form of documented technology, facilities, and qualified people, are available for each critical activity. Program management techniques for assuring that these resources are applied to each project in accordance with cost effectiveness principles are summarized.

TITLE: Improving the Transfer of Government-Sponsored Technology

AUTHOR: George A. Steiner

SOURCE: Business Horizons, 9(3), pp. 55-62

DATE: Fall 1966

ANNOTATION: In sum, I contend that once a technology is developed through government-sponsored research--or in any other way for that matter--there are two processes which are essential for its transfer to profitable commercial distribution. First is the system by means of which it is communicated to a business. Second is the planning process within the business through which a complex variety of related factors are assimilated and in which decisions are made.

The federal government now is developing better means of communicating new technology to business, which will improve the first process. I noted some of the barriers to, as well as incentives for, more rapid technology transfer in individual businesses. This discussion pointed to effective comprehensive corporate planning as a major process by means of which technological transfer has, can, and will be accelerated. This is not enough, however. It seems essential that some individual or group be given responsibility for assuring coordination of technical communications within and without a business to deal with two vital questions: what technology do we need, and what are the sources for getting it. (Author)

CORPORATE AUTHOR: Office of State Technical Services, Washington, D. C.

TITLE: Office of State Technical Services: First Annual Report, Fiscal Year 1966

DATE: January 1967

ACCESSION NUMBER: PB-175 820

ANNOTATION: This document states objectives, organization, plans, and programs of OSTS for fiscal year 1966. Also included is a selected synopsis of five-year plans and annual programs of several states.

TITLE: Determining Costs of Information Systems

AUTHOR: Monroe E. Freeman

SOURCE: Journal of Chemical Documentation 7(2)

DATE: May 1967

ANNOTATION: Little has been reported on the cost of information systems, partly because of the newness of such systems and partly because of their complexity. This paper separates the various activities of the system used at Science Information Exchange and presents a critical cost analysis of these activities The Exchange has some unique features, including constant input an annual corpus of nearly 100,000 research summaries which yield about 2,000,000 items of information, and input from both Federal and non-Federal sources. Illustrations and tables show the various steps followed in determining the costs and productivity at the Science Information Exchange. (Author)

CORPORATE AUTHOR: National Aeronautics And Space Administration Washington D. C.

TITLE: Economic Aspects Of Technical And Scientific Information (Report To The Minister Of The Budget On The Meeting Held By A Work Group Of The OCSE)

AUTHOR: A. Simari

DATE: May 1967

ACCESSION NUMBER: N67-29004

ANNOTATION: This report examines: (1) Analysis of literature on the subject; (2) Study of total cost of information; (3) Studies on cost/efficiency relationship and (4) Application of methods of economic analysis.

CORPORATE AUTHOR: National Scienc Foundation, Washington, D. C.

TITLE: Federal Funds for Research, Development, and Other Scientific Activities - FY 1966, 1967 And 1968

DATE: August 1967

ACCESSION NUMBER: NSF 67-19

ANNOTATION: Federal obligations for scientific and technical information (STINFO) amounted to $278 million in fiscal year 1966 and were expected to reach $315 million and $348 million in 1967 and 1968, respectively.

STINFO obligations have grown rapidly since 1960 (the first year such data were reported) but generally at a reduced rate since 1963. The average annual rate of growth from 1960 to 1968 is 21 percent.

Three agencies -- DoD, Commerce, and HEW -- account for about 70 percent of total Federal STINFO obligations reported for the period 1966 through 1968.

About 65 percent of STINFO funds reported by Federal agencies represent intramural performance, but wide differences exist between agencies, and for some agencies the extramural performance data are substantially understated.

CORPORATE AUTHOR: Graduate School Of Business, Indiana University, Indiana

TITLE: Managerial Cost Accounting For A Technical Information Center

AUTHOR: John G. Helmkamp

DATE: January 1968

ACCESSION NUMBER: N68-15502

ANNOTATION: While the operating characteristics of a center are highly analogous to those of a typical business firm, management currently does not possess relevant cost information concerning the literature searching activity. This condition creates a critical problem since the objective of a NASA Regional Dissemination Center is to operate as a self-supporting entity. In order to accomplish the financial objective, relevant cost information is essential for such managerial functions as planning, controlling, performance evaluation, pricing, reporting, and general decision-making.

A two-fold solution to the cost information efficiency problem is proposed in this study. A formal managerial cost accounting system is designed expressly for the two information services of a NASA Regional Dissemination Center, retrospective search and selective dissemination. The system was employed during a trial period at the Aerospace Research Applications Center to test its effectiveness in a technical information center. Once appropriate service cost data are available, the statistical cost model developed in this study can be used in lieu of the formal cost accounting system and will provide an efficient and economical cost control technique.

A random sample of five searches is selected every month for both information services, and the direct costs consumed for each sampled search are registered on a single record. The mean and range are calculated for each sample and are recorded on the appropriate cost control chart. The null hypothesis which is tested with the sample information is that the direct unit search costs are ''in control'' when compared with the representative values. If the sample observations are within the control limits, the hypothesis is accepted, but immediate managerial action is required if a value is recorded outside the desirable limits.

TITLE: The State Technical Services Program At The National Level

AUTHOR: Paul J. Grogan

SOURCE: Special Libraries

DATE: March 1968

ANNOTATION: The State Technical Services Act supports programs of state, regional, and national significance ''to place the findings of science usefully in the hands of American enterprise.'' Resources are limited; knowledge is not; thus, the needs of man both here and abroad depend ultimately upon the exploitation of knowledge and not resources. To accomplish this purpose on a broad front requires extensive institutional involvement, interfacing at the local level with the needs and potentials of the ''appliers of science,'' or business and industry. Educational institutions, state agencies, and nonprofit organizations throughout the country are joining the effort with matching funds and programs of continuing education, information and referral services, demonstrations, and field services. Highly experimental, and not totally committed to any single approach as being most effective in the transfer of technology, the State Technical Services Act nevertheless offers the private sector a number of options in being ''served technically'' by the introduction of scientific and technical information to their daily practice, employment potential, profit picture, and share in the $30 billion annual growth of the U. S. economy. (Author)

TITLE: The State Technical Services Program At The State Level

AUTHOR: H. F. Heintz

SOURCE: Special Libraries

DATE: March 1968

ANNOTATION: In Developing Connecticut's first annual technical services program, it was necessary to probe beneath the surface of the state's economy to identify problem areas that could benefit from such programs. A superficial analysis of the state's economy would indicate an apparent lack of need for technical services programs. As an example, in 1965 and 1966 Connecticut ranked first of all the states in per capita income, as well as having the largest dollar volume of defense contracts per capita. The in-depth analysis of the state's economy revealed that problems that could inhabit Connecticut's future economic growth do exist. (Author)

TITLE: The State Technical Services Program -- An Interface With Industry

AUTHOR: Robert Levesque

SOURCE: Special Libraries

DATE: March 1968

ANNOTATION: State Technical Services activities as accomplished by the Technical Resources Center at Syracuse University, sponsored by the New York State Department of Commerce are described. Operating in the Upstate New York area, the center's program for determining and satisfying regional industrial and business needs for new scientific and technical information are described. Downtown offices provide involvement with smaller firms through a program of workshops and seminars. The use of professional societies, developing relations with the New York Reference and Research Resources Program, plus the use of certain area special libraries in providing reference service are described. Emphasis is on facilitating the rapid exchange of scientific and technical information with the goal of promoting economic development. Aspirations for establishing demonstration and pilot projects for the broader use of selected special library holdings are outlined. (Author)

TITLE: A Librarian Looks at the State Technical Services Act

AUTHOR: Chris G. Stevenson

SOURCE: Special Libraries

DATE: March 1968

ANNOTATION: The State Technical Services Act of 1965 is designed to assure the fullest industrial utilization of technical information resulting from federal research and development programs. Since the mechanics of technology transfer are uncertain, the Act encourages states to develop new and imaginative programs to bring useful information to local industry. Many of these programs involve extensive utilization of existing library systems. In the long run, the Act will be of great benefit to libraries and librarians since it will encourage broader use of information resources. (Author)

C. Commercial, Non-Profit Organizations, & Universities

TITLE: Standards for Measuring the Effectiveness of Technical Library Performance

AUTHOR: R. E. Maizell

SOURCE: IRE Transactions of Engineering Management (IEEE Transactions of Engineering Management) Volume EM-7 (2)

DATE: June 1960

ANNOTATION: Current criteria for the evaluations of technical library performance are examined. Data are lacking for establishing standards based on what the better libraries are doing. Guides are presented for evaluating the quality of book and journal collections, the adequacy of reference service, the library's effectiveness in meeting requests, and the impact of a technical library on its associated research laboratory. (Author)

TITLE: Handbook of Industrial Research Management

AUTHOR: Carl Heyel, Editor

SOURCE: Chapman & Hall Ltd.

DATE: 1960

ANNOTATION: In the scientific periodicals of the world there appear reports of new knowledge within a very short time after it has been acquired. For the specific purpose of avoiding work to obtain knowledge after it has already been acquired, it is most important that a basic scientist make library research an important part of his operations. He also receives many direct benefits from this. It broadens his horizons, triggers off new areas of thought, and frequently contributes to the design of the experiment. For these reasons a library with adequate professional staff is an essential component of facilities for basic research. Where libraries sufficiently large to be comprehensive are economically impossible, arrangements can be made with large libraries for supplementary service.

CORPORATE AUTHOR: Center for Documentation & Communication Research, Case-Western Reserve University, Cleveland, Ohio

TITLE: Report on Study of Status of Aerospace Corporation in Information Retrieval

AUTHOR: Allen Kent, Jessica Melton, & Alan M. Rees

DATE: August 1961

ACCESSION NUMBER: AD-267 401

ANNOTATION: This report states that there is no direct, quantitative evidence available, to support the conclusion that the provision of more effective library services will lead to monetary or other advantages. Qualitative statements are plentiful, which indicate a more or less general feeling that significant research cannot be performed with economy of time and money unless effective access to the literature is available.

Therefore, any benefits that may accrue from this study will most likely come from the directions of:

(1) Increased awareness of the availability of sources of recorded knowledge of interest

(2) Increasing understanding of the opportunities for, and problems involved in effective exploitation of the recorded knowledge on the part of management, technical, and library staffs

(3) The initiation of an active development program designed to lead to a dynamic approach to the use of recorded technical knowledge.

CORPORATE AUTHOR: Lockheed Missiles and Space Co., Sunnyvale, California

TITLE: MATICO. Machine Applications To Technical Information Center Operations

AUTHOR: Kenneth D. Carroll and Roger K. Summit

DATE: September 1962

ACCESSION NUMBER: AD-401 227

ANNOTATION: This report gives the comparative costs of catalog card production.

The benefits of more rapid card delivery to the catalog, the improved services through both wider and selective dissemination of information of new acquisitions, automated searching---all these allow greater staff time to examine processing and reader services.

TITLE: Financing A Technical Information Center

AUTHOR: Bernard K. Dennis

SOURCE: Information Retrieval Management, American Data Processing Inc., Detroit, Michigan

DATE: 1962

ANNOTATION: The Technical Information Center of General Electric's Flight Propulsion Division has attempted to develop a method for maintaining a level of operation realistically related to the information needs of its users, the expanding parameters of the technical information explosion and the needs of the business. Even though a permanent long range funding plan has not yet been fully defined, certain basic indications have begun to emerge.

The first and most significant indication is that the level of funding which can be expected as a direct charge against general overhead or administrative costs is not likely to exceed the requirements for a bare minimum of basic library services. Therefore, in the long run, the more refined and specialized technical information services must in some way be supported by a direct charge against the specific using group, whether or not the using group is part of the local organization. In other words, customers must pay for the services.

This means, of course, that the Technical Information Center must act to a certain extent as a business entity, complete with continuing problems of customer satisfaction, sales volume and seeking out of new markets. It is obvious that the financial as well as the technical success of the center depends upon its consistently "delivering the goods."

TITLE: An Analysis of Output Costs and Procedures for an Operational Searching Service

AUTHOR: La Vahn Overmyer

DATE: April 1963

SOURCE: American Documentation

ANNOTATION: Those who are responsible for administering the Service do not think it is feasible to attempt to produce a single dollar-and-cents figure to identify the cost of conducting a search. Because of the many variables and assumptions which were explained in detail in previous tables, the final summary of costs is presented in three parts. Comparisons are made in costs for the three questions; comparisons are also made between biweekly and retrospective searches.

The costs of analyzing, structuring, and keypunching the structure for the three questions are compared.

Comparisons are also made of the cost of a biweekly one-tape search of 20 simultaneous questions, 600-card output, with the cost of a retrospective 16-tape search of 5 simultaneous questions, 2,000-card output. Since the searching processes are the same regardless of whether the original questions are simple or complex, the mention of the original questions is not made in this part.

The costs for a biweekly search of each of the three questions and the costs for a retrospective search of each of the three are compared.

The problems encountered in attempting to arrive at some reasonbaly significant figures are evidenced by the wide range of costs for both biweekly and retrospective searches. Ranges of $7,904-$53,074 for biweekly and $105,310-$150,480 for retrospective searches will be of little value to anyone unless he gives serious consideration to the inherent factors which cause these ranges. Even then, these figures can best serve only as examples to assist the management of potential searching services.

In spite of a sincere attempt to approach these costs from several directions, some areas mentioned briefly in this report need to be explored more fully.

One which comes to mind immediately is the percentage of computer answers which are retained for transmittal to the subscriber. Although we assume a 'not sent' rate of 25%, this was purely for illustration. What must be kept in mind by anyone operating a searching service is that every 'not sent' is money

lost, for it cannot be recovered from the subscriber. Since the Documentation Center is primarily engaged in research and development, we learn from the 'not sent' abstracts by investigating the reasons and restudying our methods and procedures. However, anyone establishing an optimal system within a rigid cost structure must be aware of this one important but often very elusive cost factor.

TITLE: Information Retrieval

AUTHOR: Ralph R. Shaw

SOURCE: Science, v. 140

DATE: May 10, 1963

ANNOTATION: American Society for Metals literature service had passed the experimental stage and that searches for a single subject would be made for ASM by the Center for $500 per search, the items to be searched numbering something less than 100,000. While making a study for a great industrial organization, Shaw found a pitiful example of the inefficiency that can result from pressure of this type. The organization had a documentation group using an IBM 601. Study of the work of this group showed that in some 6 years they had, at a cost of about $100,000 per year, built up a total file of approximately 16,000 indexed articles. To determine the most efficient method through a management-engineering analysis based on times and costs and frequency of use of the alternative methods should be relatively simple, but we have little hard information about the relative efficiencies of these tools, or about the various input and output approaches and devices, upon which to base such an analysis. The field, therefore, remains one in which claim is matched by counterclaim, neither being supported by objective evidence.

Regardless of the system (or systems) selected to achieve our purpose, the measure of its efficiency is the effectiveness with which it provides the information required and its ratio of input to output in providing the information. Unfortunately, this approach discloses, in the clearest possible fashion, the present lack of scientific basis for such selection amounts of information by conventional means. Our support of systems that have proved capable of providing these services has not kept pace with the demands made upon the systems. So, first of all, very great improvement in information services could be effected immediately, were libraries and other existing information services (including primary publication, abstracting, reviewing, and information centers) supported to a degree consistent with the greatly increased volume of research, and then held accountable for providing services proportional to this increased support by means of the most efficient techniques available. Until we support the basic library and dissemination functions more adequately, no other devices can possibly be effective, since they are based upon and dependent upon these.

Second, it is doubtful that we can radically improve the technology in this field so long as it must rest as heavily as it does on purely empirical foundations. This means that we should be putting massive effort into the development of a science upon which a better information technology may be built.

Finally, technological proposals and essays in this field should be subjected to rigorous objective investigation to determine whether they do provide something demonstrably useful which cannot be provided by other known means; or, lacking that, whether they do offer improvements over known methods for achieving the same objective.

CORPORATE AUTHOR: Systems Development Corp., Santa Monica, California

TITLE: Factors That Affect the Cost of Computer Programming

AUTHOR: Leonard Farr and Burt Nanus

DATE: July 1964

ACCESSION NUMBER: AD-603 707

ANNOTATION: Although accurate estimation of computer programming costs is an important prerequisite for effective programming management, such estimates have historically been very unreliable. Some of the underlying causes of this problem are discussed, and about fifty factors that appear to contribute to the cost of computer programs are identified. Data concerning the effects of a few of these factors upon cost are presented by way of illustration. Recommendations are made for more detailed cost collection, cost analysis, and experimentation. (Author)

CORPORATE AUTHOR: California Univ., Los Angeles, Graduate School of Business Administration

TITLE: Problems In Information Economics

AUTHOR: Jacob Marschak

DATE: 1964

ACCESSION NUMBER: AD-447 688

ANNOTATION: Problems in information economics consist in characterizing optimal ''information systems.'' The microeconomics of information, an extension of the usual theory of the firm, a household, or a government agency considers a single decider with fixed tastes, beliefs, and resources. It is concerned with the choice of an optimal information system under those fixed conditions. An information system may be a simple instrument for collecting observations of the environment, or a complex network (an ''organization'') of men and machines who make observations, process them, and send messages to each other and finally to those who perform actions impinging on the environment and thus yielding a ''payoff.'' In this complex case, the chooser of the optimal information system can be visualized as the ''organizer'' (e.g., a management consultant). Corresponding to the description of micro-economics of information, the macro-economics of information is regarded as an extension of the theory of welfare economics, or public policy. (Author)

TITLE: The Interlibrary Loan Transaction

AUTHOR: Vern M. Pings

DATE: April 1965

ACCESSION NUMBER: PB-170 792

ANNOTATION: Although the number of items borrowed through interlibrary loan may not increase as dramatically as it has in the past ten years, the trend can be expected to continue because of the growing interdisciplinary nature of biomedical research and because of the anticipated improved bibliographic control of biomedical literature. To provide a framework for collecting data on volume of flow between institutions, on time requirements for processing operations, on cost of interlibrary transactions, on the efficiency of communication channels and on alternative procedures for performing the transaction, block diagrams were prepared to show the flow of information and materials between individuals and institutions. These diagrams show the interinstitutional dependence: any alterations in procedures one institution affect other institutions. Even though it can be clearly shown where alterations in the flow pattern can be effected, there are little quantitative data available to serve as a justification for maintaining or modifying existing procedures. (Author)

CORPORATE AUTHOR: University of Calif. of La. Western Management Science Institute

TITLE: Economic Comparability of Information Systems

AUTHOR: Jacob Marschak and Koichi Miyasawa

DATE: July 1965

ACCESSION NUMBER: AD-619 767

ANNOTATION: An information system is a set of potential messages to be received by the decision maker. It is characterized by the statistical relation of the messages to the payoff-relevant events, and also by the message cost. Neglecting this cost, the (gross) value of an information system for a given user is the (gross) payoff that he would obtain, on the average, if he would respond to each message by the most appropriate decision. Thus (gross) information value depends not only on the statistical relation between messages and events out also on the payoff function. The latter expresses the user's ''tastes'' and ''technology.'' The ordering of statistically defined information systems by their values is therefore at most a partial one. This contrasts with the complete ordering of information systems (''channels'') by their ''equivocation:'' a statistical parameter used in the classified information theory, which disregards variation of payoff functions from user to user.

Indeed, if ''noise'' is defined to increase with equivocation a ''noisy'' information system may be more valuable to a given user than a noiseless one.

The partial ordering of information systems by their (gross) values are studied. In particular, conditions (sufficient or necessary) are stated under two systems which are comparable, so that one of them is ''more informative'' than the other in the following sense: one of them can never have smaller value than the other, for any payoff function defined on a given set of events. The ordering of information systems according to their informativeness has applications in the economics of information and organization.

TITLE: Post-Mortems Can Be Fun, The Cost Analysis Of Information Systems

AUTHOR: Harold Wooster

SOURCE: Library Journal, pp. 2968-2973

DATE: July 1965

ANNOTATION: This paper summarizes four doctoral dissertations from the Graduate School of Library Services at Rutgers University which were funded by the Directorate of Information Sciences, Air Force Office of Scientific Research as part of its dialectic approach to the problems of information handling.

These studies were carried out under the supervision of Ralph Shaw and bear one of the nonupper-or-lower-case-scarecrow Shaw trademarks -- a meticulous analysis of unit costs of operations.

A recurring dilemma of the information system designer is found when he attempts to provide the user with his own reference collection of items. There are at least two possible approaches. One is to prefile by binding the items together in a book. The other, and superficially more attractive approach, is to issue the items as individual pieces of paper with detailed instructions as to where they should be filed, and count on the user (or more realistically, his secretary) to put the separate pieces of paper in the correct places in a three-ring binder or card file.

Dr. Wooster reviews Dr. Robert Clarke's investigation of photocopying and the question is asked; when is it cheaper to photocopy specific articles to buy and keep a journal. A review is also made of Norman Stevens' study of fact-retrieval operation--a punched card compilation of properties of explosives made by Arthur D. Little for Picatinny Arsenal. Dr. Wooster also reviewed Richard Dougherty's study of the Chemical-Biological Coordination Center.

CORPORATE AUTHOR: Battelle Memorial Institute and Oak Ridge National Laboratory

TITLE: Proceedings of 1st Ad-Hoc Forum of Scientific and Technical Analysis Center Managers, Directors, and Professional Analysts

DATE: November 1965

ACCESSION NUMBER: CONF-651131 (TID-4500)

ANNOTATION: Talks included are: (1) The DASA Data Center; (2) Information Research at ESSO; (3) Organization of a New Information Center on Nuclear Fuel Technology; (4) Training Manpower for Technical Information Centers--First Considerations; (5) Procurement of Information Analysis Center Staff; (6) Financing Information Analysis Centers; (7) Management of Information Analysis Centers; (8) Panel Discussion: "How Can Effectiveness of Analysis Centers Be Measured"; (9) Information Analysis Center Communications; (10) Inter-Center Problem Areas; (11) Automation; and (12) The National Documentation Handling System.

TITLE: Cost Analysis Study

AUTHOR: Barbara Aro, Judith Gripton and Carol Strashem

SOURCE: Technical Service Division University Of Denver Library. Studies In Librarianship. Number 4, Denver, Colorado

DATE: 1965

ANNOTATION: Report of an appraisal of operational costs on the basis of time and work measurement in the University of Denver Library, Technical Services Division.

A major objective of study was establishment of qualitative and quantitative norms for technical service costs, which would (a) provide realistic basis in budgeting for determining costs and future needs, (b) provide impartial evaluation of what daily output and achievement should be, (c) indicate needs for procedural improvements and provide means for evaluating effects of change.

Specific objectives were (a) balance work load and responsibility, (b) improve operating efficiency, (c) develop processing standards, (d) provide basis of production figures for planning needs.

In conducting a cost effectiveness study, supervisors should (a) study work descriptions and write instructions and classifications of activities to fit particular library, (b) provide full explanation to library staff of purpose of study and method of keeping time and activity records, (c) allow orientation period and place less emphasis on early data at least six months to collect representative data, (e) submit data to conventional statistical analysis by professional statistician, (f) submit analysis and conclusions to all staff members, (g) examine comparative studies of other libraries. (Author)

CORPORATE AUTHOR: Hughes Dynamics, Los Angeles, California

TITLE: Report on a Study of Behavioral Factors in Information Systems

AUTHOR: John A. Postley

DATE: 1965

ACCESSION NUMBER: AD-419 622

ANNOTATION: This report evaluates effects of behavioral factors on the attainment of objectives of computer-based information retrieval systems. Much is applicable to information systems generally. Need for study comes from great variation in total effectiveness of different systems with similar operating environments and objectives.

Measures of effectiveness must consider system goals as well as objective criteria such as cost and machine utilization. Implicit system goals are best understood by increased understanding of system designers and operators. Effectiveness depends upon the attitudes and goals of the people who manage, create, maintain and use the system. The study was concerned with three major areas: (a) attitude identification and measurement, (b) analysis of organizations, (c) descriptive and objective criteria of effectiveness.

The study of the problem of developing criteria for measuring system effectiveness revealed very few common trends. In some cases cost was considered the only criterion, with great divergence on how to determine cost. Others felt that indirect benefits are a measure of system effectiveness and considered such matters as direct service to users, unanticipated benefits, and speed of reporting.

TITLE: Economic Analysis of A Technical Information Dissemination System

AUTHOR: N. P. Levy and R. M. Sigmon

SOURCE: Abstracts, 1965 FID Congress, p 73(a)

DATE: 1965

ANNOTATION: Crucial question posed by management when developing a technical information dissemination system is: Will the participating engineers gain sufficient benefit from its service to pay for the system's operating costs. An economic analysis conducted on an experimental basis in 1964 in Western Electric, indicated that a technical information system can pay for itself if it services those engineers with needs for relatively large amounts of information. This conclusion was based on quantitative estimates obtained from surveying the 121 engineers (mainly research, development and planning engineers) from eight locations, who were participants in an experimental technical information dissemination system. The questions concerning the economic evaluation were based on the concept which is described as the "Cost of Information Transfer." This concept is described in detail and related to a real technical information dissemination system.

TITLE: Setting Up Your Company's Technical Information Service

SOURCE: McGraw-Hill, New York. OECD Unit, TMIS Annex No. 18081

DATE: 1965

ANNOTATION: This document provides basic information needed for the practical setup of an information service:

1. Initial setup costs. Room and furniture, collection, an appropriate abstract journal or two, stationery, duplicating or photocopying machine. Most of these are already on hand, and this cost is fairly small.

2. Running expenses. 65% to 85% of total cost will be salaries.

Many companies already receive and pay for journals; these expenses are not totally over and above current expenses. The library will save the time of valuable, high-salaried people and information will be retrieved more rapidly and efficiently. The cash outlay for initiating and operating an information service is an inaccurate measure of its real cost to the company.

CORPORATE AUTHOR: HRB-Singer, Inc., A Subsidiary Of The Singer Company

TITLE: A General Model For Simulating Information Storage And Retrieval Systems

AUTHOR: C. R. Blunt, R. F. Duquet and P. T. Luckie

DATE: April 1966

ACCESSION NUMBER: AD-636 435

ANNOTATION: This research report summarizes attempts to produce a general information systems model. The operating cost of an information system is the sum of the operating costs of each function (e.g., data collection, input preparation, storage, retrieval and presentation) plus the maintenance and support costs incurred to maintain the operations. Initial costs may include expenditures for research, development, equipment purchases and personnel training. Although cost determinations involve a reasonable direct accounting of expenditures, value determinations are a more complex problem. The value of an information system and its costs are not necessarily in proportion nor are they measured in the same manner. Costs can be quantitatively denoted at every stage of processing from collection to output; however, the value of an information system is connected with user performance and capability which may only be assessed in a qualitative manner. (Author)

TITLE: The Fear of Innovation

AUTHOR: Donald A. Schon

SOURCE: International Science & Technology

DATE: November 1966

ABSTRACT: The modern industrial corporation is required to undertake technological change, change that is destructive to the corporation's stable state. In the framework of cost-benefit analysis, the risk of innovation is how much we stand to lose if we fail, multiplied by the probability of failure.

CORPORATE AUTHOR: New Mexico University, Albuquerque.
Technology Application Center

TITLE: An Analysis of System Criteria and Implementation Costs for an Advanced Computerized Information Retrieval System

AUTHOR: R. D. Eck, W. A. Shinnick

DATE: 1 April 1967

ACCESSION NUMBER: N67-38878(NASA-CR-84648)CSCL058

ANNOTATION: The role of the Technology Application Center is appraised based on its operating experiences, developments in information dissemination procedures, and the information requirements of the greater Southwest market. Increased competition for the community's information purchasing dollars, and constraints on in-house computerized data retrieval services are cited as limiting factors. The types of computer capabilities required are outlined in terms of responsiveness in satisfying requests; providing minimum cost methods for the communication of information availability; internal efficiency by minimizing the availability of the professional staff for creative applications efforts; and offering computerized services for regional programs. An analysis of the anticipated costs of implementing and operating the proposed system is included.

CORPORATE AUTHOR: University of Dayton Research Institute, Ohio

TITLE: The Role of Searching Services in an Acquisition Program

AUTHOR: Antoinette L. Lueck, James M. Tierney, Ann T. Dodson

SOURCE: Presented at Annual Convention of Special Libraries Association (58th)

DATE: May 1967

ACCESSION NUMBER: AD-652 737

ANNOTATION: A user presents his point of view of literature searching through the major searching services in the overall program of acquisitions for the engineering staff of the Air Force Aero Propulsion Laboratory. These major searching services include the Defense Documentation Center (DDC), the National Aeronautics and Space Administration (NASA), the Science Information Exchange (SIE), and the National Referral Center (NRC). Procedures have been established within the laboratory for utilizing these searching services. These procedures include writing and submitting the requests for retrospective literature searches and interest profiles for current-awareness services as well as the subsequent acquisition of documents and information cited in the returns. The relative value of the returns from these searching services is described; the value of a search return is determined by its completeness, response time, format, accuracy, and availability of cited information. (Author)

CORPORATE AUTHOR: Alfred P. Sloan School of Management, Cambridge, Massachusetts

TITLE: Criteria For Selection Of An Information Source

AUTHOR: Thomas J. Allen and Peter G. Gerstberger

DATE: September 1967

ACCESSION NUMBER: PB 176 899

ANNOTATION: This study is directed at the measurement of relative costs associated with the use of each of nine information channels by R and D engineers and the relative weights assigned cost and value in this decision process. Cost in this sense is a rather complex concept. It may consist of many dimensions--economic, psychological and physical. This study measures perceived cost to the user in terms of channel accessibility and ease of use.

CORPORATE AUTHOR: Indiana University Foundation, Bloomington. Aerospace Research Applications Center

TITLE: A Pilot Program for Investigation of Various Techniques to Enhance the Utilization of New Knowledge Related to or Stemming from Aerospace Research and Technology. Quarterly Report, Period Ending Sep. 30, 1967

AUTHOR: Joseph diSalvo

DATE: October 15, 1967

ACCESSION NUMBER: N67-40335, (NASA-CR-89779)C5CL05B

ANNOTATION: Regional Dissemination Center (RDC) services, personnel organization, and operating expenses are reviewed. A program to increase membership in this information retrieval system through revisions in fees and the offering of trial introductory memberships is evaluated. Brief quarterly activity summaries are given for services performed in the following categories: retrospective searches, custom interest profiles, standard interest profiles, document requests, back-up information requests, and computer information services.

TITLE: How Much Information Work

AUTHOR: Peter F. Cole and G. J. Brockis

SOURCE: New Scientist

DATE: October 1967

ANNOTATION: Within the content of research and development activity, Technical information serves two main functions. The first of these is to stimulate new lines of investigation and fresh approaches to existing ones: the second is to prevent unintentional duplication of research.

It appears almost impossible to set a value upon this first, creative function. Attempts to evaluate the second, defensive, aspect have produced a wide spread of results. An inquiry by Hirsh, Milwitt and Oakes into the activities of members of aeronautical and electronic societies in Southern California indicated that anywhere between 30 and 85 percent of scientific man-hours were wasted because of duplication of effort. The annual cost to the US economy of such duplication has been variously estimated at $200 million and $1000 million, representing 2 and 9 percent respectively of the 1958/9 US research expenditure. John Martyn, of the Association of Special Libraries and Information Bureaux, assessed the extent of such duplication in the UK at a more modest level. He concluded (New Scientist, Vol. 21, p. 338) that some wastage of resources had occurred in 14 percent of the total research budget. This figure is widely regarded as too low: Martyn himself concedes that the true figure could easily be twice his estimate, and Leslie Wilson, in an address to the Parliamentary and Scientific Committee, has recently suggested that it may be too low by a factor of five or even 10.

Only very limited guidance is available as to how much effort should be put into providing technical information. Sir Frank Francis, addressing the same Committee, quotes an estimate prepared by the Scientific Attache in Moscow that "a working scientist spends up to one third of his time searching for information and that the cost of this search represents one fifth of all the money allocated to science." It might be concluded from this that there could usefully be one information worker to every three research scientists. And, indeed, to quote Wilson again, two large American companies are reported to have accepted as realistic ratios 1:4 and 1:5.

CORPORATE AUTHOR: Indiana University Foundation, Bloomington. Aerospace Research Applications Center

TITLE: Standard Interest Profiles: Development Of Technical Subjects. Final Report

AUTHOR: Joseph DiSalvo, Robert W. Hall

DATE: February 1968

ACCESSION NUMBER: N68-18733, NASA-CR-93480

ANNOTATION: The chronology of Standard Interest Profiles (SIP) development is given, and an overview is presented on the approach taken to reduce the costs of current-awareness service by standardizing the product or sending the same abstracting service output to many users. The logic behind each SIP topic is defined as an effort to segment a potential market for current-awareness service to match areas in which a sufficient volume of reports are regularly released in government literature so as to make service feasible. Summary information on the technical subject area of each SIP is provided, along with a title list and index.

CORPORATE AUTHOR: Armstrong Cork Co., Lancaster, Pennsylvania

TITLE: Uniterm Index to U. S. Chemical Patents - User Evaluation

AUTHOR: Alan R. McGarvey

SOURCE: Journal of Chemical Documentation 8(1)

DATE: February 1968

ANNOTATION: The Uniterm Index to U.S. Chemical Patents System is expected to substantially increase savings in the Patent Department of Armstrong Cork Co. Since the average length of patents is between 4 and 5 pages, this system allows the copy cost per patent (about 7 cents per page) to be considerably less than its purchase cost. Furthermore, the intangible but real cost of merely processing an order is eliminated. Also, the elimination of the weeks of waiting for a patent ordered from Washington is another plus factor for this Uniterm Index System. The value of this service is illustrated where a savings of about 1000 hours was made.

CORPORATE AUTHOR: Association Of Data Processing Service Organizations Inc., New York, New York

TITLE: An Economic Analysis of the Data Processing Service Industry

AUTHOR: Robert B. DesJardins

DATE: 1968

ANNOTATION: In 1966 the Board of Directors of the Association of Data Processing Service Organizations, Inc. (ADAPSO) initiated an industry-wide survey to obtain statistics and opinion on the size, rate of growth, sources of revenue, number and type of customers, distribution of costs, degree of competition and other pertinent aspects of the data processing service industry throughout the United States and Canada. To obtain this information ADAPSO prepared and distributed a ''trends questionnaire.'' This questionnaire was initially distributed in the spring of 1967. Approximately 2000 questionnaires were mailed to the members of ADAPSO and other data processing centers throughout the country. The only major group of data processing centers which were not included in the survey were centers which are operated by banks. The survey was validated through accepted methods of research.

In 1966 the data processing service industry consisted of approximately 700 firms which operated 1130 service centers. These firms served almost 80,000 customers in 1966. Slightly less than 70% of the firms operated a single center; these firms ran 43% of the centers and served 34% of the customers. Five percent of the firms in the industry operated 30% of the data processing centers and provided service for more than 40% of the industry's customers.

The major expense for a firm in the data processing industry is wages. Approximately 40% of total revenue is spent for salaries regardless of the size of the firm. The interquartile range for wage expenditures tends to decrease as the size of the firm increases. However, even for the larger firms the expenditures for wages exhibit a fairly large variation.

The next largest item of expense is the cost of purchasing and renting equipment. The median value for this expenditure decreases as the size of the firm increases. This reduction in the relative expense for equipment is the major difference between firms of different sizes. The interquartile range also decreases as the size of the firm increases. Since the 25th percentile is the same for each group of firms, the decrease in the range is accomplished entirely by the decrease

in the value of the 75th percentile.

The percent of total revenue which is spent for marketing decreases as the size of the firm increases. The only item which shows a significant increase as the size of the firm increases is miscellaneous expense. The relative expenditures for supplies, transportation, and space are approximately the same for firms of all sizes.

The median profit tends to increase as the size of the firm increases. The increase occurs primarily because a large number of small firms incur large losses but only a few large firms fail to make a profit. For example, more than one-third of the firms which had a revenue of less than $150,000 did not make a profit in 1966. For 10% of these firms the before tax loss was greater than 25% of total revenue. However, 10% of the small firms made a profit which exceeded 20% of total revenue. In 1966, 20% of the firms, which with a revenue between $150,000 and $400,000 failed to make a profit; the worst before tax loss was 20% of total revenue. Less than 8% of the middle sized firms made a profit which was larger than 20% of revenue. Only 10% of the firms which had a revenue in excess of $400,000 did not make a profit in 1966 and the worst loss was only 1% of revenue. However, less than 3% of these firms made a profit in excess of 20% of total revenue.

Although no definite information is available, it has been estimated that time-shared systems are presently the most rapidly growing segment of the data processing service industry.

The current data processing service industry is a highly competitive, rapidly growing industry. The growing interdependence of the data processing and communications industries has created new problems for data processing service organizations. Any change in regulatory policies for the communications industry indirectly affects any time-shared system. Since 60% of the firms in the data processing industry expect to have time-shared systems by the end of the decade the regulatory policy changes will become increasingly important. In addition, the probability of direct competion between a regulated and non-regulated industry is rapidly increasing. Such competition would probably have an adverse effect on the many small firms in the data processing industry.

Because of the brief period of existence of commercial time-shared systems it is difficult to estimate the effects of proposed policy changes. For example, any policy which would decrease communication costs would obviously favor the development of time-shared systems.

However, 60% of the firms in the data processing industry expect to install such systems by 1971, (80% by 1973) so it is not clear that such a policy would adversly affect the firms in the industry. The actual effect would depend on the level of rate reduction and the economics of time-shared systems which are not yet clear.

D. Generalized Applications

TITLE: The Efficiency of Subject Catalogues and the Cost of Information Searches

AUTHOR: R. G. Thorne

SOURCE: Journal of Documentation 11(130-148)

DATE: September 1955

ANNOTATION: Efficiency of a subject catalog on index is derived from probability of success when using catalog and cost of making and using catalog, compared with cost of finding material in library stock when no subject catalog is available.

In developing an efficiency measure, the following may be used to compare any recording system with situation arising if no records are kept. If no records are kept, the total annual cost is SQN where C = total no. documents in collection, Q = no. searches in year, S = average cost per document of handsorting.

If subject catalog is kept, reduction in annual cost is SC_x-PN-RQ where N = no. documents received in year, P = processing cost to record one document in subject catalog, R = operating cost to conduct one search, since PN + RQ = annual cost of making and using catalog.

Efficiency of a recording system can be defined as cost saved by using system divided by cost if no system is used; the cost being those of satisfying all requests. This implies that if the cost saved is nil, the efficiency is nil and efficiency is unity if all the cost of operating without a system is saved.

TITLE: Information Services: Measuring the Cost

AUTHOR: J. M. S. Risk

SOURCE: Aslib Proceedings 8(269-287)

DATE: 1956

ANNOTATION: The author outlines means of applying cost accounting methods to information services:

1. Measuring total cost for staff; material; outside services such as binding, repairs; information and knowledge; external payments such as legal fees, audits, insurance; charges for equipment use; interest charges on capital invested in books and equipment.

2. Defining activities under direct customer services and indirect work.

3. Determining units of output: (a) Measurable unit of output for each activity, where possible. (b) Measure of work normal person can do under satisfactory conditions at normal pace, or standard hour. This provides common unit to compare and add different activities.

4. Uses of standard hour work measure: (a) Divide standard hours produced by hours worked, multiply by 100 for rate of output. (b) Divide budgeted total cost by standard hour for budgeted cost of services. (c) Use data for planning work loads, forecasting effect of peak periods of work, budgetary control, etc.

TITLE: Cost Analysis of Bibliographies on Bibliographic Services

AUTHOR: Malcolm Rigby, Marian K. Rigby

SOURCE: Proceedings of the International Conference on Scientific Information, Wash., D. C. Vol. 1

DATE: Nov. 16-21, 1958

ANNOTATION: This report represents the tentative results of preliminary work done under a grant from the National Science Foundation for the purpose of establishing under controlled conditions an empirical formula for obtaining estimates of the order of magnitude of the costs involved in preparation of either "one-shot" bibliographies or more extensive or continuing services, regardless of quantity, accuracy, exhaustiveness, subject matter, languages involved, country where prepared, type of frequency of indexes, quality of annotations or reproduction, etc.

As the material produced in this analysis is quite voluminous and the exact figures for a number of the examples are not yet obtained, the tables and the curves on the nomograms should be considered as rough approximations by anyone not wishing to examine the 'exhibits' (which will be available to those desiring to verify the cost or the quality of the product). Costs may vary by 200 or 300% from the "normal," on account of unpredictable factors, but in general they range between 50c and $50 per item under "average" conditions.

The explanation of the range in costs of from 1 to 2 orders of magnitude lies not only in the complexity, exhaustiveness or sophistication involved, but to a large measure in the "entropy" of the system; i.e., in the amount and skill of the work previously done by some library or bibliographer and available for exploitation by others; or, conversely on the amount of effort which is expended by the farsighted in putting material in shape for others to exploit to their advantage or to the advantage of science.

Finally one of the most significant factors, which usually operates in direct opposition to that which would be predicted, is the rising cost with increasing volume or size of a bibliography, for the extra controls, tools, possible mechanization, research, development of codes or class systems for large projects more than offsets any savings due to "streamlining."

CORPORATE AUTHOR: Documentation, Inc., Washington, D. C.

TITLE: Cost As The Measure Of Efficiency Of Storage And Retrieval Systems

AUTHOR: Mortimer Taube

DATE: December 1958

ACCESSION NUMBER: AD-137 799

ANNOTATION: Cost is proposed as the measure of efficiency of information storage and retrieval systems.

The measurement of the efficiency of a system in terms of cost requires the assumption that all systems can be made equal in reference adequacy by varying input and output costs. Although on first inspection this assumption may appear unwarranted by practical experience, it is actually quite in accordance with the general theory of storage and retrieval systems. As we have noted above, storage and retrieval theory (especially the mathematical theory of coding) tells us that for equal amounts of coding space, all physical systems can enter equal amounts of information and that for an equal amount of circuity, all physical systems deliver the identical product for any search. It may be simpler or less costly to punch holes in cards than to make black and white patterns on film; it may be possible to transport film past a reading head at speeds wholly out of the question with cards; drilling of holes in a Batten system may be less costly than posting numbers in a Uniterm system; posting in a Uniterm system may be simpler than filing in a subject heading catalog, etc. These physical differences may be of major importance in the determination of the relative costs of suitability of one physical device or another for particular purposes; but they do not distinguish one device from another with respect to indexing possibilities, searching possibilities or reference adequacy. Even within the confines of a single physical system, we can distinguish between theoretical indexing possibilities and the cost or convenience of a search.

CORPORATE AUTHOR: Operations Research Division
Lockheed Aircraft Corporation, California

TITLE: Time, Cost and Value Factors in Information Retrieval

AUTHOR: Max W. Mueller

SOURCE: IBM Information Retrieval Conference in Poughkeepsie

DATE: September 1959

ANNOTATION: This paper deals with the specific intent of unearthing some of the economic factors behind the library information handling system in a typical engineering organization. While many of the findings are still of a preliminary nature, they show the need for further development of the commodity concept and provide some interesting design criteria for improved information systems.

TITLE: How to Cope with Information

AUTHOR: Francis Bello

SOURCE: Fortune

DATE: September 1960

ANNOTATION: A number of I.R. machines have already been devised and built. There are also in use systems that have adapted for I.R. purposes conventional punched-card machines and computers. I.B.M. estimates that industry is now spending about $2 million a year on systems of the latter sort. By 1965, according to I.B.M., the expenditure on I.R. will jump to over $100 million a year, and thereafter double every three years. Before long, in other words, I.R. will be as familiar to businessmen as E.D.P. (electronic data processing) is today. In fact, I.R. in 1960 is just about where E.D.P. was ten years ago.

Those most acutely aware of the importance of I.R. are scientists and engineers who are haunted by the fear -- indeed, the certainty -- that they are working on problems that have already been solved and whose solutions have been published somewhere. When such duplications are discovered, no one is anxious to publicize the fact, but a few examples can be cited:

For several years U.S. experts struggled with the mathematics of an electronic switching problem important to military communications. It was not until they got the problem solved that they discovered that the Russians had published the solution in 1950, just about the time the U.S. had started work.

One of the most vexatious problems in the ballistic-missile program was development of flow-control valves that would reliably handle liquid oxygen. Several of the nation's leading valve builders were given the problem, and missile firings were held up for four months before satisfactory valves were designed. The Air Force then discovered that a researcher in one of its own laboratories knew all about the problem from working on valves for use in high-altitude balloon flights, and could have pointed the way to the solution directly.

A major electronics firm recently paid $8 million for two patented inventions, only to find that it had wasted its money. The two patents had no value: buried in the patent-office files were patents showing that both ideas had been anticipated by earlier inventors. Such failures in information retrieval occur, even though the Patent Office has one of the world's best-indexed files and 1,000 highly skilled patent examiners.

CORPORATE AUTHOR: Case-Western Reserve University, Cleveland, Ohio

TITLE: Measurement of Value of Recorded Scientific Information

DATE: July 1961

DISTRIBUTION/AVAILABILITY STATEMENT: Also available from Office of Scientific Information Service, National Science Foundation, Washington, D. C.

ACCESSION NUMBER: AD-260 734

ANNOTATION: This exploratory study was directed towards measuring the value of a unit of scientific information. Experiments were performed in an attempt to objectively evaluate citation counts as an index of value of scientific articles. It was concluded that the usefulness of citation counts was open to serious doubts.

Attempts were made to develop an improved measure of value by providing a conceptual and metrical foundation for a behavioral theory of human communication.

TITLE: A Comparative Study of Three Systems of Information Retrieval: A Summary

AUTHOR: Norman D. Stevens

SOURCE: American Documentation

DATE: October 1961

ANNOTATION: Three approaches to the problems of information retrieval were examined to determine factors affecting conditions of use. Input costs and cost per usage were higher for the mechanized approaches than for conventional library techniques. The mechanized system was, for certain types of questions, more efficient than the library reference approach in producing answers. The difference was not great enough to offset the higher basic costs; and a punched card-handbook system of the type examined is not, therefore, recommended. Conditions under which such a system might be feasible, and what such a system should provide if used, are given. The major recommendation, however, points out the need to find ways in which library catalogs can be strengthened to provide a more efficient level of indexing and more ready access to concealed data. (Author)

CORPORATE AUTHOR: Stanford Research Institute

TITLE: Requirements, Criteria, and Measures of Performance of Information Storage and Retrieval Systems

AUTHOR: C. P. Bourne, C. D. Peterson, B. Lefkowitz, and D. Ford

DATE: December 1961

ACCESSION NUMBER: AD-270 942

ANNOTATION: A preliminary study was made of the requirements, criteria, and measures of performance of information storage and retrieval systems. A total of 92 applied electronics researchers and 11 metallurgists were interviewed to measure and rank several different requirements for information. It was found that some requirements could definitely be measured, and that there was general disagreement among the users about the relative importance of various information requirements. The methodology and the interview guide could be extended, with minor modifications, to other technical subject fields. In addition, three separate and complementary tools were developed for the analysis and evaluation of information retrieval systems: (1) a coarse screening procedure; (2) two different performance evaluation procedures; and (3) two cost analysis procedures that used computer programs to simulate the operation of candidate systems to determine their operating costs over wide ranges in operating conditions. A general functional model of a storage and retrieval system was developed for use by these cost analysis programs. A number of specific research tasks are also suggested to further develop the techniques for the determination of user requirements and the measurement of the performance of information storage and retrieval systems.

CORPORATE AUTHOR: Center for Documentation & Communication Research, Case-Western Reserve University, Cleveland, Ohio

TITLE: Resolution of the Literature Crisis in the Decade 1961-1970

AUTHOR: Allen Kent

SOURCE: Research Management 5(1)

DATE: January 1962

ANNOTATION: The following questionnaire was sent to representative research managers, scientists, and librarians in the United States.

How would you answer the following questions if they were put to you on a confidential basis.

1. Please check the appropriate figure which most closely represents your estimate of the value to your organization of an exhaustive and precise search of everything published over a period of five (5) years that you may specify, that has a bearing on a question such as illustrated below under Chemistry, Engineering, Medicine, Law, and Economics.

Would it be worth (per interrogation) $10; $100; $1,000; $10,000; or $100,000; to your organization if you could be assured that you have all previously published literature bearing on a research problem that you are undertaking-and if the problem were of a complexity similar to those listed.

2. How many questions per year-of the type given-do you estimate your organization could profitably have answered each year. 10; 100; 1,000; 10,000; More than 10,000.

Kent received more than 400 replies. They indicated an average value for searches (answer to question 1) of $3,340, and a total number of questions of interest per year (answer to question 2) of 2,284,614, or a total annual value of question answering services of $2,927,039,153. Of those responding, 47% preferred to obtain answers to their questions from a centralized point (answer to question 3), leading to the estimate of $1,375,708,377 as the potential annual market for a centralized information service in the United States.

CORPORATE AUTHOR: Arthur Anderson & Co., New York, New York

TITLE: Research Study of Criteria and Procedures for Evaluating Scientific Information Retrieval Systems

DATE: March 1962

ACCESSION NUMBER: AD-273 115

ANNOTATION: This study deals with the requirements, criteria, and measures of performance which might be used to evaluate and compare scientific information retrieval systems. A review of existing literature indicated that useful contributions might be made with respect to both cost measurements and system simulations. A cost-time-volume model was conceived, detailed by stage and tested. Flow charts for use in applying the model are presented along with a proposed "operating statement" to facilitate evaluation. Following the simulation approach an information retrieval system performance simulator was developed and applied. Simulation is feasible and useful for comparing systems. Both evaluation models are based upon the conclusion that all scientific information retrieval systems are comprised of four basic stages: coding and indexing of objects for storage; coding of inquiries in a language consistent with that applied to objects; matching inquiries with objects in accordance with system-imposed rules; and user appraisal of retrieved objects. In general, these stages can be represented abstractly in binary language within a matrix of stored objects and indexing terms.

CORPORATE AUTHOR: University of Arizona, Tucson, Arizona

TITLE: Defining the Query Spectrum - The Basis for Developing and Evaluating Information-Retrieval Methods

AUTHOR: James W. Perry

SOURCE: IEEE Transactions of Engineering Writing and Speech EWS 6(1)

DATE: April 1962

ACCESSION NUMBER: AD-434 293

ANNOTATION: In designing a retrieval system for technical information, consideration of what practical benefits will result must be weighed against the costs of its operation. Thus definitions of what queries to the system and what responses to them will be most useful in a given research, industrial, or management situation are of great importance. In such analysis, there are important factors (such as the actual relation between technological progress and recorded information) that can be defined qualitatively, but that defy precise study and quantitative measurement. Corresponding factors in Patent Office operations offer the possibility of operational study, since queries that the Patent examiner must answer have a similarity to the queries of importance in planning and conducting industrial research and development.

TITLE: Time Required, Cost, and Personnel For Documentation

AUTHOR: Kenzo Herayama

SOURCE: American Documentation, pp. 313-319

DATE: July 1962

ANNOTATION: Within the scope of documentation of chemical literature, the methods using visual card (non-punched card, NPC), edge-punched card (hand-sorted punched card, HSPC), and Hollerith card (machine-sorted punched card, MSPC) are compared for the processing documents from collection to retrieval. Each of these three methods has many variations and discussions will be made on an average method. All the costs were calculated on the current price in Japan, and the redemption of equipment is taken into consideration. In comparing matters of cost between two countries, consideration should be taken of commodity prices as well as international exchange rates. For example, in converting Japanese cost in Yen to U. S. dollars, it seems more appropriate to make it at the rate of Y100 to $1.00.

TITLE: Information Cost, Amount of Payoff, and Level of Aspiration as Determinants of Information Seeking in Decision Making

AUTHOR: John T. Lanzetta, Vera T. Kanareff

SOURCE: Behavioral Science 7(4) p.p.459

DATE: October 1962

ANNOTATION: The study is directed to determine the effects on information acquisition of varying the cost of information, the payoff for a correct decision and level of aspiration for performance.

TITLE: The Management Process and Science Information Systems

AUTHOR: Edward M. McCormick

SOURCE: Information Retrieval Management. Detroit: American Data Processing

DATE: 1962

ANNOTATION: Science information center is defined as an aggressive information collector, as opposed to the library's passive role of random storing. Goals and objectives of center may best be determined through market survey techniques, because often the scientist-user is unable to determine needs of system. General goal is that the system should be easy to use. Evaluation of system must be based on validity of assumed user needs as well as on feedback from user. At present it is difficult to measure value of services against cost. Comparison of pricing by various competitive and self-sustaining commercial activities would help in evaluation of cost. Also interesting would be a study in which service activities are taken off overhead and charges made to the appropriate department.

CORPORATE AUTHOR: Thesis For School Of Systems And Logistics, Air Force Institute Of Technology, Wright-Patterson Air Force Base

TITLE: Analysis Of Costs And Benefits Of EDP Systems

AUTHOR: Ivan B. Thompson and Harold A. W. Tibbs

DATE: June 1963

ACCESSION NUMBER: AD-424 885

ANNOTATION: The principle of allocating costs to cost objectives on the basis of benefits received provides a sound basis for estimating costs of electronic data processing systems. Estimated direct costs are those that will be incurred for the exclusive benefit of the system. Estimated indirect costs are those that will be incurred for the benefit of two or more cost objectives and, consequently, must be equitably apportioned between them. Only those costs that will directly or indirectly benefit the electronic data processing system should be considered in the estimate of system costs.

Two kinds of costs arise in installing an electronic data processing system: preparation and installation costs and operational costs. Preparation and installation costs include the costs of survey, systems analysis, systems design, programming, debugging, outside advisory services, personnel training and orientation, remodeling, equipment, file conversion, acceptance testing, site occupancy, and parallel operations. Operational costs are made up of the cost of input, equipment rentals or charges, personnel costs, the costs of standby facilities, and other costs.

Costs pertaining to proposed management information systems are always uncertain, especially when they relate to the distant future. Cost estimates must reflect these uncertainties by presenting a range of costs for each doubtful item. The decision maker, aware of the uncertainties, may then use his judgement in weighing costs against benefits.

The costs of electronic data processing systems occur at various future dates. Valid comparisons of costs that occur at different points of time can be made if future costs are discounted. Discounting is usually accomplished at the highest decision level. Estimates must reflect the magnitude of costs over their general time of occurrence so that the decision maker can appropriately

discount future costs.

CORPORATE AUTHOR: Information Dynamics Corp., Wakefield, Massachusetts

TITLE: Science Information Service Networks: A Method For Systems Design and Analysis

DATE: September 1963

ACCESSION NUMBER: PB-176 191

ANNOTATION: This document describes the construction of economic models for a comparison of geographically-regionalized information services and subject-specialized information service networks.

CORPORATE AUTHOR: Information Dynamics Corp., Wakefield, Massachusetts

TITLE: Information Service System Modeling

AUTHOR: Mark Chodrow, David E. Sparks and David P. Waite

DATE: December 1963

ACCESSION NUMBER: PB-169596

ANNOTATION: Information Dynamics Corporation has been under contract to NSF to attack the problem of analyzing operating costs of information service networks by employing mathematical modeling techniques. As a result of this work, it is now possible to evaluate alternative network configurations on the basis of operating costs. The model developed permits representation of the multitude of variables of subject disciplines, geographic location, communications, the variety of existing forms of input information, the type and location of information processing operations, and many others.

This report is presented in two parts: Part I provides an interpretive report to management on the objectives, results, conclusions, and utility of the mathematical model created to represent and evaluate the operating costs. The development of the model and an illustrative calculation are reported in technical detail in Part II. (Author)

TITLE: The Value And Cost Of Information

AUTHOR: Robert H. Gregory and Richard L. Van Horn

SOURCE: Automatic Data-Processing Systems Principles And Procedures. Second Edition, Wadsworth Publishing Company, Inc., Belmont, California, 1963, Chapter 15

DATE: 1963

ANNOTATION: The concepts of cost--both average and marginal--are pertinent to the volume of data handled and to decisions for changing procedures. Factors that have an important bearing on the cost of processing data are quality, quantity, timeliness, and relevance. Short intervals and frequent reports go together; they are two sides of the coin. The costs of reporting probably double each time the interval is cut in half. On the other hand, the value of reports first increases and then may actually decrease as intervals are made shorter. In extremely short intervals, unusual events may outweigh and mask the underlying events. The delay--the length of time before a report about a single event or a series of events is available--can be shortened to get up-to-date reports. Costs may increase rapidly, if large facilities are used to meet peak demands for quick processing because such facilities are underutilized most of the time. The increase in the value of results learned sooner--whether an hour, minutes, or seconds earlier--depends on the circumstances of the situation.

The nature of input data is fundamental to the design and operation of the whole system. All four factors are considered for selection of input data. The data-processing system has some measure of control over kind, quality, quantity, and timeliness, at least at the syntactic level. The makeup of reports is determined in terms of their information content. A decision maker gets certain quantities of reports with some specified degree of kind, quality, quantity, timeliness, and format. The primary considerations for a report user are the meaning and impact of reports--their semantic aspect. Following these, he must consider the practical consequences of his action.

The cost and value emphasize the point that costs are incurred at every stage of processing while benefits result only from managerial action utilizing system output. The raison d'etre of an information system is to improve the operation of the organization. Even good decisions are valueless unless they lead to action.

For several reasons, few general principles or rules exist for guidance in designing data-processing systems: analysis is expensive and time-consuming, systems are essentially unique to an environment, insufficient experience with new equipment is available to permit long-run conclusions, and data-processing and information-production systems are complex because they pervade an entire organization.

TITLE: Information Economics and Management Systems

AUTHOR: Adrian M. McDonough

SOURCE: McGraw-Hill Book Co., Inc. pages 72-83, 106-117

DATE: Copyright-1963

ANNOTATION: Much has been written on the cost side of the Economics of Information. Let me review a few of these cost-of-information considerations. First, recall that I have been concentrating on an analysis that considers the costs of a study up to the point of possible installation. These are the costs of systems development. Now I wish to relate the costs of both systems development and of the operation of the installed system.

We can think in terms of the costs that would be incurred in both the period of study effort and in the period of application of study findings. At the end of the study period we should have: (1) A statement of the stream of benefits to be derived from the application of the study findings (2) A statement of the stream of costs necessary to implement the study findings (3) A statement of record of what it has cost to make the study.

At the end of a study period the costs of making the study are, practically, sunk costs. Therefore only statements 1 and 2 are relevant. Statements of benefits and costs should be weighted with probabilities, and a decision made as to application of the study. Cost of the study itself is important only when we can do something about these costs, i.e., while the study is in process. This is especially true at the point of decision as to whether to start the study or not.

The decision to add an increment of cost at any point in the preapplication phase is a function of: (1) The estimate of net gain of system value minus its costs during the postapplication phase (2) The comparison of the estimated net gains for alternative studies (3) The application of the opportunity cost concept whereby study resources are applied to studies with the best estimates of net gain. Thus the assembly of costs, like those of values, is a matter of projecting ahead and reflecting back to the present.

Preapplication Costs. The cost factors that are significant during a study are those associated with the quantity and quality of the personnel making the study and, of course, the length of time during which these costs are being incurred. Here I merely note that these costs cover activities from initial problem search to the final application of study findings.

Postapplication Costs. Postapplication costs are those costs that are generated in installing and operating the system. These are the costs normally associated with the hardware usage

and the clerical costs of data processing.

The assembly of both values and costs for a particular study should be placed on a schedule basis for any worthwhile study. Cost estimates should be considered simultaneously with value estimates. In a given study, statements of both costs and values should be made as explicit as possible. At significant stages of a study, now being called "milestones," a profile of the assembly of pre- and postapplication values and costs should be assembled. In some cases such project status can be quite explicit. In other cases it may be possible to obtain only very general statements of values and costs. The important consideration is that a standard format be developed and used consistently. Only then is it possible to provide other than intuitive bases for decisions concerning the allocation of resources among alternative studies.

TITLE: The Dollars and Cents of Basic Operations In Information Retrieval

AUTHOR: LaVann Overmyer

SOURCE: Information Retrieval in Action

DATE: 1963

ANNOTATION: This report analyzes the detailed breakdown of what it costs to prepare the input for over 36,000 abstracts and to provide the output by means of searching on a computer.

TITLE: Unintentional Duplication of Research

AUTHOR: John Martyn

SOURCE: New Scientist 377(338)

DATE: February 1964

ANNOTATION: This survey reveals instances of belated discovery of information in the literature leading to an estimate of what duplication costs. A modest assumption is that 10% of the funds allocated to 88 projects might have been saved had the relevant information been found earlier. In 1962 the expenditure on research and development in the United Kingdom was about 640 million pounds. Results derived from the sample, if applied to this total, give a figure of about 6 million pounds and this is the minimum amount that is estimated to have been spent unnecessarily because the published information was not discovered earlier.

TITLE: Cost Analysis and Simulation Procedures for the Evaluation of Large Information Systems

AUTHOR: Charles P. Bourne & Donald F. Ford

SOURCE: American Documentation

DATE: April 1964

ANNOTATION: A computer program has been written and used which simulates the several-year operation of an information system and computes estimates of the expected operating costs as well as the amount of equipment and personnel required during that time period. The program has been used for the analysis of several large systems and has proven itself to be a useful research tool for the study of systems with so many components and interrelated operations that an equivalent manual analysis would be extremely cumbersome and time consuming, and perhaps even impractical. This paper describes this program and shows, as an example some of the results of a simulation of two of several suggested designs for a specific information system.

TITLE: The Charter: A "Must" for Effective Information System Planning and Design

AUTHOR: John C. Costello, Jr.

SOURCE: Journal of Chemical Documentation 4(12)

DATE: 1964

ANNOTATION: A number of quality control considerations are discussed such as standards for screening both internally and externally generated input. Screening standards should be the same for input of current acquisitions and backlog, and for removal of obsolescent material. Standardization of screening for input and removal is a most important consideration since the "aging" of backlog documents may have reduced their residual value to lower than that of minimum-value current acquisitions. Similarly, no current acquisition should be included if its apparent value is less than documents to be included from the backlog. Screening standards for input and removal should be based on the premise that the system is designed to provide for recall and reuse of information, not merely to serve as a warehouse or mausoleum for all documents that have ever been written. Individual systems must determine whether screening is to be based on (a) cost in research dollars of producing the document, (b) research dollars to be saved by retrieval of the document, (c) costs required to include the document in the index and collection, or (d) time to be saved in conducting searches. For externally generated documents, standards must be developed for equating their value in relation to internally generated documents.

TITLE: The Cost of Scientific Information

AUTHOR: James W. Ramey

SOURCE: Journal of Chemical Documentation, Volume 6, Number 4, November 1955, pp. 210-211

DATE: November 1965

ANNOTATION: If we agree to lump together, as legitimate costs of obtaining information, all expenses of maintaining and staffing the information center (which in industry amount to 1/5 to 2.5% of the total research budget according to a survey by Herner, et. al., plus the total time research scientists spend consulting the collection and other written sources, it would still be necessary to assess oral means of getting information. Case Institute study found chemists spending twice as much time in oral scientific communication as in reading. Here we have the same basic difficulty in assessing costs. Whether we talk about formal oral communication methods (such as attending meetings) or informal oral means (such as telephone and face-to-face conversations), participation in professional activities, use of consultants, or allowing staff members to be consultants, the same question can always be asked: how much of the cost should actually be charged to the cost of obtaining information. While most of these activities also serve other purposes they are nevertheless legitimate information-getting activities. It might even be instructive to ask which dollar is most productively spent: for journals, long distance calls, another information specialist, or perhaps the addition of a coordinate indexing system to the document collection.

If one is willing to exclude these philosophical imponderables, one could arbitrarily add up the total cost of the information center, all subscriptions, telephone bills, travel, consultants' costs, cost of allowing members of research staffs to be consultants, postage, formal and ad hoc meetings, and participation in professional activities and conclude that the resultant dollar figure is the out-of-pocket cost ob obtaining information. This would be a sizeable chunk of the total research budget. Add to this the Case Institute figure of 32% of the salary cost of the researchers, while they are involved in these information-seeking activities, and the resulting figure could run as high as 40% of the total research budget. After one has this figure, what does it mean. Lacking knowledge of how expenditures for these activities are related to the output of the research effort, one cannot say that any figure is too little or too much. Attempting to separate the cost in dollars and time of the information-gathering activities of scientists, both formal and informal, from the over-all cost of their creative

effort is a stick problem--one which again makes our cost figures meaningless.

While I do not doubt that sooner or later someone will manage to conduct a rigorous research study with proper control of the myriad and complex variables involved and suitable control groups, which will determine the effect of various types of information service on creativity, much more research will be needed before we can feel secure about assigning cost figures to these functions.

In the meantime, even if it is not possible to assign precisely the cost of each method of obtaining information, it may be possible to show that one means is more expensive than another. We would thus be establishing a gross value hierarchy, even though precise cost measurements were lacking. By constructing a table that combines the average cost of the chemists' time spent on reading (9.5%), using the Case study figures, with total information center costs (postage and subscriptions, his general discussion time (7.5%) with attending formal and ad hoc conferences and travel, and his oral nondiscussion communication time (11%) with total telephone costs, consulting costs, and use of personal files), it would be possible, in very gross terms, to compare the cost of these three means of obtaining information--but unless these figures can be related to a unit of information, such as cost per question answered, these comparisons will still be meaningless.

Even after developing such crude cost figures, we are still faced with a value problem that goes beyond dollar expenditure. The researchers themselves value certain information-gathering means far out of proportion to their relative cost. Nevertheless, it may be that even they (the creative group we hope to assist) may not be the final arbiters of this question. A recent MIT study of the utilization of information sources during the preparation of research proposals indicates that some of the factors involved in obtaining information may be very heavily weighted, at least in the minds of those who approve research contracts, without regard to their relative cost to the contractor. For example, technically competent full-time staff people are apparently valued much more than outside consultants. If it could be shown that this is generally the case among those who decide which proposals to approve, the question, ''what price, scientific information'' becomes even more meaningless.

It would seem more meaningful to me to ask such operationally definable questions as what is the unit cost of an information service per answer, rather than per search. Furthermore, what is the unit cost per answer delivered vs. unit cost per answer accepted. To carry this line of inquiry

even further, we could ask the unit cost per question satisfied. A similar question can be posed with regard to ancillary services, for example, routing. Routing can be evaluated in terms of unit cost per new idea or previously unknown document discovered, that is, in terms of novelty. Hopefully as a result of chipping away at the problem through getting answers to such questions as these, we will one day be able to answer the question, ''what is our cost of obtaining information per unit of productivity.'' This is really the $64 question. (1) Herner, S., et al, Ind. Eng. Chem., 51, 569 (1959); and (2) Allen T. J., ''The Utilization of Information Sources During R and D Proposal Preparation; Research Program on the Organization of R and D;'' Alfred P. Sloan School of Management, Cambridge, Mass. 1965.

TITLE: Comparative Costs of Document Indexing and Book Cataloging

AUTHOR: L. H. Linder

SOURCE: Special Libraries 56(724-726)

DATE: 1965

ANNOTATION: This document compares costs and functions of document indexing and book cataloging. The average cost per item of conventional book cataloging was found to be $3.67, of indexing reports into a machine document address storage system, $2.99. Factors contributing to the greater cost of cataloging are (a) different size units of knowledge contained in collection, (b) different mental activities required, and (c) task of creating and maintaining subject authority control file.

Although the ultimate costs of cataloging and indexing are both the retrieval of items of information, the systems are not precisely comparable. A book catalog leads a user to more broad treatments of a subject, a report index to more specialized items. Cataloging and indexing are only inputs of information storage and retrieval systems. Final evaluation of two such systems must include measures of comparative retrieval effectiveness and dollar costs for retrieval.

TITLE: Measuring The Value Of Information--An Information Theory Approach

AUTHOR: Norton M. Bedford and Mohamed Onsi

SOURCE: Management Services, 3(1) pp. 15-22

DATE: Jan-Feb 1966

ANNOTATION: A distinction has been made between the amount and value of information. Information value and information amount do not necessarily correspond. The ranking of information structures according to their value is a subjective matter, depending on its usefulness for a given user and the payoff function. On the other hand the amount of information is independent of the payoff function and it reaches its maximum when the messages are equiprobable and as such remove the highest degree of uncertainty.

The emphasis on measuring the amount of information in the system as a whole and at each level of reporting is a result of developing an information flow matrix for the entire organization. Within this matrix, not only the periodicity of information flow and time-lag problems but also the amount of information and the redundancy of information can be manipulated. A simulated model of the amount of information that can be sent over a given channel(s) with a certain noise can be developed.

It is our belief that continuing research will increase the reliability and significance of accounting planning and control systems.

TITLE: Cost Distribution and Analysis in Computer Storage and Retrieval

AUTHOR: Harvey Marron, Martin Snyderman, Jr.

SOURCE: American Documentation

DATE: April 1966

ANNOTATION: A method for costing computer jobs done by a mechanized storage and retrieval activity is proposed and discussed. Attention is confined solely to computer costs. The Science Information Exchange, a mechanized installation handling information on research in progress is used as the case in point. All computer jobs are grouped as batched, singly run or maintenance tasks. Job unit costs are calculated with and without inclusion of file maintenance costs. Should other activities compute their costs similarly, interactivity cost comparisons can be made readily, opening the door to cost-quality criteria for mechanized searches and report preparation.

TITLE: Information Retrieval--The Economic Aspect

AUTHOR: W. E. Batten

SOURCE: Journal of Documentation, Vol. 22, No. 2, pp. 87-92.

DATE: June 1966

ANNOTATION: The objectives and methods of an information retrieval system determine its input and output costs and the relation between them. The present trend seems to be towards increased sophistication (and cost) of input. "Retrieval efficiency" can be measured, but the true "worth" of a system depends not only on retrieval cost, but also on the value to the user of what is retrieved. Future changes--with computers being used more, and perhaps accepting 'syntax' as well as "vocabulary"--will substantially change the economic picture. (Author)

CORPORATE AUTHOR: Systems Development Corp.
Santa Monica, California

TITLE: Current Results from the Analysis of Cost Data for Computer Programming

AUTHOR: T. Fleishman

DATE: August 1966

ACCESSION NUMBER: AD 637 801

ANNOTATION: The report describes the third cycle in the continuing research to develop cost estimating relationships between cost and cost factors, to be used in the management of computer programming. Several features of the work are presented, including basic assumptions of the analyses, definitions, data collection and validation procedures, and application of statistical techniques such as correlation and multivariate regression analyses. The analysis is being performed with 169 data points, representing computer programming efforts completed by system development corporation, various industrial organizations, and agencies of the United States Air Force. Several characteristics of the data base are presented, e.g., source, size, range of selected variables, average age of the data points, and applications and computer languages used. In addition, statistical tests were performed to ascertain the presence of subsamples in our data; the results of these tests are also presented. The report concludes with recommendations for the collection and validation of more accurate data, as well as for general improvements in the approach and methods implemented in the work. (Author)

CORPORATE AUTHOR: Mitre Corp. Bedford, Mass.

TITLE: Information Requirements for Development Decisions

AUTHOR: Richard S. Rosenblum

DATE: 1966

ACCESSION NUMBER: AD-632 587

ANNOTATION: This document concerns function and value of information as it affects the conduct of organized development projects. Major function of information in an organized development effort is to guide the decisions which allocate resources to alternative activities.

To acquire information, the value of the result should be comparable in some rough measure to the cost of the activity. This idea underlies the techniques for experimental design and is at the base of the scientific method. The role of information in a purposeful activity should be based on some explicit conception of the character of that activity. A much closer linkage should exist between the study of decision making and research on information systems.

Measures of value cannot be considered separately from range of economic factors inherent in choices affected by information. Information which does not change behavior has no value within activities having economic aims.

TITLE: The Economics of Information Retrieval

AUTHOR: W. E. Batten

SOURCE: Library Journal, Vol. 92, No. 5, pp. 974-975

DATE: March 1, 1967

ANNOTATION: This article discusses the economics of information retrieved from a philosophical standpoint. The author treats the objectives, methods, and performance of information systems and concludes that because of their rapidly changing nature today's ''systems'' go largely uncosted and unevaluated.

TITLE: User Evaluation Of Information Services

AUTHOR: F. Dugger and R. F. Klinger

SOURCE: Proceedings Of The Fourth Annual National Colloquium On Information Retrieval

DATE: May 3-4 1967

ANNOTATION: A study was made on the value of benefit placed by the user on information retrieval. Questionnaires were used to make the evaluation.

TITLE: How to Build a Marketing Information System

AUTHOR: Donald F. Cox and Robert E. Good

SOURCE: Harvard Business Review, Vol. 45 no. 3, May-June 1967, pp 145-154

DATE: May-June 1967

ANNOTATION: This is a partial report of a study of the development of marketing information systems (MIS).

It is difficult to generalize about how much an MIS will cost -- or how much it will be worth. Usually there is not a large increase in data gathering costs, since many companies now have available to them much of the raw data required. Cost increases result from data storage and transforming the raw data into useful information. It is extremely difficult to determine MIS development costs, since many companies lack accounting arrangements, like interdepartmental billing, which allow them to keep track of the total cost of the manpower contributing to the program.

On a "best estimate" basis, we are aware of simple or partial systems which have cost only a few thousand dollars. At the other extreme, one complex marketing system we know of must have cost several million dollars. A large company with sales in the $500 million range should expect to invest several hundred thousand dollars (plus equipment charges) to develop a relatively sophisticated, computer-based MIS. And development costs will not end there, since after the first stage is operational, it is probable that management will want to upgrade the system continually.

If top executives authorize expenditures of this magnitude, they are likely to want a justification of the value of the system. Usually, computer-based information systems, such as those used for accounting, have been justified mainly on the ground that they reduce personnel and other administrative costs. Few advanced marketing information systems could be justified on the basis of cost reduction.

However, that test alone is not appropriate for an MIS. The main purpose of an MIS is to help the marketing manager make more profitable decisions, not to reduce data handling and paperwork costs. So an MIS should be evaluated in terms of its estimated effects on marketing efficiency.

Determining how much an MIS could increase marketing effectiveness is not an easy task. The involvement of management in developing overall specifications should help in making an estimate, however imprecise, of system benefits. In addition, the decision on a budget for MIS development need not be made in a single giant step. Rather, it is possible to attain system sophistication in discrete increments, involving a series of smaller budgeting decisions and

cost/benefit evaluations.

CORPORATE AUTHOR: System Development Corp.

TITLE: Analytical Cost Comparison of Computer Operating Systems

AUTHOR: Warren J. Erikson

DATE: June 30, 1967

ACCESSION NUMBER: AD-661 983

ANNOTATION: Quantitative models are developed of computer center users, the programs they run, and the different operating systems they might use. Data about these same subjects are used with the models to determine how well the various computer systems could serve different set of users.

The major measure of system performance is cost, where this includes both computer system cost and user cost. This is done because each of the other commonly used measures of system performance (throughput and turnaround or response time) can be reduced to a cost effect. However, the choice of a computer system as a management decision should be based upon total cost, rather than technical performance evaluation alone. In the choice between two systems, the mere fact that one is faster is not enough. More relevant to the choice is knowledge about which one will process the required workload at the lower cost.

The use of cost as a measure of system performance also helps to eliminate some subtle errors that can creep in when using more direct measures of performance such as central processing unit (CPU) time and user time. It is possible for both CPU time and user time to be lower for a timesharing system (TSS), and yet have the TSS be less economical than, say, a batch-processing system (BPS) with which it is being compared. This result can occur because of the relatively higher cost of the TSS.

This research focus is on systems where the major system load is provided by individual users who have their own jobs to be run on the system. Most industrial research and development and university computer centers fall in this category.

Hypothetical System Use and Cost:

System--User Cost ($) per Hour, TSS - 10.00
BPS - 10.00;

System--Computer System Cost ($) per Hour, TSS 1500.00
BPS 1000.00;

System--Mean User Hours per Job, TSS 10.0
BPS 12.0;

System--Mean Computer Hours per Job, TSS 0.10
BPS 0.12;

System--User Cost ($) per Job, TSS 100.00
BPS 120.00;

System--Computer Cost ($) per Job, TSS 150.00
BPS 120.00;

System--Total Cost ($) per Job, TSS 250.00
BPS 240.00.

TITLE: Cost Distribution And Analysis In Computer Storage And Retrieval. Part II

AUTHOR: Harvey Marron and Martin Snyderman, Jr.

SOURCE: American Documentation, July 1967

DATE: July 1967

ANNOTATION: Additional data are presented on the cost of computer storage and retrieval activities. The effects of system modification and new hardware are noted.

In an earlier paper a method was proposed allocating computer costs in a mechanized storage and retrieval activity. Also included was actual operating cost experience for the Science Information Exchange (SIE) from the period January 1964 to June 1965. System modifications and equipment changes since then have continued to reduce costs further are shown.

In May 1965, an IBM 1460 central processing unit replaced the Exchange's IBM 1401. In April 1966, SIE replaced its IBM 1460 with an IBM 360/30 and added direct access disc capability to the tape oriented system. The master file was retained on magnetic tape and from it an inverted subject file was generated on discs enabling direct access searching. The inverted disc file contains a list of all the subject index points used at SIE. Appended to each point are all the identification numbers of projects which have been indexed with that particular point.

The necessary computer programming for direct access disc searching was completed late in the summer of 1966. September 1966 was the first full month in which the inverted subject search system was used for many tasks that would have been batched and run against the magnetic tape master file. The cost reduction per job has been in accordance with expectations, and costs are expected to go even lower as further refinements are made to the operating system.

The batched jobs (i.e., subject or bibliographic searches which for economy considerations were batched and run against a single pass of a master tape file) declined from $37 per job in early 1964 to about $30 per job in mid-1965.

When a prorated share of the maintenance expense is added, however, the costs range from $49 to $41 per search over the same time periods.

Shown are the results of the period 7/65-6/66 for some systems improvements plus the faster cycle time of the 1460 central processing unit. The direct cost per search was

reduced to about $22 or about $32 per search with the maintenance burden added. The costs per tape search did not decrease further upon installation of the 360 until disc searches were initiated.

The costs for September 1966 are shown when most of the searches were performed using the disc files. Master tape files still had to be used in certain special cases. The cost per subject search was further reduced to $11 per job for direct cost and $23 per job with maintenance burden added.

We expect the cost per bibliographic search to decrease further because: (1) a greater proportion of bibliographic searches will be accomplished via the disc files; (2) additional improvements are already being made to the operating systems; and (3) computer usage will increase thus decreasing the cost per hour and the prorated burden each task must carry for the maintenance expense.

TITLE: Evaluating the Technical Information Function

AUTHOR: G. J. Brockis & Peter F. Cole

SOURCE: Chemistry in Britain

DATE: October 1967

ANNOTATION: Adequate awareness of all relevant technical information can be decisive in determining the success of any research project. However, no adequate criteria for evaluating the contribution so made have yet been developed; neither is there any general agreement on criteria for assessing the optimum size for the technical information function. This paper briefly reviews some existing pointers and examines the results of a small-scale investigation which appear to offer some new data in both areas. (Author)

CORPORATE AUTHOR: American University, Washington, D. C. Center for Research in Social Systems

TITLE: Information System Operation Group

AUTHOR: Bernard K. Dennis and Frederick N. White, Jr.

SOURCE: Social Science Information Systems Workshop Proceedings November 1966 p.p. 35-43

DATE: November 1967

ACCESSION NUMBER: N67-18458

ANNOTATION: A conference workshop gaming approach to two real-life information system situations was tested in consideration of current and potential problems and possibilities for mechanization of social science information. Broad categories of interests were represented for information systems primarily in the physical sciences and engineering fields. The need was cited for increased coordination among information activities in the social sciences, the information systems for which lag behind the systems operative for the physical science and engineering fields. While discussing the cost effectiveness of information retrieval, it was considered that most present systems are too small to economically justify mechanization by computer. Group analysis of the information scientist concept appeared to indicate some doubt as to whether individuals could become adequately qualified in all necessary areas to fulfill the role as stated, effectively and in depth.

CORPORATE AUTHOR: National Bureau of Standards, Gaithersburg, Maryland

TITLE: Evaluation of Information Systems. A Selected Bibliography with Informative Abstracts

AUTHOR: Madeline M. Henderson

DATE: December 1967

ACCESSION NUMBER: Technical Note 297

ANNOTATION: A survey of the literature on evaluation of information systems has been conducted by the Technical Information Exchange, Center for Computer Sciences and Technology, National Bureau of Standards. During the early stages of the survey, the literature was divided among descriptions of programs which compared the performance of two or more information systems, accounts of programs which studied the performance of one system, papers and reports which discussed the problems of evaluation programs, and documents which proposed new techniques for evaluation of systems. From the total literature collected, those references which were judged to be most directly concerned with the subject of evaluation of information systems were selected and abstracted. The abstracts are designed to give a summary of the content of the corresponding paper; the author's own wording was used extensively, in order to avoid misinterpretation. All of the references collected are listed, in alphabetic order of authors' names, in the appendix to the main body of this publication. (Author)

TITLE: The Decision-Theory Approach To The Evaluation Of Information-Retrieval Systems

AUTHOR: I. J. Good

SOURCE: Information Storage Retrieval

DATE: 1967

ANNOTATION: It is argued that the evaluation of information-retrieval systems should ultimately be based on the principle of rationality, the maximization of expected utility. In full generality this would involve an estimation of both the cost and value of a system, but the emphasis in this paper is on the problem of value, in terms of which the efficiency of the system could be defined. One implication of the discussion is that it is not legitimate to superimpose the 2 x 2 contingency tables that refer to selected/discarded and relevant/irrelevant, corresponding to each request, but it might be all right to superimpose them after applying a monotonic function to the entries. In particular, it is questionable whether a useful statistic is the ratio of the total number of relevant selected documents to the total number of relevant ones, over a sample of requests. (Author)

TITLE: Evaluating the Economic Efficiency of of a Document Retrieval System

AUTHOR: F. W. Lancaster and W. D. Climenson

SOURCE: Journal of Documentation 24(1) pp. 16-40

DATE: March 1968

ANNOTATION: A retrieval system may be evaluated strictly in terms of user satisfaction (operating efficiency), or it may be evaluated from the point of view of efficient means of satisfying user requirements (economic efficiency). When we consider the relationship between operating efficiency and economic efficiency, we are faced with a whole series of possible trade-offs. There may be several alternative paths we can follow in order to serve user needs. The problem is to determine the most economical path to follow. Payoff factors, break-even points, and diminishing returns must be taken into consideration. This paper considers some of these factors in relation to various parts of the complete retrieval system: the acquisition subsystem, the indexing subsystem, the index language, the searching subsystem, and the equipment subsystem.

II. Technology Transfer

E. Department of Defense

CORPORATE AUTHOR: Vitro Engineering Co., Washington, D. C.

TITLE: Analysis of Current Systems
Management of Engineering Documentation

DATE: March 1961

ACCESSION NUMBER: AD-461 555

ANNOTATION: Over-emphasis on equipment to the detriment of its documentation is a false economy. A million dollar equipment which cannot be repaired because the two-dollar part which wore out was not listed in the provisioning documentation, the engineering drawings, or the maintenance manual, may be idle for days or weeks. Also, training or combat missions could be delayed from such a simple oversight. While the solution is not a simple one, this problem and its impact must be recognized and remedied.

One of the many important facts disclosed by a recent DoD report is that the costs to the military for acquiring engineering drawings are not known. Cost figures of $1.5 billion spent annually for acquisition of this type of documentation and another half billion for its reproduction are used, but they are merely estimates. The report states that these "Data are generally not priced separately in the contract but are included in the cost of the principal items." Without accurate cost data, effective management decisions or evaluations are difficult to make.

If the estimated cost figure is reasonably accurate, approximately 5% of the annual DoD budget is used to acquire and reproduce engineering drawings. When all other forms of engineering documentation (such as specifications, provisioning lists, publications, reports and manuals) are included, the figure could approach 20%. The report emphasizes that, "The same dollar cannot buy both hardware and blueprints."

Although millions of engineering drawings and associated lists are acquired by DoD activities each year, they are of little value unless they can be located, retrieved, and transmitted rapidly to the activity requiring their use. Many problems are associated with the logistics of this documentation, owing to the large number of activities involved, their diverse locations, and the irregular demand. Factors of cost, manpower, and bulk preclude sending copies of all drawings to every activity.

TITLE: Gearing Military R&D to Economic Growth

AUTHOR: Robert A. Solo

SOURCE: Harvard Business Review

DATE: November - December 1962

ANNOTATION: The author analyzes some leading issues concerning economic growth and development in the U. S. The following questions are considered:

1. Do our rising expenditures on research and development ensure faster economic growth. Despite a popular impression to the contrary, the answer seems to be no. In fact, the present pattern of R&D outlays in the United States may even be reducing the rate of economic growth.

2. Are the scientific and technological advances made in space and military R&D easily transferable to private industry. While there are many examples of successful transference, the process is becoming increasingly difficult. Not only is space and military research growing farther apart from industrial research in a technical way, but communication between the two sectors is becoming more unmanageable.

3. What organizations can help transmit the benefits of military and space R&D to private industry. Government agencies, universities, and industrial corporations themselves all have critical roles in this task, but each group has a long way to go to fulfill its promise.

4. How can the great potentials in scientific research be utilized for economic growth as well as for progress in space and military programs. Increasing the payoff is an immensely difficult but vital task for social engineering. The output of government-sponsored R&D must be geared to the needs of civilian industry (not to the detriment, but to the ultimate gain, of military-space programs). Also, industrial companies must become more responsive to the opportunities offered.

TITLE: A Fresh Look at Improving Personal Filing Systems

AUTHOR: Ralph Cushing

SOURCE: Chemical Engineering

DATE: January 1963

ANNOTATION: There is indication that management is at last beginning to see the magnitude of the information problem. A survey taken in 1959 showed that 75% of engineering executives cited information retrieval as the biggest waste of engineering time.

The real value of any kind of information is not to be equated with the expense of obtaining it; it is more accurately evaluated by the cost of not having it. As one canny executive has put it, "The price of ignorance is technological surprise."

In addition, professional obsolescence may soon hinge more on an engineer's ability to evaluate and retrieve information than on his mathematical ability. Even his basic knowledge and understanding in his special field depends largely on his acquaintance with published literature, which he must be able to retrieve rapidly.

A survey of industrial laboratories doing work for the Department of Defense has indicated that from 30-85% of the research and development being performed duplicates work already done elsewhere. This is caused primarily by a lack of adequate information retrieval. Some companies have stated that it is not economical to make a literature search for a research problem costing less than $100,000. When smaller problems are involved, it is cheaper to go to the laboratory and start from scratch. It has recently been reported that a cloud-seeding experiment originally costing $256,000 had unknowingly been done over again, at an expense of almost $3 million.

TITLE: The Responsibilities of the Technical Community and the Government in the Transfer of Information

AUTHOR: Alvin M. Weinberg, Chairman

SOURCE: U. S. Government Printing Office

DATE: January 1963

ANNOTATION: This report of the President's Science Advisory Committee makes the following recommendations:

A. Recommendations to the Technical Community:

1. The technical community must recognize that handling of technical information is a worthy and integral part of science;

2. The individual author must accept more responsibility for subsequent retrieval of what is published;

3. Techniques of handling information must be widely taught;

4. Technical community must explore and exploit new switching methods;

5. Uniformity and compatibility are desirable.

B. Recommendations to Government Agencies:

1. Each Federal Agency concerned with science and technology must accept its responsibility for information activities in fields that are relevant to its mission;

2. To carry out these broad responsibilities each agency should establish a highly placed focal point of responsibility for information activities that is part of the research and development arm, not of some administrative arm, of the Agency;

3. The entire network of Government information systems should be kept under surveillance by the Federal Council for Science and Technology;

4. The various Government and non-Government systems must be articulated by means of information clearinghouses;

5. Each agency must maintain its internal systems in effective working order;

6. Problems of scientific information should be given continued attention by the President's Science Advisory Committee

CORPORATE AUTHOR: Office of Aerospace Research, Arlington, Virginia

TITLE: Research Technology Coupling in Air Force In-House Laboratories

AUTHOR: H. J. Sander

DATE: January 1965

ACCESSION NUMBER: AD-612 950

ANNOTATION: This is a review of recent social-science research relevant to the OAR management responsibility for stimulating research scientists in Air Force laboratories to greater personal participation in relating research knowledge to technological and operational problems. Basic issues of the motivation and performance of basic-research scientists are discussed.

A summary of tentative findings includes the following: (a) the promotion and stimulation of increased research-technology coupling is the mutual responsibility of management in both research and applied-technology laboratories; (b) such coupling activities may occupy from 15% to 30% of a research scientist's time without reducing his research productivity; (c) there is evidence of greater willingness on the part of scientists to engage in coupling activities than there are opportunities and mechanisms for doing so as provided by management; (d) essential requirements are: an atmosphere of free, two-way communication between management and research scientists; significant participation by scientists in the decision of what research they are to perform, and almost unrestricted freedom in day-to-day research activities; (e) given a fair salary and promotion opportunity resonably competitive with academic and industrial research organizations, the most important incentives are personal and professional---opportunity for self-development, professional recognition, creativity and accomplishment. (Author)

CORPORATE AUTHOR: Office of the Director of Defense Research and Engineering, Washington, D. C.

TITLE: First Interim Rept. on Project Hindsight (Summary)

AUTHOR: Chalmers W. Sherwin & R. S. Isenson

DATE: June 1966

ACCESSION NUMBER: AD-642 400

ANNOTATION: Project HINDSIGHT is a study of the recent science and technology which has been utilized by the Department of Defense in weapon systems. As a consequence, the focus is primarily on the physical and engineering sciences and related technologies. Consideration of contributions from the life, behavioral, or environmental sciences is peripheral.

The study is retrospective in character because the criteria is proven utilization and it is likely that delays of 5 to 10 years, or more, frequently occur between a scientific discovery or an invention and the time of its practical utilization. The effort has two basic objectives: (1) to identify and firmly establish management factors for research and technology programs which have been associated with the utilization of the results produced by these programs; and (2) to measure the overall increase in cost-effectiveness in the current generation of weapon systems compared to their predecessors (when such can be identified) which is assignable to any part of the total DOD investment in research and technology.

The project has been underway for 2 1/2 years and is planned to continue. During the first 1 1/2 years, pilot studies developed and established the techniques of analysis. Throughout the past year, teams of in-house scientists and engineers, working with the voluntary support of contractors, performed the bulk of the data collection. It is estimated that about 40 professional man-years were used in collecting and analyzing the data reported.

CORPORATE AUTHOR: Office of the Chief of Research and Development (Army), Washington, D. C.

TITLE: U. S. Army Scientific and Technical Information Program, FY 1966 Through 1972

AUTHOR: Dale L. Vincent

DATE: December 1966

ACCESSION NUMBER: AD-664 785

ANNOTATION: The purpose of the Army program is to insure continuous and effective exchange of scientific and technical information. In so doing it is the program's additional purpose to preclude unnecessary expenditure of resources, reduce lead time, and make more effective use of known technology. It will provide guidance and direction for control and improvement of the acquisition, evaluation, storage, retrieval and dissemination of scientific and technical information.

To be of optimum value, an information system or program must be responsive to the needs of Army scientific, technical and management personnel and support the accomplishment of the Army mission. From this premise stems the basic objective of the U. S. Army Scientific and Technical Information Program, viz., to improve the cost effectiveness of transfer of scientific and technical information from source to user in support of scientific, technical, and related activities.

The On-Site Survey of Scientific and Technical Information Functions and Activities revealed that current annual costs for transferring scientific and technical information from source to user throughout the Army is approximately fifty-five million dollars. These expenditures relate to the operation of 180 technical organizations at 50 world-wide locations, which perform 60 types of data handling functions involving 540 substantial holdings of technical data. For example, the survey revealed that an estimated $15,600,000 per year is spent by the RDT and E in the above areas. In addition, the portion of the salaries of scientists and engineers for time spent in personal search of chemical literature and other currently available chemical information media, are extracted from preliminary reports on the Chemical Information and Data Systems survey conducted in May-November 1964, amounts to approximately $7,000,000 per year. This results in a total Army expenditure of approximately $22,600,000 for chemical information services. This same kind of analysis can be made for any

other discipline, field, or subfield.

By way of contrast to this total expenditure, the amount being spent by the Army Scientific and Technical Information Program to develop improved techniques in information handling is approximately 2 million dollars or 4% of the total cost of scientific and technical data handling.

CORPORATE AUTHOR: Howard University, Washington, D. C., Dept. of Economics

TITLE: Military Transfer of Technology: International Techno-Economic Transfers via Military By-Products and Initiative Based on Cases from Japan and other Pacific Countries

AUTHOR: Daniel L. Spencer

DATE: March 1967

ACCESSION NUMBER: AD-660 537

ANNOTATION: The transfer of technology through military and related channels is discussed. Case studies are drawn from Japan, Taiwan, and Korea. The materials constitute a first attempt to bulldoze through a new dimension in cost/benefit assessments of military activity overseas. The report concludes that a dollar spent on military assistance may produce as much benefit as, or more than, a dollar spent on economic assistance. (Author)

CORPORATE AUTHOR: RAND Corp., Santa Monica, California

TITLE: Aircraft Co-Production And Production Strategy

AUTHOR: G. R. Hall and R. Johnson

DATE: May 1967

ACCESSION NUMBER: AD-659 373

ANNOTATION: An analysis of the co-production in 1955-1964 of four U. S. military aircraft--the T-33A, P2V-7, F-86F, and F-104J--by Japanese firms. The process of transferring the required manufacturing technology is examined. For the F-104J the costs of transfer are also analyzed. These costs were lower than expected--sufficiently so, that when combined with Japan's labor-cost advantage, the Japanese-built F-104J's cost at least 10 percent less than Lockheed's likely selling price. Co-production's aid to the development of Japan's aviation industry and to making the acquisition of military aircraft politically feasible has important implications for foreign aid policy. Co-production also suggests that conventional views about the costs and benefits of reprocuring weapon systems only from the developer may be erroneous. A policy of separating programs for contracting purposes could greatly expand the role of competition and reliance on market-generated prices in weapon system procurement. The benefits of such a policy could be substantial.

Analysis of the F-104J costs showed that the direct costs of transfer were only a small fraction of the total program costs, nor were the indirect costs as great as might be expected. It appears that Lockheed transferred a significant part of its accumulated F-104J learning along with the transfer of manufacturing responsibility and technical information. This result was partly due to the incentives provided Lockheed in the form of royalty and technical assistance payments. Also, some of the progress curve advantages were no doubt embodied in the tooling or tool design information.

The costs of transfer fall into two groups. One includes the direct costs--the payments for the activities required to move technology from the United States to Japan, including license fees and royalties, and technical assistance expenses. The second group includes the indirect cost impacts of transfer, stemming from the loss of economies of scale and losses associated with learning or progress curve effects.

TITLE: Project Hindsight: A Defense Department Study of the Utility of Research

AUTHOR: Chalmers W. Sherwin, Raymond S. Isenson

SOURCE: Science, Vol. 156

DATE: June 23, 1967

ANNOTATION: No matter how much science and technology may add to the quality of life, no matter how brilliant and meritorious are its practitioners, and no matter how many individual results that have been of social and economic significance are pointed to with pride, the fact remains that public support of the overall enterprise on the present scale eventually demands satisfactory economic measures of benefit. The question is not whether such measures should be made, it is only how to make them.

We wish to report here on an attempt by the Department of Defense to make such measures. This effort, known as Project Hindsight, is a study of the role that research played in the development of weapon systems between the end of World War II and about 1962 (1).

To appreciate the need for Project Hindsight one has merely to examine the budget of the Defense Department. In recent years, the Department has been spending $300 to $400 million a year for "research." Of this sum, we estimate that about 25 percent is committed to basic or undirected science, although concentrated in areas generally relevant to the DOD missions, and about 75 percent to applied science more directly related to defined DOD needs. The Department has been spending an additional billion dollars a year for "exploratory development," which includes the more sharply defined applied research, small-component development, and other activities of the sort generally characterized as "technology" (2). (This $1.4-billion expenditure does not include the system development programs which are its main reason for existence.) Questions were constantly being asked, both in the Executive Branch of Government and in Congress: Was this large a sum really needed. What has been the return for the expenditure. Can the Defense Department not depend for more of its science and technology on the private sector or on other Government agencies. These are reasonable questions, but there seemed to be no systematic, quantitative answers. One of the objects of Project Hindsight was to try to provide such answers; that is, to try to measure the payoff to Defense of its own investments in science and technology. A second object was to see whether there were some patterns of management that led more frequently than others to usable results and that might therefore suggest ways in which the management of research could be improved.

Assumptions and Methods -- Given these objects, how doe

one start. Since the challenge was essentially an economic one, the answers would have to be based upon economic benefits. The economic return of a scientific or technical innovation is through its utilization in an end-item--a piece of equipment, a process, or an operational procedure. Therefore in order to assess return one has to measure the value of the end-item made possible by the innovation. As a practical matter, for military hardware the easiest way of measuring economic benefit is by comparing the value of an end-item which it partly or wholly replaces.

Our method of analysis was the follows: One begins by comparing a successor item with a predecessor, identifying all the contributions from science and technology which were significant in the improvement in performance or the reduction in cost of the item. One then estimates the portion of the increase in the cost-benefit of the end-item which is attributable to the scientific and technical innovations utilized. (This portion is, of course, very large for defense equipment.) One then calculates what it would cost to obtain enough predecessor equipment to do the job that the successor equipment is now doing, assuming that the same capital resources and management skills were available for the predecessor as for the successor. The difference between this cost and the actural cost of the successor is a measure of the economic benefit assignable to the set of significant contributions from science and technology.

TITLE: The Prospects For Technology Transfer. Report Of The Subcommittee On Science And Technology To The Select Committee On Small Business, United States Senate, 90th Congress, 2nd Session

SOURCE: U. S. Government Printing Office

DATE: May 1968

ANNOTATION: This report is a summary of subcommittee findings to date in a continuing study of technology transfer--the conscious process by which new knowledge is made available to others than those who generate it.

The objective of the study is to define policies in the Federal Government which achieve the maximum return on the investment of public funds in research and development.

The concept of technology transfer assumes that additional and substantial secondary uses can be found for technical knowledge, originally developed for specific agency missions. These new applications may be either in other government programs or in the private commercial economy.

Transfer occurs slowly and sporadically without some deliberate effort to accelerate its flow. The central policy question is whether present Federal transfer programs produce a net benefit to the economy in comparison to their cost of operation.

The subcommittee began this study in May of 1966 and has communicated and conferred with a broad segment of industry, business, universities, trade organizations, research institutes, and government agencies, both the Federal and State levels.

The Subcommittee on Science and Technology has completed the first phase of a study of the transfer of technology. The subcommittee is convinced that there are significant potential benefits in the secondary application of knowledge which is originated in Federal R and D programs. Public funds support two-thirds of all U. S. R and D (amounting to over $100 billion in the past decade) and this fact is the strongest possible motivation to maximize the use of the resultant technology.

The business community in general has not made enough investment of time, money, and interest in participating in transfer programs. Government agencies have made little effort to find the technical data they need in the R and D

reports of others. The cost-benefit ratio of varying approaches to technology transfer cannot be evaluated without more feedback from users.

F. Federal (non-DoD) & State Services

TITLE: Science and Technology Act of 1958
Analysis & Summary 1958 Prepared by
the Staff and Submitted to the Senate
Committee on Government Operations on
S.3126. 85th Congress, 2nd Session

SOURCE: U. S. Government Printing Office

DATE: 1958

ANNOTATION: An analysis is made of the Act,
included are costs, discussion of information
transfer and the need for the dessimination of and
interchange of information.

CORPORATE AUTHOR: 87th Congress, 1st session

TITLE: Coordination of Information on Current Scientific Research and Development Supported by The United States Government. Administrative and Scientific Problems and Opportunities of Central Registration of Research Projects in Science and Engineering. Prepared for the Committee on Government Operations United States Senate and its Subcommittee on Reorganization and International Organizations

SOURCE: U.S. Government Printing Office, Washington, D. C.

DATE: April 17, 1961

ANNOTATION: Hon. Hubert H. Humphrey, Chairman, Subcommittee on Reorganization and International Organizations. This report concerns one phase of an activity upon which may hinge the survival of the free world. The activity is research, development, testing and evaluation, as supported by agencies of the U. S. Government.

The phase of this activity on which we focus specific attention is the coordination of masses of administrative and scientific information on current research and development work.

The reason for this focus is clear:

The initial aim of research and development is to generate helpful information. If good scientific work is done, but information does not flow promptly about it and from it, much of its value may be dissipated.

Information is the cruicial means to the end. The goal is progress in military and civilian scientific technology. The means is the circulation of facts about how this goal is being approached. Throughout the process, the management of information may crucially affect how fast and how well successive aims are reached.

So far as the Federal Government is concerned, the coordination of information (or lack of it) may also crucially affect the policies of many agencies.

A "revolution" in the science of information storage and retrieval has occurred. So, this publication explores the question, "Has this revolution, as it affects the management of data on research still in process, been capitalized upon by Federal agencies for purpose of planning and administering science programs."

This is, by no means, the first occasion on which the Senate Committee on Government Operations has submitted judgment on this subject and on matters related to it. Indeed, the present

publication is but the latest phase of a long series of interrelated studies, hearings, and reports conducted and issued by the committee, as a whole, and by this subcommittee.

Each phase has contributed logically to its successor; each publication has expanded upon our prior experience and findings.

Taken together, it is believed that the committee's and subcommittee's publications in this field represent the most comprehensive body of data on scientific information problems ever compiled by a committee of the Congress.

TITLE: NASA's Industrial Applications Program

AUTHOR: Louis B. C. Fong

SOURCE: Research/Development

DATE: April 1963

ANNOTATION: NASA's Industrial Applications Program is a major organized effort to turn the results of Government Research and Development back to the civilian economy. This article reviews the program from the pilot study to identify innovations to the newest technical publications.

TITLE: Pilot Program...For Non-Space Industry

AUTHOR: Howard M. Gadberry

SOURCE: Research/Development

DATE: April 1963

ANNOTATION: This article discusses an important pilot program being carried out in the Middle West. An ASTRA (Applied Space Technology-Regional Advancement) team identifies profitable industrial applications for space-generated innovations which are not lying around neatly packaged and labeled.

TITLE: Space Technology.....Opportunities For All

AUTHOR: Charles Kimball

SOURCE: Research/Development

DATE: April 1963

ANNOTATION: MRI's six-state pilot program for NASA involved communication in depth with 15 ranking universities, industrial briefings for 2,500 persons, representing 400 companies, in 20 cities.

TITLE: Astra Team Objective.....Stimulate The University Role

AUTHOR: Max H. Thornton and James A. Alcott

SOURCE: Research/Development

DATE: April 1963

ANNOTATION: With Midwest Research Institute as advocate to expanded cooperation in fields of mutual interest, the number of universities in NASA programs was trebled in the six-state pilot program area, in only one year's time.

CORPORATE AUTHOR: Denver Research Institute, Denver, Colorado

TITLE: The Commercial Application Of Missile/Space Technology. Part I

AUTHOR: John G. Welles et al

DATE: September 1963

ANNOTATION: Primary objectives of this study were to identify tangible economic by-products of missile/space programs which have or are expected to find commercial use, and to determine the origin, and circumstances surrounding the origin, of these by-products.

Principal findings and conclusions follow: (1) Within the study objectives, the transfer of technology has been by far the most important contribution of missile/space programs to the civilian sector of the economy.

(2) A portion of the technology advanced by the missile/space programs has found, and will continue to find in increasing amounts, application in commercial industry for non-missile/space purposes.

(3) A time lag exists between the development of technology for primary missile/space use and its commercial application. Large expenditures on missile/space programs have been made only in recent years and there has not been sufficient time for many transfers to take place. It is highly probable, therefore, that most of the transfer is still to occur.

(4) Relatively little importance can be attached to the direct transfer of products from missile/space programs to the civilian sector of the economy at this time.

(5) Six types of missile/space contribution to the commercial sector were noted. Individual areas of transfer identified in this study embodied from one to all six types: (a) Stimulation of basic and applied research; (b) Development of new or improved processes and techniques; (c) Improvement of existing products; (d) Increased availability of materials, testing equipment, and laboratory equipment; (e) Development of new products; and (f) Cost reduction.

(6) Missile/space R and D is but one

contributor to the vast store of knowledge which is the source of technology for both the government and commercial sectors of the economy. Other R and D contributors include industry, universities, and non-missile/space government agencies.

(7) The nature of the transfer process is such that it does not appear feasible to measure in quantitative terms the economic impact of the missile/space contribution embodied in identified transfers to the commercial sector, to say nothing of transfers which defy identification.

(8) Insufficient understanding of the nature of the transfer process appears to have been one reason for widely divergent views on the past and future importance of missile/space contributions to commercially useful technology.

(9) Diffusion of missile/space technology for secondary, or commercial, uses may be substantially slower than diffusion for primary, or missile/space, uses. Further, there are indications that informal communication channels may be more important to the transfer process than formal communication channels.

(10) There are apparent gaps between the persons or organizations responsible for developing missile/space technology and those persons or organizations which can give such technology commercial application.

(11) Present efforts to accelerate the transfer of missile/space technology to commercial application appear handicapped by insufficient knowledge of how technology is applied at the level of the firm. This study indicates that efforts to accelerate the transfer process should be accompanied by efforts to better understand the stimuli and barriers to the application of technology.

CORPORATE AUTHOR: NASA, Washington, D. C.

TITLE: The NASA Program For Technology Utilization

AUTHOR: Richard H. Brenneman

SOURCE: Transforming And Using Space-Research Knowledge (Ten Diversified Views): NASA-UCLA Symposium And Workshop, Los Angeles, California

DATE: June 2, 1964

ACCESSION NUMBER: NASA-SP-5018

ANNOTATION: The NASA Program for Technology Utilization dates back to 1961, at which time Denver Research Institute was engaged to conduct a survey intended to identify tangible economic non-space by-products of space research, including current applications of past research and future or potential applications of current research. They were also asked to evaluate by-product identification techniques and study the flow of information from space research to commercial applications.

Here is a summary of their findings: (1) They concluded that the transfer of technology, rather than the transfer of products, has been by far the most important contribution of missile/space programs to the civilian section of the economy. Moreover, it was pointed out that product transfers have not been significant, and that the term ''by-product'' is misleading, in that it doesn't describe the total transfer process; (2) The study identified some 33 broad technological areas that have benefited and should continue to benefit; (3) Emphasis was given to the time lag between space technology and its commercial application, suggesting that most of the transfer is still to occur; (4) Although the study concluded that transfers from the space program are feasible, the difficulty of tracing the source of contribution--university, industry, or governmental lab., all of which generate new knowledge--is quite complex and probably not worth resolving; (5) The study pointed out that commercial applications have appeared in almost their original form in the following areas: electronic components and systems, instrumentation, telemetry and communications, and packaging; (6) Other types of contributions were noted as follows: (a) Stimulation of both basic and applied research; (b) Development of new or improved processes and techniques; (c) Increased availability of materials, along with lab and test equipment; and (d) Cost reduction; and (7) Mention was made of the gaps that exist between organizations that harbor the new technology and organizations with commercial marketing capabilities. And, finally, the

study noted that the communication channels through which technological knowledge flows to secondary uses are not understood, but that informal channels might well exceed in importance the formal channels.

CORPORATE AUTHOR: NASA, Washington, D. C.

TITLE: Some Questions on the Economics of Technological Transformation

AUTHOR: J. Morley English

SOURCE: Transforming and Using Space-Research Knowledge (Ten Diversified Views): NASA-UCLA Symposium and Workshop, Los Angeles, California

DATE: June 2, 1964

ACCESSION NUMBER: NASA SP-5018

ANNOTATION: Any consideration of the economics of technological transformation from a space-oriented to a civil, Earth-oriented industry must be predicated on certain underlying assumptions. Perhaps the most important of these is that, in the first place, the national economy justifies the space program. This implies that we, as a nation, have agreed to allocate a certain percentage of our resources to achieve some defined objectives in space. Such a social decision, in turn, is based on some assessment of how much it will cost us as a nation to meet these objectives. On the other hand, it should be apparent that, to the extent that other than space program benefits may derive from the space program, some allocation of costs may be charged to them. However, since the primary objective is the space program, such allocations must perforce be considered as incidental.

Secondly, we must assume that there are developments which are occurring in the space program that are significant to our non-space economy. The problem then becomes one of identifying these contributions to the non-space economy, establishing some reasonable basis for their cost allocation. The purpose of this paper is to raise questions germane to this problem, rather than to provide answers.

The implications of these remarks are that returns may be realized from the space program and that certain economies are possible. However, it is also implied that Government has a role to play if maximum benefit is to result. The Government, of course, represents society and, as such, should create an environment in which people individually will act to maximize returns. In this connection, I wish to make two points. First, society has an important stake in the investment and knowledge of the people employed in the space industry. Any shift in emphasis in the space industry must necessarily be accompanied by Government action to effect transference of these people to non-space industry, in order to utilize this resource for a social benefit.

Second, programs that involve excessive risks for private industry may not be excessive for the nation as a whole. Some

mechanism must be found to absorb at least part of the risk by the whole society, in order that the remaining risk may represent attractive investment opportunities for private capital. This is, in effect, what was accomplished in the first instance with the space program. Space, as an undertaking, was far too risky for private industry to have undertaken on its own, but it was not too risky for society to do. As a result, we now have the potential for worldwide communication by satellite that is owned by private enterprise.

CORPORATE AUTHOR: NASA, Washington, D. C.

TITLE: Transformation of New Knowledge for Economic Growth

AUTHOR: Werner Z. Hirsch

SOURCE: Transforming and Using Space-Research Knowledge (Ten Diversified Views), NASA-UCLA Symposium and Workshop, Los Angeles, California

DATE: June 2, 1964

ACCESSION NUMBER: NASA SP-5018

ANNOTATION: As always, the question remains whether the payoff from knowledge transformation will be great enough to justify the necessary costs. Actually, we cannot be sure. But the prospects are good, and the goal of economic growth is so important that we must assume the risk. If we are enterprising, we can visualize the emerging of a new major branch of our exciting knowledge industry. Organized knowledge transformation in years to come is likely to become a joint government-university-private industry effort of major proportions, attracting, it is to be hoped, men of the highest caliber, who will develop a common language between originators and users of new knowledge. The rewards to companies in terms of new products for better living, accelerated economic growth, and fuller employment can be large--and they are within our reach.

Up to fifty billion dollars and six years hence, we hope to put a man on the moon. During these six years, much new knowledge will be gained in the pursuit of this objective. How can we assure that the billions of dollars spent by the Federal Government in research and development will promote the economic as well as the scientific and military health of the United States. Our national science policy must concern itself with the implications of new knowledge for economic growth, must actively engage in the process of knowledge transformation.

New knowledge in its various forms often can be translated into novel processes, materials, products, and procedures. Some such technological advances increase the quantity of existing goods and services that the economy can produce, while others provide us with goods and services that were not available before and that meet certain needs better than did previously available alternatives. In short, new knowledge that is transformed from specialized space and military uses into commercial uses contributes to economic growth in two ways: it increases the ability of the economy both to produce more of the old and to produce new goods and services.

TITLE: Commercial Use Of Space Research And Technology

AUTHOR: James E. Webb

SOURCE: Astronautics and Aeronautics

DATE: June 1964

ANNOTATION: This article reviews new efforts to make programs pay off in the economy. The Denver Research Institute study results are stressed.

CORPORATE AUTHOR: Argonne National Laboratory,
Argonne, Illinois

TITLE: Semiannual Reports of the Argonne Office Of
Industrial Cooperation (OIC) (Total Of 6 Reports)

SOURCE: Office of Industrial Cooperation, Argonne
National Laboratory

DATE: First Semiannual Report, 1 Jan-30 Jun 65
Second Semiannual Report, 1 Jul-31 Dec 65
Third Semiannual Report, 1 Jan-30 Jun 66
Fourth Semiannual Report, 1 Jul-31 Dec 66
Fifth Semiannual Report, 1 Jan-30 Jun 67
Sixth Semiannual Report, 1 Jul-31 Dec 67

ANNOTATION: These reports review three years of operation. The technology transfer activities of this office include industrial cooperation via training agreements, trade meetings, engineering seminars and consulting services.

CORPORATE AUTHOR: Midwest Research Institute, Kansas City, Missouri

TITLE: Opportunities For The Practical Use Of Space Technology By Businessmen

AUTHOR: Charles N. Kimball

DATE: April 1965

ACCESSION NUMBER: N65 19959

ANNOTATION: This talk gives several examples of economic fallout from the space program and explores the benefits of the ASTRA Program.

CORPORATE AUTHOR: U. S. Atomic Energy Commission, Oak Ridge, Tennessee

TITLE: Transference of Non-Nuclear Technology to Industry

DATE: July [illegible]

ACCESSION NUMBER: ORO-629

ANNOTATION: Technology utilization, in the present context, involves the use of technology developed for one purpose to fulfill a need elsewhere. It requires: (1) the knowledge that an advance has occurred in one field, (2) the recognition of its significance in a different field, and (3) the capability to make the required adaptations. Technology will be used by industry if it permits the improvement of a process or the manufacture of a product more economically, and not because it might be intrinsically interesting or just new. Because of this, any AEC effort to promote technology utilization should recognize the importance of market information. Specifically, it should apply the tests of the market place to: (1) the kind of technology to be transferred, (2) the audience to whom the information should be directed, and (3) the form in which the information should be presented.

Experience has shown that it is futile to attempt to measure the value in dollars of technology transfer. Before transfer, it is not only difficult to identify potential users but also often impossible to estimate the value to them in terms of increased sales or decreased cost of operation. After transfer, successive modification of the technology during its adaptation makes evaluation difficult. The best, and possibly the only means of measuring the success of technology utilization programs, is simply to gauge the degree of interest of industry in them. (Author)

TITLE: Government Research & Development Inventions -- A New Resource.

AUTHOR: Mary A. Holman

SOURCE: Land Economics 41(3)

DATE: August 1965

ANNOTATION: This article shows factual evidence that patented inventions arising from government-financed research are not a great economic resource. In fact, very few of these inventions hold any commercial potential whatever.

CORPORATE AUTHOR: General Electric Company, Santa Barbara, California

TITLE: Application of Aerospace Technologies to Urban Community Problems

AUTHOR: M. L. Feldman, et al

SOURCE: Technology Utilization Officer, Western Operations Officer, Western Operations Office of the National Aeronautics and Space Administration, Santa Monica, California

DATE: September 23, 1965

ACCESSION NUMBER: RM-65TMP-53

ANNOTATION: Technological solutions to critical problems of urban communities in the United States are, to a large extent, dependent upon feasible past, present and predictable technologies. The research reported was undertaken to identify and isolate specific critical city problems amenable to technological solutions and to determine and suggest technologies resulting from past and current NASA programs applicable to the solution of these problems. The study focuses on major city problems deserving immediate attention and suggests applications from a broad scope of NASA-developed technologies. An evaluative matrix is included in the report which relates categories of critical city problems to categories of NASA aerospace technologies. Four individual concept papers are appended to the report as examples of areas where programs could be initiated to aid in the resolution of serious urban problems utilizing NASA technologies. (Author)

TITLE: Background, Guidelines, and Recommendations For Use in Assessing Effective Means of Channeling New Technologies in Promising Directions

AUTHOR: Richard L. Lesher and George J. Howick

DATE: November 1965

ACCESSION NUMBER: N66 19042

ANNOTATION: One task of the National Commission on Technology, Automation, and Economic Progress is to assess the most effective means of channeling new technologies in promising directions. This paper is directed to that question. This paper does not recommend any single ''most effective means.'' That ideal probably does not exist. Certainly, too little is known about the complex process of technology transfer to permit any such sweeping judgments at this time.

This paper then directs itself principally to the following questions: (1) Is the transfer of technology a worthwhile national goal. (2) Is there sufficient technology available, from federally supported sources, to permit a useful inter-sectoral transfer effort. (3) Is the available technology relevant to those needs and objectives that will aid the national interest. (4) Can technology be transferred from one industry to another, one discipline to another, one region to another, one-mission-orientation to another mission-orientation. (5) What is known about the incentives and barriers to the transfer of technology. (6) What transfer mechanisms, or channels, have been employed to date. With what success. (7) What has been learned in transfer efforts to date that will aid in the development of future efforts of this type. (8) What has been the degree and type of involvement of the Federal Government in technology transfer to date. (9) What are the essential elements, as perceived today, in any effective method of channeling new technologies in promising directions.

To prepare this paper, the authors conducted depth interviews with personnel in the agencies that currently have significant technology transfer and technical information dissemination programs. A comprehensive literature search was also completed. (Author)

CORPORATE AUTHOR: Arthur D. Little, Inc.

TITLE: Technology Transfer and the Technology Utilization Program, 1965. Report to the Office of Technology Utilization National Aeronautics and Space Administration

DATE: April 1966

ANNOTATION: This report describes the continuing activities of Arthur D. Little, Inc., for 1965 in the Technology Utilization Program of the National Aeronautics and Space Administration.

During 1965, Arthur D. Little, Inc., reviewed and reported on 114 innovations, and supplemental information was submitted on four that were previously reported. Twenty-eight of these innovations were selected for write-up as Tech Briefs, which were also submitted. No innovations were selected for full evaluation, although in two instances (the didymium battery additive, and ferrite loop welding device) an advanced evaluation was made to determine technical feasibility.

Work on the Technology Survey of Thermal Protection Systems has proceeded according to plan. As previously agreed, final reporting will take place by 1 September 1966.

Beginning in June, our work in technology transfer has produced three kinds of results: (1) Several innovations have been licensed and are in industrial development. These include the elastic orifice for gas bearings, the improved silicate paint (two instances) and the RF feedthrough. A number of others are still undecided.

(2) A large number of industrial firms have been contacted, and some are actively working with us to explore investment opportunities based on NASA technology.

(3) We have developed a far clearer and more detailed understanding of the sources and distribution of advances in technology within NASA and its contractors, together with some knowledge of the pitfalls and problems associated with the transfer effort.

TITLE: National Science Policy and Technology Transfer

AUTHOR: Harvey Brooks

SOURCE: Proceedings Of A Conference On Technology Transfer And Innovation, Washington, D. C.

DATE: May 15-17, 1966

ANNOTATION: The article defines and describes Technology Transfer, describes the kinds of transfer of technology, the role and attitude of the government in technology transfer.

Some of the ways in which Federal R and D policy influences technology transfer may be listed as follows: (1) Through the support of basic and academic research by the mission-oriented agencies; (2) Through the mix of institutions and organizations to which support is given, including extramural and intramural institutions and, among extramural performers, the balance between industry, Federal contact centers, non-profit institutes, and universities; (3) Through the selection of mechanisms for support, especially project vs. institutional funding; (4) Through the types of controls exerted over supported institutions, including such matters as conflict of interest, outside consulting, segregation of government and non-government work, reporting requirements, etc; (5) Through its policies for the diffusion and indexing of scientific and technical information; (6) Through patent and copyright policy as applied to sponsored research and development; (7) Through the type of funding instruments used, and the way in which problems are defined; and (8) Through its use of external advisers from industry and universities; Through the geographical distribution of R and D funds and the criteria used in the selection of contractors and grantees.

The following mechanisms of technology transfer in the broad sense in which I have been using it in this paper may be listed as follows: (1) The movement of people between different fields of science and technology and from science into technology; (2) Entrepreneurial activity in the broad sense, that is, the spin-off of new missions or enterprises from existing organizations; (3) The scientific and technological literature; (4) Interaction between the supplier and the customer in the broad sense, that is, the developer and the user; (5) Programs of training and education; (6) Consulting and advisory activities; (7) Patents and trade in know-how; (8) Marketing and applications engineering; (9) Accidental personal contracts; and (10) Technical meetings.

TITLE: Research In Technology Transfer: Where We Stand And What Needs To Be Done

AUTHOR: H. E. Riley

SOURCE: Proceedings Of A Conference On Technology Transfer And Innovation, May 15-17, 1966, Washington, D. C.

DATE: May 15-17, 1966

ANNOTATION: Just about every type of scientific or technological activity, such as research and development, science information exchange, innovation, or imitation, contributes directly or indirectly to the transfer of technological know-how. The Office of Economic and Manpower Studies look at these activities from the standpoint of support for, allocation of resources for, the promotion of progress in the sciences and technology.

What we hope to do in the future is to expand and refine our knowledge in this field and to be in a position to focus more closely on specific questions, such as the role of technology transfer in the various sectors and throughout the economy.

Thus, for example, we are planning to pay more attention to problems of transferability of basic scientific skills.

In the field of financing research and development, more emphasis will be placed on the collection of information on State and local governments, on the tracing of fund flows from source to user, the identification and quantification of the relative amounts devoted to basic and applied research and to development, and the analyses of Federal support for academic science. That is the field that the President is especially concerned about.

Last September 13 he issued a special directive, calling on all the agencies to provide detailed information on how much support had been provided for so-called academic science to the educational institutions in this country. We in my office have been in the process of collecting and analyzing these data, emphasizing the distribution of support by size of institution, geographic location, and agency source of support.

We are also studying the factors involved in long-range projections of research and development expenditures and the relationships between the size of industrial concern, type of activity, rates of growth, and the volume of research and development expenditures.

Finally, special studies are planned of the techniques of achieving government-industry cooperation in the exploitation of modern technological phenomena, such as the communications satellite, or the resources of the ocean. Others include studies of the role of scientists in policy formulation at government and industry levels, problems of conflicts of interest arising through consulting activities of faculty members in publicly supported institutions, and the role of instrumentation in the research process.

CORPORATE AUTHOR: Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia

TITLE: Technology Transfer and Innovation: A Guide to the Literature (94 citations)

DATE: August 1966

ACCESSION NUMBER: PB-170 991

ANNOTATION: This guide to literature on technology transfer and innovation was prepared to assist State organizations in the implementation of the State Technical Services Act of 1965. The information was gathered by the Clearinghouse for Federal Scientific and Technical Information at the request of the Office of State Technical Services, both groups being a part of the Department of Commerce.

As used in this review, technology transfer means the application of technical knowledge in an area other than its field or place of origin, especially as this knowledge can be used by industry in solving production problems, instituting new techniques, and developing new products. If the transfer is made successfully, innovation follows as a matter of course, and therefore, these two subjects are treated as integral parts of the process of technological change.

The publication contains two major sections: a review section that categorizes and highlights some of the ideas contained in the literature, and a bibliography section that cites and summarizes the literature as it has appeared in scientific and business journals as well as relevant Government reports.

The review section is broken into four parts. Part I deals with aspects of technological change as reflected in the literature; Part II is devoted to information on transferring space and military technology to industry; Part III summarizes some factors that encourage innovation; and Part IV briefly outlines congressional hearings regarding problems associated with technology transfer.

References in the review section are keyed by number to the annotated bibliography which is arranged alphabetically by personal or corporate author. Arrangement is by title when no author was given. (Author)

TITLE: Guidelines To The Application Of Space Technology To Medicine

AUTHOR: Quentin L. Hartwig, David Bendersky

SOURCE: Research/Development

DATE: September 1966

ANNOTATION: Space technology is being applied to the problem areas of biology and medicine at a rapid pace, with current emphasis on the establishment of direct communication between NASA and a large number of medical research teams. The intent is to provide a broader range of questions for answers from all disciplines. (Author)

TITLE: Technology: A Resource

AUTHOR: George J. Nowick, James E. Mahoney

SOURCE: Research/Development

DATE: September 1966

CORPORATE AUTHOR: National Aeronautics and Space Administration, Washington, D. C.

TITLE: Assessing Technology Transfer

AUTHOR: Richard L. Lesher & George J. Howick

DATE: October 1966

ACCESSION NUMBER: NASA SP-5067

ANNOTATION: This publication is an abridgment of a report prepared for the Commission in November 1965, and directing itself primarily toward the fourth of those functions, i.e., assessing effective means of channeling new technologies in promising new directions. It does not recommend any single "most effective means," for too little is known at this time about the complex mechanisms of technology transfer. It does, however, consider such questions as: (1) Is the transfer of technology a worthwhile national goal. (2) Is there sufficient technology available, from federally supported sources, to permit a useful intersectoral transfer effort. (3) Can technology be transferred from one industry to another, one discipline to another, one region to another. (4) What is known about the incentives and barriers to transfer. (5) What mechanisms or channels have been employed to date, and with what success. (6) What are the essential elements, as perceived today, in the most effective methods.

To prepare the original paper, the authors conducted depth interviews with persons in the Government agencies that have technology-transfer and information-dissemination programs. A comprehensive literature search was also conducted. (Author)

CORPORATE AUTHOR: Daniel Yankelovich, Inc, New York, New York

TITLE: Cost-Benefit Study of Selected Products in Atomic Energy Commission's Low-Dose Food Irradiation Program

DATE: December 1966

ACCESSION number; NYO-3666-1

ANNOTATION: This report presents findings and conclusions from a study of prospective costs and benefits of selected products within the Atomic Energy Commission's low-dose food irradiation program. The objectives of the study were to estimate the tangible and intangible benefits likely to accrue as a result of commercialized food irradiation taking into account:

1. The value added by the process;

2. The expenditure of government funds required to achieve commercialization; and

3. The costs to be incurred by private industry in establishing and operating the process. (Author)

TITLE: The NASA Authorization, 1967 Hearings On The Technology Utilization Program Before the Subcommittee On Advanced Research and Technology of the House Committee on Science and Astronautics For Fiscal Year 1967

SOURCE: U. S. Government Printing Office

DATE: 1966

CORPORATE AUTHOR: Panel on Invention and Innovation

TITLE: Technological Innovation: Its Environment and Management

AUTHOR: Robert A. Charpie, Chairman

SOURCE: U. S. Department of Commerce

DATE: January 1967

ANNOTATION: This report represents the views of the panel on invention and innovation, an advisory committee of private citizens convened by and reporting to the Secretary of Commerce.

The panel considered three main factors: taxation, finance, and competition. On the basis of its analysis, the panel concluded that there was no need to recommend any major changes in the present laws governing these three areas.

CORPORATE AUTHOR: Office of State Technical Services, Washington, D. C.

TITLE: Office of State Technical Services: First Annual Report, Fiscal Year 1966

DATE: January 1967

ACCESSION NUMBER: PB-175 820

ANNOTATION: This document states objectives, organization, plans, and programs of OSTS for fiscal year 1966. Also included is a selected synopsis of five-year plans and annual programs of several states.

CORPORATE AUTHOR: National Aeronautics and Space Administration, Washington, D. C.

TITLE: NASA's Space Science and Applications Program

AUTHOR: Homer E. Newell

DATE: April 1967

ACCESSION NUMBER: NASA-TM-X-60553

ANNOTATION: This booklet contains information which was prepared by NASA's Office of Space Science and Applications for presentation to the Congress of the United States in the course of the fiscal year 1968 authorization process. Much of the text is directed toward some of the issues raised by the congressional committees. There is a discussion of basic research, its value as a source of knowledge, techniques and skills that go into the development of technology, and practical applications. Also discussed is the importance to the strength, well being, and security of the nation of a continuing level of effort in basic research, of which space research is an important and fruitful component. (Author)

CORPORATE AUTHOR: Technology Use Studies Center, Durant, Oklahoma

TITLE: Progress To Enhance The Transfer Of New Technology To Potential Industrial, Governmental, And Academic Users In Oklahoma Area. Quarterly Status Rept. No. 8, 1 Jan 67-31 Mar 67

AUTHOR: Lee B. Zink

DATE: April 1967

ACCESSION NUMBER: N67-25665

ANNOTATION: Several problems and solutions in technology transfer in the Oklahoma area are cited.

CORPORATE AUTHOR: National Academy of Science, Research Council, Washington, D. C.

TITLE: Applied Science and Technological Progress

DATE: June 1967

ACCESSION NUMBER: N67-38508

ANNOTATION: The complex relationships among government, science, technology, society, and individuals are considered in a series of reports on applied science and technological progress in the United States. Prepared by the National Academy of Sciences for the House Committee on Science and Astronautics, the report includes papers on various aspects of applied and basic research in both the biological and physical sciences. Technology transfer and technological innovations are treated, costs to industry and economic growth from innovations are cited, and problems in engineering education and computer-aided learning are discussed by various members who comprised the NAS panel charged with this investigation.

CORPORATE AUTHOR: Denver Research Institute, University of Denver, Denver, Colorado

TITLE: The Channels of Technology Acquisition in Commercial Firms, and the NASA Dissemination Program

AUTHOR: John S. Gilmore et al

DATE: June 1967

ACCESSION NUMBER: N67-31477

ANNOTATION: The research report examines some of the problems of making government R & D results available for broad industrial use. Specifically, it describes the technology-acquiring process by which commercial firms get externally-generated technological information. Based on these findings, it suggests how government-developed technology might better be communicated to industrial firms, through the communication channels they customarily use. (Author)

CORPORATE AUTHOR: North Carolina Science & Technology Research Center, Research Triangle Park, North Carolina

TITLE: First Quarterly Report on Three Special Experimental Projects in Technology Utilization

DATE: June 1967

ACCESSION NUMBER: N67-33018

ANNOTATION: During this quarter, the center began preliminary planning to conduct a pilot project measuring the benefits that may have accrued to industry clients and the State of North Carolina from the STRC's operation of a Regional Dissemination Center for new technology.

The Center's applications engineers evaluated titles of master's theses from N. C. State University to determine if they contain technology potentially useful for industry.

CORPORATE AUTHOR: Technology Use Studies Center,
Durant, Oklahoma

TITLE: Progress To Enhance The Transfer Of New Technology To Potential Industrial, Governmental, And Academic Users In The Oklahoma Area, 1 April 67-30 June 67

AUTHOR: Lee B. Zink

DATE: July 1967

ACCESSION NUMBER: N67-32974

ANNOTATION: Many examples of technology utilization in the Oklahoma area are cited.

CORPORATE AUTHOR: Aerospace Research Applications Center, Indiana University, Indiana

TITLE: Report of the National Conference on Technology Utilization and Economic Growth

AUTHOR: Charles W. Mullis, Editor

DATE: August 1967

ANNOTATION: This is a partial transcription of a summer institute for technology utilization. The conference objects are: (1) acquaint potential users with technology utilization, (2) transmit to those attending current information on services, techniques, organizations, philosophy, and programs in this area, and (3) analyze and evaluate the findings of current research in the technology utilization area.

Sessions included are: (1) the role of the business school, (2) economic growth studies, (3) urban administration, (4) the role of federal government programs, (5) financial institutions, (6) the impact of NASA R and D programs on management and economic growth, and (7) education needs in technology utilization.

CORPORATE AUTHOR: NASA, Washington, D. C.

TITLE: Communicating Across Disciplinary and Industry Barriers

AUTHOR: George T. Howick

SOURCE: American Society of Technical Editors and Writers Annual Conference, Cocoa Beach, Florida

DATE: September 16, 1967

ANNOTATION: The author presents the picture of technology transfer and/or technology utilization from the Aerospace industry to other fields. He also cites several examples of technology transfer.

TITLE: Hearings Before The Subcommittee On Science And Technology Of The Select Committee On Small Business, United States Senate, 90th Congress. First Session On Policy Planning For Technology Transfer

DATE: September 20, 26, 27, 28 and October 12, 1967

ANNOTATION: The analysis of information in this report shows the following relationships in technology transfer: (1) Public funds generate about two-thirds of the available technology and the Government has a responsibility to get full benefits from this knowledge. (2) Federally derived technology has appreciable utility to industry and to other public programs at all levels of government. Well documented ''second applications'' are appearing with increasing frequency. (3) Therefore, Federal Government efforts are warranted in devising and operating programs to make this technology readily available to all users (see p. 58). (4) The private sector innovation rate is affected by a ''climate'' of which the availability of technology is an important part. Traditional sources of technology need to be expanded beyond the permanent staff capabilities of many firms. (5) Reeducation and counseling as to the technological needs of industry are necessary before strong demands for new information will arise. The Federal Government can logically participate in technical services but local and individual initiative will be most important in recognizing the potential for technology transfer.

Various cost benefits are presented for technology transfer.

For further discussion see the reference ''Greater Coordination likely in Technology Transfer'' published in Industrial Research, November, 1967.

TITLE: Policy Planning for Technology Transfer

SOURCE: A report of the Subcommittee on Science & Technology to the Select Committee on Small Business - 90th Cong. 1st Session Doc. No. 15

DATE: October 1967

ANNOTATION: The identification, reporting and processing for dissemination may become continuing Government costs. A rough estimate is constructed as follows:

Special analysis I of the fiscal year 1968 budget states:

Both the existing science information activities of the Federal agencies designed to put data on research into the hands of users more effectively, and investigations designed to make the entire National effort in this field more efficient, will be strengthened in 1968. Approximately $60 million will be provided for the support of research and development on scientific and technical information systems, techniques, and devices.

Assuming that this figure includes the current NASA and DOC dissemination programs, the direct costs to the Government could be expected to remain $60 to 100 million for a continuing or somewhat expanded program. The indirect costs of the Government arise from increased allowable charges by contractors for the performance of the identification and reporting function. NASA guidelines suggest that one-half to 1 percent of the direct science and engineering labor would be appropriate. Assuming that one-half the total R. & D. expenditure for direct labor, a $16 billion annual Federal R. & D. budget would represent a $40 to 80 million identification and reporting cost.

These figures, rough as they necessarily are indicate that a Government-wide technology processing program would require perhaps $150 million annual Federal funding if the dissemination and application costs were supported by fees from users. If this total is accounted as an alternative to direct newly performed R. & D. estimated, for example, as 5 percent of net sales or as a 5-percent royalty, then the $150 million in new technology should result in at least $3 billion in increased sales or public benefits.

This arithmetic exercise shows that while technology originated for one purpose may be considered free for a secondary use, the cost of packaging and transfer is significant. On the other hand, the cost of transferred technology, as an information source for industrial innovation appears to be quite competitive with direct research. Furthermore, the worth of new technology cannot be measured in dollars alone.

TITLE: Greater Coordination Likely in Technology Transfer

SOURCE: Industrial Research

DATE: November, 1967

ANNOTATION: The federal government's "technology transfer" programs are underfinanced, overlapping, and largely ineffective.

This was the message witnesses carried recently to the Subcommittee on Science & Technology of the Senate Select Committee on Small Business.

The subcommittee, headed by Sen. Jennings Randolph (D-W.Va.), is seeking ways to improve and accelerate the transfer of technology from federally financed research and development to industry.

There was little disagreement on the nature of the problem at the hearings, but there wide differences of opinion on how to make technology transfer more effective.

NASA, Dept. of Defense, Atomic Energy Commission, Dept. of Commerce, and other federal agencies were praised for their pioneering transfer efforts, but they also were criticized for failing to achieve substantial transfer of technology, especially among small and medium-sized companies.

Most witnesses called for greater funding and coordination of federal technology transfer programs. However, there was little support for a highly centralized or "Comsat" approach, as proposed in a subcommittee report prepared by the Science Policy Research Div. of the Library of Congress.

Robert H. Gifford, executive director, Southern Interstate Nuclear Board, said most federal transfer programs- and particularly those of NASA and AEC- are not very useful because they are too complex, too obscure, and/or too inaccessible for the typical businessman and his company.

He also critized the highly publicized Office of State Technical Services program for not being able to conduct long-range planning and research; for limiting "block" grants to states; and for moving away from support in the managerial sciences

Gifford favors the establishment of regional centers with "bookmobile" extension services that could assist potential users in their own environment.

Henry J. Cappello, consultant to the National Small Business Assn., said the present OSTS concept leads to "a fractionated, diffused, and highly duplicative effort, and fails to utilize available federal funds in a way that contributes to dissemination of technical information to small business."

He believes, the Dept. of Commerce program should be changed to give individual universities responsibility for technology dissemination in those fields in which they have special competence. He would have the institutions prepare two publications- a yearbook detailing all recent accomplishments in selected fields and a loose-leaf codified booklet continuing basis.

Cappello also would like to see funds earmarked for direct consultant services to small business.

Dr. Arthur M. Weimer, special assistant to the president, Indiana University, told of his institution's experiences in operating the NASA Aerospace Research Applications Center.

"Like other educational efforts," he said, "technology utilization programs tend to be resisted by the very people who need help the most."

Weimer believes the transfer programs have been useful in channeling new technology to industry, but he also believes improvements are needed.

Dr. Charles Kimball, president, Mid-west Research Institute, whose organization also has been involved in the NASA transfer program, cited the importance of technology transfer, but questioned the effectiveness of current efforts.

He called for a network of technically oriented personnel who could carry new technology directly to those companies needing assistance.

Dr. Jesse F. Hobson, partner in the Heald, Hobson & Associates consulting firm and former head of Stanford and IIT Research Institutes, reminded the subcommittee, "Technology follows need, and the requirement is more frequently to adapt technology to a particular commerrcial situation

than it is to adopt known technology directly to fit a problem or an opportunity."

He said the organization best suited to transfer and further the effective use of known technology on a regional basis is the research institute or public service organization.

Perhaps the most novel plan for accelerating technology transfer and industrial innovation was offered by Dr. Victor .. Danilov, executive editor of Industrial Research.

He described a five-point "technological partnership" in which the federal government and private industry would work with universities, trade associations, professional societies, and technical publications in transferring new ideas to industry.

The Danilov plan would attack the technology transfer problem on an industry basis, and would establish industrial councils and research centers to deal with the technological needs of each industry.

He said the program could provide "the missing link" in the nation's R&D system. He estimated that it would take about 20 centers to serve the needs of major industries.

It is doubtful if any of the foregoing plans will be endorsed by the Senate subcommittee, but the proposals are likely to bring about greater coordination and, hopefully, effectiveness in the nation's technology transfer efforts.

CORPORATE AUTHOR: Southwest Research Institute, San Antonio, Texas

TITLE: Southwest Research Institute Assistance to NASA in Biomedical Areas of the Technology Utilization Program. Final Report

AUTHOR: Ray W. Ware and Louis S. Berger

DATE: December 1967

ANNOTATION: The TUD's investigations of the chain of events leading to the introduction of new products, technological inventions, and methods into medical practice have suggested that the biomedical research teams at medical schools and similar biomedical research institutions play a key role in this process. New discoveries, introduced by these groups, tend to proceed naturally through stages of professional approval, manufacturing interest and participation, on to the level of the practicing physicians, bringing direct health benefits to the public. It would seem an attractive goal to introduce NASA-derived advances at the level of the biomedical research team, and thus to utilize the existing channels to the medical practitioner and his patients for effective technological transfer.

As a result of these investigations, NASA's TUD has developed a general methodology for the solution of this important and special technological transfer problem. Prominently included in this methodology was the establishment of several strategically placed Biomedical Applications Teams consisting of appropriately cross-training and broadly experienced physical and biological scientists. It is the task of the Biomedical Applications Team to facilitate and improve the productive interaction between NASA centers and biomedical research teams. Empha is is on interpersonal contact, in which the cross-trained members of the Biomedical Applications Team form an active link between these two groups of scientists. (Author)

TITLE: The NASA Authorization, 1968 Hearings on the Technology Utilization Program Before The Subcommittee On Advanced Research and Technology of the House Committee On Science and Astronautics for Fiscal Year 1968

SOURCE: U. S. Government Printing Office

DATE: 1967

TITLE: Evaluators Give Good Grade to State Technical Services Office

SOURCE: Chemical and Engineering News

DATE: March 1968

ANNOTATION: An example of what can happen under the OSTS program is a project for computer use in the construction industry in Illinois. Three companies joined the project the first year; one, which installed a remote-access terminal, saved $30,000 to $60,000 in direct labor costs alone. Director Grogan estimated potential annual savings to the construction industry from the project's computer as $5 million.

CORPORATE AUTHOR: Aerospace Research Applications Center, Indiana University, Indiana

TITLE: Final Five-Year Report Experiment to Transfer Technology from a University-Based Center

AUTHOR: Joseph DiSalvo

DATE: February 1968

ANNOTATION: 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. (Author)

TITLE: The Prospects For Technology Transfer. Report Of The Subcommittee On Science And Technology To The Select Committee On Small Business, United States Senate, 90th Congress, 2nd Session

SOURCE: U. S. Government Printing Office

DATE: May 1968

ANNOTATION: This report is a summary of subcommittee findings to date in a continuing study of technology transfer--the conscious process by which new knowledge is made available to others than those who generate it.

The objective of the study is to define policies in the Federal Government which achieve the maximum return on the investment of public funds in research and development.

The concept of technology transfer assumes that additional and substantial secondary uses can be found for technical knowledge, originally developed for specific agency missions. These new applications may be either in other government programs or in the private commercial economy.

Transfer occurs slowly and sporadically without some deliberate effort to accelerate its flow. The central policy question is whether present Federal transfer programs produce a net benefit to the economy in comparison to their cost of operation.

The subcommittee began this study in May of 1966 and has communicated and conferred with a broad segment of industry, business, universities, trade organizations, research institutes, and government agencies, both the Federal and State levels.

The Subcommittee on Science and Technology has completed the first phase of a study of the transfer of technology. The subcommittee is convinced that there are significant potential benefits in the secondary application of knowledge which is originated in Federal R and D programs. Public funds support two-thirds of all U. S. R and D (amounting to over $100 billion in the past decade) and this fact is the strongest possible motivation to maximize the use of the resultant technology.

The business community in general has not made enough investment of time, money, and interest in participating in transfer programs. Government agencies have made little effort to find the technical data they need in the R and D

reports of others. The cost-benefit ratio of varying approaches to technology transfer cannot be evaluated without more feedback from users.

CORPORATE AUTHOR: National Aeronautics and Space Administration

TITLE: Documentation Guidelines For New Technology Reporting

DATE: May 1969

ACCESSION NUMBER: NHB-2710.3

ANNOTATION: This handbook provides a documentation, guidelines to reporters of new technology, whether they be innovators, inventors, New Technology Representatives or Technology Utilization personnel, in both NASA and NASA contractor organizations. General documentation criteria and detailed documentation guidelines are provided in generic terms as they are applicable to all types of information relevant to the Technology Utilization Program. Unique requirements for specific disciplines are also discussed briefly. (Author)

TITLE: The NASA Authorization, 1969 Hearings On The Technology Utilization Program Before The Subcommittee On Advanced Research and Technology Of The House Committe On Science and Astronautics For Fiscal Year 1969

SOURCE: U. S. Government Printing Office

DATE: 1968

CORPORATE AUTHOR: National Aeronautics and Space Administration

TITLE: Useful Technology From Space Research

SOURCE: U. S. Government Printing Office

DATE: 1968

ANNOTATION: This pamphlet briefly discusses NASA's mission, how new technology is reported, regional dissemination centers, patents and licenses, technology utilization services, sources, and costs.

CORPORATE AUTHOR: Midwest Research Institute. Kansas City, Missouri

TITLE: The Emperor's New Clothes: New Technology As Threat And Promise

AUTHOR: Charlton R. Price

ANNOTATION: This paper reviews some problems and processes which characterize the formal programs designed to disseminate information on technology from government (primarily aerospace R and D) sources to ''civilian'' (primarily non-aerospace industry). Special emphasis is placed on the importance of factors within the individual business firm to the success or failure of transfer efforts.

G. Commercial, Non-Profit Organizations, & Universities

CORPORATE AUTHOR: The Rand Corporation, Santa Monica, California

TITLE: Excerpts from a Statement by F. R. Collbohm President of The Rand Corporation Before the Military Operations Subcommittee House Committee on Government Operations

AUTHOR: Franklin R. Collbohm

DATE: August 1962

ACCESSION NUMBER: AD-224 170

ANNOTATION: This report discusses unexpected payoffs from research, for example, Rand-sponsored research was undertaken to apply some advanced mathematical techniques to problems confronting cancer researchers. The results on the cancer research problem pointed the way to a much better solution of a missile trajectory problem - a solution that had eluded Rand for a long time.

TITLE: The Responsibilities of the Technical Community and the Government in the Transfer of Information

AUTHOR: Alvin M. Weinberg, Chairman

SOURCE: U. S. Government Printing Office

DATE: January 1963

ANNOTATION: This report of the President's Science Advisory Committee makes the following recommendations:

A. Recommendations to the Technical Community:

1. The technical community must recognize that handling of technical information is a worthy and integral part of science;

2. The individual author must accept more responsibility for subsequent retrieval of what is published;

3. Techniques of handling information must be widely taught;

4. Technical community must explore and exploit new switching methods;

5. Uniformity and compatibility are desirable.

B. Recommendations to Government Agencies:

1. Each Federal Agency concerned with science and technology must accept its responsibility for information activities in fields that are relevant to its mission;

2. To carry out these broad responsibilities each agency should establish a highly placed focal point of responsibility for information activities that is part of the research and development arm, not of some administrative arm, of the Agency;

3. The entire network of Government information systems should be kept under surveillance by the Federal Council for Science and Technology;

4. The various Government and non-Government systems must be articulated by means of information clearinghouses;

5. Each agency must maintain its internal systems in effective working order;

6. Problems of scientific information should be given continued attention by the President's Science Advisory Committee

TITLE: Space Technology: Payoff From Spin-off

AUTHOR: John G. Welles and Robert H. Waterman, Jr

SOURCE: Harvard Business Review, 42(4)

DATE: July-August 1964

ANNOTATION: This document discusses the definition of spin-off, the types of companies that should try to capitalize on spin-off, and how they can do it effectively.

CORPORATE AUTHOR: American Psychological Association, Washington, D. C.

TITLE: Systems In Scientific Information Exchange And The Effects Of Innovation And Change

AUTHOR: Belver C. Griffith and William Garvey

DATE: 1964

ACCESSION NUMBER: PB-170 837

ANNOTATION: Possible innovations in disseminating, storing and retrieving research reports are viewed against some data and theory on scientific information exchange. While certain innovations may simply ameliorate particular problems, others may have for reaching effects, even extending into the conduct of scientific work or the organization of the science into sub-areas.

CORPORATE AUTHOR: Committee on Space, American Academy of Arts and Sciences

TITLE: Technology Transfer and the Flow of Technical Information in a Large Industrial Corporation

AUTHOR: Curtis P. McLaughlin, Richard S. Rosenbloom, Francis W. Wolek

DATE: March 1965

ACCESSION NUMBER: PB173457

ANNOTATION: This is a "user study" of the acquisition of useful technical information by scientists and engineers in five divisions of a large industrial corporation. More than 1,200 instances of the acquisition of such information were described on self-administered questionnaires by 430 respondents. Additional data were gathered by personal interviews with more than 30 respondents.

The survey shows that the respondent's intention in searching for information, the nature of the source which proved useful, and the medium which joined source and recipient are closely related aspects of the communications process.

The report discusses the pattern of relationships among these characteristics, and considers how it is influenced by personal factors, such as experience, and situational factors, such as the type of work done in the engineering section. Explanations for the observed relationships are suggested on the basis of interview data concerning organization structure and policy, geography, and the character of the relevant technologies. Thus, the transfer of technical information is depicted as a complex social process, one in which technology, personal characteristics, organizational values and structure, and the beliefs of significant professional subcultures interact to influence the patterns of behavior.

The report concludes with a brief discussion of some implications for management and for the conduct of further research on the subject.

CORPORATE AUTHOR: American Machine and Foundary Company, Santa Barbara, California

TITLE: Space Technology Applied to Man's Earthly Needs

AUTHOR: Albert Nagy, Walter J. Dembiczak, and A. Wade Brock

DATE: April 1965

ACCESSION NUMBER: N66-13375

ANNOTATION: This report covers Phase I of a feasibility study on the acceleration of transfer of aerospace technology to commercial industry. A determination was made of the extent of the present use of NASA technology within an industrial family - AMF. A survey of aerospace literature, its quality, quantity and availability from the aspect of the non-aerospace user was accomplished. Forty-seven specific candidates for transfer of knowledge to satisfy needs were formulated.

CORPORATE AUTHOR: The Independence Foundation of Philadelphia, Pennsylvania

TITLE: Intrex Report of Planning Conference On Information Transfer Experiments (Chapter 5, The Information Transfer System At MIT In 1975)

AUTHOR: Carl F. J. Overhage

SOURCE: MIT Press

DATE: September 3, 1965

ANNOTATION: The information transfer system that has been described as a conceptual pattern for 1975 is vastly different from the library of today in the scope of the services it seeks to provide. While no cost estimates for such a system can be made until there has been extensive experimental investigation, it is clear that substantially larger budgets will be required for such an information transfer complex than would be available under a normal extrapolation of today's library budgets. The Planning Conference has indulged in some speculation on the proper magnitude of an MIT information transfer budget for 1975, and has arrived at a figure of $15 million by two different routes.

It is well-known phenomenon that the amount of published information doubles approximately every 13 years. Since scientific information increases at a somewhat higher rate, and since libraries should, if anything, increase their relative holdings, it seems unreasonable to assume that the amount of material available to the typical library, assuming no changes were made in its function, would in 1975 be at least double the amount now contained.

Project Intrex will, of course, result in an increased emphasis on libraries at MIT; and we can reasonably expect to see an increase in the relative size of the MIT library compared to other universities (it has been decreasing steadily since 1930). With due allowance for all these factors, we might expect the total amount of stored information in the MIT information-transfer system of 1975 to be more than ten times as large as it is in the library of today. We conclude that the magnitude of the information available in 1975 could demand a 15-fold increase in the budget of the library. While the advances sparked by Project Intrex could result in a decrease in the actual budget, a more probable outcome, if past experience is any guide, will be a very great increase in the services rendered. Thus, we might expect that the total budget for information transfer services at MIT will be of the order of $15 M in 1975.

Alternatively, we can base an estimated budget on
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an assumed size of the MIT community in 1975, and on the needs of the individual in the community. For this purpose, we shall take the community to contain 15,000 people: students, faculty, research staff, and some of the surrounding community. With increased mechanization that makes other services available and with the increase in total available information, it is not unreasonable to expect that the total expenditure for information services per user will increase. There is, of course, a very wide difference in annual expenditure per user at different universities. An estimate of $1000 per user of the future MIT information transfer system would bring us to the same $15 M figure previously cited for 1975. (Author)

TITLE: An Analytical Concept for the Selection, Flow, and Transference of Technology in a Large Electronics/Aerospace Firm.

AUTHOR: Robert R. Kley

SOURCE: IEEE Transactions on Engineering Management

DATE: March 1966

ANNOTATION: The basic functions of any firm can be separated into planning, control, and operations, the time span of decision being the separating variable. In the planning sector, the three basic factors of importance are the methodologies and concepts used to relate and integrate corporate strategy, structure, and policies. As the physical size of a firm changes, possibly accompanied by shifts in customer and market orientation, the combinations of strategy, structure, and policies change. In the electronics/aerospace industry, these three factors readily translate into 1) a process for selecting market areas as well as developing a technological resource base for a firm, and 2) a process of ensuring that this technological activity is embedded in an environment which will permit an intrafirm flow and transference of technology. For the selection process, a method is presented which develops a technique for establishing a physical cross-sectoral relationship between the military and commercial markets using a unique tree diagram and matrix approach. A related concept for developing technological flow and transference is developed using a Shannon-Weaver communication model. A composite organization structure model correlating all of these factors is also developed using a small group behavior, linking pin, and decision model. (Author)

TITLE: A Model of the Innovative Process (As Viewed From a Non-Science-Based Fragmented Industry)

AUTHOR: Aaron Gellman

SOURCE: Proceedings of a Conference on Technology Transfer and Innovation, May 15-17, 1966, Washington, D. C. National Science Foundation, NSF67-5

DATE: May 15-17, 1966

ANNOTATION: Presented is a discussion of the prospects of profits from innovations. Many successful innovations are not recognized by industry. One of the characteristics of a so-called "integrated" industry is its response to technological and other changes that make innovation attractive from a profit standpoint. In the face of such conditions, firms in these industries "integrate": they huddle together for a special kind of warmth.

In contrast to the behavior of firms in the "integrated" industries, those in the "fragmented" sort of industry tend to scurry about in panic. Above all, there is no united front, no organized plan or program, for dealing with the opportunity or threat on either a firm or an industry level.

As for the "science-based" and "non-science-based" terminology, does not nearly every business rest upon a foundation of science of one sort or another. But many firms and industries do not recognize their scientific basis, and this, in large measure, is what the term "non-science-based" must be interpreted as meaning in the present context. The contrasts among industries and firms are very sharp if you view it this way. For example, Bell Telephone Laboratories represents the ultimate in recognition of a "science-based" character, while the railroads of the United States show us quite the opposite extreme.

One of the primary characteristics of good management is recognition of the importance of successful innovation to the long-run viability of a firm, which, in turn, leads to a drive to elevate firms and industries from the "non-science-based" category with as much "integration" in the process as the law will allow. But I am getting ahead of the story.

I would like to introduce what I believe to be a new concept worthy of consideration in the study of the innovative process. The "innovation quotient" of a firm (or industry) relates to its propensity to innovate. Use of the term "innovation quotient"-"IQ"-is not intended merely to be clever, but rather to have meaning and predictive value.

TITLE: A Model of the Innovative Process (As Viewed From a Science-Based Integrated Industry)

AUTHOR: J. A. Morton

SOURCE: Proceedings of a Conference on Technology Transfer and Innovation May 15-17, 1966

DATE: May 15-17, 1966

ANNOTATION: Technology innovations from a science integrated industry are presented. The study is concerned with the total process of relevant research and its development into new technology with its introduction into manufacture to meet economic objectives. The study also goes into the systems approach as a useful aid in technology innovations.

TITLE: Technology Transfer Via A Research Institute

AUTHOR: James Alcott

SOURCE: Research/Development

DATE: September 1966

ANNOTATION: Information forms, person-to-person interviews, and new publications were among the tools used when NASA's First Regional Dissemination Center was established more than four years ago. Today's program is on a cost-sharing basis and consists of personalized consultation service, information services, and seminar participation. In addition, technology surveys are written to shorten time gaps. (Author)

TITLE: The University of New Mexico Technology Application Center

AUTHOR: A. A. Blumenfeld, W. A. Shinnick

SOURCE: Research/Development

DATE: September 1966

ANNOTATION: The Technology Application Center in New Mexico disseminates NASA information to the natural-resources industry with value added through interpretation. (Author)

TITLE: North Carolina Science and Technology Research Center

AUTHOR: Peter J. Chenery

SOURCE: Research/Development

DATE: September 1966

ANNOTATION: Personal contact between technically trained staff members at the North Carolina Science and Technology Research Center and industry has aided greatly in the identification and understanding of company problems and interests. Success of this Center's service, it was found, strongly depends on the support of top management. (Author)

TITLE: The Aerospace Research Applications Center

AUTHOR: D. W. Cravens

SOURCE: Research/Development

DATE: September 1966

ANNOTATION: Through a service designed to identify, evaluate, and communicate product and process ideas originating from Government R and D projects, Center provides technology building blocks to industrial firms, as well as studying approaches and mechanisms in technology transfer. (Author)

TITLE: Space Technology Transfer At The University Of Pittsburgh

AUTHOR: Allen Kent

SOURCE: Research/Development

DATE: September 1966

ANNOTATION: University of Pittsburgh's Knowledge Availability Systems Center disseminates NASA data on the basis of user interest profiles. The program incorporates feedback for profile revision; utilizes two specialized computerized search techniques, UPLIFTS and STERILE to improve the efficiency of mechanized information transfer. (Author)

TITLE: Maximizing Deliberate Use of Scientific and Technical Information

AUTHOR: Don H. Overly, Bruce W. Pince

SOURCE: Research/Development

DATE: September 1966

ANNOTATION: By providing information to potential user systems in a format which permits effective utilization, the Wayne State University Center for Application of Sciences and Technology solves many of the problems which today hinder economic, social, and cultural progress. Experimental efforts are being expanded with diverse user systems and new sources of information to further its usefulness. (Author)

CORPORATE AUTHOR: Northwestern University, Evanston, Illinois

TITLE: Program Of Research On The Management Of Research And Development

AUTHOR: Albert H. Rubenstein

DATE: September 1966

ACCESSION NUMBER: AD-658 897

ANNOTATION: This report gives the descriptions of individual projects: Progress September 1965-September 1966; Progress in the period 1960-1966; Publications, Reports, and Working Papers 1950-1966.

Other descriptions of the projects are as follows: (1) Idea flow in research and development; (2) Control of research and development in decentralized organizations; (3) Strategies for organization and diffusion of research in developing countries; (4) R and D responses to crises; (5) Sources of R and D achievements in electronics since 1945; (6) The acquisition and development of new technical skills in research and development; (7) Integration and utilization of management science activities in organizations; (8) Liaison relations: Transition and interface problems between phases of research, development and application; (9) The information-seeking behavior of researchers; (10) Project selection in R and D; (11) Key researchable problem areas in R and D management; (12) Environmental and management factors influencing the performance of research and development groups.

Other related activities are: (a) The transactions on engineering management; (b) The college on research and development (COLRAD); (c) Short courses and seminars; (d) Methodology of field studies of organizational behavior; and (e) Advisory relations with other related groups.

TITLE: Technology Transfer And Utilization: Active Promotion Or Passive Dissemination

AUTHOR: Philip Wright

SOURCE: Research/Development

DATE: September 1966

ANNOTATION: A two-phase program at the Office Of Industrial Applications at the University of Maryland seeks to promote the merit of a selected portion of NASA technology as a source for new products and processes and to trace the outcome of self-generated interest in the technology. (Author)

TITLE: Technology Utilization In A Non-Urban Region

AUTHOR: Lee B. Zink

SOURCE: Research/Development

DATE: September 1966

ANNOTATION: Lacking a set pattern for the accomplishment of technology transfer in any situation, policy planners at the Technology Use Studies Center, Southeastern State College, have attempted to provide a staff with the capability of responding to all legitimate requests for assistance. More effective results are expected as the working of the transfer process are better understood. (Author)

CORPORATE AUTHOR: California University, Los Angeles Western Management Science Institute

TITLE: Notes On The Private And Social Value Of Information

AUTHOR: Jack Hirshleifer

DATE: March 1967

ACCESSION NUMBER: AD-650 256

ANNOTATION: Recent research on the 'economics of information' has examined the acquisition and dissemination of information in a context where uncertainty attaches to the supply-demand offers of potential market partners. In this paper markets are assumed to be perfect, and uncertainty is attached to each individual's perception of his own endowment and productive opportunities. The private and public values of sure prior information are compared where individuals aim to distribute their consumption optimally over dates and states. Under pure exchange, information as to which future state will obtain is generally of enormous private value but of no social value; hence, there is an incentive for individuals to expend resources in a socially wasteful way to generate and disseminate this information. In a world of production and exchange these results are modified somewhat, since prior public information will affect production decisions in the appropriate way. It is shown that there still remains a bias, suggesting that private investigations into to the question of which state does or will obtain (e.g., private scientific research) are carried beyond what is socially optimal. On the other hand, there is a strong presumption that the dissemination of information will be socially valuable. Thus, the government should support industrial research less but industrial espionage more.

TITLE: Materials Applications

SOURCE: Industrial Research

DATE: May 1967

ANNOTATION: This article gives the following examples of technology utilization: (1) Of 60-million porcelain teeth in the U.S., 20-million are front teeth with expensive gold pins. Alone, the gold pins cost about 40 cents a tooth. A new bonding method has resulted from a recently completed investigation. The new silane coupling agent could mean a savings of roughly $8-million annually in the precious metal. (2) Graduate student David James of California Institute of Technology discovered a form of elastic water that flows upward and over the lip of a raised beaker and down to a receptacle below. James' phenomenon was an accidental outgrowth of research on the effects of small amounts of the thickening agent polyethylene oxide in water. This polymer in dilute solution works to dampen turbulence in water or other liquids to provide more laminar flow in pipes. The oil industry, for example, has gained 50% to 70% reduction in pipe friction in this way.

CORPORATE AUTHOR: Indiana University Foundation, Bloomington. Aerospace Research Applications Center

TITLE: A Pilot Program for Investigation of Various Techniques to Enhance the Utilization of New Knowledge Related to or Stemming from Aerospace Research and Technology. Quarterly Report, Period Ending Sep. 30, 1967

AUTHOR: Joseph diSalvo

DATE: October 15, 1967

ACCESSION NUMBER: N67-40335, (NASA-CR-89779)C5CL05B

ANNOTATION: Regional Dissemination Center (RDC) services, personnel organization, and operating expenses are reviewed. A program to increase membership in this information retrieval system through revisions in fees and the offering of trial introductory memberships is evaluated. Brief quarterly activity summaries are given for services performed in the following categories: retrospective searches, custom interest profiles, standard interest profiles, document requests, back-up information requests, and computer information services.

CORPORATE AUTHOR: Air Force Office Of Scientific Research (SRI), Arlington, Virginia 22209

TITLE: Policy Planning For Technical Information In Industry

AUTHOR: Harold Wooster

DATE: 29 November 1967

ANNOTATION: The paper is divided into three parts (1) management of research and development in industry; (2) information transfer in industrial research and development, and (3) responsibilities of the documentalist in industry. Part I stresses that research and development can only flourish in a properly oriented national environment; Part II points out the heavy reliance of engineers on informal, oral internal sources of information, but says that documentalists aren't all that different; Part II discusses the allocation of information sources and services to meet users' real or imagined needs. The author concludes with an admonitory note on the difficulties of establishing national information policies in developing countries: East is East and West is West/Though this may not seem relevant// We all know how to milk a cow//But you can't muck about with an elephant. (Author)

CORPORATE AUTHOR: Indiana University Foundation, Bloomington. Aerospace Research Applications Center

TITLE: Experiment To Transfer Technology From A University-Based Center. Final Report

AUTHOR: Joseph DiSalvo

DATE: February 1968

ACCESSION NUMBER: N68-18732, NASA-CR-93482

ANNOTATION: The experimental efforts undertaken to transfer technology from a university-based information center to industrial organizations are reviewed. The successes and failures of the various transfer mechanisms used are discussed, and summary information is given on activity highlights and promotional activities. The factors influencing the ability of the center to meet the factors influencing the ability of the center to meet the market test of generating enough income through its activity to support its operations are assessed, and problem areas are identified. To indicate that reasonable success was achieved, quantitative figures are cited on the custom retrospective searches and current-awareness searches performed the industrial applications reports and technical reports disseminated, and the computer programs transferred. It is suggested that 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.

CORPORATE AUTHOR: Oklahoma State University, Stillwater. College of Engineering

TITLE: A Pilot Program For Selecting, Editing and Disseminating Engineering and Scientific Educational Subject Matter From NASA Technical Reports

DATE: February 1968

ACCESSION NUMBER: N68-18667, NASA-CR-93484, ER-68-1-2

ANNOTATION: An overview is presented on the dissemination of monographs and visual briefs based on engineering and scientific subject matter to industrial organizations and universities. This includes an advertisement in an engineering journal, letters to deans, an industrial survey, and contacts with book publishers. The various comments and responses on the visual briefs and monographs are presented along with a list of various organizations contacted.

TITLE: Technology Utilization
UTC's Techite Seen as Major Contender in Pipe Market

SOURCE: Aerospace Technology 21(21)

DATE: April 1968

ANNOTATION: A commercial product line that is a direct fallout from solid rocket technology is expected to give United Aircraft Corp.'s United Technology Center a large share in the estimated $2 billion spent annually on concrete/asbestos and cast iron pipe for water distribution and sewage systems in the U.S.

The new product, glass fiber filament-wound pipe called Techite by its manufacturer, shows so much promise that Johns-Manville, one of the world's largest pipe manufacturers, already has negotiated a license from UTC to produce the light-weight, flexible Techite pipe. Johns-Manville's license presently is for the U.S and Canada.

N. V. Turney, division vice president for Techite, told AEROSPACE TECHNOLOGY that he expects UTC also will grant manufacturing licenses to firms in the United Kingdom, Europe, Japan and Australia. The South American market also will be explored but, Turney admitted, Johns-Manville might want to keep the entire Western Hemisphere market, and therefore would be interested in extending its license to South America.

Techite is a fallout of UTC experience in filament winding solid propellant rocket cases ranging from the samll FW-4 motor used as an upper stage on Thor to the huge 156-in. rocket case designed and wound as part of the Air Force's Large Solid Rocket Motor Program.

The company also developed a method to fabricate the shipping cases for its Titan III 120-in. solid motors from glass fiber filaments. It was the experience with the shipping cases and their proven durability that pointed to the pipe application.

The finished pipe, to be made in 8- to 72-in. sizes and 10- and 20-ft. lengths, has the appearance of concrete on the outside. It has a glass-smooth surface on the inside and will withstand from 100 to 200 psi. It is glass fiber with a sand (silica) filler interspersed between layers of glass filaments wound on equipment similar to that developed for the rocket cases.

The exact process in its manufacture, Turney said, is considered proprietary information.

High flow rate -- The smooth interior surface gives the pipe a high flow rate equal to that now available only in clay pipe, and it is non-metallic and therefore non-corrosive. In tests it was immersed in sulphuric acid for more than a year with no effect. It is reasonably flexible, especially when compared to rigid pipe fabricated of concrete and iron.

It can stand very high external pressures and therefore may be used under backfills, roads etc. It has a high degree of resiliency and can be compressed by a third of its diameter without breaking and will spring back into shape. It simply bounces when dropped from heights. Connections are made with a simple 'bell and spigot' closure and a neoprene 'O' ring.

Eight to 12-in. and 48- to 72-in. sizes will be manufactured in a facility adjacent to the UTC executive offices in Sunnyvale, Calif. Twelve to 48-in. sizes will be manufactured in a new 40,000-sq.-ft. plant at Riverside, Calif., dedicated last month.

Strength of steel -- Turney cites the development of Techite as a 'breakthrough in the production of a pipe that combines the strength of steel and the chemical resistance of vitrified clay; a pipe that provides for the first time at a competitive price a strong, lightweight, corrosion-resistant pipe for application to water distribution and waste conveyance systems.'

He says that with no conducting reinforcement the pipe is not subject to galvanic or electrolytic action and resists the corrosive effects of all types of waters, soils and normal sewage constituents, including hydrogen sulfide. Small diameters can be installed by hand and only light rigs are required for larger sizes. Small helicopters are capable of delivery in inaccessible areas.

This is the company's first venture outside the aerospace market but UTC President Barnet R. Adleman says he has 'an intensive program in being to identify and expand into all markets where UTC capability might apply.'

II. Generalized Applications

TITLE: The Information Gathering Habits of American Medical Scientists

AUTHOR: Saul Herner

SOURCE: Proceedings of the International Conference on Scientific Information Vol. I, Washington, D. C. National Academy of Sciences 1959

DATE: November 16-21, 1958

ANNOTATION: There has been a growing interest in the methods by which scientists obtain information and communicate information to one another. For the most part, this interest has stemmed from a rapid growth in the world's scientific activity and a corresponding growth in the written and published output of scientists. It has also arisen from an increased appreciation of the economic and political significance of scientific information.

One manifestation of the increase in the appreciation of the political and economic aspects of scientific information has been the organization of efforts, in the United States and abroad, to increase the availability of Soviet scientific information. This preoccupation with Soviet information came to a head with the launching of the first Russian satellite.

But even before the advent of the satellite there were various Soviet information programs in operation among a number of agencies of the United States Government. These programs took various forms and went in various directions, but all shared the common goal of making Soviet scientific information more readily available to the American scientist.

One of these Government Soviet information programs gave rise to the study upon which the present paper is based. The specific mission of this program was the dissemination of information on Soviet medical research to American medical scientists. In order to ascertain the most effective directions that such a program might take, a project was organized to determine, on a statistically dependable basis, the current use that 500 American medical scientists in 59 institutions and organizations make of Soviet information in their fields.

For purposes of comparison, the project was designed to consider not only the scientists' use of Soviet information, but also their use of information in general and foreign-language information in general. Thus, the project under discussion was actually a trichotomous study of the habits and patterns of American medical scientists in the use of information

in general, foreign-language information in general, and Soviet information in particular.

The thinking behind this project design was that the most expeditious way to make useful Soviet information available to American medical scientists was by utilizing the already established channels and mechanisms by which they obtain other types of information. Obviously, if Soviet information is channeled to American scientists through uncommon or unfamiliar media, it will not be used as effectively as it would be if it were channeled to them through media that they are already using. Thus, the purpose of the project was to determine the media used by the respondent-scientists to obtain Soviet information at present and in the very recent past. Where respondents had made no recent use of Soviet information, the study sought to determine how they gained access to other foreigh-language information. In cases where respondents had not made recent use of any foreign-language information, the study turned to their use of information in general. The focus always was on existing, familiar channels of information.

CORPORATE AUTHOR: Battelle Memorial Institute
Columbus, Ohio

TITLE: Qualitative Approach to Scientific Information Problems

AUTHOR: G. S. Simpson, Jr. and John W. Murdock

SOURCE: Battelle Technical Review 9(11)

DATE: November 1960

ANNOTATION: Much of the scientific literature adds little to our useable knowledge; it is redundant, ineffectively presented, or appears too late to be of value. Redundancy in the scientific information available in interpretive presentations is a serious problem, yet it is a condition that must be accepted. Creation of new knowledge calls for its rapid initial communication to the select few who can use it effectively. Later, as developments are relayed to the broader group that has a less critical need for the knowledge, additional and different types of communication are called for. Often authors of the early papers in a particular technical field present their findings in varied forms, which add nothing to their original statement; then, others interpret and restate the same points. The multiplicity of communications swells the stream of information, but adds little or nothing to our knowledge. Eliminating the valueless is a qualitative problem.

Ineffective presentation is another characteristic of many scientific publications. Poor writing, unimaginative organization, and the use of jargon known only to a very specialized fields make "reception" of such writings by any but the most select and perceptive reader very difficult. Making the best of such problems calls for the exercise of qualitative talents.

The value of many scientific communications depends upon their being quickly available. When handled through conventional channels, some information is certain to reach potential users too late; this suggests that scientific progress can be deterred by ineffective information systems. Fortunately, however, other than conventional methods of information dissemination are available. Thus, knowledge that is not obtainable quickly enough through published reports may often be obtained through visits, letters, and conferences among interested persons. What has been said about the special problems of presenting and receiving scientific information through published writings makes one point clear: The special

relationship between the presenter and the receiver precludes the possibility of really effective standardized retrieval and dissemination systems.

TITLE: Information and Research--Blood Relatives or In-Laws

AUTHOR: Dwight E. Gray

SOURCE: Science Vol. 137, pp. 263-266

DATE: 27 July 1962

ANNOTATION: None of these mechanisms for information support is tied appreciably more closely to the funding of experimentation than are the society dues and subscriptions of individuals, which I mentioned earlier. But if dissemination of the results of experimentation really is an integral phase of the research process--if, say, $95 or $96 worth of experimentation plus $4 or $5 spent to make the results available actually is preferable to $100 worth of experimentation that no one ever hears about--then, support for information control and dissemination should vary more or less directly with total R and D funds. One assumes as a matter of course that multiplying an R and D budget by a factor of X will, on the average, provide about X times as much money for employing personnel and purchasing experimental equipment; it should be equally natural and valid to assume that such an increase in R and D funds would multiply roughly by X the financial support available for activities related to disseminating the results of the expanded research program.

First comes the question of deciding what fraction or amount of R and D funds should be marked for information control and dissemination. Obviously, no one can predict either the quantity or the significance of the new knowledge that will come out of any given project or program. Consequently, the costs of its initial dissemination, by publication or other means, and of abstracting and indexing coverage also are unpredictable. However, to make an order-of-magnitude estimate of the average, overall cost of the information phase of research in relation to total R and D funds is possible.

A recent National Science Foundation report shows that for the 3-year period fiscal 1960 through fiscal 1962, federal obligations clearly identifiable as being for scientific and technical information average a little less than 1 percent of the government's total R and D expenditures. (The data show, incidentially, that less than half of these monies identifiable as for information actually comes from

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R and D funds). Information-associated activities too closely interrelated with other aspects of research and development to be readily separable probably cost at least another 1 percent, making total federal expenditure for scientific information of the order of 2 percent, plus, of the R and D budget.

A survey made several years ago of a group of companies with R and D programs showed their identifiable expenditues for scientific information activities varying from less than 1 percent to 10 percent of their research budgets, the median being around 2 percent (5). Allowing for the present inadequacies of both public and private scientific information systems, one might estimate 4 to 5 percent as a minimum order-of-magnitude portion of R and D funds that could justifiably and effectively be devoted to the control and dissemination of the results of research.

However, the important point is not whether 4, 5, 8, or some other percentage is optimal for the information phase of research and development; it is, rather, that planners, and administrators of research and development fully accept the principle involved. The use of appropriated, contracted, and granted R and D funds to support information activities associated with scientific experimentation generally has been permitted. The very fact that such funding has been only permissive, however, has had two bad effects: (1) intellectually, it has helped maintain the in-law of distant-cousin relationship between information dissemination and experimentation, and (2) practically, it often has meant that a scientist preferred to spend all of his R and D funds in other ways, with dissemination of results falling into an afterthought category. Complete realistic acceptance of the thesis discussed in the first part of this article would mean that some portion of research funds always would be devoted to dissemination of the results of the experimentation.

The second general problem mentioned earlier--that of the mechanisms for channeling an an appropriate fraction of R and D funds into information control and dissemination--has both intra-agency and extra-agency aspects. The former concern an organization's own library and searching services, its internal reporting system, and the like. (Author)

TITLE: The Civilian Technology Lag

AUTHOR: David Allison

SOURCE: International Science and Technology

DATE: December 1963

ANNOTATION: Some of the great technological developments in history have come from research and development of military sponsorship. But there is concern these days that military--and now space--technology is too sophisticated to have direct application in civilian technologies. Thus a development in military or space technology might take years to find civilian application. And other such developments might never be applied. Several efforts are now under way to transfer ideas from space and the military.

The most important derivative of the great R&D effort in space and the military may be a new ability to solve problems: from the vast capability of organizing and directing interdisciplinary team efforts to the more modest--but crucial--capability of introducing new techniques in industries whose technologies lag. (Author)

TITLE: Information Management in an Era of Accelerating Technology

AUTHOR: Fremont E. Kast and James E. Rosenzweig

SOURCE: Science, Technology and Management, New York McGraw-Hill Book Co.

DATE: 1963

ANNOTATION: These authors discuss the importance of the translation and flow of information in an age of increasing technological change.

CORPORATE AUTHOR: Howard University, Washington, D. C.

TITLE: External Technological Transfer and Structural Change

AUTHOR: Daniel L. Spencer

DATE: February 1965

ACCESSION NUMBER: AD-612 169

ANNOTATION: The rapidity of technological change within a country is functionally related to a nation's propensity to borrow technology. Japan, with a celebrated propensity to borrow Western technology, has, in the Post-World War II period, again made impressive gains, based in large part, on borrowed technology. The United States military presence in Japan has been an important transmission belt making possible much of this technological transfer, and consequent structural change.

This research points to basic conclusions that the impact of an external military is far from the negative image popularly conceived. A military presence endowed with a higher technical civilization can initiate a fillip to a recipient country's structural evolution. Moreover, military aid, contrary to the often made negative contrast with economic aid, has long-term dynamic effects in the transfer of higher level technology which can shift production functions significantly over time. Implications of the United States military presence also can obtain for other countries as well, but with varying levels of intensity depending on the country's national propensity to borrow technology, and other strategic factors. (Author)

TITLE: The Case for Technological Transfer: Part 7 of the Case for Going to the Moon

AUTHOR: Neil P. Ruzic

SOURCE: Industrial Research

DATE: March 1965

ANNOTATION: The author explains how and why space science and engineering knowledge can be transferred profitably into the industrial and social sectors of our lives.

CORPORATE AUTHOR: National Planning Association, Washington, D. C.

TITLE: Technology Transfer - Process and Policy an Analysis of the Utilization of Technological By-Products of Military and Space R&D

AUTHOR: Richard S. Rosenbloom

SOURCE: NPA Carmrand Committee, Special Rept. 62

DATE: July 1965

ANNOTATION: The subject of this paper is analyzed within the framework set by new conditions in technology and in the economy. In the introduction the problem is defined more precisely some economic factors are investigated. The paper addresses three principle objectives. First, the author arrives at some realistic set of expectations concerning the magnitude and character of the potential for transfer. The author identifies not only the mechanisms by which transfer takes place, but also the barriers which inhibit realization of its full potential. Last, some questions concerning policies, public and private, which might facilitate transfer are considered.

TITLE: The Measurement of Efficiency of Scientific Research

AUTHOR: Ben-Ami Lipetz

SOURCE: Intermedia, Inc. Carlisle, Massachusetts

DATE: 1965

ANNOTATION: This book includes chapters on the measurements of scientific content of communications and problems in the development of measurements of scientific contents.

CORPORATE AUTHOR: System Development Corp., Santa Monica, California

TITLE: From Research to Development to Use

AUTHOR: Launor B. Carter

DATE: January 1966

ACCESSION NUMBER: PB-169 377

ANNOTATION: This document states that special efforts must be made to assure that the results of research or new developments are carried through to application in a school or any other applied situation. There is widespread recognition that a problem exists in making the translation process effective, and this is recognized by many actions at the national level. This report discusses some of the studies and investigations that have been made. Also it describes three different studies to illustrate findings and problems associated with the generation of new knowledge and its impact on the institutions which receive the knowledge. The report relates these studies to the mission of the regional laboratories. (Author)

CORPORATE AUTHOR: National Commission on Technology, Automation, and Economic Progress

TITLE: Technology and the American Economy

AUTHOR: Howard R. Bowen, Chairman

DATE: February 1966

ANNOTATION: This report identifies and describes the impact of technological and economic change on production and employment. It assesses the most effective means for channeling new technologies into promising directions, including civilian industries where accelerated technological advancements will yield general benefits.

TITLE: Information Transfer

AUTHOR: Evan Herbert

SOURCE: International Science & Technology

DATE: March 1966

ANNOTATION: In information retrieval, the process of asking questions, examining answers for relevance, has been speeded by refinements in data storage and communication so that direct dialogs with remote files are now technically feasible. Activity of a file and speed of access are the criteria for justifying mechanization. Document images stored on microfiche are becoming standard for information dissemination. While pressure is mounting for networks of specialized information centers, intellectual access to them via indexes and other representations of content hinges on how effectively meaning can be transferred when data is manipulated. Natural language information processing and associative memory techniques, holding promise of better approaches to classifying relevance, are being tested in models of research libraries of the future. Generalized service programs for data management via computer will be needed for information networks.

CORPORATE AUTHOR: Howard University Department of Economics, Washington, D. C.

TITLE: Economic Theory and Transfer of Technology

AUTHOR: Jan Kmenta

SOURCE: The Transfer of Technology to Developing Countries, Papers and Proceeding of a Conference Held at Airlie House, Warrenton, Virginia

DATE: April 28-30, 1966

ACCESSION NUMBER: AD-645 594

ANNOTATION: The aim of this paper has been to discuss the transfer of technology primarily from the point of view of economic theory. We began by considering the difference in the stock of technical knowledge between advanced and underdeveloped countries. Two models of adjustment have been proposed, both assuming that the underdeveloped countries follow the technological leadership of the advanced countries. It was concluded that the possibility of closing the technological gap depends in part on factors that would change the adjustment parameters -- in particular, income and level of education in the underdeveloped countries -- and, in part, on the rate of change of technology in the advanced countries. In the rest of the paper we took technical knowledge as given and discussed different kinds of transferral of technology. Firstly we considered the diffusion of technical change embodied in capital equipment. We found that, given the rate of investment, the economic factors that are mostly responsible for the slow rate of transfer to underdeveloped countries are the high price of capital, the low wage rate, and the low degree of competition. However, the importance of these factors is likely to be overridden by the slow rate of capital accumulation which, of course, restricts the rate at which capital-embodied technological progress can be effected.

Next we considered technical change which is not necessarily allied with fixed investment. Some technical change of this kind may be expected to occur through the process of "adapting" production functions of the underdeveloped countries to those of the advanced countries. The crucial factors here are the initial disvergence and the rate of adaptation. Transfer of technology without fixed investment may also be effected by improving the skill of the labor force in the less-developed countries. This may be especially important since skilled labor is relatively scarce in underdeveloped compared to developed countries and since technological progress tends to have a bias toward saving unskilled labor. In this case the benefits of technical progress are likely to be considerably smaller for the underdeveloped than for the developed countries. (Author)

TITLE: National Science Policy and Technology Transfer

AUTHOR: Harvey Brooks

SOURCE: Proceedings Of A Conference On Technology Transfer And Innovation, Washington, D. C.

DATE: May 15-17, 1966

ANNOTATION: The article defines and describes Technology Transfer, describes the kinds of transfer of technology, the role and attitude of the government in technology transfer.

Some of the ways in which Federal R and D policy influences technology transfer may be listed as follows: (1) Through the support of basic and academic research by the mission-oriented agencies; (2) Through the mix of institutions and organizations to which support is given, including extramural and intramural institutions and, among extramural performers, the balance between industry, Federal contact centers, non-profit institutes, and universities; (3) Through the selection of mechanisms for support, especially project vs. institutional funding; (4) Through the types of controls exerted over supported institutions, including such matters as conflict of interest, outside consulting, segregation of government and non-government work, reporting requirements, etc; (5) Through its policies for the diffusion and indexing of scientific and technical information; (6) Through patent and copyright policy as applied to sponsored research and development; (7) Through the type of funding instruments used, and the way in which problems are defined; and (8) Through its use of external advisers from industry and universities; Through the geographical distribution of R and D funds and the criteria used in the selection of contractors and grantees.

The following mechanisms of technology transfer in the broad sense in which I have been using it in this paper may be listed as follows: (1) The movement of people between different fields of science and technology and from science into technology; (2) Entrepreneurial activity in the broad sense, that is, the spin-off of new missions or enterprises from existing organizations; (3) The scientific and technological literature; (4) Interaction between the supplier and the customer in the broad sense, that is, the developer and the user; (5) Programs of training and education; (6) Consulting and advisory activities; (7) Patents and trade in know-how; (8) Marketing and applications engineering; (9) Accidental personal contracts; and (10) Technical meetings.

TITLE: Technology Transfer

AUTHOR: J. Herbert Holloman

SOURCE: Proceedings Of A Conference On Technology Transfer And Innovation, Washington, D. C.

DATE: May 15-17, 1966

ANNOTATION: Technology Transfer is a special case of technological change--involving the transfer of technology for practical use in one field to another. To understand the problem of technology transfer, it is necessary to appreciate the more general problem of the application of technology to the needs of industry and society. Technological change is the use of techniques new to the economy to produce new or improved goods, services, or processes. Technological change occurs in three overlapping steps, which are (1) invention, (2) innovation, and (3) diffusion.

Some of the principles of technological change, and some of the problems this nation and its industry face in the use of new technology and are discussed, and it is hoped to stimulate one's thinking about technology and the economy.

The first step of technological change is invention, the conception of the notion that will improve goods, services, or processes. In invention a potential possibility is married to a potential need.

The second step is innovation, in which the new concept is first introduced into the economy, the society, or into the ''business'' of the government. Since the benefits of the introduction of the technology cannot be accurately predicted--and more often than not, the cost cannot accurately be determined in advance--a high degree of risk is involved in the process of innovation, and someone must accept that risk in order to provide the possibility of greater return for the investment. He is the entrepreneur.

Invention, obviously, cannot come after innovation. It must precede it. As a consequence, there will always be a lag between invention and innovation, and that lag will be determined by the ingenuity of the people who exploit it, on the one hand, and the requirements of the market for the invention.

Innovation does not involve the same kind of creative ingenuity as does invention, but another kind--that

of the entrepreneur. The successful entrepreneur is willing to innovate, to undergo the difficulties of change, and is ingenious enough to bring it off. The attribute of entrepreneurship is thought to be innate, but one is convinced it can be taught. The willingness to innovate is certainly affected deeply by the social character of the society in which innovation takes place. One is convinced that, for example, in the western society the religious revolution which people underwent in the early Renaissance fundamentally changed their thinking.

The spread of the new technology into other parts of a particular industry and to other industries where that technology is not be being used.

CORPORATE AUTHOR: Alfred P. Sloan School of Management
Cambridge, Massachusetts

TITLE: The Differential Performance Of Information Channels In The Transfer Of Technology

AUTHOR: Thomas J. Allen

DATE: June 1966

ANNOTATION: This study was measured the relative performance of six channels in transferring technical information. The research technique employs the vehicle of parallel R and D projects to provide a control over the substance of the problem and a relative evaluation of solutions. Data are gathered by means of Solution Development Records and lengthy interviews with the engineers. The ideas considered for solution to each problem are thus associated with the channels whence they came, and measures of performance are generated for the channels. There is a serious misalignment between the quality of the ideas generated through the channels studied, and the frequency with which these channels are used by engineers. Literature is not greatly used, and is mediocre at best in its performance. Better performing groups rely more than the poorer performers upon sources within the laboratory (the technical staff, and other company research programs) as contrasted with sources outside the lab. A mismatch in information coding schemes appears to be responsible for the ineffectiveness of communication across the organizational boundary. The possible existence of key individuals (technological gatekeepers) shows promise of providing a means of surmounting this organizational boundary impedance.

CORPORATE AUTHOR: Alfred P. Sloan School of Management, Cambridge, Massachusetts

TITLE: Managing the Flow of Scientific and Technological Information

AUTHOR: Thomas J. Allen

DATE: September 1966

ACCESSION NUMBER: PB 174440

ANNOTATION: Over the past ten years, behavioral scientists have become increasingly interested in the flow of technical information among scientists and engineers. This thesis summarizes many of the results attained over this period and presents new evidence gained from the study of sets of parallel R&D projects.

Data were gathered by means of time allocation forms submitted by individual engineers, tape recorded periodic progress reports by the project managers, Solution Development Records -- a form which provides a weekly estimate of the probability of adoption of the approaches under consideration as possible solutions to a technical problem -- and post-project interviews with the engineers responsible for each of the project's sub-problems.

The parallel nature (two or more R&D teams assigned the same set of problems) of the projects studied comparisons can be made between the information gathering patterns of the teams, holding the substance of the problems constant. In addition, since evaluations of relative performance were obtained, the information patterns are compared on the basis of their relation to performance.

Scientists are found to rely more heavily upon written than oral sources of information, while for technologists the pattern is reversed.

For technologists, the organization to which they belong imposes rather severe barriers to communication. Communication across organizational bounds is relatively ineffective, and intramural communication, while relatively effective, is little used. (Author)

CORPORATE AUTHOR: University of Florida, Florida

TITLE: 20Th National Congress On The Administration Of Research

DATE: October 1966

ANNOTATION: This book includes the following talks: (1) Technology Transfer and Entrepreneurial Success, by Edward B. Roberts and Herbert A. Wainer. The author examined the characteristics of technology transfer via the route of information flow through new technical enterprises. This talk was based upon a conviction as to the importance of people as carriers and pushers of technology, and was focused on the activities of new enterprise formation.

(2) The Diffusion of Technological Information, by Thomas J. Allen.

(3) Motivation For Utilized Technology, by Raymond S. Isenson. This talk reviews the status of Project Hindsight.

(4) Some Preliminary Experiments And A Model Of Information -- Seeking Style Of Researchers, by Albert H. Rubenstein et al.

(5) Industrial Innovations And The Utilization Of Research Output, by Sumner Meyers.

TITLE: Technology and World Trade, Proceedings of a Symposium

SOURCE: U. S. Government Printing Office

DATE: November 16-17, 1966

ACCESSION NUMBER: C13.10:284

ANNOTATION: The purpose of the Symposium was to examine and forecast the impact of technology upon the patterns and conduct of international trade and investment; to consider the international environment needed for the wider generation and utilization of technology; and to explore prospects for evolving policies and institutions that promote economic development through technology and trade.

CORPORATE AUTHOR: Howard University, Washington, D. C. Dept. Of Economics

TITLE: The Transfer Of Technology To Developing Countries

AUTHOR: Daniel L. Spencer and Alexander Woroniak

DATE: December 1966

ACCESSION NUMBER: AD-645 594

ANNOTATION: The theme is the search for an optimum method to transfer technology. Topics include: Historical cases of transfer; economic theory as applied to the technological gap concept; a reexamination of the seminal work of Schumpeter and Continental scholars, comparatively unknown in the U. S.; analysis of socio-economic variables with particular reference to the possibility of utilizing simulation technique; and possible strategies for improved methods of technological transfer, using sponsoring institutions such as 'fomentos,' international business, indigenous military organizations, external military bases and missions, and others. Results, among others, include: (1) recognition of relative neglect of transfer of technology studies in social science, particularly in economics; (2) acceptance of the concept as a strategic tool for theoretical and operational use; (3) criticism of the linear homogeneous production function technique; (4) exploration of the potential of simulation models for technological transfer; (5) establishment of a nexus between historical or European experience and present day operational problems; and (6) exposure of the issue between those who think that transfer is a problem in imitation and information theory, and those who feel that the shock of social change attendant on the introduction of new technology must be socially engineered.

TITLE: Transferring Technology, Editorial

SOURCE: Electronics p. 23

DATE: January 23, 1967

ANNOTATION: As the 90th Congress convened last week, a Senate subcommittee prepared to investigate an old subject: the transfer of technology from Government-sponsored research, mainly paid for by the Defense Department and NASA, to the civilian economy. Chances are that the subcommittee members, like other nontechnical people who have probed the subject before, will conclude that there has been practically no transfer.

But this conclusion would be wrong. Much of the technology used and polished in defense and space programs has spread and is spreading to civilian projects. Those who can't see it happening have been looking in all the wrong places.

What's wrong, of course, is that the investigators keep hunting for a transfer of hardware, rather than of techniques or knowledge. They conclude there hasn't been much transfer of technology because they can't report that the steering wheel developed for the Gemini space vehicle is being used on automobiles, or that the integrated circuits produced for the Minuteman missile are going into television sets, or that computers developed for a strategic bomber are flying commercial jets.

Yet there is plenty of evidence that Government-sponsored research and development has spurred technical progress in civilian areas. In fact, Government-sponsored R and D is the greatest single stimulus to technical progress today; nothing else is even a close second.

Probably the most valuable contribution Government programs have made has been an educational one: they have forced technical people to learn new developments, new techniques and new products. Since technology is transferred by people, the first stip in a transfer has to be educational. Not until engineers know and understand the new technology can it be applied to civilian endeavors.

But, on balance, the civilian economy of the U.S. has benefited hugely from the Government's giant expenditures for military and space programs. The clearest evidence of this is the fact that foreign concerns fear the technical repercussions of U.S. Government programs more than any other factor in their markets.

CORPORATE AUTHOR: Harvard University, Cambridge, Massachusetts

TITLE: Studies of the Flow of Technical Information

AUTHOR: Richard S. Rosenbloom

DATE: June 1967

ACCESSION NUMBER: PB-175 714

ANNOTATION: This is the final report that describes the study of flow of technical information and its role in research and development of decision making.

CORPORATE AUTHOR: Graduate School of Business Administration, Harvard University

TITLE: Technology, Information and Organization Information Transfer In Industrial R and D

AUTHOR: Richard S. Rosenbloom and Francis W. Wolek

DATE: June 1967

ANNOTATION: This is an empirical study of information transfer in the R and D operations of large industrial corporations. Its basis is a body of survey data collected from 2000 engineers and scientists in 13 establishments of four corporations and from 1200 members of the Institute of Electrical and Electronics Engineers. The data describe instances in which respondents acquired useful technical information from sources outside their immediate circle of colleagues. The analysis is descriptive in character, following a functional approach in which the use of various means of information transfer is considered in relation to the purposes of technical work.

While the data, in general, confirm the results of other studies of this sort, they demonstrate also that the relative use of alternative means will vary significantly with the circumstances of their use. The report explores the association of variations in a number of specific personal, organizational, and technological factors with variations in the use of sources of information. In a more general interpretation of these findings, those variations are related to aspects of the goals of the work to which the information was applied.

The purposes of technical work are considered along two basic dimensions, one relating the potential for contribution to the development of some body of systematic knowledge, the other to the support of particular operational objectives. When the focus of work is on operational goals, local and informal sources account for most instances of information transfer. Formal and more distant sources are the most common means used when the focus is on ''professional'' goals, i.e., those concerned with contributions to the knowledge.

In conclusion, the report discusses the effects which management may have, within an organization, on the process of information transfer, and the need for managers and students of the process to take into account the interplay in this process of personal values, task requisites, and the structure of formal and informal social groups. Firms need to establish two-way communication about needs and possibilities; by so doing they ma_ enhance the effectiveness with which

advances in knowledge are translated into innovations in technology meeting the needs of society.

CORPORATE AUTHOR: Rowland and Co. Inc., Haddonfield, New Jersey

TITLE: The Process of Professional Information Exchange Among Science Information Specialists

AUTHOR: George E. Rowland et al

DATE: June 1967

ACCESSION NUMBER: PB-175 568

ANNOTATION: An extensive nationwide field survey was made by interviewing 127 science information specialists who were located in 72 different qualified science information centers located from California to the East Coast. An effort was made to select from each organization one subject who was actively engaged in performing tasks necessary to provide science information to scientists, and one who administered or supervised the performance of those tasks. The respondents filled out a questionnaire and were each interviewed for approximately 45 minutes to one hour.

The data clearly indicate that the science information specialist is educationally and functionally different from the librarian; that the process of science information exchange among science information specialists is inadequate and needs considerable revision; and that government, industry, and academic institutions should all become involved in constructing a better communication system. Specific recommendations are given. (Author)

TITLE: Impact of Space Research on Science and Technology

AUTHOR: Homer E. Newell and Leonard Jaffe

SOURCE: Science 157, July 7, 1967, pp 29-39

DATE: July 7, 1967

ANNOTATION: Today is rich with challenge and opportunity. Political, social, and economic problems of the most vexing nature confront the peoples of the world.

Various tools must be shaped and applied by the human intellect to the solution of these problems.

Important among these tools are those of science and technology.

In the present climate, science faces a double challenge. On the one hand, there are the problems of understanding and interpreting nature and of extending the frontier of knowledge. On the other hand, there is the challenge, more clearly defined than ever before, to scientists to apply the results of science and technology for the benefit of mankind.

While short-range predictions of the weather are important to our daily activities and to the saving of lives and property, the value of weather forecasts would increase manyfold if such predictions could be extended over a longer period, perhaps as much as 2 weeks or more. The National Academy of Sciences-National Research Council in a 1965 report estimated that the potential savings as a result of such long-range forecasting could approach $2 1/2 billion annually for the United States alone.

CORPORATE AUTHOR: Howard University Department of Economics, Washington, D. C.

TITLE: The Feasibility of Developing Transfer of Technology Functions

AUTHOR: Daniel L. Spencer, Alexander Woroniak

DATE: August 1967

ACCESSION NUMBER: AD-657 040

ANNOTATION: The paper attempts to develop transfer of technology functions. Using data based on post-war experience of Japan, the issue is raised: how to facilitate the transfer of technology (absorption function). At the same time, an effort is made to identify and measure the relationship between the growth of output produced by the application of new borrowed technology and a group of significant explanatory variables (impact function).

The absorption regression indicates that explanatory variables which facilitate a society's ability to absorb technology are mainly some combination of quantifiable measures of: (1) educational and technological niveau, (2) society's planned and predetermined effort to raise this niveau, (3) coordinated policies of government guidance in the induction of productive types of technology, as well as (4) availability of channels for intake of information about foreign technology and markets for new goods abroad (i.e. antennae). Findings of the two impact functions indicate a strong correlation between the growth in foreign and domestic sales of goods produced with new borrowed technology and two major explanatory inputs. On the one side, a nation's own effort to elevate the technological level of production processes stands out prominently; on the other hand, the visible indicators of induced technology (e.g. import of technically advanced machinery and raw materials reflecting new productive processes) figure prominently as major contributory factors. The question of which input contributes more or less to technological transfer and its impact is not being raised, because it is in some sense irrelevant. What is held, in effect, is that the transfer of technology is governed by a complex of factors which create a setting or an institutional milieu conducive to the transfer mechanism and its impact.

TITLE: Spin-Off And Fall-Out: Implications For Information Transfer Institutions

AUTHOR: Philip R. D. Corrigan

SOURCE: The Library World, Number 809

DATE: November 1967

ANNOTATION: Spin-off is defined, and studies in the U. S. A. and the U. K. are detailed. The implications of spin-off for information transfer institutions are discussed. Levels of information stability are defined and implications discussed. A new information transfer system is outlined: national, regional and area information transfer institutions are proposed, as are national and locality subject centres. There is a bibliography of 30 items. (Author)

TITLE: Utilizing R and D By-Products

AUTHOR: Jerome W. Blood, Editor

SOURCE: American Management Association, Inc., New York

DATE: 1967

ANNOTATION: Contents: Introduction, by J. D. Stice;
R and D By-Products: An Opportunity to Improve Corporate Profits, by John F. Corwin;
Capitalizing on the By-Products of Research, by R. G. Fordyce;
Making Profitable Use of By-Products, by Joseph Z. Krezanoski;
Industrial Utilization of Research By-Products of an Aerospace Company, by John E. Oliver;
A Marketing-Oriented Licensing Program, by C. E. Hughes;
Background and Philosophy of Navan Incorporated, by Pat Bales;
How to Realize Income Through Licensing, by Jeffrey C. Freedman;
The University of California Patent Program, by Mark Owens, Jr.;
The NASA Technology Utilization Program, by George J. Howick;
What to Do About the Product of Serendipity, by E. W. Wickert;
R and D By-Products: Technical Currency, by M. Russell Dock;
University Inventions, by Willard Marcy;
Invention Management, by Walter J. Cairns;
Domestic Product Scouting, by Ralph G. Miller;
International Scouting, by John V. Donovan.

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13. ABSTRACT

This bibliography is a compilation of literature existing in both the government and public sectors and concerning Cost/Benefits of Technical Information Services and Technology Transfer. Not only was the cost-benefit to the user reflected, but consideration was given to the initial cost of information collections, the cost of processing the information and the cost of the flow of this information to the user. Cost-benefit was therefore considered as a trade-off between the expenditures for processing services and the benefit to the user. Technology transfer was considered as communication from one field to another for practical use of technology.

The 218 Unclassified-Unlimited references are divided into two parts: Technical Information Services and Technology Transfer. Each part is arranged into four sections by source: DoD; Federal (non-DoD) and state services; Commercial and non-profit organizations and universities, and General. Within each source, the references are arranged in chronological order. Three indexes, Corporate Author, Personal Author and Title, are appended.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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