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ABSTRACT

Presented are the findings of the Committee on Scientific and Technical Communication of the National Academy of Science and the National Academy of Engineering after a three-year survey of scientific and technical communication activities in the United States and abroad. There are eleven recommendations concerned with planning, co-ordination and leadership at the national level, including the creation of a joint commission on scientific and technical communication responsible to both academies. Sixteen recommendations consider problems of "consolidation and reprocessing", including the necessity for critical reviews, evaluations and consolidation of information in particular subject-matter areas. The operation of publishing, abstracting, and literature-access services is considered and sixteen recommendations made for improving these activities, including the provision of grants from funding agencies to ensure the utilization of work they sponsor. Two recommendations to facilitate personal communication at meetings and during sabbatical leave, and ten suggestions for experiments in the storage, dissemination and machine processing of information are made. Appendices list the consultants to the project, and a collected list of recommendations serves as an index. Bibliography. For synopsis of this document see ED 034 682. (AL)

NATIONAL ACADEMY OF SCIENCES
NATIONAL ACADEMY OF ENGINEERING

SCIENTIFIC AND TECHNICAL COMMUNICATION

SCIENTIFIC AND TECHNICAL COMMUNICATION

A Pressing National Problem and Recommendations for Its Solution

A REPORT BY THE
COMMITTEE ON SCIENTIFIC AND TECHNICAL COMMUNICATION
OF THE
NATIONAL ACADEMY OF SCIENCES–NATIONAL ACADEMY OF ENGINEERING

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June 1969

Dr. Leland J. Haworth
Director
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550

Dear Dr. Haworth:

The Committee on Scientific and Technical Communication (SATCOM) was established in February of 1966 by the National Academy of Sciences and the National Academy of Engineering to investigate the present status and future requirements of the scientific and engineering communities with respect to the flow and transfer of information. The Committee was established in response to the National Science Foundation's request of October 20, 1965.

Fulfilling the assigned tasks of broadly surveying the complex interrelationship of federal and privately operated information activities and of considering the most effective intellectual, economic, and technological means of increasing the efficiency of information transfer and use has required the full three years allotted the Committee.

Because of the extreme diversity and complexity of U.S. scientific-and-technical-information systems and services, this Committee's recommendations are many and far-reaching. They reflect the Committee's firm conviction that generators and users of scientific and technical information must assume increasing responsibility for the more effective transfer of such information—a responsibility which entails: (a) fostering the availability of the products of the basic access services and their reprocessing and consolidation to serve specialized areas of need; and (b) strengthening our present decentralized system of operation through more-effective coordinating mechanisms, thereby ensuring continued flexibility and increased responsiveness to user requirements as well as preserving the independence of the private for-profit and not-for-profit organizations.

A major recommendation is the establishment of a Joint Commission on Scientific and Technical Communication, responsible to the Councils of the two Academies. The Commission would provide guidance useful to public and private organizations in the development of more-effective scientific-and-technical-information programs. It also would lead private organizations in the coordination of their interests and programs and would foster their interaction with appropriate federal agencies involved in the evolution of plans and policies affecting scientific and technical communication.

We agree with this central recommendation and with the basic philosophy and approach to communication problems outlined in this report, which we submit in fulfillment of our contract.

Sincerely yours,

FREDERICK SEITZ
President
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ERIC A. WALKER
President
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Acknowledgments

This report of a three-year survey (1966–1968) of scientific and technical communication was undertaken at the suggestion and with the support of the National Science Foundation (NSF C-310, Task Order 111). The National Academy of Sciences and the National Academy of Engineering cooperated in the appointment of a committee to conduct this study and to recommend needed policies and courses of action. The Academies also provided a secretariat, which included F. Joachim Weyl, as Executive Secretary, Bertita E. Compton (from May 1968), as Staff Officer, and Judith A. Werdel, as Staff Associate, to support the Committee in all its endeavors. They were assisted by Victoria B. Crawford and Barbara S. Adams, who handled the complex operations of the SATCOM office most responsively and ensured order and timeliness in the massive flow of paper emanating from and received by the Committee.

The conduct of such a survey and the genesis of a report on this broad subject necessarily required the help and contributions of a large number of organizations and individuals. The Committee is deeply appreciative of the assistance it has received throughout the community of scientific-and-technical-information activities. Many organizations, including scientific and technical societies, commercial establishments in the information field, industrial corporations, and key agencies of the government, consented to discuss their information programs with the Committee.

Another source of substantial contributions was the work of SATCOM's four Task Groups on: the scientific-and-technical-information problems of the Department of the Interior, the handling of toxicological information, the application of copyright to computer usage, and the interchange of scientific and technical information in machine language. SATCOM's participation in the review of currently significant problems through these Task Groups added much to its knowledge and insight. Recognition is given to their membership and activities in Appendix A. In addition, we want to express to the staff of the Task Group for the Interchange of Scientific and Technical Information in Machine Language (ISTIM) our deep appreciation of their work. This staff was jointly appointed and supported by SATCOM and the Office of Science and Technology and included William Bowman (Department of Commerce), Clifford Paulson (Department of Commerce), Robert Hooper (IBM), and Melvin Weinstock (Herner and Company), with Eugene Garfield (Institute for Scientific Information) and Lawrence Buckland (Inforonics, Inc.) serving as consultants.

The special care given to the records of the four Task Groups and the minutes of SATCOM's meetings make these documents an important archival record of the Committee's work.

To organize the accumulating material, and augment it when necessary, the SATCOM staff received assistance from time to time that contributed greatly to the success of its efforts. During the spring and summer of 1967, Robert Maizell advised on industrial information systems and their problems. Dwight B. Gray and Benjamin Malcolm served as consultants and assisted in drafting early versions of working papers for consideration by the Committee and its Consulting Correspondents (listed in Appendix B). Dwight B. Gray also participated in efforts to prepare a first working draft of the complete report and prepared the initial version of much of the material found in Chapter 4. In addition, a subcontract was negotiated with Programming Services, Inc. of Palo Alto, California, to secure the services of Charles P. Bourne and some of his staff in the preparation of draft material, which now appears in parts of Chapters 4, 5, 6, and 7.

From the summer of 1967 onward, SATCOM enlisted the help of some 200 key individuals in the field as Consulting Correspondents in an effort to increase the community's sense of participation in planning for future scientific-and-technical-information efforts and to assure broadly informed discussion of SATCOM's general conclusions and recommended courses of action. These Consulting Correspondents made significant contributions to the material and perspectives presented in the report and helped immeasurably in improving early drafts of it. (Appendix B lists the SATCOM Consulting Correspondents, and Appendix A indicates the nature of their interaction with SATCOM.)

A major concern of SATCOM was to maintain effective contact with other agencies and organizations deeply involved in problems of scientific and technical communication. Therefore, representatives of certain major agencies in this area served as Associate Members of the Committee, and we are most grateful for their interest, advice, and participation. These Associate Members are: Burton W. Adkinson, Office of Science Information Service of the National Science Foundation; Ernest R. Sohns, Office of Science Information Service of the National Science Foundation; Andrew A. Aines, Office of Science and Technology and Committee on Scientific and Technical Information of the Federal Council for Science and Technology; C. E. Sunderlin, National Academy of Sciences; Harold K. Work (through August 1968), National Academy of Engineering; James H. Mulligan, Jr. (from September 1968), National Academy of Engineering; and Edmund C. Rowan, Office of the Foreign Secretary, National Academy of Sciences.

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CHAPTER 1

The Committee on Scientific and Technical Communication

A. BACKGROUND AND INCEPTION

How to communicate and use scientific and technical information effectively has been a problem of serious and growing concern to both government and private organizations for at least the past two decades. The steadily expanding volume of scientific and technical information, the emergence of new disciplines and of new links between existing ones, and the increasing number and diversity of user groups and user needs are three obvious and urgent aspects of the information problem.

Scientific and technical information and the insight it provides are indeed hard won; this information constitutes the principal result of an annual research-and-development expenditure in the United States alone that is mounting above $27 billion, with little indication of leveling off. New science and technology rest firmly on the base of information generated in the past; thus the effectiveness of future work in universities, government laboratories, and industry depends on the efficiency of present information transfer. Information costs are usually no more than a few percent, at most, of the cost of doing scientific and technical work. The improvement in the efficiency of such work that would result from increasing the effectiveness of information-handling procedures would offset—easily and severalfold—information costs substantially greater than the present level of expenditures for this purpose.

Unfortunately, the proliferation of useful research together with a burgeoning increase in the numbers of trained people involved in science and technology has overcome the capacity of the classical information services to respond effectively. To avert a crisis of major proportions, the only present alternative is a strong effort to accelerate the utilization of modern computer-aided techniques for handling information. Since success in this effort must rely on a proper blend of intellectual effort and complex machine processing, shortcuts are not available. The voluminous nature of this report speaks well for the complexities of this problem.

The reappraisal of our country's scientific and technological effort that occurred in the late 1950's stimulated increased attention to problems of scientific and technical communication. Special committees and subcommittees of the U.S. Senate and House of Representatives conducted a number of major studies of such problems, among which outstanding examples were those of the Senate Committee on Government Operations and of the House Committees on Science and Astronautics, Education and Labor, and Government Research (see Chapter 8, Section B). In addition, the executive branch appointed a series of special panels and task groups to conduct short-term analyses and assessments of scientific-and-technical-information problems and to recommend possible solutions. Examples of these efforts are the reports of the Baker Panel,[14] the Crawford Task Group,[55] the Weinberg Panel,[170] and the Licklider Panel.[109] (See Chapter 8, Section B, for a summary of the main objectives and findings of each of these reports.)

Three major results of these various congressional and White House studies were the creation of an Office of Science Information Service in the National Science Foundation (NSF), acceptance of a presidential reorganization plan to establish the Office of Science and Technology (OST) in the Executive Office of the President, and the organization of the Committee on Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology, which endeavored to develop standard practices and procedures among the information-handling activities of federal agencies and to foster greater coordination among them. At the same time, major scientific and technical societies and libraries began to take steps to enhance the effectiveness of their communication programs, many such efforts being stimulated and funded by the NSF. In short, during these years federal and private organizations came to recognize that "strong science and technology is a national necessity and adequate communication is a prerequisite for strong science and technology."[99]

Unified and continuing surveillance and coordination of federal information activities were made possible through COSATI, but there was still no comparable perspective or coordinating mechanism for the ever-increasing number of information-related activities of non-federal groups. Though previous studies, notably that of the Weinberg Panel,[170] had recommended certain broad policies to the scientific and engineering community, specific implementation was left to the uncoordinated judgment of many diverse individuals and organizations. Therefore, both the OST and the NSF came to recognize the need for a nonfederal body to facilitate coordinated planning by the many diverse private organizations, as COSATI does for the federal agencies. A careful assessment of the over-all scientific-and-technical-communication complex and of the interrelationships between government programs and those of the for-profit and not-for-profit organizations was essential to effective planning. And there was need for a mechanism that would facilitate effective interaction between the government and private organizations in regard to scientific-and-technical-information problems. As a first step toward the fulfillment of these functions, a study was needed by a group broadly representative of the many kinds of private information activities, a study that could survey these activities in much more detail than any of the previous panels and make more sharply directed recommendations, some of which would be aimed at ways of ensuring continuing coordination and at the proper division of responsibility between the federal and private organizations. Therefore, the NSF, with OST concurrence, requested the National Academy of Sciences (NAS), in cooperation with the National Academy of Engineering (NAE), to appoint a committee for this purpose.

As a result, the Committee on Scientific and Technical Communication (SATCOM) came into being in February 1966, with support for three years provided by the NSF. Its membership was chosen to represent various segments of the nonfederal community (major scientific and technical disciplines, libraries, commercial publishers, industry, and universities), subject to the exigencies of personal commitments. The membership also included a wide range of interests and types of expertise in scientific-and-technical-information activities to assure insight, awareness of the implications of new technologies, and sensitivity to the information problems and needs of the everyday working scientist, engineer, and practitioner.

The Committee's charter (Figure 1), with minor modifications, corresponded to its original assignment from the NSF.

To define the scope of its activities more precisely, SATCOM distinguished between literature that presents the results of research, development, analysis, or experimentation and documents that describe work in progress or planned. The Committee agreed to make the publication, dissemination, and utilization of information on completed work the main subject of its study, to devote less attention to work in progress, and to exclude from its consideration the problems of handling information on planned programs of future activity.

From the beginning, and consistent with its charter, SATCOM regarded

COMMITTEE ON SCIENTIFIC AND TECHNICAL COMMUNICATION

Revised Charter

The Committee will be expected to examine in broad perspective and to make recommendations on the present status and future requirements of the members of the scientific and engineering community with respect to the structuring, flow, and transfer of scientific and technical information and insight.

Since information activities of the federal government combine with those conducted in the private sector (by groups and organizations of all kinds—in the United States, and to a lesser degree, abroad) to serve all the individual scientists and engineers in the United States and their organizations, and since the demands upon this combined effort are rapidly increasing, the Committee will give special attention to:

1. Information activities, policies, and relationships, interrelating the groups and organizations of the private sector (both at home and, as relevant, abroad),
2. Interactions and interrelationships between the federal government and the private sector in connection with scientific and technical information, especially federal executive or legislative actions or operations that affect substantial portions of the private sector,

with a view to making recommendations to the organizations and individuals of the private sector, as well as to the federal government.

The Committee will also consider, particularly (but not exclusively) in the light of the overall problem:

1. Methods for promoting more effective relationships between information systems and scientists and engineers, the principal producers and users of scientific and technical information
2. Techniques and systems for facilitating the effectiveness of information transfer
3. Needs for new means of providing greater selectivity and consolidation in information transfer

FIGURE 1 Charter of the Committee on Scientific and Technical Communication.

the scope of its survey as encompassing the entire series of organized activities involved in the transmission of information from early informal communication through formal publication, announcement in secondary media, and, finally, review and consolidation to adapt it to the working context of a potential user. Therefore, our survey focused chiefly on the efforts of people and functions of organizations rather than only on documents and documentation tools.

SATCOM's activities during its three years of existence have been of several sorts, as detailed in Appendix A. To gain perspective, we surveyed in depth each of a large number of private and governmental information-handling activities, often by visiting the headquarters of an activity. To assist in the resolution of some currently acute issues as well as to develop perspectives on possible coordination procedures in certain special fields, we organized four *ad hoc* Task Groups (see Appendix A). Finally, to sound out the opinions of the scientific, technical, and information-handling communities, and to secure their broad participation in the formulation and resolution of policy questions, we selected and maintained contact with a group of about 200 key individuals from diverse institutions and disciplines (see Appendixes A and B), called SATCOM's Consulting Correspondents.

B. ORGANIZATION OF THE SATCOM REPORT

Following this introductory chapter is one that briefly presents SATCOM's basic philosophy and the subject areas treated in its recommendations. The third and core chapter of the report introduces each recommendation in its entirety, with accompanying discussion to indicate the thinking that led to its formulation as well as its action implications. Subsequent chapters provide additional detailed information on topics and problems treated in the recommendations. Chapter 4 deals with primary communications and includes material on generators and users as well as on such major types of primary communications as meetings, preprints, technical reports, serials, and translations. Chapter 5 describes basic access services and emphasizes especially the functions of libraries and of basic abstracting and indexing services. Consolidation and reprocessing—services that replace the incoherent mass of primary information with a concise, coherent, and evaluated account, and when appropriate tailor it to specific user groups to facilitate its application —are discussed in Chapter 6. Chapter 7 describes the implications and applications of new technologies in relation to the processing and transmission of scientific and technical information and briefly discusses some of the related problems of copyright. National concern with the over-all planning and coordination of scientific-and-technical-information activities and some of the major studies and recommendations of legislative and executive bodies are summarized in Chapter 8. Chapter 9 turns to the international arena and three types of cooperative arrangements to facilitate the exchange of scientific and technical information across national boundaries. Finally, in Chapter 10, we describe more fully the role and functions of the proposed NAS-NAE Joint Commission on Scientific and Technical Communication.

For the hasty reader, Chapters 1 and 2 are suggested as essential, together with the list of recommendations in Appendix C. For greater detail, Chapter 3 gives the recommendations in complete form, with accompanying discussion, and Chapters 4 through 10 offer back-up material in depth.

CHAPTER 2

A Summary of SATCOM'S Thinking and Recommendations on Scientific and Technical Communication

A. BASIC PRINCIPLES

A primary concern throughout our survey was to relate the complex network of scientific-and-technical-communication activities to the environment that has shaped it, supports its current operation, and will influence the course of its future development. A variety of factors affect and, in turn, are affected by patterns of scientific and technical communication. These include:

1. The education, objectives, and work habits of those who guide or participate in the conduct of science and technology
2. The missions, resources, and intellectual authority of the organizations and institutions that establish policies, set standards of performance, and determine the allocation of resources
3. The emergence of new technological and procedural tools

The philosophy that we have developed during our three years of existence accords with and builds on that expressed in the earlier reports of the Baker Panel[14] and the Weinberg Panel.[110] Our philosophy also has been strongly influenced by the extraordinary diversity of the things we have learned about information services and systems and about the needs and aspirations of those whom they serve. This diversity, of which we hope the reader will get at least a taste in Chapters 4 through 9, can be bewildering, yet at the same time filled with opportunities, and it is the latter aspect that has impressed us most.

Our recommendations reflect our effort to stimulate recognition of some of the major opportunities and acceptance of responsibility for action. For example, we have tried to challenge the *scientific and technical* *societies* to appreciate the crucial role they must play and have pointed to some specific areas in which they can take steps to fulfill this role. We have emphasized to *sponsors of research and development* that such work is of value only when the results are accessible and capable of being adapted to the contexts in which they can be applied. In other words, the sponsors' responsibility for such work includes whatever steps are appropriate (patent, publication, or announcement, for example) and necessary to assure its availability.

We have pointed to the *feasibility and necessity of serving special user groups* (each numbering a thousand or so) who have common information needs that often cut across several disciplines or encompass only one particular subdivision of a broad discipline. Effective service to such groups is a first approach to the future goal of individual service geared to each user's specific requirements.

We have called particular attention, as have several committees and panels before us (for example, the Weinberg Panel[119]), to the *ever-growing need to sift, evaluate, compile, and consolidate* the rapidly expanding store of scientific and technical information.

And possibly most crucial, we have suggested mechanisms and policies that we believe will be the most *effective means of coordinating and focusing scientific-and-technical-communication efforts* during this transitional period of burgeoning activity and rapid change.

Fundamental to the SATCOM philosophy is our recognition that a basic element of strength in our country's over-all scientific-and-technical-communication effort is the *participation of the members of the scientific and technical community* in its development and administration. As a result of their broad participation, our extraordinarily diverse communication programs and services have maintained a flexible responsiveness to changing and newly emerging needs as well as fulfilling a variety of other functions not entirely relevant to communication but reflecting firmly established traditions and work habits of scientists, engineers, and practitioners or of the organizations with which they are associated. Because so many kinds of information must be communicated, and because there are increasingly wide variations among groups of users in regard to the types of information that they need and the forms and language in which they need it (see Chapter 4, Sections A and B), this flexibility and responsiveness must remain intrinsic to our scientific-and-technical-communication network.

In our concern for maximizing the strengths implicit in our diversity (diverse components, fulfilling an ever-expanding range of functions, and associated with various managing, producing, using, and marketing groups) and for providing continuing responsiveness and progress in meeting new and increasing demands, we have developed *a few broad guiding principles* that have colored nearly all our recommendations and supplied criteria for our decisions on difficult and controversial issues.

The first of these guiding principles is: *The management of all scientific-and-technical-communication activities must be as responsive as possible to the needs, desires, and innovative ideas of the scientific and technical groups that they serve. These activities must be sufficiently flexible to adapt rapidly to changes in user needs and communication techniques.* In this context, we especially emphasize the need for an equitable balance of influence among the managers of information programs, the generators and users of information, and those who market information products. Therefore, there should be ample opportunities for interaction among these groups, both within particular programs and between different programs.

Though we have emphasized diversity in speaking of today's scientific-and-technical-information needs and concerns, the most obvious problem is that of sheer size. The great bulk of material to be handled poses administrative, economic, and intellectual problems, which have been further aggravated by the rapid expansion of our country's research-and-development effort, the accelerated pace of science and technology, and the ever-growing diversity of needs. While there are obvious advantages to centralizing authority over large areas of information and communication activities, overcentralization can negate the responsiveness that we regard as so vital to the continued effectiveness of scientific and technical communication. Consequently, as a second guiding principle, we believe that: *The administrative entities responsible for scientific-and-technical-information programs must be so organized and coordinated that they represent a logical and efficient division of functions, but authority over them must be sufficiently widely distributed to achieve the responsiveness we deem essential.*

Third, we feel that it would be fatal to ignore the purely intellectual problems posed by the mass of knowledge that is inexorably accumulating; therefore: *The planning of our information activities must involve constant attention to the simplification and consolidation of existing knowledge and its frequent reprocessing to adapt it to the needs of diverse users, especially those engaged primarily in the practical application of scientific and technical information.*

A brief discussion of three vitally important problem areas will further illustrate the SATCOM philosophy. The first such problem area is that of defining *the relative roles of the federal government and private organizations—both those not for profit and those for profit*—in the communication of scientific and technical information. Private and government organizations have, or should have, the common objective of providing information services that are increasingly responsive to the needs of users of scientific and technical information. However, there are basic differences in the motivation and capabilities inherently identified with not-for-profit, for-profit, and government organizations, and each of these types of organizations has characteristics or attributes that are uniquely its own. The roles of these various kinds of organizations should be mutually reinforcing, with each being assisted in or given the opportunity to fulfill those communication functions to which it is best suited.

The *not-for-profit private organizations* have a vital part to play in the communication of scientific and technical information. Such organizations include the vast array of scientific and technical societies that came into existence principally to serve the information needs of the disciplines that they represent. Because their members typically are among the principal generators and users of scientific and technical information, the societies are uniquely able to collect, assemble, and assure the quality of the information that they distribute through their basic primary- and secondary-publications programs. And they have a widely recognized and generally accepted responsibility for assuring the continuity and progress of their particular domains of science or technology.

The unique attribute of the *private for-profit organizations* in the fulfillment of their equally vital role in the communication of scientific and technical information is that their survival and growth depend directly on their ability to recognize, understand, and adequately serve users' needs. This ability has important applications in the service of both scientific and technical societies and the federal government and should be fully utilized. Such organizations traditionally have been particularly effective in providing information for the practitioner and in developing specialized, highly user-oriented services, some of which are designed especially to serve the research community.

Every *government agency* must support the scientific-and-technical-information activities that are required in the accomplishment of its mission. In addition, the federal government inevitably must provide substantial support, through certain of its agencies, to scientific-and-technical-information efforts in the public interest. Clearly such support cannot be extended without the exercise of responsible management and control. Minimizing the danger of conflict between such control and a ready response to the needs and views of the scientific and technical communities is a difficult task. We believe that such difficulties can be minimized if the support of a discipline's scientific-and-technical-information services does not become more narrowly concentrated than is support of that discipline's over-all research-and-development effort.

The *economics of information services* constitutes a second major and pervasive problem area. At the present time, different mechanisms provide for the revenues and determine the market prices of primary publications and secondary awareness and access services, though both types of services are directly related to our government's massive commitment to science and technology. In the case of primary publications, the practice of allowing the payment of page charges for publication of work generated under research-and-development contracts has provided a logical distribution of responsibility between generators and users and has afforded financial stability to journals in spite of fluctuations in amount of input and number of subscribers (see Chapter 4, Section B). But at no time has this practice been universally accepted (see the recent study of the Biological Sciences Communication Project of The George Washington University on *Scientific Journal Page Charge Practice*[16]), and, as budgets tighten, opposition is increasing. The collection of adequate data on costs and experimentation with new publishing procedures and with other, possibly more feasible, means of supporting publication are sorely needed. And the situation is even more complex in regard to secondary services that provide for bibliographic control, document availability, and abstracting and indexing. Such services have derived federal support under legislatively authorized programs, through direct subsidy, and from indirect charges under government contracts. Therefore, they are geared to widely differing demands and market conditions. As a result, any comparison of efficiency is difficult, and obstacles to seemingly practical cooperative arrangements are numerous.

The costs of scientific and technical communication undoubtedly will increase, both absolutely and as a fraction of the over-all cost of research and development, and our recommendations recognize the strong dependence of the scope, nature, and time scale of further developments in scientific and technical communication on economic factors. The economic efficiency of all services, and the viability of unsubsidized ones, would be greatly enhanced by a rational division of functions among different types of organizations, by their recognition and acceptance of such coordination, and by the provision of adequate channels for communication and cooperation among them. In addition, operators of scientific-and-technical-information programs should incorporate into their services on a continuous and systematic basis appropriate feedback mechanisms and methods of performance evaluation and should continually explore *the possibilities of establishing a closer relationship between costs and the effectiveness of services.* Unless there are palpable indications to the contrary, market rates that establish themselves for services should be used as empirical guides to user needs (though sluggish user responses to new services must be taken into consideration). In many instances, sufficient assured support (from government or private sources) should be provided to permit necessary modifications or innovations to be applied promptly.

A third vitally important area is the impact of new techniques on scientific-and-technical-communication programs and practices. New information-handling technology offers the key to further promising advances, but it also raises difficult problems. We expect continued changes, probably major ones, in the near future in many aspects of scientific and technical communication as a result of such new developments as techniques of inexpensive and rapid photoduplication (full-scale and microform). In the more distant future, the on-line use of modern electronic computer systems in combination with more effective communication facilities holds great promise. These techniques offer opportunities to make information services more responsive than ever before to the needs of diverse groups of users. To realize this objective, the management of such information programs and services should foster imaginative innovations and provide ample opportunities for the exploration and testing of new procedures. Because of the complexity of the problems to be solved and the need for experimental approaches to many of them, it is difficult to predict the forms that new information services will assume or the times at which they will come into being. In many instances, the development of new services should be gradual, often involving some parallelism with existing ones; the latter should not be allowed to cease operation before the ability of new ones to replace them has been tested adequately.

B. ORGANIZATION OF AND SUBJECT AREAS TREATED IN SATCOM RECOMMENDATIONS

In the following chapter, "The Recommendations Discussed," our 55 recommendations are presented in full, with accompanying discussion to indicate the rationale for and implications of each. The purpose of this section is to sketch briefly the organization and general subject matter of the recommendations. (A guide to the SATCOM recommendations appears in Appendix C and summarizes the specific content of each recommendation for the reader who needs to locate particular ones rapidly.)

Since a chief objective of SATCOM is to build upon and strengthen the present pluralistic and decentralized scientific-and-technical-communication complex by fostering greater cooperation and coordination among its diverse components, our first 11 recommendations in the initial section of Chapter 3 deal with "Planning, Coordination, and Leadership at the National Level.' Foremost among these recommendations is one that calls for the creation of a broadly representative and high-prestige *nongovernmental body to stimulate greater coordination* among private interests—both not-for-profit and for-profit—and to serve as a channel for their interaction with governmental policy-making bodies (Recommendation A1). The proposed body would operate within the structure of the National Academies where (a) maximum knowledge and expertise would be available to it; (b) there would be broad representation of the organizations, groups, and individuals whose efforts depend on and influence scientific and technical communication; (c) the desired type of interaction with the federal government would be facilitated; and (d) a tradition of diversified and intensive involvement in scientific-and-technical-communication activities exists. The proposed organization would be a continuing one with a full-time professional staff.

Four subsequent recommendations emphasize a philosophy of *shared responsibility* between the federal government and private for-profit and not-for-profit organizations for the effective communication of scientific and technical information. These recommendations (A2–A5) define the relative roles of each of these types of organizations and indicate specific areas of responsibility.

Looking beyond national boundaries, which signify little in scientific and technical communication, we next address a series of recommendations (A6–A9) to the principal types of *international communication activities:* (a) direct arrangements between societies or government-agency programs for sharing the work and products of information services; (b) cooperative international research projects, such as the International Geophysical Year and the International Biological Program; and (c) efforts of international organizations to stimulate or develop cooperative arrangements among nations that will facilitate the flow of scientific and technical information.

In the final two of the initial group of recommendations, we deal with two complex problem areas, *copyright legislation* and the *evolution of standards* affecting scientific and technical communication. Since, in both instances, we feel that no rapid and easy solutions can be achieved, we suggest careful study and continuing attention to the development of appropriate and feasible arrangements (Recommendations A10 and A11).

In a second group of 16 recommendations entitled "Consolidation and Reprocessing—Services for the User," we look at the ever more diversified and specialized demands for scientific and technical information and the ways in which such demands can and must be met. First, *review and consolidation* always have been among the best means of facilitating the effective use of information and, with the accelerating growth of the existing body of information and data, must assume an even more prominent role. Therefore, four recommendations (B1–B4) urge recognition and acceptance of responsibilities for the consolidation of the information generated in research and development, measures to increase the allocation of resources—both economic and intellectual—to this function, and steps to enhance access to such consolidations.

Recommendations B5 through B9 deal with the provision of specialized services that will *facilitate the practical application of information,* especially in engineering, agriculture, and medicine. Hand-tailored services for groups of at least a thousand who share common information needs can and must be provided. Such groups must be identified and their needs clearly defined so that they can be served more effectively. In this area, the private for-profit organizations have been especially active, and their experience and capabilities should be utilized to the fullest. Such specialized services typically involve the reprocessing of the products of basic abstracting and indexing services; therefore, funding policies that will foster the ready availability of such information products for reprocessing are urgently required. We regard the stimulation and expansion of reprocessing activities as the most important thrust in making scientific and technical information effective for those who use it, and suggestions that will further this effort appear in Recommendations B10 through B12.

Even as access to reviews presents a problem, so too does access to the basic abstracting and indexing services appropriate to the particular needs of diverse user groups; Recommendation B13 is addressed to this problem. The largely unrealized potential of the information-analysis centers (IAC's) in the provision of specialized services is the subject of Recommendation B14, and two final recommendations treat management problems which, though encountered in all forms and levels of scientific and technical communication, are especially prominent in providing highly user-oriented services. The development of adequate and continuing feedback mechanisms to assure the relevance of services and increased recognition of the need for substantial marketing and educational efforts to overcome the so-called "in a rut" and "line of least resistance" behavior patterns of users faced with new and improved services are the concerns of the two concluding recommendations in this section (B15 and B16).

The third group of 16 recommendations deals with "The Classical Services" of basic abstracting and indexing, library functions, formal and semiformal publications, and meetings. In line with the principles advocated in the initial section with regard to the government and private-sector roles in the communication of scientific and technical information, we explicitly advocate management of *discipline-wide basic abstracting and indexing services* by appropriate scientific and technical societies and the management of other broad bibliographic services (e.g., title listings and citation indexes) by commercial organizations, national libraries, or societies, with support of these activities, when necessary, by the government agencies to whose operations they are relevant (Recommendation C1). Three subsequent recommendations (C2–C4) suggest measures that will enhance the effectiveness of basic abstracting and indexing services.

The *crucial role of libraries* as nodes in a vast switching network is an area of particular concern and is the focus of the recent report of the National Advisory Commission on Libraries (see Chapter 3, Section C, and Reference 121). We believe that pouring more and more money indiscriminately into libraries will not solve their complex problems. Recommendation C5 advocates a funding policy aimed at introducing: (a) a more realistic reflection of library costs into the conduct of scientific and technological work; (b) a closer relationship between costs and services; and (c) more options of extra service for an extra price. A subsequent recommendation (C6) focuses on education—both education of users in relation to the existing array of library services and training programs that place greater emphasis on the operational analysis of library services. Such measures would help libraries to perform more efficiently and effectively.

Seven recommendations (C7–C13) are directed to the organizations and institutions that exercise *stewardship and control over primary scientific and technical publications*. The increasing volume and diversity of primary communications raise special problems, particularly in the area of pricing and funding. Difficulties underlying much of the existing controversy about the appropriate placement of financial responsibility for the publication of new findings result from (a) the dependence of the way of funding scientific and technical communication on the ways our nation funds education and research; and (b) the economics of supply and demand relating to scientific and technical communication, which depart so far from the classical pattern that allowing the fate of publications to rest entirely on the test of the marketplace frequently is not feasible. Systematic study and analysis of the economics of formal publications are required for the development of flexible and feasible funding and pricing policies (Recommendation C7). Further, in this transitional stage when new and more-effective funding mechanisms have yet to emerge, it is essential that sponsors of research and development continue to recognize their responsibilities for the dissemination of results by observing the established page-charge policy. This policy offers a logical division of responsibility between producer and consumer and has helped to stabilize the economic position of journals in the face of fluctuations in input and subscriptions (Recommendation C8). Succeeding recommendations in this group (C9–C13) suggest measures to stimulate experimentation with new media and techniques of formal publication (for example, with systems for the selective dissemination of information) and efforts to enhance the effectiveness of formal media.

Two recommendations pertaining to *semiformal communication* center on (a) ensuring, insofar as is practicable, adequate bibliographic control, so that such material can be identified and located; (b) affording general accessibility through storage in depositories; and (c) limiting distribution to the extent necessary to protect formal, refereed publications. Measures to facilitate the use of technical reports with substantive content also are suggested (Recommendations C14 and C15).

In the last recommendation of this group, we recognize the effectiveness of meetings in providing current information and facilitating productive informal interaction and urge a more innovative and forward-looking approach to the *planning and conduct of meetings* by sponsoring groups (Recommendation C16).

The fourth section deals with the major role of "Personal Informal Communication" in the conduct of research and the application of scientific and technical knowledge and describes some of the factors that foster widespread dependence on this type of information exchange. Pending the conduct of studies that will clarify and provide more-comprehensive data on the ways in which informal channels operate, we offer in this area only two recommendations (D1 and D2), which are directed toward facilitating the occurrence of informal interaction in certain contexts.

Throughout the preceding groups of recommendations, the need for additional data and for experiments with new approaches and technologies appears and reappears. In a final section on "Studies, Research, and Experiments," ten recommendations indicate the *types of studies and experiments most urgently needed* and guidelines for their conduct. High priority is accorded the initiation of comprehensive analyses of and experiments on the functioning of different parts of the network of scientific and technical communication as well as its over-all operation (Recommendation E1). Efforts to develop measures of the value of information services and means of overcoming user apathy or resistance in the face of new options and services should receive major emphasis in such studies (Recommendation E2). Additionally, comparisons of various means of storage and transmission, and careful consideration of their implications for information-handling practices, deserve special attention (Recommendation E3).

The *application of advanced technologies* to the scientific-and-technical communication process presents multifaceted and challenging problems. Recommendations E4 through E9 suggest significant and much-needed types of experiments involving (a) machine-aided indexing, (b) evolutionary indexing of small, widely used, single-interest-area files, (c) development and evaluation of languages for describing the formats of files and of other types of digital communication systems, and (d) development of standard structures for each widely used bibliographic documentary information element. The participation of highly competent scientists, engineers, and practitioners in such experiments is of vital importance; consequently, the responsibility of the scientific and technical societies for encouraging this participation receives special emphasis (Recommendation E7).

Large-scale experiments that involve large populations and the use of advanced technologies are necessary for the fulfillment of increasingly diverse needs; such experiments constitute exploratory development as well as research. As a result, they require special provisions for planning and funding—provisions that assure continuity by assigning responsibility for the development of a unified program of critical experiments to a single group and by adequately supporting this group (Recommendation E10).

C. IMPLICATIONS FOR THE FUTURE

Implicit in SATCOM'S philosophy, and the recommendations that follow from it, is recognition of the need for continuing change in the ways of doing the work of science and technology. By calling upon scientists, engineers, and practitioners to take a greater personal role in the development and use of their communication systems; by summoning administrators of information systems, be they university officials, scientific and technical society officers, corporation presidents, or government officials, to recognize the pervasive role of economics in scientific and technical communication and to adapt or modify their policies and practices accordingly; and by presenting to policy planners new options in organization and methodology, we are, in effect, seeking appropriate changes in their values and behavior, and, ultimately, in the methodologies of science and technology.

Corollary to this effort is the role of education. If such changes as we are recommending are necessary to strengthen science and technology —and we believe they are—then efforts must be made at all levels to effect such changes. We have refrained—wisely, we believe, given the complicated nature of our own topic—from making recommendations on the future course of scientific and technological education. We hope, however, that those of our colleagues who are actively engaged in educating the next generation of scientists, engineers, and practitioners will find in this report stimuli for new approaches and ideas.

CHAPTER 3

The Recommendations Discussed

In the 55 recommendations presented in this chapter, we propose policies and courses of action that we consider essential for the effective communication of scientific and technical information. A brief discussion accompanies each recommendation to relate it to the framework of basic concepts developed in our survey and to indicate specific implications or applications. Subsequent chapters (4–10) offer detailed background and supporting material (acquired principally during 1966, 1967, and early 1968).

Our recommendations recognize and reflect the extraordinary diversity of our country's information requirements and of the scientific and technical organizations that contribute to the development and maintenance of information-exchange media and services. They deal with the management, performance, and economics of the principal functions demanded of this complex network of interacting efforts and advocate the adoption of certain principles and courses of action without, however, subjecting the activities of any particular organization to individual criticism. We hope that the leadership of the major institutions engaged in developing and operating information programs and in marketing their output will review these recommendations in their entirety. The priority assigned by them to specific recommendations will vary, depending on the status of current efforts toward implementation and on the intellectual and material resources that can be mobilized.

The recommendations deal with problems in five general areas. The first of these areas, which we have titled "Planning, Coordination, and Leadership at the National Level," has to do with those policies and mechanisms for fostering effective communication that can be considered national in scope, whether they pertain to the federal government, to private organizations, or to both. If such policies and mechanisms are to evolve effectively, there must be provision for a continuing broad and farsighted assessment of the activities of the government and of the for-profit and not-for-profit private organizations. Also necessary are mechanisms through which the various agencies and organizations involved in scientific and technical communication can be given guidelines and incentives for greater cooperation and can be stimulated to perceive and accept their responsibilities. A second major problem is that of stimulating the allocation of increased effort and support to the functions of reviewing, consolidating, and producing compilations of accruing information and data. Policies and programs to further this objective and to encourage the development and proliferation of access services meeting the requirements of specific groups whose members have common professional interests comprise the second grouping, "Consolidation and Reprocessing—Services for the User." The so-called "Classical Services"—including the information-exchange mechanisms of meetings; formal and informal primary publications; the selection, acquisition, bibliographic control, reference, storage, document-delivery, and other service functions of libraries; and abstracting and indexing services—are the subjects of the third set of recommendations. In view of the continuing rapid growth of scientific and technical information, these recommendations advocate steps for improving its documentation and effective diffusion as it becomes part of the body of recorded contemporary knowledge. A clearer understanding of the functions of "Personal Informal Communication," so vital to the transmission and application of scientific and technical information, and of its relationship to more-formal media, is necessary to guide the development of measures that will foster its occurrence and enhance its effectiveness. In the absence of sufficient information on the operation of informal interpersonal channels, we confine our treatment of this topic to a brief discussion and to two recommended policies to facilitate such interaction. In a final group of recommendations, we recognize the pressing need for "Studies, Research, and Experiments," especially critical experiments involving large populations and large stores of information. Since the future development of scientific and technical communication will depend to an increasing extent on such experiments of operational scale, provision for their planning, conduct, and support must be assured.

A. PLANNING, COORDINATION, AND LEADERSHIP AT THE NATIONAL LEVEL

Today in the United States, scientific and technical communication exhibits the characteristic heterogeneity of a system that evolved by fits and starts through adaptations to locally perceived needs and opportunities. No master plan prepared by experts guided its evolution, nor are our information services staffed by an organized body of such experts. Instead, decisions have been made, and are still being made, at numerous points and with a considerable degree of autonomy, often by leaders of scientific and technical societies who function as volunteers in the management of information programs.

Though the performance of this heterogeneous aggregate of activities has been criticized on many counts, there is no evidence of critically inefficient operation or catastrophic failure. Nevertheless, with the necessary and continued expansion of information services, scientific and technical communication presents increasingly diverse problems, and our ability to maintain high-quality services under such unstructured coordination and leadership is frequently questioned. As long as it continues to function reasonably well, the present dispersed system of decision-making is a source of great strength. Moreover, deeply rooted principles and traditions of this country's scientific and technical community argue against placing scientific and technical communication under centralized management. Therefore, rather than urging immediate and radical change at the present time, we see the implementation of recommendations directed toward more effective coordination, planning, and decentralized management as the best means of coping with the growing and increasingly varied demands for scientific and technical information.

As a prime objective, we urge that the initiative of individuals, institutions, and organizations continue to be accorded substantial scope in the development and operation of those scientific-and-technical-communication services that they consider to be in their best interest. Such information activities should be designed and operated as individual and somewhat independent parts of a comprehensive network, and, as a matter of policy or principle, no attempt should be made to centralize them either physically or managerially. The conversion at this time to a national monolithic system, comprehensively planned, developed, and operated, for recording, structuring, and distributing scientific and technical information would be exceedingly costly and would not ensure improved performance.*

Economics and the increasing overlap of various disciplines even-

* Such a comprehensive system has been established in the Soviet Union for many years. Subject to both the advantages and disadvantages of operation in a social and economic system that is much more conducive to central planning than is that of the United States, it appears in sum to have an operational effectiveness and sophistication of methodology well behind our best disciplinary and mission-oriented systems.

tually must force greater cooperation, with a consequent decrease in duplication of intellectual effort. It is vitally important that continued efforts toward effective coordination and voluntary cooperation be vigorously fostered. SATCOM was strongly impressed by the evidence that currently existing mechanisms have not been sufficient to elicit the required degree of cooperation among private not-for-profit and for-profit organizations. Nor have the private organizations as a whole been able to work closely enough, and to their mutual benefit, with federal information services and systems. There is need for a body through which private organizations can coordinate their interests and cooperate with a similarly representative government group in formulating, and fostering acceptance of, necessary new or modified national policy.

RECOMMENDATION A1

We recommend the establishment of a Joint Commission on Scientific and Technical Communication, responsible to the Councils of the National Academy of Sciences and the National Academy of Engineering. This Commission should be conversant with activities in scientific and technical information and should provide guidance useful to public and private organizations in the development of more-effective scientific and technical communication. The Commission should be a group with as broad a representation as feasible of the major scientific and technical communities and the principal kinds of organizations engaged in related information-handling activities. It should be supported by a professional secretariat. The Commission should be responsible for leading the private sector in the coordination of its interests and programs and in the development of broad and farsighted plans. It should also be responsible for working with appropriate government groups in formulating needed national policies and programs and for gaining broad acceptance of them.

Several considerations prompted the selection of the National Academy of Sciences (NAS) and the National Academy of Engineering (NAE) as the optimum location for the recommended Commission. First, a major goal of this body will be to effect a closer coupling of the development of the scientific-and-technical-communication network to the pattern and requirements inherent in the development of science and technology; therefore, the Commission should be placed where it has ready access to the greatest competence and knowledge in regard to science and technology. Second, no existing institution comes as close as do the two Academies and the National Research Council to embracing the representative organizations, groups, and individuals whose efforts depend on or influence the pattern of scientific and technical communication. Such broad representation is essential if the Commission is to foster increased awareness of and participation in the development of policies affecting scientific and technical communication and to stimulate efforts toward implementation. Third, the type of interaction with the federal government envisioned for the proposed Commission is completely in accord with that which has characterized the Academies from their inception and was, in fact, the principal reason for their creation, as reflected in their charters. Finally, the very substantial and diversified involvement of the two Academies and the National Research Council in scientific-and-technical-communication activities is well recognized and of long standing (see Chapter 10, Section D, for illustrative examples). Moreover, the charter of the National Research Council specifically directs this body to assume certain responsibilities in scientific and technical communication (see Chapter 10, Section C). Thus, it seems clear that the structure of the Academies makes them the most effective location for the type of coordinating Commission proposed, a Commission whose mission entails:

1. Serving the scientific and technical community as a foremost agency in fostering coordination and in consolidating its interests in the handling of scientific and technical information
2. Serving the government by providing representatively comprehensive and authoritative information and advice on the activities, needs, and ideas of the scientific and technical community in this field

Among the possible alternatives considered by SATCOM was that of establishing a new federal agency or entrusting an existing one with the responsibility to supervise and regulate the national aggregate of scientific-and-technical-communication activities. We rejected this possibility because we did not believe that at the present time such a course would produce gains sufficient to offset the decrease in effectiveness likely to result if the participation of the scientific and technical community in the management of communication programs and services were reduced, a view that was held also by the earlier Baker Panel (see Chapter 8, Section B, and Reference 14). A second alternative was that of creating an entirely new and independent nongovernmental organization to take an active role in coordinating scientific-and-technical-communication activities; however, it appeared to us that no newly created body outside the government could offer or soon achieve the prestige, authority, and broad representation so vital to the performance of its intended function. We subscribe instead to a third alternative: to locate the proposed coordinating body within the structure of an existing organization—the one most nearly fulfilling the required conditions for its successful operation and with whose traditions and objectives it would be in complete accord.

In addition, we believe that the recommended Commission, working in cooperation with an active Committee on Scientific and Technical Information (COSATI), which advises and assists the Federal Council for Science and Technology (FCST) in coordinating the government's programs, would reflect the spirit, if not all administrative details, of a recent recommendation made by the Science Ministers of the Organization for Economic Cooperation and Development (OECD). This group urged each member country to establish a single high-level focus for all national activities in scientific and technical communication.

In recommending such a Commission, SATCOM emphatically is not providing for its own continuation under a new name. We have interpreted our task as surveying the complex and evolving patterns of communication and, on the basis of our findings, suggesting constructive approaches to the future planning of information-transfer activities and productive forms of interaction among the responsible groups involved. Though we have discussed the directions in which certain trends are leading us, and have expressed specific preferences for alternatives in policy and action, we cannot forecast the probable broad outcomes even within the next five years. The rate of change in information activities is so rapid, and the interplay of private organizations among themselves and with the federal government so complex, that even the broadest issues require continuing attention. The major tasks of the proposed Commission must go far beyond those undertaken by SATCOM. Metaphorically, one could say that we reconnoitered a complex landscape; the Commission must supply the leadership necessary to get bridges built, expenditures assigned, and a viable economy established.

There should be no protracted hiatus between the discharge of SATCOM and the establishment of the Commission. To assure some degree of continuity, several of our recommended policies and principles can serve as selected points of departure for on-going and future Commission activities (see Chapter 10, Section A). Further, the Commission should maintain and enlarge the relationships established by SATCOM with the scientific, technical, and information-handling communities through its group of some 200 Consulting Correspondents.

The Roles and Responsibilities of Federal and Private Organizations in the Planning and Coordination of Scientific and Technical Communication

With regard to the present role of the federal government in the planning and coordination of scientific and technical communication at the national level, an understanding formalized in 1964 between the President's Special Assistant for Science and Technology and the Director of the National Science Foundation (NSF) resulted in a clear apportionment of responsibility for two major domains (see Reference 43). The Office of Science and Technology (OST) was to "provide leadership in effecting cooperation and coordination among Federal agencies with respect to their scientific and technical information activities." Such leadership would be exercised through the Federal Council for Science and Technology, with the assistance and advice of its Committee on Scientific and Technical Information. The responsibility for "providing leadership in effecting cooperation and coordination among non-Federal scientific and technical information services and organizations toward the end of developing adequate systems for the collection, organization, and dissemination of information" was assigned to the NSF. In the fulfillment of its assignment, the NSF supported the development of more-effective information-handling systems in major scientific and technical disciplines and provided for the widespread dissemination of information on federal and nonfederal information programs and activities. However, a federal agency could not fulfill, among nonfederal organizations, a role comparable to that of COSATI in relation to federal agencies. The need for a broadly representative nonfederal body to interact with private organizations and provide information on their communication requirements and capabilities was recognized and led to the creation of SATCOM in the National Academies at the request, and with the support, of the NSF. (See also Chapter 8, Sections B and C.)

It is vital that the role of the government and private organizations be mutually reinforcing. Therefore, it is important that, as a basic philosophy of management of this country's information programs, the involvement of private organizations be encouraged by the government to the maximum extent possible. Such encouragement should include government financial support as warranted. As we emphasize later in this section and in subsequent portions of this chapter (e.g., Sections B and C), there are certain situations in which we feel that the not-for-profit organizations should be the preferred instruments for fulfilling a particular objective. In other instances, the for-profit organizations should be preferred. In any event, financial support policies should be permissive and should not automatically preclude support for any group.

In recent years, a number of studies and discussions have dealt with proposed arrangements for the comprehensive planning and coordination of the complex network of scientific-and-technical-communication activities. Foremost among these studies are the ones catalyzed by the COSATI Task Group on National Systems, three of which deal with national document-handling systems,[37,46] abstracting and indexing services,[168] and scientific and technical data-handling services.[150] In these and other major planning efforts, the importance of establishing suitable forms of cooperation between the operations of private organizations and the federal government was recognized, but little consensus developed with regard to the hierarchical level and scope of responsibility assigned to private institutions. One approach entailed complete operational and policy control by a new independent government agency; another concept was that of a government-chartered private corporation, with a board of directors drawn from both the government and private organizations. This private corporation's operating activities would be supplemented by a governmental commission to establish and define policy. (See Reference 37 or Reference 46 for a detailed review of various proposed plans.) A more recent suggestion[157] involves the creation of a quasi-governmental body, an NAS-NAE office, directed by a board composed initially of COSATI and SATCOM members and funded through congressional appropriation. Possibly, the plan which has stimulated widest discussion is that of a governmental "capping" agency which would delegate responsibility for information handling in various subject areas to appropriate government agencies; the latter, in turn, could interact and cooperate with private organizations in the development and operation of needed information programs and services (see Reference 37).

At one time, the Task Group on National Systems advocated the trial operation of the latter plan in four disciplines—agriculture, chemistry, medicine, and nuclear science. This trial was to include a National Systems Planning Staff of modest size at the White House level to coordinate, monitor, and appraise the experiment. The mission-oriented information needs of the designated responsible agents were expected to give each a major stake in at least a part of its assigned area. Information programs would operate as extensions of agency programs and would include provision of services, research and development, and education for use.

The policies of the NSF represent yet another approach to the sharing of responsibility for the management of scientific and technical communication. Through incentives of support for not-for-profit bodies, the NSF attempts to stimulate major disciplines to improve and strengthen their scientific-and-technical-communication programs and thereby fulfill more effectively the information needs of these disciplines as well as those of closely allied mission-oriented endeavors. Further, the NSF facilitates the coordination of information activities through wide-scale dissemination of information about national and international information programs and projects of private and governmental organizations.*

Since we believe that our pluralistic network of information activities has many advantages and strengths, we subscribe to a philosophy of shared responsibility between the government and not-for-profit and for-profit private organizations in the management of scientific and technical communication as outlined in the following recommendation.

RECOMMENDATION A2

Effectiveness and economy demand a basic philosophy of shared responsibility between private organizations—those for profit and those not for profit—and the federal government in the management of scientific and technical information. In this sharing, the major scientific and technical communities and organizations involved in major information-handling activities should exercise leadership in improvement and management, recognizing the place of their activities as part of a national aggregate of endeavor in which the government also plays a major role. Equally, all government agencies should rely on organizations of the relevant scientific, technical, and information-handling communities for a major share in the management of the information services required by agency missions and activities.

Implementing this recommendation and establishing the proposed Joint Commission on Scientific and Technical Communication (Recommendation A1) would provide the mechanisms necessary to guide the evolution of scientific-and-technical-communication programs in balanced and flexible responsiveness to the requirements of both governmental and private institutions. But these mechanisms must be supplemented by a framework of supporting policies and principles.

Foremost among the required policies is one that clarifies and defines the relative roles of the government and the private organizations.

* Unfortunately, the NSF's very useful *Scientific Information Notes* was discontinued in the recent economy move—an untimely step backward in a crisis period for the information field.

The federal government has many reasons for starting, expanding, and supporting information programs, some of which are narrowly mission-oriented and others so broad that they cover whole fields of science. Few can be fully effective if conducted in a routine way; insight and guidance from persons skilled in relevant fields of science and technology and in the communication of information are nearly always necessary to ensure the usefulness of these programs.

In the management of information programs, scientific and technical societies, or jointly established institutions of such societies, can fulfill three conditions essential to effective operation. The first is continuity; erratic shifts of emphasis with the drift of fashion and major excursions in annual budget are controlled in the interest of the long-term unfolding of science. Second, many highly competent people, because of their lively and devoted interest in the information services so essential to the advancement of their respective disciplines, are willing to assume responsibility for the professional quality of such services and to work on a voluntary or part-time basis. This point was emphasized in a 1958 report issued by a special panel of the President's Science Advisory Committee,[14] and more recently a COSATI task group report[54] also referred to the ability of the scientific and technical societies to marshal the best efforts of their members to their publication programs. Third, when scientific and technical societies provide necessary information services, operating as they inevitably must with government assistance, their performance can be carefully monitored and assessed by the contracting agency in the best interest of the public. Substantive experts on the staff of a funding agency act as public advocates, ensuring that quality and responsiveness are intrinsic to the supported programs. When the government provides such services itself, its substantive experts frequently must function in an operating role, which may detract from or obstruct their power of deliberate review in the interest of the public.

In regard to for-profit bodies, their responsiveness to user needs and their sensitivity to the marketplace enables them in certain instances to accomplish most effectively the objectives of the government.

RECOMMENDATION A3

We recommend that, as a guiding principle, all government-sponsored scientific-and-technical-information programs directed in major part to workers outside government service, or to workers in government whose activities are similar to those outside, should be managed, in whole or in part, by the appropriate societies or institutions jointly created by such societies or by commercial organizations.

In support of this principle, we recommend, in addition, that federal agencies engaged in setting up and operating mission-oriented information programs be guided by a government-wide policy, to be developed by the Federal Council for Science and Technology, which directs the use of and, if necessary, appropriate steps to upgrade or stimulate the initiation of the privately operated basic information services which could serve as component elements in such programs.

Three obvious exceptions to this guiding principle are the national libraries (the Library of Congress, the National Library of Medicine, and the National Agricultural Library). In addition, when an appropriate society or private body does not exist, a federal agency must provide for the fulfillment of its information needs in other ways. In such cases, private for-profit organizations often can supply valuable assistance. Frequently, too, the federal agency can stimulate the organization of a society that not only will take an active part in developing services to meet mission-oriented agency needs but also will serve the emerging or evolving discipline more effectively. The establishment of the American Institute of Aeronautics and Astronautics (a merger of the American Rocket Society and the Institute of the Aerospace Sciences), which was fostered by the National Aeronautics and Space Administration (NASA), exemplifies such an effort.

The fields of aerospace and geology provide illustrative instances of shared responsibility between private organizations and the federal government in the management of major scientific-and-technical-information programs. In the former, NASA provides access to relevant worldwide technical report literature through *Scientific and Technical Aerospace Reports* (STAR), which is managed by a commercial enterprise under contract to NASA. Complementing STAR's coverage is *International Aerospace Abstracts*, operated by the American Institute of Aeronautics and Astronautics, also under contract to NASA, which covers the world's journal literature, books, and meeting papers in this field. In the case of geology and the earth sciences, the United States Geological Survey (USGS) has afforded access to the technical report and journal literature of North America, with the American Geological Institute (AGI) assuming responsibility for coverage of relevant literature from other parts of the world. Currently, the AGI has accepted responsibility for the preparation of an index (*Bibliography and Index of Geology*) that consolidates all entries assembled by the USGS and the AGI and that is issued by the Geological Society of America in cooperation with the AGI.

RECOMMENDATION A4

In consonance with the above recommendation, we call on the Federal Council for Science and Technology to extend its 1961 policy statement (NSF Press Release, NSF 61-147, October 25, 1961; Scientific Information Notes, Vol. 3, No. 5, p. 1, 1961),* *revising it to embrace as integral to the sponsorship of research and development not only the publication but also the processing of the information so generated for access, consolidation, and use in education, training, and application.*

As the size of the accumulating body of scientific and technical information and the variety of means and purposes for its communication increase, publication no longer completes the job of making the results available to the community for whose use they were acquired. The consolidation of information through critical review and evaluation, its condensation for use in announcement, awareness, and access services, and its preparation for storage in computer-managed structures providing for search, retrieval, and selective dissemination—all these are as essential to effective diffusion as is initial publication. (See also Recommendations B2, B3, C1, C2, and pertinent discussion, Sections B and C of this chapter.)

The operations of a number of federal agencies present specialized information-handling problems, the magnitude of which requires the creation of highly structured and centrally managed mission-oriented programs. Some of these agencies, such as the Atomic Energy Commission, the National Aeronautics and Space Administration, and the Public Health Service, have statutorily assigned information functions relating to their missions. Others, for example, the Department of Defense or certain agencies of the Department of Commerce, require broad and diverse information programs in support of the numerous teams and organizations with which they work. Because of their scope and the resources they command, they exert a dominant influence on the evolving patterns of scientific and technical communication. Progressively better coordination of their activities is a vital task in the performance of which COSATI deserves all possible support from governmental as well as private sources.

* The FCST policy allows budgeting and payment of page charges under federal research grants and contracts in accordance with four criteria: (a) work reported is government supported; (b) charges are levied impartially on all papers published by a journal; (c) payment is not a condition of acceptance; and (d) journals operate on a not-for-profit basis.

Of particular significance in this context are the slowly knitting, massive programs that have emerged in recent years to deal with such major social concerns as natural resources, education, transportation, pollution, and urban problems. For each of these, the role that science and technology ultimately will play still is evolving, and so, too, are the nature, scope, and structure of the information programs that will be required.

RECOMMENDATION A5

We urge that the sponsors of major programs of research, analysis, and, in particular, field experimentation in such contexts as resources management, environmental control, transportation systems development, and urban renewal consider it one of their central tasks to develop the information systems that their scope and impact require. Information-management activities should receive focused attention at a high level, assuring continuity and authority in their administration. Full use should be made of the institutions and pertinent resources in both the government and private organizations under the policies and procedures we have advocated.

The application of the policies and practices that we recommend for the effective operation of scientific and technical communication is especially important in this new range of national endeavors. The extent to which we shall ultimately succeed in marshaling the full potential of science and technology for such purposes as control of environment, husbandry of natural resources, or planned modification of the urban community pattern is difficult to foretell, but one thing is certain: This objective will not be achieved without data bases and information systems that are substantially more extensive than those that previously have supported our major scientific and engineering ventures. Information of economic, demographic, and sociological character, which in research contexts would be considered the exclusive domain of the social sciences, must now be available and used in complete integration with engineering, environmental, and geographic information.

INTERNATIONAL COOPERATION

The need for international cooperation in establishing and operating scientific-and-technical-information services already is great and will continue to grow. Knowledge has little to do with national boundaries, and as the rapid expansion of knowledge demands more extensive and diversified information services, the waste entailed when each nation provides a complete set of services for itself becomes more and more inexcusable. We in the United States should recognize that our contribution to the world's primary literature has always been only a fraction of the total, and that this fraction is decreasing as more of the world's countries achieve high productivity. The need for cooperative efforts of international scope is apparent; the only question is how best to effect such cooperation.

The four recommendations that follow result from our survey of the many and diverse endeavors to achieve international cooperation now in progress and of the difficulties they so often encounter. Such endeavors, a number of which are described in Chapter 9, comprise three broad categories:

1. Direct cooperative arrangements between information-handling programs of societies or groups in the same discipline or of equivalent mission orientation (An example of discipline-oriented cooperation is that of the Institute of Electrical and Electronics Engineers with the London-based Institution of Electrical Engineers in the production of *Electrical and Electronics Abstracts*. An example of mission-oriented cooperative activities is the development of the International Nuclear Information System in which the Atomic Energy Commission is an active participant.)
2. Cooperative stewardship of the information resulting from large international research programs, such as the International Geophysical Year
3. Internationally sponsored programs integrating the efforts of many countries in the solution of information-handling problems and the development of more-extensive information networks (An example is the Committee on Data for Science and Technology, sponsored by the International Council of Scientific Unions.)

Leadership in and support of our so-called national programs increasingly involve concomitant responsibility for the development of more-effective international scientific-and-technical-communication systems. Our recommendations emphasize this responsibility in relation to the three types of endeavors described above.

RECOMMENDATION A6

The policy making groups of our scientific and technical societies must encourage the managers of their major information services to develop *ways in which access and transfer activities can operate on a more truly international basis through sharing the work as well as the products across national boundaries.*

Of particular importance in the development of direct cooperative arrangements of international scope is the introduction of such considerations during the early stages of planning new advanced information programs and services. In every instance, maximal receptiveness to international partnership should be emphasized and suitable mechanisms of cooperation developed. Further, there is great need for the significant involvement of planners and managers of information programs in the special problems of access faced by the developing countries. Such involvement can best be achieved through direct professional contacts.

The federal government has provided guidance and strong encouragement to international arrangements effected by its various agencies through a 1968 policy statement of the Federal Council for Science and Technology,[63] which is discussed in detail in Chapter 9. The following recommendation results from our recognition of a comparable, though somewhat different, need for guidance and assistance from the federal government with regard to the international aspects of nonfederal programs.

RECOMMENDATION A7

To minimize the delays and frustrations that so often beset professional groups striving for international agreements, the appropriate agencies of the federal government should explicitly acknowledge their responsibility to encourage and, if necessary, officially assist such groups in their efforts to set up and implement international agreements for sharing the work and products of scientific-and-technical-information services. In turn, professional organizations in the private sector should inform appropriate government agencies of their international activities in scientific and technical communication, including the planning of international meetings.

The federal agencies whose assistance will most often be required are the Office of International Scientific and Technological Affairs of the Department of State, the Office of Science and Technology, and the Office of Science Information Service of the National Science Foundation. Such assistance may take a variety of forms: e.g., issuance of United States visas for visiting representatives of Eastern European information activities, encouragement of measures to facilitate the export of technical information, or provision of travel funds for American delegations.

Past international research programs sometimes have not made adequate provision for the storage and dissemination of the information they have generated, or have done so only belatedly (see Chapter 9, Section B). There should be an early effort to anticipate and identify the requirements for special information programs, to determine their scope and cost, to appraise the impact of the program output on existing informatic. activities, and to determine whether the latter are adequate for . iew demands, need modification, or should be supplemented by *ad hoc* activities. (Examples of new information activities generated by an international research program appear in the discussion of the International Geophysical Year in Chapter 9.)

RECOMMENDATION A8

We recommend that, whenever any large international research program is undertaken, the central management of the program provide, from the earliest stages of planning, a special effort addressed to the handling of the information and data pertaining to and generated by the projected research.

Programs of particular relevance to less-developed countries will require special efforts to develop ways of making newly generated information available to them in forms that will facilitate its most effective use.

Our final recommendation of this group on international communication deals with U.S. participation in information activities sponsored by international organizations.

RECOMMENDATION A9

When federal agencies participate in internationally managed information activities that touch areas of significant interest to nongovernmental organizations or services, the federal government should ensure that the U.S. delegations include knowledgeable representatives of the major groups affected.

Such action is important (a) to ensure proper regard for the legitimate concerns of nongovernmental groups and (b) to provide for maximum effectiveness, breadth of outlook, and technical expertise within the groups representing our country.

SPECIAL PROBLEM AREAS OF NATIONAL CONCERN

The implications of copyright law and practice present a number of issues and problems at the national level for the development of information systems. The statutory basis of contemporary copyright practice dates from 1909, and the law has undergone no major revisions since that time. Rapid advances in information-handling technology during recent years have brought into increasingly sharp focus the often conflicting needs to provide for the free flow of information by every possible means, to assure authors recognition and, when applicable, material returns for their effort, to protect the integrity and identity of original intellectual work, and to protect the equity of those who venture resources to assure the availability of information. Major problem areas relevant to scientific and technical communication are of three general types (see Chapter 7, Section C, for further details):

1. Questions of copyright coverage for certain types of works, such as critical or informative abstracts, computer programs, and documents resulting from federally funded research or educational programs
2. Questions related to exemptions of the use of copyrighted works for certain limited purposes; e.g., the definition and interpretation of the doctrine of fair use
3. Questions of the appropriate conditions and mechanisms for compensating copyright holders in connection with on-demand document services, computer transmission and display of information, and new machine methods of establishing and maintaining library collections

Before the development of new statutory language for use in arbitrating these various issues, SATCOM believes that thorough studies should be conducted to obtain data on and evaluate experiences in the operation of affected information services. Legislation[19] has been introduced that would establish a National Commission on New Technological Uses of Copyrighted Works (this Commission is *not* related to the Joint Commission on Scientific and Technical Communication described and discussed in Recommendation A1) to study and compile data on the reproduction and use of copyrighted works in automatic systems and by various forms of machine reproduction.

RECOMMENDATION A10

SATCOM *endorses the statutory establishment of a national commission to study and report on the impact of the new information-transfer technologies on copyright principles. At the present intermediate stage in the development of information-handling technology, only a flexible and evaluative approach can provide an adequate basis for future legislation that will best satisfy the needs for broad and rapid accessibility of infor-*

mation, maintenance of incentives, and protection of investments in copyrighted resources.

The Commission proposed in Senate Bill S.2216 would be chaired by the Librarian of Congress and composed of members who represent the Congress, authors and publishers, information users, and the general public. Following its studies and analyses of the data collected, this Commission would recommend legislative language and interpretive procedures to be incorporated into copyright law and practice. Our endorsement is of the general concept of a commission to study copyright problems; it does not cover this or any other relevant proposal in every detail.

A second major problem area pertains to standardization and convertibility. Margins of increased performance and reduced costs, affording greater opportunities for information service systems to adapt to changing conditions, can be achieved through mechanisms that foster broader utilization among information services of one another's tools and products. Efforts toward standardization typically relate to this problem area, yet outright standardization often may be inappropriate or not feasible. A broader range of alternatives is needed to minimize inadvertent incompatibilities and to avoid excessive duplication in the effort of fitting the same information into different service structures. New forms of conventions and agreements, in addition to the adoption of suitable standards, can help to reduce the seemingly arbitrary multiplicity of procedures and products of the many organizations, subsystems, and components contributing to the structuring, transfer, and use of scientific and technical information. The need for better standards and their wider use is particularly important if operators of information services are to take full advantage of modern computer-processing methods.

The principal substantive problems of standardization that affect scientific and technical communication are of concern to so many other fields that we cannot expect to exert a dominant influence, but, in efforts addressed to their resolution, it is important that the needs of scientific and technical communication receive adequate consideration. Beyond assuring this consideration, SATCOM and the proposed Commission (see Recommendation A1) should devote their best efforts to fostering developments that will enhance the compatibility and coherence of information transfer and processing in this field, such as encouraging the establishment of working groups that bring together leading activities, especially in the large-scale computer handling of scientific and technical information, for joint consideration of questions concerning compatibility of equipment, programs, and data formats.

RECOMMENDATION A11

Responsible to the Joint Commission proposed in Recommendation A1, there should be a working group charged with keeping abreast of developments in standards that pertain to the transfer and processing of scientific and technical information and with reporting to the Commission on: (a) the adequacy with which scientific-and-technical-communication activities are represented; (b) the degree to which standards activities are meeting the needs of this field; and (c) the foreseeable impact of on-going standards activities on scientific and technical communication. Other working groups also should be created and assigned to problems relevant to the handling of scientific and technical information, such as the formulation and implementation of agreements to enhance software compatibility among organizations in the field.

Such working groups should have representatives from appropriate organizations in both the government and private institutions—the network of private, university, and national libraries, major government-agency information programs, leading university programs, the principal abstracting and indexing services, and commercial information enterprises.

In its concern with information transfer, scientific and technical communication overlaps the over-all domain of communication where problems of equipment ar l procedural compatibility involving such technical matters as byte size, character set, or transmission rate and mode are receiving the systematic attention of established standards organizations. However, the problems of securing interchangeability of certain widely applicable computer programs and of many files of substantive information have only recently become the targets of comparable efforts. A recent and encouraging development in this area was the formation of the Joint Agreement Group (JAG) in mid-1968 (see Chapter 5, Section B) to foster agreement on definitions of data elements, structure for tapes, and specifications for tape formats.

The task of fostering interchangeability requires accomplishments ranging from a common file description language to the coordinated planning and design of system programs to make the various information-processing systems compatible with one another. The working group proposed in Recommendation A11 should use the year 1973 as its target date for accomplishing such interchangeability on a significant scale.

B. CONSOLIDATION AND REPROCESSING—SERVICES FOR THE USER

The history of scientific communication, as seen by the user, is one of repeated innovation, with ever newer mechanisms connecting him to a rapidly growing body of information. About three centuries ago the progress of science became so rapid that waiting for the writing of books was impractical, and the scientific journal emerged as a new mechanism for announcing current advances. Some 150 years ago, the abstract journal came into existence to meet the need for access to a rapidly growing journal literature. And today the facility of the modern computer in selecting and sorting offers the possibility of another major step in assisting users to acquire needed answers and insights.

If we could afford it, we would give each worker his own hand-tailored information system, which would best accelerate the progress of all who use science and technology. The special features of these individualized systems would be most apparent in those media in which a user seeks first for facts, ideas, and suggestions:

1. Consolidations of accumulated knowledge (articles reviewing research progress in specific fields, critical compilations of numerical data, state-of-the-art articles in the literature of practice, and the like)
2. Handbooks
3. Abstracting and indexing services
4. Library catalogs

The time when we can afford to supply hand-tailored access for an individual or a very small group is not yet in sight; what is done about this will depend on the efforts of the individual or small group concerned. What can be done for groups of reasonable size—a thousand or so—is a very different matter. It is both feasible and necessary to hand-tailor access to information for what we shall call "need groups." Because science and technology cannot make progress when completely fragmented any more than they can without rather detailed specialization, a need group cannot be an isolatable set of people. In the field of heat transfer, for example, we find one or two thousand people deeply involved in it on a continuing basis. Yet many others in related fields will have less frequent but similar needs for access to heat-transfer information and will belong from time to time to this "heat-transfer need group."

The information service that supports such need groups occurs at a level beyond primary (initial publication) and secondary (basic abstracting and indexing) communications; therefore, we shall call these specialized need-group services "third-level services" and refer to them as such in subsequent portions of this chapter. The emergence of the third-level need-group service is an inevitable consequence of the rapid growth of knowledge, and, in its emphasis on "how to find" rather than on "what is known," it closely parallels the shift that has necessarily occurred in scientific education.

How then do matters stand with each of the major component services toward which a user is likely to turn? Scholarly consolidations of current advances—articles reviewing research progress—almost by necessity cover fields of limited scope; often they are of immediate and continuing interest to far less than a thousand people (see Chapter 6, Section A). However, since science and technology are not and cannot be tightly compartmented, and since each worker, no matter how specialized, must occasionally have access to knowledge in broader areas, the number who eventually make use of such consolidations is much larger.

Of broader appeal are the survey articles that account for a sizable fraction of the material commercially published by the technical press. These articles typically employ less-technical language and are more superficial in treatment than the scholarly reviews and tend to be strongly practice-oriented. As a result, they command a wide market, which suggests their usefulness in facilitating the transfer and application of scientific information.

Critical collections of data (Chapter 6, Section A) have passed through a dark age, but during the last few years the necessity of making them less comprehensive, of hand-tailoring them for special-interest areas of reasonable size to facilitate their use, has gained broader acceptance.

Handbooks typically have attempted to cover whole disciplines. Today, there is growing difficulty in adequately covering entire disciplines as well as an increasing need to supplement such compendia with smaller reference sources more nearly hand-tailored to specific requirements.

Abstracting and indexing services play an irreplaceable part in the use of scientific and technical information (see also Section C of this chapter). These services developed in relation to broad disciplines, such as chemistry or biology, and tended to cover only the scholarly journals, a trend that recently has been followed by a proliferation of more-specialized services or by major efforts among the traditional services. Some degree of coverage is now provided in some disciplines (e.g., chemistry) for the wide variety of practice-oriented literature, especially patents and trade publications. The resulting general growth has brought apparent disorder and difficulty, which we are beginning to recognize as the early stage of a major step in hand-tailoring information access for our need groups. Rather than less of such growth, we must expect more, both in numbers and in diversity, for the time has come when we badly need and are able to separate in our thinking and planning: (a) the basic abstracting and indexing function, in which abstracts are obtained, assembled, and indexed (often in great depth); and (b) the reprocessing function, in which these collected abstracts are made available to need groups in a number of diverse ways. The latter function may be as simple as sorting out the abstracts associated with part of the field covered by a basic service, though even here pressures for modified emphasis in the abstract and different schemes of organization and indexing are great. At an intermediate level, it might be necessary to combine abstracts from a number of basic services; heat transfer, again a natural example, would require information from mathematics, physics, chemistry, aerodynamics, and astronomy. At a deeper level—one not yet attained—reprocessing might include a steady accumulation of comments, observed relationships, and modified descriptions through which the active members of a need group could keep their information in a much more nearly consolidated state. *For the near future, stimulating and expanding reprocessing is the single most important thrust in making scientific and technical information effective for those who use it.*

Library catalogs until recently have shown little evidence of hand-tailoring. Current emphasis on special catalogs in book format and the initiation of research directed toward effecting a better match of card catalog information with user needs and research patterns [111] are encouraging signs. But here, too, greater effort is necessary.

CONSOLIDATION

A singularly pervasive conclusion in regard to scientific and technical communication is that the functions performed by critical reviews and compilations—digesting, consolidating, simplifying, and repackaging for specific categories of users—are essential if information is to be used effectively. Such endeavors, though necessary for research-front scientists, are of particular importance to engineers and other practice-oriented users concerned with applying contemporary knowledge to the provision of better goods and services.

The broad range of requirements for critical reviews and data compilations includes not only the need for periodic syntheses and compilations of the accumulated literature in particular scientific and technical fields but also the need to record systematically the results of research-and-development programs that generate new technologies, often without an accompanying body of published literature (e.g., research and development aimed at the construction of prototype hardware and sponsored by mission-oriented agencies of the federal government, such as the Department of Defense, the Atomic Energy Commission, and the National Aeronautics and Space Administration). In engineering, periodic syntheses of progress are accomplished largely through articles in technical journals published for private profit. Such articles typically are easy to read and of limited scope. Representing another level of consolidation are a wide variety of series of "Annual Reviews of . . ." or "Advances in . . .," in which strict delineation of the time interval to be covered necessarily prevents deep synthesis. Least often encountered but among the most useful forms of consolidation are critical and evaluative reviews that relate and clarify findings and their implications within a given field or establish relationships between fields (see Chapter 6, Section A).

RECOMMENDATION B1

Scientific and technical societies must develop, propose, and assist in implementing new and better ways to identify needs for critical reviews and data compilations and to further efficient preparation of them. They should also give greater emphasis to fostering awareness of the existence of such reviews among potential users and stimulating education in their use.

Individual experts might be mobilized for reviews of particular disciplines, teams of experts could serve in larger areas, and systematic use should be made of the numerous information-analysis centers now in operation (see Chapter 6, Section B). Fiscal support and prestige must provide the incentives: Coveted fellowships, possibly combined with arrangements under which royalties from published work accrue to the author(s), might help to increase to a more nearly adequate level the fraction of their time that scientists, engineers, and practitioners would dedicate to this purpose. Additionally, assistance with the location and excerpting of references, numerical calculations, the preparation of graphs, and other mechanical tasks in the editing of manuscripts should be provided.

RECOMMENDATION B2

Supporters of research and development should recognize their responsibility to provide for the preparation of critical reviews and data compila-

tions. In most cases, this effort will involve the investment of a larger fraction of their resources in this activity than heretofore.

In addition, sponsors must recognize their more specific responsibilities for consolidation.

RECOMMENDATION B3

Sponsors of major programs of research and engineering experimentation, such as those agencies of the federal government so engaged, must recognize, as a matter of principle, that each such program has as a part of its task the critical filtering, reviewing, and consolidating of the publications that it engenders and recording in a systematic manner the new technologies that result from it. It is mandatory that each major program be evaluated to determine the level of synthesis and condensation of the accumulating primary literature that is required. Appropriate steps should be taken to carry out any indicated critical surveys.

The conduct of such critical reviews and consolidations on a continuing basis should be supported through the allocation of funds that, as a matter of policy, would be related to the total support assigned to research and experimentation. In certain instances, the preparation of such reviews could be an explicit contractual requirement for large-scale, long-term projects. Additionally, special opportunities for appraisal and consolidation occur when a major regrouping of our country's scientific and technical resources is necessary. The end of World War II provided such an opportunity and stimulated the preparation of such reports as the Radiation Laboratory Series, which summarized advances in electronic engineering during the war years. When our involvement in Vietnam draws to a close, the military agencies should consider the preparation of similarly comprehensive surveys, which will critically review what has accumulated in the way of classified or inadequately reported information and make it generally available, if and when this can be done safely and usefully.

The problem of access to reviews is critical and merits serious attention (see Chapter 6, Section A, for a description of this problem).

RECOMMENDATION B4

The Commission should determine what steps, such as a greater assembly of reviews into series or the development of indexes and guides, should *be taken to foster easier and more-effective access to the reviews appropriate to a user's specific need.*

NEED-GROUP SERVICES

The scientific and technical societies, like so many of our political and social institutions, face increasing feelings of alienation among a growing number of their members. Together with significant pressures toward one large unified society serving all scientists and technologists in each discipline, the feeling is already rife in some disciplines that societies have become too large and distant to be effective. Though it is too early to predict the results of these diverse pressures, one possibility deserves attention. Since scientific and technical communication is the central purpose of the societies, a change in the user's view of such communication could influence the organization of these societies. Possibly, a two-level structure, attained in very different ways in different disciplines, will develop: Small societies, and divisions, professional groups, and committees of larger ones, may exist in large measure to serve need groups, while large societies and federations of smaller ones would carry out tasks, such as basic abstracting and indexing, that require greater size and scope to make them effective.

If the information requirements that define need groups are to be met, both formal and informal organizations must participate in meeting them. The problems of doing this change radically as we move from research through development to practice. Active researchers typically participate effectively in organizations and interact with those working on similar problems. Workers involved in development form a transitional group. Those engaged in practice are least accustomed to such organizational participation and interaction; consequently, the problems of meeting their needs are greater and more puzzling. In the recent report of the Committee on Science and Public Policy (COSPUP) of the National Academy of Sciences, *Applied Science and Technological Progress*,[11] Harvey Brooks describes the information problem of the practice-oriented scientist or technologist as follows:

". . . the scientists in a given area of work are much less likely to know each other or each other's work in applied science than in basic science. This is partly because of the fact that in technology the method of communication is much more by personal contact than by literature. Documentation, especially public documentation, of new ideas, is given much less attention by technologists than by scientists. In tracing the history of innovation, one is struck by the frequency of reinvention of ideas by different groups without knowledge of each other's work."

This finding suggests that the scientific traditions of public documentation should be extended as far as possible into the literature on applications of science—and that the extension will not be easy.

A matter requiring special attention is the practical application of information used primarily by engineers, agriculturalists, physicians, and other practitioners and less frequently or importantly by research scientists. Information programs designed to meet these needs must be fairly specific and, therefore, often are small and numerous. Many that can be lucratively operated are run by commercial groups, but a number of requirements have not been met. Additionally, industrial concerns often provide practice-oriented information programs to meet their own needs (Chapter 6, Section C).

In attempting to fulfill the needs relevant to the practical application of information, we must remember that much of this kind of information resides in the research literature as well as in various technical publications and patents. Another body of useful information that is less accessible is produced by commercial concerns. Convenient access to and reprocessing and repackaging of these various kinds of technical information are sorely needed.

RECOMMENDATION B5

Each society or association, the membership of which includes many persons concerned with practice, especially in engineering, medicine, and agriculture, should increase substantially its attention to information programs that will:

1. Ensure that access, awareness, and appraisal services comparable to those supplied for the body of research literature are provided also for publications of particular interest to the practitioner, such as textbooks, monographs, handbooks, manuals, patents, trade journal publications, company reports, catalogs, specifications, and standards

2. Stimulate the production of critical reviews and surveys of contemporary fields of knowledge, the condensation being focused on particular domains of application of interest to the practitioner and adapted to his needs

3. Identify types of data banks, including diverse types such as Sweet's Catalog, the Chemical Compound Registry (of Chemical Abstracts Service), and the Thermophysical Properties Research Center at Purdue, which need to be established in a field; establish or foster the creation of required data banks; and provide an indexed inventory for existing ones that describes coverage and conditions of access

4. Meet the needs resulting from requirements of continued education to keep practitioners in its field up to date

Since many of the services enumerated in this recommendation traditionally have been handled by for-profit organizations, scientific and technical societies should take the initiative in encouraging these organizations to undertake them. In instances in which it is clear that such services will not be available from for-profit organizations, then societies should undertake them directly.

Many of the smaller need groups, with the exception of those served by small societies, feel particularly the lack of specialized services. We need to create organizational structures that will foster the initiation and development of services for such groups.

RECOMMENDATION B6

Each larger scientific or technical society or association should assist and encourage its natural subdisciplinary groups to organize for and initiate the conduct of appropriate need-group services.

Leadership in obtaining specialized services and in the management of repackaging, updating, and annotating current bibliographic files and their associated literature very frequently will have to rest with subdisciplinary groups. In engineering, for example, estimates suggest 200 such groups, with varying degrees of overlap, whose efforts, if mobilized toward these ends, could greatly enhance the development and provision of such services.

A salient point with regard to need-group services is that information must be transferred in usable form, which is not the same as simply disseminating documents. The information must be recast into the language of the professional community through such media as brochures, specifications, performance and characteristics compilations, standards, and handbooks. Often, it also must be conveyed personally if effective transfer is to take place (see Chapter 4, Section A). And here the traditions and institutions of the individual professions must determine the most suitable arrangements.

In agriculture, for example, the information activities of the Department of Agriculture, centered on the National Agricultural Library, work closely with the Extension Service and the County Agents System to reach the researcher, business manager, and individual farmer, each in his own terms. In engineering, the State Technical Services Program,[159] recently established by the Department of Commerce, explores ways and means of filling a major gap (see Chapter 6, Section C); others remain unattended.

In medicine, there are several ways in which a highly motivated practitioner may get the information he needs to keep up with advances and to assist him in meeting specific problems of diagnosis, treatment, prognosis, and technique. Special journals, books, manuals, and brochures addressed to his needs exist; nor have medical libraries overlooked his needs. Hospitals, through their various conferences and professional meetings, serve as focal points for continuing education, and medical schools and professional organizations offer postgraduate courses. A program that serves the purpose of education is the Self-Assessment Test for Physicians, sponsored by the American College of Physicians, now available to all physicians. However, most of the recasting of information for the general practitioner use still is left to commercial organizations, and most of the personal dissemination, to the detail men of pharmaceutical firms. We suggest a re-evaluation of physicians' information needs in this period of technological advance to take better advantage of modern techniques of information handling.

Especially in areas of development and practice, third-level information systems (i.e., specialized services beyond the primary and secondary levels) pose many detailed problems for which we have no answers. It is far easier to say what such an information system ought to do than to say how to do it. Once more, as an illustration, we consider a group of specialists in heat transfer, the ASME-AIChE* Heat Transfer Committee, which holds annual technical meetings. The generation of an information file that would serve the members of this group would enhance the transfer and application of information from disciplines such as physics, chemistry, aerodynamics, and astronomy. Further, it would greatly assist those just beginning work in this specialized area. Abstracts and bibliographic aids to past literature, including reports and current catalogs of equipment, would be compiled, annotated, organized, and maintained by a group of interested and competent individuals from the Heat Transfer Committee. The structure of the file, definition of terms, and selection of peripheral subjects could be made jointly by practitioners expert in the field covered and experts in system design and use. Once established, such a system would be continually and iteratively updated through the use of field profiles filed with the discipline-oriented secondary services and through continuing interaction and annotation by the individuals who use the system. Thus, the information system on heat transfer could be developed to serve 2,000 to 3,000 individuals.

Only through the provision of such service will the individual be able to cope with the ever-growing body of knowledge and use the new technologies effectively. The breadth of activity within a field, from practice

* American Society of Mechanical Engineers and American Institute of Chemical Engineers.

to pure research—in universities, industry, or government—depends upon having the entire range of information in it available to the student and neophyte as well as to the active professional long identified with it. (See Chapter 6, Section D, for a more detailed discussion of the scope and potential of need-group services.)

Learning how to operate such services most effectively will require the best efforts of all concerned, as will the relatively difficult task of communicating one group's experiences to the many other parallel groups.

RECOMMENDATION B7

While need-group information services eventually should be supported through their users, experimental and developmental stages will require funds. A wide variety of sponsors, including private foundations, the NSF, and mission-oriented government agencies, should provide support for these early stages.

RECOMMENDATION B8

As experience in the operation of need-group information services develops, a suitable organization, perhaps the American Society for Information Science, should seek support as required from private and government sources for a program that, through publications, workshops, and meetings, will advance know-how and general understanding of the design and operation of such services.*

The vital importance of developments in this area for scientific and technical communication during the next decade or two cannot be overemphasized. They present difficult new problems that undoubtedly will be with us for some time to come (see Chapter 6, Sections C, D, and E).

RECOMMENDATION B9

The Commission (proposed in Recommendation A1) should aid in the growth of appropriate need-group information services. It will need to do this in a variety of ways.

STIMULATION OF REPROCESSING

In developing information services for need groups we must be careful to separate a near future in the next decade, using tested tools, from a

* Formerly the American Documentation Institute.

more distant future when still newer tools would provide even more effective services. Today we can: (a) sort out abstracts, especially if available in machine-readable form; (b) rearrange and merge selected abstracts; and (c) reproduce copies of the results in readable form, either on paper or in microform. The early information services for need groups will have to take such an approach for both technological and economic reasons. Consequently, immediate attention should be given to making abstracts and associated indexing information readily available for reprocessing, which, in turn, requires special attention to low cost and machine readability.

In the far future, so attractive yet so dotted with technological and economic question marks, this paper or film approach would be replaced by conversational, on-line access to computer-mediated files. The possibilities of on-going file modification alone (see Recommendation E6 and associated discussion in the final section of this chapter) are extremely attractive. As the motivation to seek out and use available information continues to increase, work habits and patterns of acquiring information will change and lead to still greater modifications and further advances.

The immediate task in expanding the implementation of need-group information services is to stimulate the reprocessing of abstracts and associated indexing information prepared by the basic abstracting and indexing services. The most effective way to do so would be to restructure the support of abstracting services, providing sufficient funds from the sponsors of research—governmental or nongovernmental—to nearly cover the input costs of the basic services. If this were done, these services could make their abstracts (and index entries) available for reprocessing at output costs (actual runoff costs or the nearest equivalent thereto) without endangering their solvency (see Section C of this chapter; Chapter 5, Section C; and Chapter 6, Section D). It is important to move toward such a situation, but it would be unrealistic to ignore the major barriers that stand in the way, not the least of which is the development of feasible international agreements and arrangements.

RECOMMENDATION B10

Those societies and agencies concerned with the conduct and support of abstracting services should seek actively to identify difficulties, find solutions, and take the initiative in proposing and testing arrangements through which an increasing contribution by the sponsors of research to the input costs of the basic abstracting services can make transfer for reprocessing financially possible at approximately output costs.

In the interim, the responsibility not only to encourage but to make real a diversified and healthy growth of reprocessing must rest on those organizations now conducting the basic abstracting services.

RECOMMENDATION B11

Each basic abstracting service must take active responsibility, as part of its obligation to science, for the launching of diverse and useful reprocessing efforts and for helping to ensure, by the provision of information and education, effective use of the resulting products.

As the situation evolves toward adequate author–referee–editor abstracting and more nearly adequate sponsor-of-research support for input costs, the opportunities for assuming responsibility in reprocessing will spread.

RECOMMENDATION B12

Not only major societies and federations of societies, but smaller societies and divisions within larger ones, should begin now to prepare for the day when provision for adequate broadly used reprocessing of access information is one of their major responsibilities, both to their members and to the future of the fields of science and technology they represent. The aid of commercial services should be actively sought for the fullest development of useful information reprocessing.

Access to Basic Services

Need-group information services, even those based on simple reprocessing of abstracts and associated indexing information, will not spring into being at once. For a long time many workers will have to rely on the basic services, while all workers probably will do so when seeking information outside their areas of specialization.

Indexing and abstracting services have developed in a wide variety of patterns. The *Guide to the World's Indexing and Abstracting Services in Science and Technology* lists over 1,800 such services, but it is of limited value to the seeker who wishes to find either a service available in his library system that covers his area of search reasonably well or a collection of services that will give him almost exhaustive coverage. Frequently, all that keeps the user from complete bewilderment is his ignorance of what is available. We badly need a tool, or tools, that will provide guidance to users of diverse backgrounds and with varying requirements for completeness of coverage.

A well-structured index to the indexing and abstracting services, possibly incorporating a classification scheme, could be valuable. Similarly, subject entries in library catalogs might play an important role in guiding users to the most appropriate secondary services. This whole area deserves careful attention, initially in a working conference, later through the development of tools and techniques. Research may be required as an intermediate step.

RECOMMENDATION B13

The National Federation of Science Abstracting and Indexing Services and an appropriate library group or groups, perhaps the Association of Research Libraries, should organize jointly—if necessary with support from the Council of Library Resources and/or the NSF—a working conference with broad participation for the purpose of exploring means of facilitating the guidance of all library users in their choice of the indexing and abstracting services appropriate to specific information searches.

Information Analysis Centers

A potentially useful tool for the transfer of scientific and technical information exists in the information analysis centers (Chapter 6, Section B). Such centers, usually serving specific fields in which large amounts of data exist and require critical evaluation, consist of one or more active specialists who (a) systematically collect, index, and store information in a field; (b) analyze and evaluate this information; and (c) make it available in a form and language keyed to the needs of specific groups of users. Over 100 such centers are sponsored by the federal government, usually in connection with mission-oriented programs; a number of others operate under private or local sponsorship. The larger centers are capable of preparing critical reviews of topics in their areas of operation or of assisting the preparation of reviews by specialists from other institutions. The potential benefits of expanding the number and scope of information analysis centers were emphasized in the 1963 report of the President's Science Advisory Committee [170]: "Ultimately we believe the specialized center will become the accepted retailer of information." While present experience seems to limit the intellectual and economic viability of such centers to certain rather specific fields, it is clear that their potential is still far from fully exploited. The pricing of services provided by the centers requires careful consideration to ensure both economic viability and wide use.

RECOMMENDATION B14

The Commission (proposed in Recommendation A1) should assist in the identification of major information analysis centers that are operating in particular subject areas and have the capability of offering services fulfilling need-group requirements in these areas. Further, the Commission should stimulate and aid in the exploration of ways in which such services can be made more widely available.

MANAGEMENT CONSIDERATIONS

Certain problems of management arise in relation to all forms of scientific and technical communication—initial publication, basic abstracting and indexing, and need-group services. We discuss them in this section of the report because their importance increases as the services involved become more specialized and user-oriented.

RECOMMENDATION B15

All agencies which either operate or sponsor the operation of major scientific-and-technical-information programs should take steps to incorporate into their services on a continuous and systematic basis some appropriate method of performance evaluation. Provision should be made for using such evaluation measurements as a basis for modification and improvement of the services.

Most present information systems, particularly libraries, suffer from inadequate feedback mechanisms. Typically, they lack a sufficient degree of "statistical quality control." The usual measures of economic viability often are inapplicable because of the lack of any visible relationship between the cost of providing a service and the price paid by a user. In most cases, however, implementation of reasonable and practical measures of quality control, usually based on sampling the end product or services offered, need not await further research in order to provide useful results. Information services operated by for-profit organizations typically are highly sensitive to users' needs and employ effective methods for marketing their products and services. Feedback controls and market sensitivities should be employed more widely by the not-for-profit information services.

In a number of disciplines, responsible staff members of information services operated by societies maintain a booth at the national meetings of these societies to discuss problems with users. Staff members also hold open forums to discuss or explain new services and solicit constructive criticism of their products and services. Most information services have advisory boards of expert consultants and also hire professional groups to make periodic user studies and surveys. Additionally, members of the operating staffs meet regularly to discuss methods for improving their information services. Many other methods are used, and should be; obtaining critical feedback and keeping services tuned to user needs is a continuous process, and its importance cannot be overemphasized.

Each formal link in the information-transfer process must function effectively and convey information to the next link to assure efficient communication; therefore, prospective users must be made aware of the existence of the component information products and services if the process is to operate smoothly and usefully. Fostering such awareness is the marketing function. No matter how good information is, the advantages of having created it are lost or greatly reduced unless this marketing function receives sufficient attention.

RECOMMENDATION B16

It should be recognized that one of the legitimate and vital aspects of the process of creating and disseminating information is marketing the output; therefore, organizations that are involved in developing and disseminating information products should use the most effective and appropriate marketing techniques available.

Basic policies for handling the dissemination of scientific and technical information, particularly in the relevant societies, usually are formulated by members of the scientific and technical community who, for the most part, have rejected the view that information must be marketed. The general belief is that, if the information is valuable, the people for whom it is intended will find it. In fact, there is little basis for such a belief.

In the commercial publishing world one obvious test of the success of any information product is black ink on the profit-and-loss statement. The size of the profit very frequently is directly proportional to the ingenuity and intensity of the marketing effort, which typically is part of an over-all plan developed prior to the actual creation of an information product, with an appreciable part of the publishing budget assigned to it, perhaps 20 percent to 30 percent of the anticipated revenues. The marketing effort also involves a coordinated program of publicity in the form of advertising and direct mail and, where the anticipated revenue is sufficiently large, a sales staff.

Two categories of information responsibility may well emerge—wholesaling and retailing. And these two functions may be handled by two different kinds of organizations, according to their capabilities. For example, scientific and technical societies and federal information services might focus their efforts on wholesaling information, while subdisciplinary groups and, wherever appropriate, commercial organizations might handle the retailing function.

C. THE CLASSICAL SERVICES

The consolidation and reprocessing activities strongly advocated in the preceding section depend on and originate in the classical information services, which include:

1. Basic abstracting and indexing services
2. Selection, acquisition, bibliographic control, reference, housing, document delivery, and other service functions of libraries
3. Formal and semiformal publication of scientific information (in monographs, journal articles, patents, reports, and the like)
4. Informal information-exchange functions of meetings

The operation, funding, and improvement of these basic services pose a number of problems for the effective communication of scientific and technical information.

Basic Abstracting and Indexing Services

The rapid expansion of research and development during the postwar decades led to uncoordinated growth in the number and variety of media and techniques providing awareness of and access to the primary scientific and technical literature. Consequently, the basic abstracting and indexing services present a complex and confusing picture. They urgently require a clearer rationale of operation and sounder funding arrangements.

In contrast to primary communication, there is no mechanism through which resources available for the operation of secondary information services are coupled directly to over-all expenditures on science and technology (see Chapter 5, Section C). In an effort to effect such a coupling, the American Institute of Physics recently experimented with extending the page-charge policy to include partial support for abstracting and indexing; this was accomplished by levying a $10 charge per article in addition to page charges (Chapter 4, Section E). As yet, however, no widely accepted or generally feasible plan has emerged, and no comprehensive policy with regard to funding has been established.

The ready suggestion of letting this mechanism be supplied by the forces of the marketplace ignores the highly anomalous supply and demand economics of information services. For many of the present systems, there are no options of "extra service for extra price," while others are operated by the government in the fulfillment of statutorily assigned missions, with access provided, if at all, either as a privilege at no charge or at a nominal price. In regard to demand, the mounting costs, especially of the major abstracting and indexing services, have all but driven out the individual subscribers and are beginning to make inroads on the smaller institutional subscribers.

The impediments to the establishment of a *bona fide* marketplace for secondary information services have contributed to expanding the direct operation of such services by the government. In view of the general mission orientation of the government, the scientific and technical community perceives this trend as potentially jeopardizing the community's control of discipline-oriented services and gearing what should be a long-term, stable, and orderly evolution to the vagaries of federal budgets.

In part, the difficulty in developing satisfactory mechanisms for federal support of basic abstracting and indexing services may result from some of the inherent differences between primary and secondary communications. Ideally, efficient production of abstracts should be done but once—at least for a single broad field of coverage and a single language of abstracting—and the author should have no choice as to the basic abstracting journal that will cover a particular paper. Research is under way to determine the extent to which abstracts prepared by different services are equivalent with respect to their representational capacity, and data giving some indication of the adequacy of abstracts prepared under one orientation for persons of other orientations should be available soon. A second difference is that while U.S. primary publications need cover only this country's research (though it may benefit our country to do somewhat more), abstracting in English must cover the worldwide literature in one unit if it is to serve the United States effectively.

In seeking new ways to support abstracting and indexing services and to improve existing support mechanisms, special care is required to ensure the broad usefulness of the product and maximum responsiveness to the progress of science and technology. Two issues are of major importance in this context:

1. Sensitivity of management, particularly in regard to scope of coverage and adequacy of abstracting and indexing
2. Availability of abstracts for purposes of reprocessing and repackaging

Sensitivity of management depends largely on who manages. Private for-profit organizations are most sensitive to the felt wants of users as reflected in willingness to subscribe; however, they probably would give less attention to the progress of the science as a whole and preparation for progress in the future than would scientific and technical societies (or federations of these societies) to whom such considerations are of major importance. These societies also are sensitive to the felt wants of users, although usually less so than the private, for-profit publishers. As a result, we have concluded (see Recommendations A3 and A4 of this chapter) that both short- and long-term interests will be served best if the basic preparation and assembly of abstracts is significantly supported by federal grants, but managed, in the case of discipline-wide services covering broad fields of science and technology, by an appropriate society or federation of societies. However, there may be instances in which for-profit publishers are the desired managers of an abstracting service. Such possibilities should be compatible with the enunciation of federal support policies.

Mechanisms of federal support should be such that they make reprocessing and repackaging of abstracts easy and frequent. The need for collections of abstracts selected to meet the requirements of specialized groups daily becomes more critical and so, also, does the need for collections of abstracts that cut across two, three, or several broad fields of science. The scope of such boundary-crossing needs varies from technological fields of modest size, such as heat transfer (which involves mathematics, physics, chemistry, astronomy, and several branches of engineering), to nuclear science or biomedicine. Many fields need much more effective abstract coverage by selection, which can be obtained economically only by repackaging. The duality between mission- and discipline-oriented services, emphasized in the Weinberg Report,[110] is a major reason for the increasing need for reprocessing and repackaging; increasing specialization, in both missions and disciplines, is equally important.

The tasks of abstracting and indexing are of vital importance in assuring that all important information contained in original manuscripts enters the information-transfer system and in serving as a foundation for the generation of specialized services. The distinctive characteristics of these basic functions are threefold. First, the production of new abstracts and the correction and completion of old ones are still demanding and challenging intellectual tasks, although the use of author–referee–editor-produced abstracts is increasing and eventually may become the source of virtually all abstracts. Second, indexing in depth, as practiced by the best abstracting services, requires qualified personnel with expertise and insight in the fields relevant to the processed information—not only for the indexing of individual abstracts but for the reshaping of index structures in accordance with the growth and internal restructuring of the fields concerned. Major abstracting efforts often spend as much on indexing as on abstracting; however, the prestige and remuneration associated with this task generally are not commensurate with the key role it plays in scientific-and-technical-communication services. Third, abstracting and indexing can be handled best in no larger units than such broad fields as chemistry or aerospace, principally because of the structure of science and technology and the intellectual demands inherent in the tasks of abstracting and indexing. On the other hand, difficulties with gaps and duplication increase rapidly if the scope of coverage of individual services becomes too narrow.

The basic discipline-wide access services are not the only ones that we have today or will need badly tomorrow. Title listings (some with indexing of moderate depth) and citation indexes are samples of other very useful access services. Such services differ in nature and scope from basic abstracting and indexing and need not be managed in the same way. Private for-profit organizations, with their sensitivities to user needs, and the national libraries, with their responsibilities and ties to the library world, do and should continue to play important roles in developing and providing them.

RECOMMENDATION C1

The departments and agencies of the federal government should fund the literature-access services that are needed for the effective utilization of the knowledge resulting from the research and technical activities that they sponsor. In doing so, they should ensure, to the greatest practical degree:

1. Management of basic discipline-wide abstracting and indexing by the appropriate scientific and technical societies or federations thereof, though the use of for-profit services in special cases should not be precluded

2. Management of other broad bibliographic services (e.g., title listings or citation indexes) by private for-profit organizations, national libraries, or societies

The conduct of major access activities within the federal government, the national libraries aside, should be regarded as a transient phenomenon, provided adequate nongovernmental capabilities can be developed.

RECOMMENDATION C2

The scientific and technical societies should play their responsible part in the basic abstracting process, forming federations where appropriate, learning to increase timeliness where necessary, and treating reprocessing and repackaging of their material by others as normal and desirable. (See also Recommendation B10.)

The use of primary literature inevitably will be mediated to an increasing extent by secondary information concerning the content and relevance of the accumulating documents; therefore, it is important to facilitate the prompt and cogent entry of primary information into the basic secondary service structures.

RECOMMENDATION C3

Editors of primary publications should make it a general policy that each item submitted for publication be accompanied by an author-prepared documentation unit, which will undergo editorial and referee review to ensure its adequacy.

The trend in scientific-and-technical-information programs is toward increasing integration of primary and secondary services, with the objective of publishing and offering for subscription both primary documents and appropriate secondary information about them—all produced and disseminated by a series of efficiently coordinated operations. The purpose of our recommendation is to further this trend. The required documentation unit should include bibliographic data, aids for recovering index terms and primary data, and an abstract.

Implementation of this recommendation will present difficulties, such as obtaining uniform observance and cooperation and learning to cope with the diverse sources that feed into major services. Special problems involve:

1. Publications on the border of the professional literature and foreign sources of input to the major abstracting and indexing services. Though the inclusion of the former is important, there may be practical obstacles and no particular motivation to achieve cooperation.

2. Economics. How will the costs incurred in preparing and editing such documentation units be covered? What rules of equity shall govern their use if the publications of which they are a part are copyrighted? What should the attitude be in regard to the formation of service organizations to undertake the preparation of documentation units for smaller journals?

3. The relative efficiency of documentation specialists as compared with subject specialists in preparing documentation units. The most difficult and important aspects of preparation are to ensure that the documentation unit adequately represents the content of the parent document and that it is error-free.

In order to enhance the usefulness and uniformity of the documentation units prepared as part of primary publications, editors of journals published by organizations that neither operate nor are directly affiliated with the operation of a secondary information service program should be provided with the assistance, as required, of an associate with access-service expertise who can establish the policy and monitor the practice of documentation-unit preparation at the source.

RECOMMENDATION C4

The National Federation of Science Abstracting and Indexing Services should seek support for the development and promulgation of guidelines to be followed by editors and publishers of primary information in specifying the required documentation units.

National organizations, such as the Engineers Joint Council and the American Institute of Physics, as well as the Abstracting Board of the International Council of Scientific Unions, have promulgated guidelines for the preparation of documentation units; however, their lack of uniformity has limited their voluntary adoption. By eliminating some of the more obvious and frequent incompatibilities, the recommended guidelines should remove a major obstacle to the acceptance of the documentation-unit concept. Further, the National Federation of Science Abstracting and Indexing Services should enlist the cooperation of experienced editors and the principal editors' councils in this endeavor as a step toward increasing broad acceptance.

Because a multiplicity of basic services will want to employ such documentation units, many comparisons among the leading information programs and their potential standardizations will be necessary. In Section B of this chapter, we advocate certain studies of machine indexing and standardization in the secondary information field to meet this need.

Library Functions

The role of libraries, particularly research libraries and special libraries, is central in the process of communicating scientific and technical information. The great research libraries store and make accessible primary scientific and technical journals as well as secondary publications (abstracts and indexes that constitute the means of finding articles according to author, title, or subject), and even guides to these secondary services. They maintain bibliographic control, custody, and a delivery system for enormous collections of monographs and journals and provide a rich variety of reference books and services. They act in many respects as nodes in a switching network that makes available information from other sources (see Chapter 6, Section B). Through many thousands of special libraries in various types of corporations and institutions, a multiplicity of highly specialized mission-oriented services are provided. Though the role that libraries play is crucial, the tradition of informal person-to-person communication as a way of keeping up with what is taking place in a scientific specialty is strong, and very often the services of libraries are bypassed through unwillingness to put up with slower and more cumbersome procedures or through ignorance of their availability.

As the backlog of knowledge accumulates, and scientific communication therefore becomes more and more complex, it is clear that many traditional practices will become increasingly unresponsive. Two main lines of attack on the problem are clearly indicated: First, library services should be improved, and second, scientists should become more familiar with the various types of information services that *are* provided.

The push-button library of the future—a vast store of machine-recorded data interrogated in a rapidly responsive on-line interactive system and supported by a great communication network—will eventually come about in some form or, in fact, in a variety of forms. It is not our purpose to prognosticate the detailed nature or the rate of development of such systems but to attempt to point out at least some of the crucial changes of an institutional, organizational, and philosophic nature that must be brought about in order to create the kind of environment within which technological innovation and the evolutionary improvement of libraries can flourish.

If the application of modern technology seems to lag in libraries as compared with other areas, it is because the scope of the problem is immense, and more particularly, because our society and its institutions are not effectively organized for a direct attack on the broad systems-planning problems that lie at the heart of the matter. The large research libraries, in particular, face serious problems which cut across institutional boundaries. None of them can hope to be fully self-sufficient even for the relatively limited community of scientists and scholars which it serves; instead, each must rely heavily on national bibliographic services and on the cooperative use of information resources with other libraries. The same is true, but even more strongly of course, for the smaller college and research libraries.

Simply to say that more money must be poured indiscriminately into libraries is not enough, for without the proper guidelines and a reasonable degree of over-all planning on a nationwide basis, the need for funds could become a bottomless pit. A deep reappraisal of the method of funding library services should be made. The possibilities of a closer tie between obtaining library services and paying for them should be carefully explored. Even assuming some base level of "free" library service, if users had the option of extra service for an extra price, the test of the marketplace might provide valuable guidance on the optimal allocation of library resources toward the most valuable services. Very often, however, user response to new, even good, services is characteristically slow; therefore, a greater marketing effort must be mounted. Probably scientists and scholars are slow to acquaint themselves with existing library and information services simply because society tends to reward originality rather than thorough literature searching. Yet, it is hard to believe that this state of affairs will continue when it becomes widely apparent that much rediscovery of what is already known is taking place. Though the process may be slow and cumbersome, it seems clear that a readjustment of the habits of the scientific community is necessary. A different balance must be struck between the allocation of time for original research and the time spent searching, assimilating, reviewing, and consolidating the literature.

In view of this obligation of the scientific community, it is imperative that library services be made much more responsive. There are few limits to what can be done, given adequate resources. However, the burgeoning federal support of the scientific and technical research of the last two decades has not been matched with sufficient support of the library and information services that are necessary to ensure effective communication of the results of scientific research.

The following recommendations are addressed to these shortcomings and offer hope of creating an environment in which there is large scope for private for-profit and not-for-profit initiative, innovation, and the application of new technology.

RECOMMENDATION C5

More support should be provided for library services in colleges, universities, and other institutions with substantial educational and research programs in science and engineering. This should be done principally in two ways:

1. Through direct grants by the National Science Foundation, and other granting agencies where appropriate, for the strengthening of research-library services, with emphasis on start-up costs for innovative services

2. Through provision in the various research grants to these institutions, whatever the granting agency, of adequate funds specifically for library and information services, preferably provided in such a way that researchers can exercise discretion in the use of these funds for services that they find most valuable

The intent of this recommendation is to bring about a more realistic reflection of library costs in the conduct of scientific and technical research, a closer relationship between costs and services, and more options for the user of "extra service at a price." We emphasize the term library *services*, since such services may and usually should cut across institutional lines and involve the concept of networks and the cooperative use of library resources. It is presumptive that the institutions most deserving of support are those that most adequately plan and analyze library operations in terms of cost, effectiveness, and optimum allocation of resources with other institutions. However, in small colleges and universities, even the conventional resources of current journals and abstracting and indexing services often are seriously deficient, and we cannot uncritically assume that improvement is to be brought about *only* by the sharing of resources.

The program suggested in the first part of Recommendation C5 might be structured and administered in a manner similar to the NSF's program in computer facilities for universities and, in many instances, should be coordinated with the latter.

RECOMMENDATION C6

The U.S. Office of Education should support a broad program in library education (in addition to or as part of its present program under Title II B of the Higher Education Act), which gives attention to the following objectives:

1. The training of more students in systems analysis, systems planning, and operational analysis of libraries and library services
2. The training of all students as well as faculty (throughout their college careers if feasible) in the use of the increasingly complex array of existing library and information services

Marketing of library services should begin with better efforts to make the use of such services an integral part of the education process. Support of this recommended program may imply in many cases the support of library services essentially as educational laboratories for t . smaller colleges and universities, which may not have research programs extensive enough to justify library support under Recommendation C5.

The mechanism of formula grants by geographic districts, based on the number of graduates from eligible undergraduate institutions, may prove appropriate here. Arrangements should include the use of appropriate reimbursement for such services.

COMMENTS ON THE REPORT OF THE NATIONAL ADVISORY COMMISSION ON LIBRARIES

The National Advisory Commission on Libraries was directed (a) to study and appraise the role of libraries "as resources for scholarly pursuits, as centers for the dissemination of knowledge, and as components of the evolving national information systems"[111]; (b) to appraise institutional policies and practices affecting the use of libraries; (c) to appraise library funding; and (d) to develop recommendations for action. The recent report of the National Advisory Commission on Libraries[111] makes a series of five recommendations, the basic import of which is compatible with the recommendations of SATCOM. While it is not our purpose to offer either critique or over-all endorsement of their report, the following quotations from it are so much in harmony with our thinking that we invite special attention to these points. First:

> The Commission believes that libraries are both essential and major elements in providing resources for scholarship in almost all fields of knowledge, in serving as centers for the dissemination of knowledge, and in serving as components in the evolving national information systems. The library role in these matters is in fact so critical that the Commission believes that libraries serving these purposes must be significantly strengthened. This increased strength will require a variety of different approaches and techniques: Federal support, long-range planning, and better coordination and urgent requirements.

In their common recognition of the importance of what SATCOM has called need groups, it is clear that both SATCOM and the National Advisory Commission have the common objective of maximizing and taking advantage of the strength of diversity in the pluralistic system of library and information services presently existing in the nation:

No monolithic Federal or other centralized administrative control seems either feasible or desirable. There will have to be many different kinds of information systems and working relationships among a variety of institutions if we are to provide effective access to relevant information for our society. New systems, roles, and relationships are likely to emerge at very different rates of speed in response to widely varying user needs.

Further, to ensure responsiveness of services and to fulfill user needs effectively:

It follows . . . that naturally evolving systems that clearly serve the needs of users should be given support in their own right at this time. No one can perceive the final nature of communications and information-exchange networks, nor the quality of a national information system—with a single exception. The exception is that such a system will finally be made up of a large number of highly specialized individual components, each one of which should be designed to serve the needs of a defined user group.

Finally, the need for increased library support to reflect the increasing demands of federally sponsored research also is brought out clearly.

The increase in research conducted by universities and sponsored by Federal and State agencies, corporations, and foundations has made demands upon university libraries that have not been satisfied by either the growth of library collections or staffs. All agencies of government, foundations, industries, and other organizations that subsidize research by contracts, grants-in-aid, fellowships, and other means should be made aware of the greatly augmented burden on the library that their grants and subventions commonly entail. This should be taken into account in the planning of grants and programs. Continuity of such funding is critically important.

Among the five recommendations resulting from the National Advisory Commission's extensive studies, analyses, and deliberations is one that calls for the establishment of a National Commission on Libraries and Information Science, to be established by the Congress and located within the Office of the Secretary of Health, Education, and Welfare. Such a Commission would serve as a continuing federal planning agency and as a means of developing and implementing new policies and library services to meet the nation's needs. This Commission would advise the federal government and other institutions on library and information needs, would conduct studies, and recommend legislation to strengthen the nation's library and information services.

We do not feel that the Commission proposed by the National Advisory Commission conflicts with our Recommendation A1, which advocates the creation of a Joint Commission on Scientific and Technical Communication responsible to the Councils of the National Academy of Sciences and the National Academy of Engineering. Rather, we believe that these two proposed bodies could complement and supplement each other's efforts to cope with a vast and multifaceted array of problems. The important role that the libraries of the future will play as components in national information systems and networks suggests that, if the proposed National Commission on Libraries and Information Science comes into being, it could provide valuable input to the SATCOM-proposed Joint Commission on Scientific and Technical Communication, which, in turn, frequently could aid and assist the efforts of the former. We believe that the philosophies of SATCOM and the National Advisory Commission are much the same; however, we believe that those aspects of the information problem that transcend the library problem can be best handled by the mechanisms we propose, and that there is ample need and scope for the efforts of both the proposed Commissions.

Formal Publication

The stewardship and control of formal and informal primary communications exercised by the professional community of scientists, engineers, and practitioners, together with the scientific and technical publishing houses, constitute their foremost contribution to the effective utilization of such information. Therefore, the recommendations included in this and the following section are addressed to the organizations and institutions through which stewardship and control are effected.

The growth in volume and diversity of primary scientific literature, the distribution of producers of information throughout the scientific and technical community, and the relative roles of individual items in the over-all stream of publications have been extensively analyzed in recent years and have yielded data on such major trends as:

1. The growing difference between the rate at which an active field of inquiry advances and the rate at which any individual scientist can contribute to its advance
2. The shrinking fraction of the world's total publications contributed by any one of the currently leading nations, or any of the present large centers of scientific and technical activity, and the increasing concern of these nations and centers with keeping abreast of the scientific and technical literature

3. The increasing volume of literature that need not and probably will not be read again
4. The rising cost to the scientific and technical community of the entire publication effort

Since publication costs have constituted a perennial problem, especially for the not-for-profit scientific and technical organizations, a variety of economic mechanisms have been devised to meet these costs and have resulted in a complex pattern of interdependencies. During the last few years, the allowance of page charges under government contracts and grants (Chapter 4, Section E) helped to alleviate the problem, but inexorably growing requirements and the introduction of modern technology are subjecting the fiscal bases of publication programs to new and serious stress.

The discussion accompanying the next seven recommendations relates to the need for thorough study of the economics of formal publications and further illuminates Recommendation C7, which is placed first for emphasis.

RECOMMENDATION C7

We recognize the need for systematic analysis and study of the economic aspects of formal scientific and technical publications over the next five to ten years. Such a study should examine the income returned to such publications from their principal markets—users, authors, and the public—together with trends in cost factors and the impact of new technologies, to serve as a basis for the development of flexible funding and pricing policies, which, in a changing environment, should be responsive to the needs of each interested party without being unduly responsive to any.

A few questions highlight the need for such a study. For example, how and to what extent should users and authors contribute to the revenues of a publication venture that is of service to both? How are the revenues derived from advertisements used in support of scientific and technical society publications, and how should they be figured in assessing the fiscal load to be carried by generators and users? At what level and in what form is public subsidy of such publication warranted?

The striking postwar growth of both established publishing houses and newly launched commercial enterprises in scientific and technical publication shows that under good management a wide range of primary communications can be provided with profit. Moreover, commercial publishers are making significant progress in extending the range of services offered on the open market. Yet, the demand for technical publications can be fully met only by the complementary efforts of activities that are funded and function in the public interest.

In their role as publishers, scientific and technical societies must realize that publishing is "big business" and requires the taut management which commercial publishers have learned to give it. A number of current developments are radically changing whatever equilibrium former procedures and policies afforded, and their impact on the economics of journal publication must be assessed. Major examples are:

1. The demand for the option of selective dissemination of separates to individual subcribers and the concomitant requirement, primarily among institutions, for the traditional service of full subscription
2. The development and use of reprographic techniques, allowed under present interpretations of the doctrine of fair use, to supplement primary distribution
3. The changing balance between editorial and setup costs (cost of the first copy) and subsequent runoff and distribution costs resulting from the changing volume and structure of the market
4. The possibility of dividing publication of a paper between letterpress and microform—that is, a condensed version some 20 percent of the original length in the former, with the remaining 80 percent available in microform

During the present transitional stage, and consistent with the belief that research and development are not complete until the results are made available, we urge that sponsors of such efforts continue to recognize their responsibility for the dissemination of results.

RECOMMENDATION C8

It must remain the established policy for governmental or private sponsors of research to provide, as an item inseparable from the cost of such research, funds for an appropriate part of the publication process; therefore, we strongly advocate the continuance, as a matter of policy, of the provision of funds by sponsors of research and development for page charges—i.e., payments requested by journals from contributors and normally approximately covering the editorial and setup costs of the publication process.

Conflicting views exist on the proper division of financial responsibility for the essential task of publishing new findings. Two principal causes of controversy are: (a) the economics of supply and demand in scientific and technical publication, which depart so far from the classical pattern that it is unrealistic to let the entire fate of publication hang on the test of the marketplace through complete user support; and (b) the inevitable dependence of the ways of funding scientific and technical communication on the manner in which our nation funds education and research in general. A logical division of responsibility between producer and consumer is to let the producer's task include all that is necessary to provide a truly free-market option for each consumer. The page-charge practice (described in greater detail in Chapter 4, Section E; see also Chapter 5, Section C) does this and affords the related advantage of stabilizing the economic position of the journal with respect to fluctuations in input or in subscriptions. (Lack of funds for page charges has no adverse effect on publication of a paper, since payment is voluntary.) We feel that funds for publication of new results should be provided not only in research-and-development grants but also in fellowships and traineeships that support new research.

The page-charge concept, though greatly strengthened by the 1961 FCST policy[151] allowing government support of page charges for in-house and contractual work, is still far from universally employed and continues to encounter opposition. Critics point out that abuses are possible and, in fact, occur. On the other hand, some journals are in serious financial difficulty as a result of decisions to cease honoring page charges, payment of which always has been voluntary. Future changes in conditions under which primary publications operate may require modification of this policy; the study proposed in Recommendation C7 should provide the basis for such modifications.

The so-called copying revolution has implications relevant to the page-charge issue. Publishers of primary journals fulfill two very different functions: (a) attracting, reviewing, correcting, editing, and issuing valuable material in reasonably attractive, reproducible form; (b) running off and distributing reproduced copies. Prior to page charges, the return on the second function had to bear the costs of both. We now face a dilemma regarding the extent to which there shall be free competition between publisher and copying machine in performing the second function. Such competition would tend to lower costs and afford greater flexibility of services, but without the development of mechanisms that function in the same way as page charges to support the first function, such competition would destroy the economic viability of primary publications. Though this problem is becoming increasingly serious, specific recommendations must await the results of the study advocated in Recommendation C7.

Formal media traditionally have fulfilled a broad range of functions, including the announcement of new results, provision of current and general awareness, and creation of the archival record. In short, they have provided for the orderly communication of scientific and technical information, assuring to the user technical quality, timeliness, and permanent accessibility, and to the author, rewards commensurate with his service. These media include the journals, proceedings, and transactions of the scientific and technical societies, currently estimated as numbering more than 30,000; a monograph and technical report literature conservatively estimated at two million titles; a growing patent literature; and finally, an increasing number of nontextual records of primary information, such as computer media and audiovisual records. Today, formal publications face several difficult problems. First, the time scale of advance in many fields has contracted to the point at which the usual delay between submission of a paper and its publication makes inroads on the interest in reading it. Second, the proliferation and uncontrolled dissemination of unrefereed semiformal publications (Chapter 4, Section D) renders much that appears in formal media redundant. Finally, any attempt to see a substantial fraction of the primary literature that is of interest floods the prospective reader with a mass of irrelevant and useless material.

RECOMMENDATION C9

Scientific and technical organizations and other publishers must make a systematic effort to improve the quality and timeliness of formal publications. Lag times in publication of as much as a year must be considered intolerable. We believe that at present competently refereed publication is nearly always possible in six months or less, and that advancing technology will make further time reductions feasible.

Some major journals, by utilizing new methods and technologies to the fullest, have reduced the time between submission and publication of a manuscript to approximately three months. Frequently, however, the principal cause for excessive delays stems from the backlog that a journal has built up rather than from the editorial and production chain.

Shifting some of the load of research-front communication to semiformal publications should facilitate the maintenance of higher standards in formal media. Additionally, measures should be instituted to cope with such abuses as publishing nearly identical material in several places, a practice fostered by the pressure for publication exerted on scientists, engineers, and practitioners by their employing institutions. The predominant need is for greater differentiation of services with appropriate gradations in price. We advocate the development of new kinds of media and the exploration of alternative subscription arrangements in order to serve, respectively, such different purposes as rapid announcement and scholarly complete presentations, and such different categories of customers as individual and institutional subscribers.

RECOMMENDATION C10

Major scientific and technical societies (if not already doing so) should experiment with:

1. A journal for brief, refereed, and promptly published papers (letter journal), with issue period and publication lag not exceeding one month

2. Organized reprinting, from a group of journals covering either a narrow area or a group of cognate fields, of selected papers recognized as most outstanding

The *Physical Review Letters* of the American Physical Society is a most successful venture of the first kind. More recently Pergamon Press has established a number of similar journals in several of the most active fields of the physical and engineering sciences.

In disciplines in which much of the technical report literature is not submitted for formal publication, societies might consider establishing a periodical that reprints the best of these technical reports. Such an effort would be one way of giving the second concept described in Recommendation C10 a trial and of fostering greater familiarity with and use of the technical report literature.

Scientific and technical societies also could perform a valuable and much-needed service by facilitating informal interpersonal communication within and between disciplines.

RECOMMENDATION C11

Scientific and technical societies should recognize the need for publishing information that facilitates informal scientific and technical communication in their fields (sometimes referred to as meta information). Information on "who is doing what and where" can appear in newsletters, as supplements to substantive journals, or as separate publications. This support of interpersonal and intraorganizational communication should be but one approach in a continuing program to facilitate information exchange.

News organs that supply information about the inception of and current developments in major research projects in a field and provide timely information on conferences and meetings have been found most useful in this context (e.g., *Physics Today* and *Chemical and Engineering News*). This activity fails in the delicate area between scientific information and scientific intelligence; the degree to which it is useful, feasible, and appropriate and the choice of the most suitable media to employ depend on sensitive editorial judgment and must be left to the control of each individual discipline.

Two technical developments offer major opportunities for effecting the kinds of changes in the traditional patterns of disseminating scientific and technical information that we consider necessary: (a) the processing of information by high-speed computers, and (b) the increasingly flexible, rapid, and inexpensive methods of recording and reproducing graphic material. Increasingly sophisticated forms of texts and figures can be handled by computer-controlled photocomposition, and the ready reproduction of offprints and separates in full-scale or microform versions affords comparable capabilities in the distribution of copy. Of particular importance in this context is the systematic use of computer processes for the purpose of matching available documents to prospective readers, both being described in machine-readable representation.

RECOMMENDATION C12

To protect users from unwanted and irrelevant literature, greater use must be made of different methods for the selective dissemination of information (SDI). In particular, full-scale experiments should be initiated to provide information on the costs and the effectiveness in various research-and-development and technical communities of the major types of schemes for the distribution of separates.

Possible distribution schemes are: (a) outright selective dissemination of information (SDI) systems; (b) separates furnished as requested on the basis of widely circulated lists of document descriptions; and (c) publication of a concise version of each paper, either accompanied by a microfiche of full text or by the option of getting the full text in hard copy on request. Such procedures, geared to individual subscribers, differentiate the services offered them from those offered to institutional subscribers. The option of receiving all material must remain available to the latter, and, in such circumstances, the price for this service could be set in keeping with the institutional subscribers' market.

In addition to experimentation with various procedures for distribution, we also urge widespread attention to the possibilities offered by new techniques of computer composition.

RECOMMENDATION C13

Major publishers of scientific and technical literature already are making vigorous efforts in the utilization of modern methods of computer composition; we urge the publishers of the smaller journals of more limited scope to seek arrangements for merging their production activities in order to take advantage of the economies of scale implicit in such modern technology.

Consolidation of the production function will lead not only to economies in what is generally a particularly costly form of printing but also will contribute to the increased availability of full text in machine-readable form for subsequent processing in the production of access tools.

The current bottleneck appears to be the limited capacity of firms that are able to produce machine-readable records of scientific and technical text. Since this demand will continue to expand, special efforts are necessary to train appropriately qualified manpower, thus providing an entry into the information-processing field at a relatively low level of skill.

SEMIFORMAL PUBLICATION

Scientific and technical information can be given a type of dissemination which, though somewhat informal and thus highly user-directed, is subject to some formalizing constraints. A wide variety of media, such as information-exchange memoranda, preprints of papers to be presented at meetings, preliminary versions of papers prepared for publication, or technical reports, exemplify this semiformal type of publication.

RECOMMENDATION C14

The scientific and technical societies should give careful attention to needs for and practices in the circulation of the various types of semiformal communications (report literature, preprints, newsletters, and the like); should subject this material, somewhat selectively, to bibliographic control; and should be prepared to supervise distribution to whatever extent is necessary to preserve a proper balance between the advantages of broader availability of semiformal publications and the continued strength of formal archival journals. Bibliographic control in this context *refers to orderly announcement and, in those cases that involve circulation of substantive information not scheduled for formal publication to a significant number of people, the provision of indexing, abstracting, and availability in a central depository.*

Informal or semiformal communications, such as letters and reports intended for limited distribution, historically have been the forerunners of formal publication; the scientific journal had its origin in such practices. Information exchange groups recently have been the subject of much discussion, experimentation, and controversy (Chapter 4, Section D). The proponents have stressed the advantages of circumventing the delays and overdistribution characteristic of journal publication; those opposed have deplored the proliferation of unrefereed, uncontrolled literature that competes with and threatens the existence of the scientific journal. This concern is valid but does not imply that semiformal communication should be discouraged. Instead, adequate measures to ensure that such material is accessible—that is, indexed and capable of being located and obtained—are highly desirable. Distribution typically should be very limited to minimize competition with journals. A single reproducible micrograph copy in a depository (in addition to the initial distribution of possibly no more than a few dozen copies) might well suffice to maintain bibliographic control and an adequate level of access.

It may not always be easy for the scientific and technical societies to preserve the status and economic viability of refereed journals and, at the same time, provide producers and users of information with swift and highly accessible channels of research-front communication. Since much of the preprint material now circulated is submitted for formal publication, both the competition with formal journals and much of the need for additional bibliographic control will vanish for material that is circulated with a statement indicating that it has been submitted to a certain journal (though not necessarily accepted). (See the description of the preprint circulation plan of the Institute of Electrical and Electronics Engineers in Chapter 7, Section A.) This mode of operation also exerts pressure on authors to avoid circulating low-grade material. Alternatively, any circulation scheme accompanied by indexing and permanent retrievability also will encourage attention to quality, since authors will realize that their work is reviewable by all who follow. Distribution can be kept to a minimum, without discriminating against any possible recipients, if all those interested order from a list of announced titles and pay for what they get. Finally, much of the pressure for extensive preprint circulation can be relieved if unnecessary delays in formal publication are eliminated (Recommendation C9).

In fostering the effective utilization of semiformal media under the suggested bibliographic control, scientific and technical societies could benefit from ready access to and more extensive use of suitable technical reports, especially those prepared under the aegis of the federal government. In any case, the availability of this information in hard copy or microform can be used to advantage in reducing the economic load of production and distribution.

RECOMMENDATION C15

We urge that the agencies of the federal government that sponsor research and development devise and agree to a policy, to be issued by the Federal Council for Science and Technology, which establishes:

1. A clear differentiation between reports whose preparation is required for contractual purposes (periodic progress reports, some final reports, and the like) and substantive reports prepared as the status of work warrants

2. Standards of uniformity in the documentation of all substantive reports that permit the exercise of the bibliographic control advocated in Recommendation C14

The distribution of mandatorily prepared reports should be left to the discretion of the sponsoring agency and need not become the concern of the professional community. Substantive portions of such reports could be included in independent appendixes to be issued when appropriate as separate technical reports. All substantive reports should be treated as any other primary publications.

MEETINGS

To date only a small number of meetings, though in a representative sample of disciplines, have been analyzed from the viewpoint of what they contribute to the communication pattern. The findings of these analyses indicate that meetings generally fulfill a number of information needs, but they also frequently suggest possible improvements and productive innovations. Among the aspects most intensively studied are: (a) the role of meeting interaction in strengthening and expanding informal communication networks; (b) the impact of information received on the on-going or planned work of meeting participants; and (c) the effect of information generated through meetings (and typically disseminated through publication of meeting programs) on the communication activities and relevant work of nonparticipants (see Chapter 4, Section C; and Reference 50).

Criticism of the growing number and size of meetings continues to be frequent; and, in fact, many have poorly defined objectives, occur at ill-chosen sites and times, and employ facilities and arrangements that discourage rather than facilitate communication. Often, too many must be attended to get any one story in full, or the frequency of those dealing with temporarily popular subjects becomes too great and the material presented redundant. On the other hand, in terms of the currency of the information exchanged and the speed at which it can be filtered and applied to the interests of the individuals concerned, meetings are among the most effective media of dissemination. We believe that meetings have a crucial role to play in scientific and technical communication and that fulfilling that role more effectively is a major challenge.

RECOMMENDATION C16

National and international meetings can constitute an essential and effective basis for scientific and technical communication. Their predominant role can and should be given a more objective confirmation than the present intuitive backing. Societies and other groups sponsoring such meetings must acquire better insight into the purposes and functions of their meetings and must provide the appropriate logistic arrangements and measures of quality control. Additionally, the economic advantages of large meetings as a means of combining the meetings of overlapping interest groups should be exploited.

The vital significance of meetings lies in the contact they offer with current research-and-development efforts in a field and with active fellow workers. The criticism that numerous small working conferences would be better than large meetings fails to recognize that, if properly arranged, meetings can provide an especially economical way to schedule many such working conferences in which intersecting interest communities can participate. A procedure found effective by some societies is the scheduling of small special-interest-group meetings or forum sessions within the context of a large annual meeting to give participants an opportunity to question authors further about the work they have presented, to discuss problems encountered in work, and to describe procedures and apparatus more fully.

Our recommendation explicitly abstains from suggesting an increased formalization, nor do we wish to make a general recommendation on requiring preprints of major papers on a program. Although there is evidence that the availability of preprints tends to enhance the effectiveness of meetings and that the material presented at meetings where they were required was on the average no older than that presented at meetings of the same society when there was no preprint requirement, the problems of preparing and getting preprints released in time can have an adverse effect on meetings in some disciplines. Therefore, the advisability of providing for the availability of preprints before or at the time of a meeting must be left to the judgment of the organizing committee. One alternative explored in some groups is the submission, shortly before a meeting, of detailed summaries or extended abstracts, which are included in the printed program or are available at the time of registration. Session time for such papers is devoted largely to discussion and questioning. Measures that increase the opportunities for interaction, both during and after sessions, greatly enhance the effectiveness of meetings. Especially to be avoided are very lengthy or day-long sessions, with no time allocated to discussion.

In addition to urging meeting sponsors to adopt an innovative approach to the planning of such gatherings, we also suggest that agencies and organizations engaged in research and development continue to support the participation of staff members in scientific and technical meetings. To subject meeting attendance to excessive restrictions in the face of necessary budget reductions would decrease the communications effectiveness of meetings.

D. PERSONAL INFORMAL COMMUNICATION

The major role played by informal, person-to-person communication in the dissemination of information is generally recognized and has been confirmed in systematic studies of communication channels. Such communication may take the form of verbal exchanges and correspondence and frequently deals with very recent developments. Much of the scientific and technical information on which we depend is stored in the human brain rather than in the literature or in mechanical devices—and much of it never gets beyond this repository. The situation was summarized briefly by Philip Abelson [1] in a recent editorial in which he stated:

> "In a short time and after a few telephone calls, the skilled scholar is in a position to tap much of the world's store of knowledge. Reliance on this human network provides more than raw information. It provides judgement, and suggestions of more feasible approaches to the problem being considered. In view of the many strengths of this information network, computer technology has far to go to match it in effectiveness and especially in cost."

Several attributes of informal interpersonal communication have resulted in heavy reliance on it as a principal information source. First, it is prompt and conveys timely information on current and on-going work. Additionally, it is interactive and thus provides the feedback and constructive criticism so highly valued by scientists and technologists. Because it is user-directed, interpersonal communication is one of the most effective means of "translating" research findings into the contexts and terminology of those who can apply them and of bringing to the attention of a potential user information applicable to his work but originating in subject areas in which he generally would not search. Further, the types of information typically carried by interpersonal channels are those that often do not find their way into the more formal literature, such as information on methodology, hardware, pilot and exploratory work, and unsuccessful efforts. Finally, not the least important of the reasons underlying dependence upon informal interaction is the small expenditure of time and effort it usually requires. (See Chapter 4, Sections A and B, for a more detailed discussion.)

Informal interpersonal communication fulfills two major functions:

1. It stimulates and fosters the progress of research
2. It is one of the most effective ways of transferring technology to the point of application

In the performance of the first function, informal interaction supplements and enriches more-formal media by providing much of the specific information, frequently of a procedural nature, needed in the course of work, by advancing new ideas and hypotheses for investigation or pointing out factors influencing results that should be considered, and by supplying the impetus and encouragement (aften referred to as social support) necessary to bring about the implementation of ideas and to accelerate work. In regard to the second major function, although there is no uniform pattern for breaking the knowledge-application barrier, there is general agreement that the transmission and "translation" necessary to adapt scientific and technical knowledge for application is basically a "people transfer" process, and that report writing and document retrieval are not the main issues in this context.[101]

Although numerous studies of information-exchange behavior show the significant and diversified role of interpersonal communication in scientific and technological work, we still require fuller understanding of (a) how this type of communication operates and is affected by the characteristics of the persons involved and by the work environment, and (b) how government agencies, societies, industrial management, and other groups can increase its effectiveness. The types of studies advocated in Recommendation E1 (in the final section of this chapter) can help to advance our knowledge in this area. Increased reliance on mechanized media of storage and transfer also adds to the difficulty of developing farsighted recommendations to ensure the continued effectiveness of interpersonal communication or to guide its evolution. Because of these difficulties, the Committee has formulated only two recommendations in this area, both of which suggest measures to facilitate the occurrence of interpersonal interaction.

RECOMMENDATION D1

When appointing and advising the groups in charge of arrangements and the scheduling of events at scientific and technical meetings, the sponsoring societies, government agencies, or other organizations responsible for the planning of such meetings should emphasize the importance of providing adequate time and facilities for personal encounters.

In the case of international meetings, these aspects received attention in the recent studies and deliberations of the NAS Committee on the Quality and Organization of International Scientific Meetings, and figured specifically in the recommendations of this group. Additionally, this Committee pointed out the effectiveness with which U.S. attendants at international meetings widely and informally reported the highlights of such gatherings to their colleagues on their return.

The mechanics of informal communication also have been studied recently in other contexts, and suggestions for stimulating and enhancing this type of interaction offered; the study conducted by the American Institute of Research [78] and stimulated by COSATI provides an example. We believe that one aspect of interpersonal communication that can be significantly influenced by organizational policies is the development of close personal contacts between workers in different organizations. Such relationships lead to the transfer of information through encounters at meetings and through correspondence and preprint exchange. Additionally, workers who have developed good interactive information-exchange relationships typically contribute much to one another's efforts.

RECOMMENDATION D2

Employers of scientists and technologists—universities, industrial and government laboratories, and others—should provide systematic oppor-

tunities, through leave and exchange arrangements, for long-term or summer visits to other institutions by staff members likely to benefit from them and, in turn, should welcome such visitors from other institutions. There should be general acceptance of this responsibility. In addition, the funding of fellowship programs should take into account the need for the continued generation of new contacts by mature professionals as well as younger ones. Special attention should be given to the needs of workers in small or out-of-the-way institutions.

Sabbaticals, fellowship programs, summer jobs, small week-long conferences, and other such opportunities foster the development of close professional associations and thus help to strengthen and extend the informal information-transfer network.

The two recommendations included in this section obviously only scratch the surface of the important field of personal informal communication. The studies advocated in Recommendation E1 in the following section probably will point to major and long-range changes in the organization of research and development in our nation. Therefore, those charged with the responsibility for the management of research and development, and with formulation of policies relating to the acquisition of information during the conduct of work, should maintain awareness of the findings and implications of such studies of information-exchange behavior and experiment with the implementation of those results that are appropriate to their particular circumstances.

E. STUDIES, RESEARCH, AND EXPERIMENTS

Judgments, often of a quantitative nature, about the influence of various factors or innovations on the effectiveness of scientific and technical communication will determine and guide the implementation of the recommendations in our report. Estimates of the cost-effectiveness of existing communication media and of possible changes in them will be crucial; therefore, it is essential that a much more serious effort be made in the future to analyze and understand the operation of the entire network of scientific and technical communication. The network aspects deserve special emphasis; early and intermediate links and cross-links are as important as the final links that ultimately deliver information to a user (Chapter 6, Section E).

Past analyses of scientific and technical communication, generally referred to as user studies (Chapter 4, Section B), now number well into the hundreds. Though they have been conducted in a variety of disciplines and work settings, the different methods, sampling techniques, and analyses employed limit the generality and usefulness of their findings. As a consequence, there is need for better coordinated, more clearly focused work to provide badly needed data and answers to many vital questions.

RECOMMENDATION E1

Under the over-all guidance of the proposed Commission and of COSATI, *appropriate organizations should initiate and carry out comprehensive analyses of and experiments on the functioning of the different parts of the network of scientific and technical communication as well as of the network as a whole. It should be a long-term policy to provide adequate funds for such studies, and scientists, engineers, practitioners, and—as warranted by the subject of the study—commercial entrepreneurs of abundant experience and imaginative insight should always be active participants.*

Among the appropriate organizations to undertake the recommended studies are the major scientific and technical societies, the NSF's Office of Science Information Service, governmental agencies engaged in the operation of large information services, and commercial publishing houses. To be meaningful, these studies will have to deal realistically with many elusive or complicated factors—for example, inertia in behavior patterns and its effect on the acceptance of new services or the interrelationship of various communication media. The significance of such factors can be properly assessed only by persons with working experience in the fields studied.

STUDIES OF COST AND VALUE

Particularly important among the recommended studies will be those addressed to factors of cost and value. The difficulty of developing quantitative measures of the value of information services, as illustrated by the prevalence of such terms as "user satisfaction" or "document relevance to a request," suggests the need for greater ingenuity and more-systematic procedures in the conduct of such studies. Needed measures must include not only the value of different types of information but also the value of the time devoted to actively seeking information and of the waiting or lag time before it is received—that is, the "response time" of an information service. In situations in which a free market exists, the price the user is willing to pay for different information services provides a measure of such factors; however, this measure must be viewed with caution until the behavior of users, especially so-called "in a rut" behavior, is better understood. Collections of offhand opinions of scientists and technologists about the information services they think they want have little utility; often such opinions call for an exhaustive service when a less comprehensive but more reasonably priced one would be more valuable, or for an exceedingly fast service when a slower but cheaper one would be a better buy.

RECOMMENDATION E2

Among the principal objectives of the previously recommended studies (Recommendation E1) should be the development of measures of value for information services that embody various combinations of accuracy, completeness, discrimination, timeliness, and similar factors. Where appropriate, these studies should include experiments on user response to new services (see also Recommendation E4). The facility of providing additional or specialized information services at appropriately scaled prices should receive particular attention.

Such studies will provide a better foundation for monitoring the performance of information programs as advocated in Recommendation B15 (see Section B of this chapter).

Documents can be transmitted today either electronically or by mail over great distances in a relatively short time and at moderate cost. This general statement needs to be made explicit and quantitative as a basis for decisions on centralized versus decentralized depositories. Perhaps nowhere are the issues better exemplified than in the inefficiency of interlibrary loan procedures that characterize most libraries. For the larger research libraries, the question of whether to collect "everything" or to be selective and cooperate with other institutions is becoming increasingly critical. Definitive system studies are clearly needed and should include all aspects of retrieval, handling time, and costs.

RECOMMENDATION E3

Studies should be initiated to determine the relative costs of different methods of storage and transmission of recorded information. In conjunction with studies of the type described in Recommendation E2, estimates should be developed for the optimum number and location of *depositories with respect to their users so that questions of centralization versus decentralization can be clarified.*

Advanced Technologies

Implicit in Recommendation E3 is a far-reaching study of the role of electronic computers in the storage and delivery of information. Such a study must deal not only with the optimum combination of input costs, storage costs, communication costs, and access costs, but also with guidelines to determine what information is electronically stored. In addition to storage and transmission, computers may play a vital part in access. The most trivial of the human functions traditionally associated with information access involve copying, reformating, and sorting, tasks to which computers are making increasing contributions. Among the remaining functions, one to which the computer can contribute most readily and effectively is the preparation of indexes, for to be of value, the computer need not do the entire indexing task but only reduce significantly the requirement for human effort. In comparing indexes produced by a combination of human and computer effort, the emphasis should be on effectiveness rather than appearance; the tests of performance should be whether they lead the user to what he wishes to find and how easily and rapidly they do so rather than the degree of similarity or dissimilarity to former indexes.

A number of approaches to machine-aided indexing currently are being explored, and a continuing program of comparative evaluation involving users of specified backgrounds and skills is necessary to measure progress in this field.

Recommendation E4

The comparison of machine-aided indexing with wholly human-prepared indexing should receive continuing, active attention. Such comparisons should focus primarily on documents retrieved in sample searches, and secondarily on acceptability to users.

Computers also can enhance access to information by operating in a question-answering mode, performing logical analyses of the relative "distance" or similarity between documents, and sorting out clusters of related ones.

Recommendation E5

Continued experimentation in the design and use of effective combinations of machine and human functions, both in preparing for and con-

ducting searches for information, should be supported. Such combinations very possibly may not involve indexes of any conventional sort.

More exciting than retrieval of information from a static store is evolutionary indexing, in which users' additions, modifications, restructuring, and critical commentaries steadily improve the initial indexing of a collection and not only provide more-efficient access for subsequent users, but constitute a significant step in the evaluation and consolidation of primary information. If widely and wisely applied, such evolutionary indexing could make the judgments of a large number of knowledgeable experts available to the authors of reviews. So far, we know of no publicly described experiments with evolutionary indexing, though Project INTREX (see Chapter 5, Section A), in its augmented catalog experiment, plans to provide for the utilization of user comments for this purpose. This lack may have resulted in part from difficulties with motivation of user participants, but the increasing utilization of real-time computer systems for such experiments promises both greater motivation and the availability of a clearly specified set of facilities and rules.

RECOMMENDATION E6

The National Science Foundation should fund one or more experiments in which a small, widely used, single-interest-area file is subject to evolutionary indexing by authorized users who are permitted to make additions, modify the structure, and insert critical commentaries. One attractive approach is to perform such experiments on a real-time computer system.

The rather extensive and often difficult studies urged in Recommendations E4 through E6 in many cases will require experiments with sizable populations of scientists, engineers, and practitioners representing users of information stores and services. If such experiments are to be productive, the user participants must bring interest and competence to bear on these efforts.

RECOMMENDATION E7

The scientific and technical societies must use their information and publication programs to familiarize their members with experiments that explore the uses of advanced technology as a working tool in the communication of scientific and technical information, rather than just in support of documentation functions, and must insist on the participation *of scientists, engineers, and practitioners with proven discipline competence in guiding and evaluating such experiments.*

In the discussion relevant to Recommendation A11 (Section A of this chapter), we emphasize the importance to scientific and technical communciation of standardization activities directed toward facilitating intercommunication between computer-processible files of diverse origins. The variety of structures encountered gives rise to problems that are predominantly of a basic conceptual nature rather than problems of equipment and implementation. An example of a file-structure problem is how to organize large collections of bibliographic information for efficient on-line search; an example of a data-structure problem is how to represent, in a hierarchical computer memory, the structure of chemical compounds in an economical way that still permits the use of these data as an index to the related chemical literature. These are difficult problems, and all too often appalling errors in logical design still creep into schemes for the manipulation of large files. What is needed now in this area is not so much standardization as insight.

RECOMMENDATION E8

On-going activities directed toward the development and evaluation of languages for describing the formats of files as well as of alphanumeric and other digital communication are of immediate and key importance to scientific and technical communication. Thus, the National Science Foundation should cooperate with other federal agencies pursuing active programs in this area, especially the Advanced Research Projects Agency, to ensure rapid and coordinated progress. In particular, an evaluation program for a file-format language should demonstrate computer conversion from one format to another as soon as possible and for an extensive set of samples.

Once such a language is developed, a description in its terms should accompany every file, being the first thing available to any human or machine system that processes the file. One can hypothesize future computer systems that, after interpreting this description in the standard format, could then process any given file without ever having encountered one of this particular structure previously.

Any language with the required properties has many of the characteristics of a fully developed computer language for text manipulation. The generation of such a language is approximately equivalent to writing a program that permits the insertion of any new datum into the file in the proper manner or the recovery of any old datum. These are difficult and important objectives.

Another important problem of standardization concerns the closer integration of the literature access, search, and appraisal tools developed, respectively, by the libraries and the abstracting and indexing services.

RECOMMENDATION E9

Several libraries, documentation centers, and abstracting and indexing services should be supported by the NSF Office of Science Information Service in efforts to develop agreed-upon canonical forms for each widely used bibliographic documentary information element.

It would not be advisable for the Commission to attempt the development of some single-standard structures in this context. Instead, it should bring about greater coherence in the effort to discover and develop such structures. Closer interaction is needed among those people in scientific and technical communication who best understand the methods. In the final stages of reaching the desired agreement, the mechanism of the United States of America Standards Institute (USASI) Committee Z39 on Standardization in the Field of Library Work, Documentation, and Related Publishing Practices will be needed.

LARGE-SCALE EXPERIMENTS

Many of the recommended studies will require experiments with scientists, engineers, and practitioners as they perform their regular tasks. Some of these experiments will be suitable for funding as small-scale research projects in communication, but certain questions will remain that only experiments with large populations and large stores of information can answer. Large experiments should be undertaken, of course, only when a favorable outcome has been suggested by studies of smaller scale and when desired by the professional group or society representing the scientists or technologists concerned. But even such a desirable experiment may involve a capital outlay or a financial risk—especially where the use of advanced technologies is required—that would be excessive for a society as long as the outcome remained uncertain. Additionally, coordinated and coherent planning of such experiments in various areas is essential. Since these large-scale experiments will differ from the smaller ones in that they constitute exploratory development as well as research, it is appropriate that they should be planned and funded differently.

RECOMMENDATION E10

In addition to funding programs of basic research in scientific and technical communication, as well as research and development in this field that more directly supports the missions of individual agencies, the federal government should establish a single group to plan a unified program of critical experiments of operational scale in scientific and technical communication and to find, guide, and support contractors in the conduct of these experiments.

Both the initiative and the detailed responsibility for planning and directing the conduct of this program must be taken by the proposed government group. The program must neither exclude nor discriminate against for-profit organizations. An agency that is not too narrowly confined in its involvement in science and technology to a specific mission would be preferred for this assignment.

In closing this section on studies, research, and experiments, we must stress that we have sought to identify only the most urgent needs—that a continuing flow of work on a wide variety of problems is essential to progress.

CHAPTER 4

Primary Communications

A fundamental article of faith in scientific and technical communication is that research is not complete until the results are made available. But inherent in the phrase "made available" are complex problems of definition and of placement of responsibility. Exactly what constitutes availability? Where does the originating scientist's or technologist's obligation for the achievement of this goal begin and end? How much of the responsibility for ensuring availability rests with his laboratory, the sponsor of the research being reported, appropriate scientific societies, the government, the scientific community, and others? Who should worry about the exact nature and limitations of these several sub-obligations? Who should have the responsibility for identifying gaps and areas of overlap, and who should take steps to minimize these flaws? Such problems have been among SATCOM's central concerns.

Among primary communications we include media and procedures that typically provide what might be called "first-time-around access" to new scientific or technological knowledge. Primary communications are the kind that say, in effect, "Here it is, come and get it" rather than either "We'll dig it out for you" or "Don't call us—we'll send you what you need." Specifically, the forms of communication dealt with in this chapter extend from the first informal conversations with laboratory colleagues that accompany the conduct of scientific and technical work through initial publication in a primary archival journal or its equivalent. They compromise a continuum of communication methods rather than falling neatly into tidy, mutually exclusive subclasses.

The patent literature constitutes a form of primary communication of technical information that falls to some extent outside this continuum. Because it is an important information source, it should be covered by appropriate access mechanisms; however, its operation is dictated largely by requirements other than those strictly serving scientific and technical communication. Nor does it reflect the trends characterizing other forms of primary communication. For example, the patent literature has not shown a steady exponential growth, and it is an ineffectual means of measuring technological output (see Reference 75). The submission of patent applications in the United States reached its highest annual rate during the depression years of the 1930's, and only within the past few years has the rate again approached that high point. Possible reasons are the larger proportion of small corporations then in existence and government policies that frequently do not stimulate contractors to seek patents for technology developed in connection with government projects. Since scientific and technical communication is not the major function of patents, SATCOM has not attempted to analyze the evolution of this body of literature in the depth and detail that typify its consideration of other forms of primary communication.

The material discussed in this chapter supplies further background and detail for Recommendations C7 through C16 (Chapter 3, Section C), which deal with "Formal Publication," "Semiformal Publication," and "Meetings," and those of Section D of Chapter 3 on "Personal Informal Communication." This chapter presents first a broad overview of the "Forms and Growth" of primary communications, followed by a discussion of their generation and use ("Originators and Users"). The succeeding sections deal in greater detail with "Meetings," "Preprints and Technical Reports," "Serials," and "Translations."

A. FORMS AND GROWTH

Traditionally, formal publication in the established literature has been the means of making accruing scientific and technical information available, and, with necessary modifications resulting from expanding requirements and new technologies, we expect the basic book and journal article to perform this function for the foreseeable future. Various other forms of primary communication have developed over the years to complement these two, usually in a supporting but occasionally in a competing role. Figure 2 outlines the diverse media—including personal informal communication and meetings as well as preprints and technical reports—utilized by scientists and engineers to report their results. It gives some indication of the varied and numerous communication activities employed to diffuse new scientific and technical knowledge from the time when it first takes shape in the mind of an investigator to the point at which it becomes firmly integrated into the recorded body of information. The component elements of this complex network are subtly interrelated; therefore, judicious balances among them are necessary to ensure the best and most economical use of recorded information.

Formal Publication

Among the major trends of the past few decades which have created serious problems for almost every aspect of scientific and technical publication are:

1. The widening difference between the rate at which an active field of inquiry advances and that at which any individual scientist can contribute to this advance
2. The shrinking fraction of the world's scientific and technical literature contributed by the present-day industrialized nations
3. The enormous growth of science and the resulting increase not only in the total volume of technical literature but in that portion which need not (and probably will not) be read again
4. The increasingly urgent need for prompt access to information about new developments

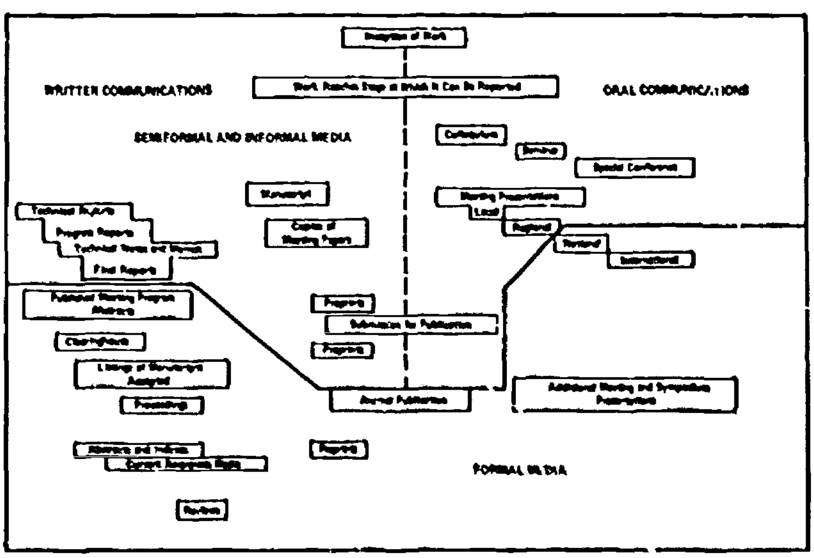

FIGURE 2 Media used for the dissemination of information from inception of work to formal publication (see Reference 71).

5. The continually rising cost to the scientific community of every element of the entire scientific-and-technical-communication effort.

In recent years, factors contributing to these developments have been investigated and reinvestigated, analyzed and reanalyzed, interpreted and reinterpreted, and as a result much is known about the trends as such. But much study and testing still are necessary if we are to develop effective remedial measures for the many specific publication problems that result.

The greatest single villain in the scientific publication picture probably is simply the enormous increase in the magnitude of the scientific and technical literature, the so-called "information explosion." This term is used often to describe what observers consider to be a rapid, uncontrolled, and potentially destructive increase in the growth rate and volume of information. Since this information explosion has been used to justify many of the proposals for new information systems and services, SATCOM had reason to consider whether there actually is such an explosion.

Statistics on the increases in different forms of communication, such as books, journals, and scientific papers, though often piecemeal and not always consistent, generally substantiate the existence of great and accelerating growth. A brief review of some of these statistics gives an indication of the magnitude of the problem and the probable direction of future trends.

In the biomedical field, Orr and Leeds [111] have provided statistics on the rate of growth and have indicated that production of technical biomedical books in the United States increased by 38 percent over three decades, or roughly one percent per year. Using the collection of monographs at the National Library of Medicine to determine the world output, they concluded that "the world-wide accumulation of biomedical books has been doubling about every 32 years. In contrast, during the same period, the shelf space occupied by NLM's book collection has doubled every 25 years." For science and technology as a whole, the number of books published per year also seems to have been increasing, but slowly. The 1963 *Census of Manufactures* shows that the annual number of scientific and technical books sold from 1958 to 1963 almost doubled (from 15.6 million to 29.6 million copies). During this same period, medical-book sales increased from 2.4 million to 4.1 million copies per annum.[11] Though the number of books published is quantitatively different from the number of titles published, data of both types give evidence of growth, and estimates made by staff members of the Library of Congress in discussions with SATCOM indicate that the

Library's holdings in the category of scientific and technical monographs and books number well over 2 million monograph and technical report titles.

The volume of book publication in recent years has received a substantial boost from the subcategory of conference proceedings. The seemingly common belief that every scientific conference must be followed by publication of a proceedings probably should be examined critically, and scientific societies appear to be the logical groups to make such a study. Criteria such as those applied by the National Science Foundation's Office of Science Information Service (OSIS) to support of the publication of proceedings volumes deserve consideration. The OSIS position is that: (a) Occurrence of a conference is not in itself sufficient reason for a proceedings; (b) the content of any such volume should be scientifically significant aside from a conference connection; and (c) other things being equal, it probably is better for individual papers to be submitted to appropriate journals where they will be refereed in the same way as nonconference articles. In regard to the latter point, SATCOM has noticed a tendency in a number of societies and conference groups to publish their proceedings in regular or special issues of a standard journal, with the customary refereeing exercised by such publications.

The increase in the number of scientific and technical journals and their associated articles is difficult to determine with any degree of certainty. Recent estimates of current titles range from 26,000 to 50,000. The lower estimate represents the number of currently available serials received by the National Lending Library for Science and Technology in England, a library that attempts to acquire every such serial.[16] Recent work on the National Serials Data Project of the Library of Congress indicates that there are about 400,000 to 600,000 different serial titles in all fields of scholarly endeavor, with no reliable estimate yet of the fraction of titles that are still alive. Since there is no firm basis for determining how many titles classed as serials are issued more than once a year and are truly what we commonly call periodicals, these estimates must be further qualified.

Gottschalk and Desmond [73] used foreign national library lists and Library of Congress records as guides and decided that 35,000 ± 10% was a reasonable figure for the total number of currently published titles. They did not estimate an over-all growth rate, but noted that, although the library definition of a periodical includes a plan to continue publication indefinitely, many titles do cease publication. They found mortality rates varying from 33 percent over a period of 50 years in radioactivity to 66 percent over a period of 60 years in aeronautics and space sciences. A sampling from the Library of Congress *Serial*

Record showed that 40 percent of the titles had ceased publication. The authors concluded that individual specialties might show rapid growth, but that "Phenomenal growth in serial titles from year to year assumed in most estimates cannot be supported."

Price [143] has assembled data showing an increase in the number of scientific journals from about ten in the late 1600's to about 100 at the beginning of the nineteenth century, and some 10,000 by 1900, and he also reports that examination of the *World List of Scientific Periodicals* indicates that we are now well on the way to the 100,000 mark. These data show a remarkably constant doubling time of 15 years, now maintained for nearly three centuries. Further, Price shows that the law of exponential increase also characterizes the number of scientific papers appearing in journals in physics. Another recent study [95] indicates a general increase in the number of papers per journal in all fields of science and technology. One example given was that the core journals covered by *Physics Abstracts* had grown 13 percent in volume in three years. Moreover, the individual papers in these journals, although maintaining their same average length because of editorial pressure, were covering more material. Such data emphasize the problems faced not only by abstracting and indexing services but by the reviewer as well.

Data from individual scientific and technical societies illustrate the greatly expanded volume of primary publication. The American Institute of Physics (AIP), for example, reports that the number of pages it published each year increased from about 8,000 in 1940 to 54,000 in 1966, a growth of 575 percent over a period of 27 years.[103] The Institute of Electrical and Electronics Engineers (IEEE) reports that its volume of primary publication has increased from 3,000 editorial pages in three journals in 1946 to over 30,000 pages in 42 journals in 1966, a tenfold increase in 21 years.[67] And a survey of 18 engineering societies shows the following increases in number of pages published in three types of primary publications: (a) proceedings, 1,000 pages in 1946 to 26,700 pages in 1966, a 2,500 percent increase; (b) transactions, 11,800 pages in 1946 to 62,000 pages in 1966, a 420 percent increase; and (c) periodicals, 4,400 pages in 1946 to 10,000 pages in 1966, a 125 percent increase.[148] As a final example, the Federation of American Societies for Experimental Biology has witnessed an increase from 2,200 to 3,100 papers at its annual meetings between 1958 and 1968.[59]

When queried about the growth in volume and variety of the scientific and technical literature, most technical librarians are quick to point out that they do not know the figures, but they do know that last year's journals took up more room than the previous year's journals. For the research library, there is really no way to avoid an increase in size of coverage if it still wishes to maintain the scope of coverage desired by its users. Such libraries seem to double their collections every 18 to 20 years.

Licklider [110] has said, "Only in high hyperbole does a thing 'explode' that takes 10 to 15 years to double its volume." He suggests instead the analogy to a flood, in which the rise is gradual, hitting first one area and then another—not all simultaneously—and in which the overflow may be sudden and dramatic. With all forms of scientific and technical literature showing increases over time, both institutions and individuals using such information must expect increasing difficulty in finding, obtaining, and assimilating it. The prospect of a university library collection's doubling from three million to six million volumes in the next 15 years, with a concurrent trebling of cost, is an outlook that suggests the anticipation of change and of some planning for it.[60] For the individual user, either gradual concentration on a narrower specialty or greater reliance on access aids to the literature, or probably a combination of both, will be needed. As Sarett [147] has pointed out, assuming that a scientist could read technical material at a rate of 200 to 300 words per minute, ". . . if all publications were to stop and a man were to try to catch up with a single year's output alone, reading 24 hours a day, 7 days a week, it would take him 50 years." Herring [87] (see also Chapter 6, Section A) graphically describes the dilemma facing the individual scientist as the width of the domain of knowledge with which he can keep abreast narrows and, at the same time, the amount of information relevant to his work increases. Clearly, the flood of information raises serious problems, especially in some fields, and taxes the ability of current means of coping with it.

Other Modes of Primary Communication

Historically, informal and semiformal communications, such as personal contacts and letters as well as memoranda and reports with limited distribution, have been the forerunners of formal publication. Their coexistence with scientific journals is established firmly in the traditions of scientific and technical communication, and so, too, are the manifold interdependencies that tie them together.

In comparison with formal media, such semiformal ones as preprints, technical reports, or information exchange memoranda offer greater speed, greater flexibility in adapting communications to context, and the increased possibility of including speculation, accounts of failures, and procedural details. They have proved of particular value in serving the needs of emerging scientific disciplines during their awkward "interdisciplinary" years. The number of items carried by the major government services for access to technical reports provides a rough measure of the volume of this semiformal literature. In 1967, the *Technical Abstracts Bulletin* (TAB) of the Defense Documentation Center reported 47,000 items; *U.S. Government Research and Development Reports*, 45,000 items; and *Scientific and Technical Aerospace Reports* (STAR), 31,000 items. Since sizable overlaps exist among these services, these figures are not additive. Figures on growth rate are even more tentative, for the various services are still in the process of enhancing the completeness of their coverage. Thus, TAB reported 32,000 items in 1963 as compared with 47,000 in 1967, an increase of 44 percent in five years. Section D of this chapter discusses more fully the growth of such forms of communication.

Documented primary communications appear to be evolving in the direction of three ever more clearly differentiated classes that function in complementary fashion:

1. Formal literature, traditionally refereed, edited, and given bibliographic services for archival and access purposes
2. Semiformal publications, such as technical reports, which typically should carry reasonable bibliographic controls, but usually should not be subjected to formal refereeing or editorial review
3. Rapid early announcement publications, refereed on a go/no-go basis and given the barest minimum of bibliographic control

The danger that semiformal media will undercut formal publications is a serious one (see Section D of this chapter) which must be minimized by keeping down the automatic circulation of the former. Such control also will keep down costs. In addition to a strictly limited primary distribution, there should be arrangements to provide an early announcement secondary service and reprographic copies on demand and at cost. Moreover, since a substantial fraction of the semiformal material probably will find its way ultimately into the formal literature, it is necessary to identify those semiformal publications that have been superseded. These considerations resulted in recommendations advocating proper bibliographic control for semiformal documents (Recommendations C14 and C15).

In a qualitative sense, we know that personal informal exchanges play a major role in the transfer of scientific and technical information. The increasing number of invisible colleges, the steadily growing tendency toward collaborative and team research, and the current emphasis on conferences, meetings, interinstitutional visits, and other occasions that facilitate informal interaction are evidence of both general awareness of the role of informal communication and increasing dependence on it. Such emphasis and dependence have resulted in numerous studies to determine the characteristics, content, and functions of interpersonal communication and the reasons that it predominates as first resort when information is needed. The goals of such efforts typically are to discover those functions that could be better performed by more formal media, if appropriately modified, and to enhance the effectiveness of informal communication in the performance of certain functions that are peculiarly its own.

Accurate, quantitative comparison of the effectiveness of the very informal interpersonal techniques of communication—informal conversations in the laboratory or at lunch, personal telephone calls and correspondence, casual get-togethers at meetings of various kinds, unplanned parleys on airplanes and in airports, and the like—with that of other communication methods would be difficult to achieve, for it would require a precisely defined unit of information or knowledge that incorporated some kind of index of significance. Additionally, attempts to collect the necessary data probably would interfere to some extent with the informality of the procedure, thus affecting the phenomenon being measured. However, the qualitative evidence makes it very clear that a substantial portion of initial, day-to-day communication about developments and discoveries in science and technology occurs in this manner.

Several attributes of informal communication have led to heavy reliance on it as a major source of information. One such characteristic is timeliness. The claim is sometimes made that for leaders in a field reference to formal information sources is virtually unnecessary, and that the content of the more formal media is largely "stale bread." A Russian scientist recently commented on the "invisible collectives" for the exchange of information and stated:

> Our scientific workers, as a rule, do not enter into these invisible international collectives. The foreign scientist who participates in such a collective becomes acquainted with new ideas during the process of their formation long before they will be published. . . . Some publications turn out to be difficult to understand because we are not acquainted with all the long discussion which preceded them.[15]

Further study probably will show that, at least in some fields, exclusive dependence on informal communication is not sufficient to provide an adequate level of current awareness. For example, a physicist who, for a year, substituted dependence on the grapevine for browsing through the current literature reported (after checking back to see what he had missed): "Out of the few hundred articles whose titles were of most interest to me, a sizable majority had not come to my attention through any other channel during the year or two subsequent to their appearance." [87]

The interactive nature of interpersonal communication is another important characteristic; seldom are any of the techniques employed confined to one-way communication traffic. Consequently, it is the principal source of the feedback so highly valued by scientists and technologists. When scientist A discusses his research with colleague B in the company cafeteria or with scientist C on the telephone or with confreres D, E, and F in a hotel lobby between formal sessions of a meeting, he invariably obtains immediate reactions to which he in turn reacts. When he sends another scientist the draft of a paper he plans to publish, he typically solicits criticism, which probably will be forthcoming whether he asks for it or not, and which enables him to test ideas and shape information before it finds its way into more formal media.

Further, informal communication is user-directed; the decision on what, when, and to whom to communicate rests almost entirely with the scientist who solicits or volunteers information. And this user-directedness greatly enhances the intelligibility of that which is communicated. For example, Coleman *et al.*[41] point out that, although the medical practitioner relies to some extent on compendia, digest magazines, and other shortcut methods, he also depends very heavily on the advice of either colleagues or detail men, and on word-of-mouth information. Frequently, he is seeking a recommended course of action, a weighing of alternatives, and needs someone to extract action implications from the theoretical language of research reports. In industry, too, this translation function plays an important role. Allen [4] has described a "boundary impedance" which exists between organizations, partly as a result of their adoption of what amounts to their own coding systems in order to cut down on "noise" and increase the efficiency of their operations. Consequently, certain individuals, in a more or less unplanned manner, have come to act as bridges or gatekeepers, translating and channeling information to those for whom it appears appropriate and linking members of one organization with those of other or different (i.e., academic, governmental) organizations. Another important consequence of user-directedness is the frequent fulfillment of an unrecognized, unvoiced information need—the provision of information that proves valuable to a user though he had not specifically looked for it, either because he did not realize that it existed or did not perceive its utility for his purpose.

A fourth important attribute accounting for the prevalence of informal communication is that these interpersonal channels typically carry ancillary information and, in effect, complement the operation of the more formal ones. One type of information very often transmitted by informal interpersonal interaction pertains to methodology and hardware, the kind of "how to" information which often does not find its way into the literature or, when it does, is not sufficiently detailed to be meaningful. Negative results and details of preliminary or on-going work also are conveyed most often through informal interaction rather than more formal outlets. Additionally, much informal communication relates to the more formal literature, either providing leads to useful published sources of relevant information or filling in the details lacking in a published report of work. A detailed breakdown on the types of content typically encountered in oral informal channels appears in a recent study stimulated by COSATI.[73]

Last but not least of the characteristics that underlie the predominance of informal interpersonal channels as information sources is the relatively small expenditure of effort and time that they typically involve. Allen and Gerstberger [5] have assembled evidence in a series of studies which indicates that: "Engineers, in selecting among information channels, act in a manner which is intended not to maximize gain, but rather to minimize loss. The loss to be minimized is the cost in terms of effort . . . which must be expended to gain access to an information channel." They conclude that accessibility is the single most important determinant of the over-all extent of a channel's use, and that, though technical quality is usually recognized, its consideration is delayed until after a channel has been selected, a situation which they label "an appallingly inefficient way of doing things. . . ." However, other data suggest that, in addition to being readily accessible, informal channels are prompt and relatively efficient. For example, in summarizing studies conducted in the Department of Defense (DOD), Carlson [86] reported that 70 percent of the first attempts to locate information needed for research-and-development work were informal in nature, and that the engineers who went first to informal sources received a higher proportion of the information that they needed, within the time limits imposed by their tasks, than did those who went first to formal sources.

These characteristics of informal communication all play their parts in enhancing its effectiveness in the performance of two principal functions: fostering the progress of research and facilitating the application of knowledge. With regard to the first of these functions, informal communication is a very frequent source of ideas and of approaches to problems. According to one estimate,

> . . . of the communication that is used by each researcher as an inspiration and as a data flow that makes his own work possible . . . some 80 percent . . . comes to him from other researchers at a stage before formal communication

and through the informal channels of the grapevine, the conference, the seminar, the preprint, and the other tentacles of what we now call the Invisible College.[144]

A number of studies, though not suggesting so high a percentage, demonstrate the prominent role of interpersonal interaction in generating hypotheses or pointing out alternative interpretations to be explored, which, in turn, lead to a new projects and new directions of research effort. Further, informal interpersonal interaction is the principal source of the encouragement or social support so necessary to convert ideas into action. Colleagues and peer groups not only evaluate completed work, they determine in large measure which ideas are acted upon and which studies actually are performed, through their interest and their assurance that what is planned is of potential value in a field. Additionally, and most clearly documented in the many studies of the ways in which informal communication stimulates and fosters research effort, is the provision of information needed to solve the various problems occurring in the course of work. Pelz,[142] for example, has shown that frequent interaction with numerous colleagues, especially those who differ in technical strategies and afford intellectual competition in arriving at the best solutions to problems, greatly improves performance. He recommends that supervisors encourage consultation outside the immediate work team, establish evaluation groups to review the work of various teams, and regroup work teams periodically.

In a current review of studies of information needs and uses,[188] the author suggests that many of the recent investigations of informal communication in industrial and government laboratories have implications for organizational policy makers, and he anticipates increased experimentation with such policies as those governing long-distance telephone calls, travel, and the attachment of technical staff members to research teams as "information men."

The second principal function of informal communication relates to the knowledge–application interface. To be applied, scientific or technical knowledge must be adapted to the "applier." At the present time, this transmission–translation function typically is accomplished verbally. Thus Kimball[101] suggests that science-and-technology transfer and use should be dealt with as a "people transfer" process and that the problem of document retrieval is not the main issue in this context. To date, there is no uniform pattern for crossing the knowledge–application interface, but on two points there is consensus: that report writing alone does not do the job, and that one of the most effective procedures is to arrange for research-and-development personnel to work side by side with, and to interact with, operational and production personnel at various stages throughout the course of work.[161] Evidence for the latter point is found in DOD studies of the factors involved in the generation and use of significant developments contributing to specific DOD systems; the investigators [10] found that in nearly all instances the developers of particular pieces of technology remained closely associated with the eventual implementation of their concepts. Additionally, subsequent studies showed that some three fourths of the inputs that advanced the work of the projects under study were personal communications during the development and production-engineering stages, and that much of the information input resulted from on-the-job experimentation in the solution of problems.[86]

Recognition of the importance of personal communication in the transfer and application of science and technology has resulted in attempts in both industry and government-sponsored projects to foster employee mobility. Such efforts probably have played a large part in reducing the median time between discovery and application from some 30 years in the 1920's to about ten years in the 1960's. Yet such lag still is too great in an era of rapid change and accelerating technological development.

Employee mobility takes two principal forms: vertical—upward in a company through promotions; and horizontal—movement of persons between component divisions or laboratories of the same company or between companies. In regard to vertical mobility, the trend since the turn of the century has been clearly in the direction of bringing scientific and technically trained personnel into the front office. For example, in 1900, only 7 percent of industrial management in this country was composed of technically trained personnel; by 1950, the proportion had increased to 20 percent; in 1968, it was 36 percent; and a figure of 50 percent has been projected for 1980. The effect of this tendency toward moving scientists and engineers into positions of greater management responsibility has been interpreted as that of increasing receptivity to the use of technologically advanced methods and procedures.[75]

Probably of even greater importance in the transfer and application of science and technology is horizontal mobility of employees between components of the same company or between companies. Such movement currently is fostered by the policies of many industrial organizations. For example, General Electric has experimented with the practice of having newly employed professional personnel from the Materials and Processes Laboratory assigned to the Research Laboratory for a time in order to broaden their outlook by having them work with the research group and become acquainted with projects and facilities.[161] A number of government organizations have taken a variety of steps to expedite the spread and utilization of technology. One example, sponsored by

NASA's Office of Technology Utilization, is the formation of biomedical application teams which contact groups doing research in biology and medicine and help to identify problems or phases of work that might benefit from the application of aerospace technology.

Though the personal communication aspects of the application of scientific and technical knowledge have been recognized and efforts have been directed toward enhancing the effectiveness of this people-transmission process, a major difficulty is that too many scientists and technologists make poor transfer agents. Their education and experience frequently do not equip them to deal effectively with the major economic factors that influence application. These mediating agents or catalysts need to possess a broad scientific or technical background as well as knowledge of the operation of commercial pressures and constraints so that they can adapt technological capabilities in feasible and appropriate ways to user problems and opportunities. Currently, the acquisition of such commercial experience usually takes place gradually while scientists and technologists are employed in industrial settings; however, the development of special training programs that would enable more scientists and technologists—both students and those already professionally active—to acquire commercial and public purpose awareness could assist them in becoming more effective transmitters of science and technology.

And there is need also for further study (a) to discover how best to combine such techniques as the exchange of software, demonstrations, lectures, and movement of personnel and (b) to determine those phases of the entire development–production–marketing process in which the interaction of personnel representing different aspects of work is most fruitful. Such studies as those advocated in Recommendation E1 (Chapter 3, Section E) could teach us things about this field that would point to profound and long-range changes in the organization of research and development in our society. For example, one might ask: What is the optimum distribution of sizes for research-and-development organizations? While the answer to this question depends considerably on the factors determining the sizes of the educational, industrial, or other enterprises to which research-and-development groups often are attached, it also depends on the relation of the efficiency of the latter groups to their sizes. Here, interpersonal relationships can be of major importance. The results of such studies could provide guidelines for developing policies that would accelerate the transfer and application of new knowledge. One such effort is a recently initiated project of the National Academy of Engineering,[22] involving six universities, which has the objective of discovering improved ways of using modern technological developments to enhance biomedical research and health care. Each university will endeavor to devise better ways of relating university activities in engineering to efforts in such fields as biology, medicine, and management science, with the goal of accelerating the development of new instruments, artificial organs, new devices for therapy and diagnosis, and other medical tools.

Although SATCOM has not attempted to crystallize into specific recommendations the implications of the numerous and varied studies dealing with informal interpersonal communication, the Committee has dealt in its recommendations with mechanisms and policies which can help to nurture and strengthen the informal communication network. Our Recommendations C11, D1, D2, and E1 (see Chapter 3, Sections C, D, and E) are addressed to these ends.

Scientific meetings constitute an important coupling mechanism between truly personal and more formal modes of communication. The maintenance of their effectiveness in this role within the changing patterns of scientific and technical communication deserves particular attention. Presumably no one would argue that large conventions should be staged solely to provide attendants with opportunities to talk informally between sessions; yet, the suggestion, occasionally voiced, that most large scientific meetings should be eliminated altogether and replaced by numerous small working-group meetings ignores the fact that a major conference, in addition to fulfilling its own over-all function, is a particularly economical and effective mechanism for bringing together small groups having like interests. For the other aspect of communication through meetings, dissemination via the formal sessions, the nature and organization of such sessions clearly play a role of vital significance. Section C of this chapter deals in more detail with studies of the effectiveness of informal interaction and presentations at meetings in a number of disciplines.

The principal criticism of meetings has focused on two charges: that their continuing growth in size and number is unwarranted, and that their purposes too frequently seem to be ill-defined. Since meetings play a major part in the advancement of science and technology, it is of vital importance that greater effort be directed toward matching their effectiveness and efficiency to contemporary requirements. Such is the purpose of our more detailed review of this topic in Section C of this chapter and of our Recommendation C16 (Chapter 3).

B. ORIGINATORS AND USERS

The originators and users of scientific and technical information are largely the same individuals, for almost everyone who generates scientific and technical information also makes use of it, while, in their turn, many users are originators of scientific and technical communications. We consider them separately simply because sharply differing interests are involved in these two aspects of scientists' and technologists' concern with communication, even though communicators and receivers of information frequently are the same people.

ORIGINATORS

Ideally, the technical paper serves the purpose of reporting significant research results for the advancement of human knowledge and the betterment of mankind. Were this its only purpose, publication should be assured and provided completely at public expense. In the real world, the situation is not this simple; other reasons include arbitrary external requirements, professional advancement, kudos of various kinds, and money. Most such motives are not inherently bad, but all can detract from the effectiveness of the over-all communication system if applied capriciously or without restraint. A brief indication of some of these not wholly communicational roles shows the mix of motives which fuels scientific and technical publication. For example, individuals write papers to:

1. Maintain or enhance their professional status and recognition in a particular field or within an organization
2. Develop a better résumé and list of publications in order to establish a better bargaining position for salary reviews or job interviews
3. Conform to the traditions of science by making their work available upon completion for the judgment of their peers and colleagues
4. Obtain the satisfaction of seeing their work in print
5. Facilitate new contacts with others doing similar work

Research organizations also have a number of motives for sponsoring the writing of papers by their staffs; for example, to:

1. Establish or maintain, for purposes of recruiting, sales, or project support, a public image of their organization as a place where most of the work, or the most interesting work, in a field is taking place
2. Obtain a measure of the productivity and quality of the efforts of the professional staff
3. Develop better staff biographies to enhance sales proposals or satisfy necessary accreditation procedures
4. Advertise particular products or services

5. Reinforce patent protection and obtain royalties or revenues from publication sales

Further, professional organizations and societies encourage the writing of papers by their members for such reasons as:

1. Improving the profession and its skills
2. Sustaining their programs of services to members, such as publications and conventions
3. Maintaining their status as active organizations and thus encouraging increased membership

Finally, there are the commercial publishers, whose efforts necessarily are guided more by profit than by enhancing the effective flow of scientific and technical information. They compete with scientific and technical society publications in fields of broad appeal, thus adding to the volume of communications in such fields, but leave to the societies the coverage of areas that interest relatively smaller groups of readers or those less involved in industry and applications.

At times, scientific and technical societies also yield to market pressures and opportunities to the detriment of the effective flow of information. As a result of tight budgets, editors may hold papers and allow a backlog to develop rather than suggest to authors that they publish elsewhere in order to obtain faster service. Further, some societies require papers presented at their conventions to be published in their journals (or editors reserve at least a right of first refusal). Such a restriction takes from the author the option of placing the article in a journal which might permit earlier publication or wider dissemination.

These various motives dilute the primary purpose of scientific and technical publication and produce a complex structure of producer interests and equities, the strengths and inadequacies of which require much clearer understanding (Recommendation C7). For example, though it is possible to differentiate clearly between technical paper and technical patent, the sociological forces which resulted in the institution of the latter also affect the former, just as the patent fulfills a number of the same information purposes that the paper does. Such overlaps, constraints, and pressures must be recognized and considered in planning for more-effective scientific and technical communication.

Users

The determination of scientists' and technologists' habits in the use of scientific and technical information and the reliable identification of their information needs present difficult and challenging problems. How they say they obtain information and what they say they do or do not want obviously cannot be ignored; however, it is equally clear that such expressions are not always reliable. For example, when one circulates a list of journal titles on which some nonexistent publications have been included and asks scientists to indicate those which they read regularly, an appreciable number of respondents invariably will check one or more of the mythical periodicals. Additionally, scientists' opinions on what information services they would like to have necessarily are formed largely in the context of what is familiar to them. They might respond differently in some framework other than their present one—or in the light of broader knowledge about potential services.

Another aspect of the operation of the communication network which we need to understand more fully is the sluggishness with which individual working habits respond to new opportunities or challenges. There is evidence that not only individuals but whole blocs of scientists or technologists often will get into a rut and for years fail to take advantage of information tools that could help their work significantly. Allen [4] has found with some consistency that the channels used with the greatest frequency are not the ones providing the greatest number of acceptable responses. Further, Parker [119] suggests that much seemingly unproductive, "low payoff" communication behavior fulfills the functions of morale building or channel maintenance. A better understanding of these aspects of communication behavior is necessary before we can effectively design and promote the use of new communication techniques and media.

The application of external testing techniques to the determination of the information habits of scientists and technologists is complicated by the likelihood that the experiment itself may distort the phenomenon under study, a situation further aggravated by the aforementioned unreliability of user reports and user adherence to firmly entrenched patterns of behavior. On the other hand, experiments in which the testing does not directly involve the subject—so-called "unobtrusive measurement"—are difficult to devise.* A number of measuring techniques have been tried in this area with varying degrees of success and are now being modified and combined with one another to meet more effectively the problems inherent in assessing user behavior. Such techniques have been described in detail and appraised in recent reviews (e.g., in

* Funkhouser [61] mentions the following two nontechnical illustrations of the unobtrusive measurement technique: (a) gauging roughly the size of a total TV audience by measuring the drop in city water pressure during commercials; and (b) placement of radio advertising by an automobile dealer on the basis of his records of stations to which radios are tuned in cars brought in for service.

those by Menzel [116] and by Parker and Paisley [141]). Briefly, they include questionnaires; diaries; records made by a trained observer who "pops in" and checks information activities in a particular setting at random intervals; analyses of records, such as library withdrawal lists or demands made on an information center; citation studies; interviews; sociometric analyses; and the "controlled experiment" types of studies. A method employed by Halbert and Ackoff [82] to circumvent the omissions and exaggerations of the diary and the neglect of out-of-working-hours acquisition of information that characterizes the participant–observer technique was to have each participating scientist or engineer carry a specially designed alarm watch during all his waking hours. The alarm was set to go off at random intervals and, when it did so, the wearer noted whether his activity was related to scientific and technical communication. If it was, he described it more fully. Another variation on the diary approach is the so-called solution development record,[4] a record of the approaches identified, selected, and rejected throughout the progress of a team's work toward the solution of a design or development problem. This record, when combined with interview data on information inputs to a work group, gives an indication of the nature and utility of information sources and of the effects of information on the progress of work.

A recent trend with regard to interview and questionnaire studies of user behavior is to focus on a "critical incident," a particular piece of information received, and to ascertain the source or sources, content, nature of acquisition (directly sought for a specific purpose or accidentally acquired), application to a task, nature of the task, and further information activities that the information stimulated. This emphasis has helped to enhance the meaning and usefulness of the resulting data.

Another technique receiving increasing attention, typically in combination with other methods, consists in the use of sociometric analysis to demonstrate the influence of personal characteristics, attitudes, and interpersonal relationships on the flow of information. Typical phenomena that this technique serves to explore are: the existence and functions of the "information man" or "gatekeeper," who acts as a kind of information source and communication channel for his colleagues; the factors determining the scope of the so-called invisible colleges and the kind and amount of information that circulates within them; and the correlation of information needs and of behavior patterns in the exchange of information with particular user characteristics and relationships in the work environment.

Finally, the methodological developments of recent years are showing more concentrated effort in the direction of the "controlled experiment." One example is the comparison of the age of work reported, types and impact of information received, and informal interaction stimulated at a number of "experimental" meeting sessions for which papers were distributed six weeks prior to the the meeting and at "control" sessions which took place at the same or previous meetings and for which such a practice was not followed.[18] Another type of experiment compared the utilization of information by several research-and-development groups engaged in the solution of the same problem and competing against one another for government contracts.[4] Experiments, such as those of Kessler MIT,[100] in which computer techniques could be employed to monitor and modify the flow of information among users, offer an approach of great potential value, the possibilities of which are as yet largely untapped.

Though the various methodologies employed are few in number and not without serious defects, their modification, use in combination, and more careful application have advanced substantially the art of designing and conducting studies of user behavior in recent years. In the past, such studies frequently focused on highly subjective "opinion poll" types of data dealing with preferences and evaluations, on simple use–nonuse data unrelated to context or consequences, or on the determination of user skills and practices, such as foreign-language facility or the number of hours spent reading in a library, which are chiefly of value in guiding the management of local information services. Current emphases in data collection pertain to:

1. Functions—the relationship of (a) the media from which information is received, (b) the nature of the information, and (c) its intended purpose to the specific uses made of it
2. Performance—the effect of information received or of patterns of information exchange behavior on the accomplishment of a specific task
3. Dissemination patterns—the media utilized and audiences reached from the time work is first reported through the time of its publication and eventual secondary coverage, and the time intervals associated with the process

Consequently, certain major themes and perspectives are emerging now that invite further study or follow-through. The first of these is the increasing adoption of a systems approach in the study of a given community's scientific and technical communication—the recognition that all information exchange arrangements, information functions, and interconnections among receivers need to be examined in order to appraise the flow of information. Corollary is a growing awareness of the ways in which varied information channels complement and supplement one another in the effective transmission of information; Menzel [115] refers to this as synergistic activity of channels in the transmission of a single message. Crucial in this context is the role of informal communication and the need for a better understanding of the regularity and order in its occurrence and of the implications of this orderliness. Finally, there is a tendency to view scientists and technologists as specialized publics, whose communication institutions are shaped and operated for many purposes other than the exchange of information.

Notwithstanding these encouraging developments, two recent reviews point to serious shortcomings that still are with us. Herner and Herner,[80] in reviewing material on communication needs and uses, list the following: (a) the relatively few techniques used; (b) the diversity of the groups to which these few techniques are applied; (c) the ambiguity of the terminology employed; (d) the failure to profit from past mistakes or to build on past gains; (e) the lack of innovation; and (f) the frequent absence of rigorous experimental designs. They additionally cite instances in which excellent data were collected, but inadequately analyzed and interpreted, because their potential was not recognized, and, on the other hand, studies in which mediocre or barely adequate data were over-analyzed, only because the statistical and mechanized techniques for doing so were known and available.

In his review of this area for the subsequent year, Paisley [138] indicated that "the study of information needs/uses has matured methodologically (in most projects, most of the time)," and he suggested as the crucial shortcoming the narrow and shallow conceptualization that so often results in such instances of inappropriate handling of findings as those pointed out by Herner and Herner.[80] In selecting a limited area for exploration, some investigators fail to keep in mind the over-all context and thus ignore possibly significant factors and influences as well as the broader implications of their findings. Four suggested questions, to which future studies should give emphasis, are:

1. What are the factors determining channel selection?
2. What are the effects of quality, quantity, currency, and diversity on productivity?
3. What is the role of background and personality factors in shaping information-exchange behavior?
4. In what ways do the social, economic, and other systems that impinge on the user and his communication system affect information exchange behavior?

In addition, SATCOM urges investigation and clarification of three areas in which data are lacking. First, except for the observation of last-link transfers, exploration of the ways in which the diffusion pattern of information throughout a network is influenced by user demands has been limited. Second, the lack of awareness of the existence of information services rather than their (imputed or experienced) ineffectiveness continues to contribute in a major way to the heavy dependence on informal channels. Finally, there is little effort to apply or implement what is learned from user studies; for example, what steps should be taken to deter users from returning to familiar and easily accessible sources, even when the expected yield is low, and to tap instead sources that promise a higher yield, albeit at greater effort.

The findings of the studies briefly mentioned in this section and of the many other user studies of recent years are too varied and numerous to permit detailed discussion (the final results of the massive User Needs Study of the Department of Defense comprise six volumes).[11, 111] They offer a wealth of suggestions for further investigations of the communication patterns and information needs of scientists, engineers, and practitioners. Particularly important in following up on these suggested lines of endeavor is the involvement of highly competent persons with a broad working knowledge in the substantive fields being studied, as we emphasize in our Recommendations E1 and E7. The absence of such involvement has accounted in large measure for the lack of continuity among earlier studies, for the frequent failure to concentrate effort on major and crucial problems and questions, and for much of the rather widespread apathy with regard to follow-up or implementation of significant findings. Broader awareness and participation among scientists, engineers, and practitioners of proven discipline competence are essential to the success of future studies and to the continued and, hopefully, more rapid progress of this field.

C. MEETINGS

The term "scientific meeting" covers a broad range of gatherings from small seminars and discussion groups to major national and international conventions. For the most part, however, "scientific meeting" brings to mind conferences, symposia, and annual conventions at which some appreciable level of over-all planning and control is exerted by someone other than the communicator. Two aspects of communication must be considered in studying such occasions: the informal, between-sessions colloquies among the attendants and the formal sessions themselves.

It is a well-known saying about scientific meetings that "You always learn more from conversations in the hallways (a euphemism that takes in a wide variety of locales) than you do from the formal papers." While this statement undoubtedly is exaggerated, there is no doubt that corridor talks at meetings can be immensely valuable, both concretely for the actual information exchanged and somewhat less tangibly because of the scientific fellowship and enthusiasm they nurture. Here, as with purely informal exchanges, content and audience largely are (or can be) controlled by the communicators. Timing, of course, depends basically on those who plan the conference or meeting. Thus, accompanying almost all large professional meetings are many related and very worthwhile breakfast, luncheon, and other working sessions of committees, panels, task forces, boards, and the like.

For the other aspect of communication through meetings—dissemination through the formal sessions—neither audience nor timing is controlled by the communicator. Within the framework of the particular conference's or session's theme, he does largely determine the content of *what* he says, *if* he has the chance to say it; his control over the latter factor varies from near zero for major invited papers (of course, he can decline) to being virtually complete for presentations in certain kinds of free-for-all sessions.

In order to enhance the effectiveness of meetings in the fulfillment of their characteristic dual function, substantially better information than previously has been available on various aspects of meetings will be needed. Data on optimum patterns of presentation—for example, reading versus discussion of predistributed papers versus panel sessions; on timeliness of papers versus the value of premeeting refereeing or screening (since either is achieved at the expense of the other); on postmeeting evaluation of benefits—the sources and types of information that proved useful in work; and on many other aspects would be useful in guiding efforts toward modification and improvement.

The provision of such data was one of the main objectives of a series of studies begun by The Johns Hopkins University Center for Research in Scientific Communication in 1966. The Center obtained comparative data on a variety of aspects of the dissemination of information at the annual meetings of a number of scientific and engineering societies.[10,*] Among the groups studied in relation to each meeting were the authors of program material, random samples of session attendants, participants

* Disciplines studied included: optical science, geophysics, meteorology, geography, sociology, aeronautical and astronautical engineering, metallurgical engineering, and heating, refrigerating, and air-conditioning engineering.

in special program events (e.g., demonstrations at exhibit booths, special-interest-group discussion sessions), and persons who purchased or requested copies of meeting papers (many of whom were not present at the meetings). The analysis [31] of the October 1966 Annual Meeting of the Optical Society of America (OSA) illustrates the types of data obtained in these meeting studies. Response rates for the participating groups at the Optical Society meeting ranged from 71 percent to 78 percent. Among the principal findings were the following:

1. The meeting attracted persons with a higher level of academic training than was typical of the field of optics as a whole.
2. Research and development were the paramount areas of effort of most participants, with authors of papers especially emphasizing basic research and the preparation of manuscripts on their work.
3. While most of the material presented dealt with single research projects, a fourth of the presentations were reviews of a series of experiments in which the speakers were involved.
4. Generally, work covered in a presentation began about a year before the meeting and became reportable a few months before it.
5. Though most of the work had been presented in oral and/or written form prior to the meeting, such dissemination tended to be of limited scope; therefore, more than three fourths of the authors planned further reports, typically as journal articles, very soon after the meeting.
6. Substantial percentages of all groups reported significant informal interaction at the meeting, with postmeeting follow-up planned in most cases.
7. Respondents who had modified, or who planned to modify, their own work as a result of information received from specific formal papers about which they were questioned, or from interaction about these papers, varied from a seventh (for session attendants) to a fourth (for authors).
8. Additionally, more than half of the attendants reported some modification of their work as a result of aspects of the meeting other than the specific papers about which they were questioned.

In the report of the Center's study of this OSA meeting,[31] the authors concluded that, taken together, the findings depicted a stimulating and effective annual meeting.

Once reliable data of these and related kinds have been obtained and analyzed, societies and other concerned groups will be able to insist that their implications be reflected in the improvement of meeting arrangements. Meanwhile, funding organizations must be convinced, first, that vigorous steps are being taken toward the achievement of maximum meeting effectiveness, and second, that meetings are an essential element in the communication complex—not merely a luxury that can be sloughed off without serious damage to scientific and technical communication. (See Recommendations C16 and D1.)

D. PREPRINTS AND TECHNICAL REPORTS

Originally the name "preprint" was limited to documents in manuscript form that would be published later, as its literal meaning implies. Current usage minimizes the significance of the second syllable and the term now applies to a sizable range of items, from communications just slightly more formal than many of those described in the latter portion of Section A of this chapter to finished manuscripts that have been accepted by a journal and are scheduled for publication. Between these extremes lie interim reports on research projects that authors reproduce and send to friends (including the invisible-college kind of round-robin communication); multiple copies of papers that speakers stack on a chair for help-yourself distribution at conference sessions and which may or may not be formally published at some future date; semiformal drafts of articles that authors plan or hope to publish after further revision; and other variations on the general preprint theme. The "preprint problem" frequently referred to involves principally members of the family in the more nearly formal portion of the spread, and it is with these that we deal primarily in this section.

Preprints distributed by, and largely at the whim of, their authors unquestionably enjoy many attractive advantages over their more formal cousins. They permit prompt dissemination of information; they allow greater flexibility in adapting communication to context; they are for the most part free of arbitrary space restrictions; and they include conjecture and accounts of failures as well as documented successes. And so, as publication time lags have lengthened for conventional journals, and as space and cost limitations have become more severe, it is not surprising that scientists and technologists have turned increasingly to the preprint kind of medium. Although its superposition upon the existing journal structure leads inevitably to redundancy and duplication, the few instances where analyses have been made have indicated the combined effect to be beneficial rather than otherwise.

But communication by preprint also has drawbacks. No permanent record is assured, at least under current conditions of insufficient bibliographic control, to provide for reliable subsequent search. Completely decentralized control of dissemination by authors means little or no standardization of, or consistency in, dissemination patterns; one who receives preprints in a given field from scientist A this year may or may not receive them from scientist B, who works in the same field, or from scientist A next year. Dependable, comprehensive indexes are almost impossible to prepare, and even if prepared would have limited usefulness because of problems of access to the documents indexed. Although the ultimate publication of preprint content in formal papers may be a net asset, the absence of any consistent way of identifying what has received duplicate recording unquestionably makes for a considerable degree of confusion.

Even more serious is the threat that preprint circulation may undercut the primary journals. When the distribution of preprints involves large areas of specialization or is worldwide in scope, it does, in fact, compete with formal types of dissemination. Though such distributior may not be intended as a substitute for journal publication, it can make widely available a complete manuscript, which is cited in bibliographies and accepted by some as sufficient to establish priority. As a result, the journal may be relegated to the role of archival depository, with low readership and use. But the preprint typically lacks refereeing and editing, the filtering and evaluation so crucial for trustworthy and effective scientific and technical communication, and its purported failure to be conscientious about citations of prior work tends to raise questions about the quality and authenticity of such communications. Nevertheless, the preprint can fulfill an important function without undercutting the more formal publications. If used to convey information, at the author's discretion, on procedures, pilot or exploratory work, brief reports on the current status of work, or extensive collections of primary data, tables, illustrations, and the like, and if automatic distribution is carefully controlled, the preprint can constructively complement rather than compete with the functions of the archival journal.

Here, as with meetings, scientific societies and similar organizations should take the lead in exploring various aspects of semiformal written communication within clusters of specialists. Such groups should certainly be kept small, but we need to know more precisely their optimum size, that is to say, the size beyond which they become economically impractical and self-defeating by reason of increased cumbersomeness of operation (greater distribution delays, lowered quality, excessive volume). In view of proposals that have been advanced for partially centralizing preprint distribution in order to ensure that all interested parties are included in the exchange and to introduce at least minimal bibliographic control, it is necessary to know how far one can go in these directions without nullifying the peculiar advantages of the preprint medium. Answers to these and similar questions should go far toward clarifying the desirability and feasibility (or lack thereof) of attempting to impose some degree of centralized control upon preprint distribution and should point the way toward effective future action. It is within such a framework that Recommendations C14 and C15 (Chapter 3) were formulated.*

Two projects, in particular, are relevant to our consideration of preprint distribution; the first is a six-year operational study conducted by the National Institutes of Health (NIH), and the other, a feasibility study carried out by the American Institute of Physics (AIP), with partial support from the Atomic Energy Commission (AEC). The former, which NIH called its Information Exchange Group (IEG) program, was initiated in 1961 to examine experimentally various aspects of the informal, rapid exchange of information common within small groups of scientists with similar research interests. Basic to the design of the experiment was the belief that each special-interest or profile group contains a core of "elite," representing roughly five percent of the total group. Members of this core group are "in the know" at all times, since they function as referees and editors and as competent critics in relation to their students, staff members, or colleagues. Further, they exchange information with one another for reaction and stimulation. A principal objective of the experiment was to make information as rapidly available to the entire profile group as it was to the core of elite so that all would be able to base their day-to-day research decisions on the latest information. A second basic belief was that a rapid flow of information would accelerate scientific advance throughout a profile group. The experiment was intended to gather data relevant to this thesis—i.e., to document those instances of a saving of research time or money that resulted from having had access to a preprint that was distributed well in advance of a journal article.

The mechanics of operation, as planned by the NIH, were relatively simple. The Institutes established a communication center to which the research papers originating within a group of scientists with common research interests could be sent, there to be duplicated (by photo-offset), with copies mailed promptly to all members of the group. The Institutes

* There is, of course, a practical limit to the amount of bibliographic control that can be exerted over preprint distribution. The author of a paper undoubtedly will continue to send copies to friends, who have friends, etc. However, the scope of such dissemination probably will remain very small, and the existence of some uncontrolled informal interaction should not deter societies from seeking to introduce as much order as is practicable.

exercised no control whatever within any group, referring any problems with regard to input to each group's chairman for decisions. Also, the NIH made no changes in any scientific communication, but served, in effect, only as a mail drop. The program was carried on for three years with a single group of research scientists before others were added. Eventually, there were seven. Table 1 presents the subject areas of these groups, the initial and final membership of each, and the total number of communications circulated.

Among the main findings of the experiment are the following:

1. Each of the subject groups became the nucleus of a growing body of scientists which, probably, would have increased to the point of approximate saturation in the research fields involved had the experiment continued.

2. Approximately half the communications were full research reports, 87% of which subsequently were published.

3. Participants generally appeared uninterested in back-and-forth comments and frequently unwilling to call attention to points of error or disagreement; however, there were indications of much private "backflow" from readers to authors.

4. Of two groups questioned after the program had operated nearly four years, nearly all (98–99 percent) indicated that participation in

TABLE 1 Age, Growth, and Communications of Information Exchange Groups in the NIH Experiment

Groups		Final Age (Years)	Total Membership		Total Communications Sent
			Initial	Final	
I	Oxidative Phosphorylation and Terminal Electron Transport	6.00	32	735	774
II	Hemostasis	2.92	19	127	176
III	Computer Simulation of Biological Systems	2.75	40	171	69
IV	Molecular Basis of Muscle Contraction	2.29	95	296	141
V	Immunopathology	2.42	72	611	320
VI	Interferon	2.21	98	250	275
VII	Nucleic Acids and the Genetic Code	2.00	222	1,472	806

IEG helped them to keep up with current literature, and more than four fifths (83–84 percent) believed that the rate of progress in their fields increased as a result of IEG.

5. In response to a final questionnaire, 466 participants reported 1,111 instances in which advanced information received through IEG influenced their research decisions, cited 346 instances in which such information prevented unnecessary duplication, and described 15 instances in which they were misled by, detected an error in, or disagreed with the advance data.

6. The 466 scientists also provided quantitative estimates of time and money saved or lost as a result of IEG information; the data suggested an overall saving (in man hours and money) on the order of $10,000,000 per year.

The NIH concluded that the IEG experiment had fulfilled its initial objectives, and as it had been set up as a feasibility test, with no contemplation of or provision for a continuing NIH-based preprint distribution service, the experiment was terminated some six years after its inception.* The NIH also suggested that this kind of quick-communication program is well worth considering for subject areas that are highly focused and readily definable, and that such a program will function most efficiently and with least friction when managed by an appropriate society or other group also involved in journal publication in a given field.

The second project grew out of an AIP–AEC discussion of the AEC's tentative plans to establish within its own organization a centralized preprint distribution system in the field of theoretical high-energy physics. Following this discussion and an Information Symposium sponsored by the American Physical Society, it was decided that AIP would conduct a study to determine the desirability of a centralized service for distributing informal communications in this field. If the results were affirmative, the AIP would then draft the rough design of an experimental service. This AIP study began in April 1966 with interviews of 45 high-energy physicists and the mailing of questionnaires to more than 550 more; a separate questionnaire was sent to 36 U.S. and 47 foreign institutions likely to have "preprint libraries" of one kind or another. The main questions raised in the interviews and the personal questionnaires were the following: (a) Would the innovation under consideration affect

* Another point of view with regard to the termination of this experiment appears in an article by Green.[79]

the journal publication system adversely; and (b) if so, all things considered, would any such effect be outweighed by the benefits of the innovation? The crucial question then asked was: "Considering the advantages and disadvantages you have listed, should a centralized preprint service in theoretical high-energy physics be tried on an experimental basis?" A breakdown of the 543 replies showed that 42 percent were wholly in favor; 36 percent indicated "yes, with reservations"; 13 percent were against the idea; and 9 percent were undecided. These results, together with the interview findings, which were compatible, suggested that at least an *experiment* in centralized preprint distribution was warranted, with a final decision regarding establishment of a full-fledged continuing service to await the results of such a test. Consequently, the AIP designed a trial system that would combine the following services: announcement of preprints; maintenance and circulation of a directory of high-energy theorists; and provision, at the discretion of the author, of copies of preprints on request and/or automatically in preselected categories.[107]

The Division of Particles and Fields of the American Physical Society, which was regarded as the most appropriate group to have cognizance of such an experimental service, is considering the proposal but has not reached a decision on its implementation. In the meantime, the AEC and its laboratories probably will begin to provide this kind of service within the nuclear-energy community.

A substantial and specialized segment of the semiformal literature consists of technical reports, a form that has been described by one writer as sired by World War II and damned by scientists and engineers ever since. The main characteristics of the technical report are the following, the latter two of which it shares with the preprint, thus permitting extensive substitution of one for the other:

1. It is written for an individual or organization that has the right to require such reports.
2. It is basically a stewardship report to some agency that has funded the research being reported.
3. It permits prompt dissemination of data and results on a typically flexible distribution basis.
4. It can recount the total research story, including exhaustive exposition, detailed tables, ample illustrations, and full discussion of unsuccessful approaches.

The individual's control of this medium is largely limited to report content. He may influence distribution, but his laboratory or funding agency controls it. Timing for many technical reports is specified in the contract under which work is done; for others, it may be the author's responsibility. Other attributes of technical reports as a whole are so heterogeneous that one can find ready examples to support almost any generalization that happens to strike his fancy: that they are too long or too short; badly refereed or well refereed—or not refereed at all; reliable or unreliable; inadequately distributed or too widely distributed; too detailed and technical or not technical enough; too expensively printed or shoddily assembled; a valuable complement to journals or a serious handicap to conventional publication. One semigeneralization that has some validity is that, while an appreciable fraction of the information in technical reports appears within a year or two in conventionally published form, a single report does not typically become a single published article. More often, a journal article will contain material from several technical reports plus data and conclusions that may never have appeared in report form; or some of the contents of a particular report may show up in several journal papers, each of which also contains other material.

Spirited arguments as to whether technical reports of the kind just described *should* exist have produced a little light, more heat, and a lot of fun over the past 25 years. Surely, however, the time for such debate is long past. Technical reports exist. For more than two decades they have been turned out in increasing quantities under a variety of auspices and conditions, and a sizable complex of accessory paraphernalia for their bibliographic control has grown up. The total annual production of these documents amounts to tens of thousands; and there are several hundred offices and agencies with responsibility for the research-and-development programs that prepare and issue the reports.

Under these circumstances, the appropriate role of scientific and technical societies appears to lie in working to improve the effectiveness of technical reports rather than in continued windmill jousting to try to eliminate them. Among the objectives to which these organizations might beneficially devote their efforts and influence is the development of a better differentiation between reports whose preparation is required for contractual purposes, such as periodic progress reports submitted at set intervals, and substantive reports whose preparation is determined by the status of work. Distribution of required reports would, of course, be at the discretion of the sponsoring agency; however, substantive reports should be treated as any other primary publications and given uniform and adequate bibliographic control. The development and adoption of such a policy could greatly enhance the usefulness of the technical report literature and is the subject of our Recommendation C15. Other areas in which the influence and efforts of scientific and technical societies would be of value are:

1. Improving the quality of technical reports with regard to such aspects as the writing itself or more effective presentation of data and results
2. Making reports or information about them more easily accessible through better or more fully coordinated services for announcement, abstracting and indexing (or their equivalents), and provision of copies
3. Achieving maximum coordination between technical report and primary journal publication programs in order to minimize confusion and undesirable duplication

E. SERIALS

Serials include such media as the conventional journals, some proceedings of meetings, and transactions of scientific and technical societies. Here, the communicator (the author) has substantially no control over either timing or distribution. His control of content is analogous to that which a federal agency has over its appropriation; he submits what he wishes to communicate, after which referees and editors decide how much, if any, of it will be published.

The "average serial" (probably as mythical as the average man) would have the following characteristics: repetitive (usually periodic) issuance; a more or less well-defined subject area; some degree of quality control of content; a fairly formal editorial structure; a format as professionally impressive as the budget permits; and, generally, a subscription price. Obviously, several of these features are not entirely unknown within the semiformal communication family. For example, the contents of some technical reports and preprints receive appreciable refereeing prior to issuance; a long, periodic series of technical reports on the same general subject eventually may become difficult to distinguish from a journal; the technical stature of semiformal documents often equals, and sometimes exceeds, that of many published papers; contractor rivalry frequently results in reports far more elegant in appearance than most journals. The published serial literature perhaps combines these various attributes more fully than does any one of the other media and probably can be thought of as constituting a fairly well-defined entity in the minds of scientists and technologists (see References 85 and 125). There are now some 30,000 or more scientific and technical journals, and for some years the birth rate has exceeded the mortality rate. That apparently no more papers per scientist are being published today than were published some decades ago is but cold comfort to the individual scientist or technologist with his personal communication problems of choosing what to read and when to write.

A further complication is that journals, in their ancient role as principal purveyors of scientific knowledge, have been expected to be all things to all scientists—to serve simultaneously as the chief medium for the announcement of new knowledge, as the fundamental archival repository of tested and accepted results, and as the major instruments through which scientists build their professional reputations. In several respects these functions are inherently incompatible. Effective performance of the announcement task requires prompt, rapid publication. But provision of a complete, reliable archival record necessitates the time-consuming tasks of prepublication refereeing and evaluation. And to the extent that scientists are judged by their professional peers (and by administrative officials who hire and promote scientists) simply on the number of their publications, the scientist is subjected to a kind of built-in pressure to publish as many papers as he can, regardless of the actual significance of their contents.* Rising costs in every phase of publication, leading to limitations on the length of papers and on the numbers of tables and illustrations that can be included, have added to the complexity of the problem. Still another factor contributing to the difficulties is the evolution of substantial areas of multidisciplinary research, for example, astrophysics, biochemistry, and geophysics. As a result, the typical individual research scientist finds himself in an increasingly difficult situation with regard to the journal literature. To cover his research interests, he needs to look at more and more different journals, all of which are continually growing in size, with "two for one splits" not uncommon. In each of these, the quantity of material not of interest to him, but within which the information he does want is submerged, also keeps expanding. Current awareness dividends are obtained at the cost of reduced reliability—and vice versa. He cannot afford to subscribe to all the journals that he feels he should, and even if he could, he would not have time to read them and get everything else done. A number of approaches have been and are being tried to assist the scientist in this many-faceted predicament.

* Currently, there are indications of the emergence of an opposing pressure to avoid duplicative and trivial publication, a tendency fostered by the low esteem in which scientists hold colleagues who indulge in this practice and by the caustic criticism that empty publication sometimes evokes.

Two possible approaches to alleviating the ills caused by the sheer quantity of the technical literature are (a) to publish less and (b) to get rid of much that already has been published. Scientists have written a great deal on the general theme of "Scientists write too much," or, at least, write too much trash. A year or so ago, for example, physicist Lewis M. Branscomb [27] wrote: "We must find a way to throw out, for good and all, a good fraction of the published scientific literature"; many others (e.g., Goudsmit [77]) have expressed similar views. The underlying questions of the contemporary value of currently published scientific and technical literature and of the length of time it will retain its value can be subjected to some degree of quantitative analysis. For example, the results of a small-scale study,[87] using a random sample of solid-state-physics papers of recent vintage, suggested that nearly half of all papers in this field retain significant value and, in particular, are not out of date or superseded even after five years have passed. Undoubtedly, many papers that contain valuable information also contain nonsense or present their cases very poorly. This fact, perhaps, is the source of the widespread contempt of scientists for the bulk of their colleagues' writings.

To combat the publish-or-perish syndrome and its inflationary effect on the quantity of scientific and technical literature, those who evaluate and judge the work of scientists and engineers, and those who are engaged in training the scientists and engineers of the future, should emphasize quality of output over the number of papers. They should also point out and stress such examples as that of the physicist, Albert Michelson, who, though his work exerted a major influence on science, published a relatively small number of papers and books. Further, his total of 75 publications did not entail the repeated issuance of the same material in slightly varying form.

The scientific and technical societies have a vital role to play both in the achievement of better publication birth control and in the exploration of procedures for the selective withdrawal or burial of useless or superseded material. One plan offered in regard to the latter is to employ two levels of abstracting: promptly issued indicative abstracts to announce the existence and availability of information, followed by informative and critical abstracts of the more useful and higher-quality material. Material for reviews and other forms of consolidation would be selected from the latter. A variety of approaches to the problem of eliminating the chaff need to be developed and tested.

The dilemma facing primary journals in trying to fulfill the dual current awareness and archival record functions has triggered various proposals for both. The relatively recent growth of letters journals—for example, *Physical Review Letters*, published weekly by the American

Physical Society, and *Applied Physics Letters,* issued semimonthly by the AIP—is a case in point. These periodicals for the most part have developed from Letters to the Editor departments in archival journals. Typically, the refereeing or editorial treatment that these letters receive is on a simple, often very stringent, acceptance or rejection basis. They are offset-printed, and the time lag from receipt of manuscript to publication can be very short. Any given item may or may not be followed eventually by a conventionally published full paper. Letters journals provide their readers with a kind of early warning system regarding work under way and give them prompt access to initial findings; they also serve the author as a medium for establishing priority of his research (see Recommendation C10).

The contradictory nature of the functions that journals have been expected to perform undoubtedly has contributed to the proliferation of certain informal and semiformal media. In some of the latter, dissemination of information can be very rapid, and there are no arbitrary space or other restrictions to prevent an author from giving a complete account of whatever research he is reporting.

A specific type of informal publication with promising potential for alleviating scientists' literature headaches is the recently proposed superjournal, a reprinted composite of the best papers from about ten or more journals of original publication (see Recommendation C10). It would share with critical reviews (discussed in Chapter 6, Section A) the role of substantially reducing the amount of material a scientist beginning work in a particular field would have to read. Because of the delay necessarily involved in such reprinting, the superjournal's principal value would be for general information rather than for communication at the research front. Such a delay also would protect the journals of original publication. The major problem presented by the publication of a superjournal is one that plagues the selection of the "best" of anything —determining the criteria for the selection and the individuals to make it.

The page-charge concept (pioneered by the American Institute of Physics almost four decades ago [17,104]) has important implications both for the cost of the journal literature to the individual scientist and for the basic relationship between research and communication. It represents one specific practical implementation of the principal stated in the first sentence of this chapter—that research is not complete until the results are published or otherwise recorded so that the scientific community can have access to them. In other words, Research = Experimentation + Making the Results Available; to spend research-and-development funds for the latter purpose is as legitimate and proper as to spend them for laboratory equipment, scientists' and technologists' salaries, and the like. Typically, the page charge is set at an amount approximately equal to the cost of getting an article ready for printing, the so-called fixed cost of publication, which includes such things as editing, preparation of manuscripts for the printer, typesetting, and proofreading. The amount of work and cost of each of these steps are proportional to the number of pages to be published and independent of the number of copies to be run. Not included in the page charge are such items as paper, folding, binding, addressing, postage, or billing, all of which are proportional to the number of subscribers and, therefore, should be covered by subscription rates. Thus, the policy recognizes that the results of scientific and technological development have value to society beyond that accruing personally to individual scientists and indicates that, while readers should pay the distribution costs of putting particular results into their hands, making the findings basically available is a proper charge against the over-all research-and-development budget. Such a division of costs and responsibilities between producers and users affords to publishers of primary journals reasonably good financial stability in the face of fluctuations in number of pages and subscribers. Though the amount of material to be published might vary, the cost and income for the editorial and composition work would remain approximately in balance. Subscription rates, of course, would have to increase somewhat with an increase in the annual total number of pages in a journal.

For a number of years there was no standard pattern among government agencies regarding the honoring of page charges; however, in October 1961, the Federal Council for Science and Technology (FCST) recognized that research was not complete until published and recommended that some part of the cost of publication be assessed, via page charges, against the original research funding (see Reference 151). The FCST stated several conditions under which it urged that all federal granting agencies honor page charges for both grantees and employees. According to a survey by the National Science Foundation,[125] very few societies—a total of 21—had used the page-charge mechanism prior to 1959. By 1962, some 38 scientific journals were levying such charges, and a dozen more indicated that they expected to do so in 1963. A recent study, funded by the NSF and conducted by the Biological Sciences Communication Project of The George Washington University,[20] provides additional data on these trends. The tendency toward broader acceptance of the page-charge concept appears to have been arrested under the impact of tightening controls on research-and-development expenditures.[104]

In addition, there is a revival of the often-heard argument that information services (secondary abstracting and indexing services, as well as the primary services that concern us here) should be supported by their users, because the users are the beneficiaries and are also the people best qualified to evaluate the services. In an unsupported free market, so the argument goes, valuable services will prosper and costly services of little value will die out. The information market, in short, is compared to that for ordinary consumer goods and services in which the stimulating effect of free competition is widely acknowledged. We accept only partial validity for this view. Surveying the response of free-market prices to changes in quantity and quality of service, we are impressed with the wide departures between the behavior of some types of information services and the classical pattern for consumer goods. These departures arise from several sources, including especially the large input costs that are independent of the number of users served and the extreme sluggishness of user response to new services. As an example of a departure from classical supply–demand behavior, we mention the situation in which libraries feel it necessary to acquire very highly priced, privately published journals as long as these contain some worthwhile material. Such journals remain economically viable as a result, though they may not, in fact, represent "good buys." At the same time, a high-quality journal can run into serious economic difficulties when an economic fluctuation causes its contributors to fall behind in honoring page charges. Relevant in this context is a comparison of journals in the field of physics with regard to number of words of scientific material received by the subscriber per subscripition dollar; the highest value of this ratio is more than 40 times the lowest.

Changing needs and opportunities require the development of more appropriate mechanisms for the support of input costs of primary journals, and the study effort advocated in Recommendation C7 (Chapter 3) should provide data to guide and facilitate their evolution. Until such time as a new dispensation can be put into effect, the continued implementation of the page-charge policy is essential for the immediate future of this country's major journals (see Reference 104). Therefore, SATCOM urges in its Recommendation C8 the continued provision of funds for publication charges not only in research-and-development agreements but also in those fellowships and traineeships that support the conduct of research.

Increasing mechanization of the primary publication process has important implications for both increased economy and improved service. The efforts of the AIP to develop a "national physics information system" (see References 6 and 103 and Chapter 7, Section B) provide an illustration. One basic phase includes development of a computer-aided photocomposition capability for use with the AIP journals. Another is the design of a new classification system for physics, to be used in conjunction with free-language index terms for intellectual organization of the physics literature. It is anticipated that classifying, indexing, and abstracting will be done by authors under the scrutiny of referees and editors. The plan then envisions a computer store that will contain both the text of a paper and the necessary bibliographic information for a variety of services, including abstracts, indexes, and special bibliographies. Other mechanization programs have different specific characteristics and vary somewhat in details of objectives, but this whole area of development is an exceedingly promising one in which scientific and technical societies can and should play a significant part (see Recommendations C12 and C13).

The field of microforms also deserves special attention and study by the scientific and technical societies. The good and bad points of microfilm, microcards, and microfiche are too familiar to require extensive discussion here. Perhaps only one society can be said to have gone "all out" in the use of a microform for primary publication. This is the Wildlife Disease Association, which publishes *Wildlife Disease* exclusively on microcards, each issue consisting of a conventionally printed pamphlet of abstracts plus microcards of the full papers. Other combinations of conventional print and microform may be well worth study to determine the optimum matching of output with user needs for different situations.

F. TRANSLATIONS

The non-English-language portion of the world's scientific and technical literature required by U.S. scientists and technologists probably amounts to as much as 50 percent, an estimate reached by the National Lending Library of Great Britain in a recent survey.[171] It also has been estimated that about one third of the world's scientific literature is published in languages that are not read by most U.S. scientists and technologists. If this proportion changes at all in the near future, it will only grow, primarily because the technologies of the emerging nations are creating a new body of literature in languages heretofore of little consequence in the technical literature. This shift in language emphasis results from both the nationalism and increasing importance of the Asian nations, particularly Japan and China, in fields of science and technology.

At present, the most expedient way to make this body of foreign-language material available is through the use of translations. Few U.S. scientists have the time or the inclination to become proficient in several languages, and fewer do so now than was true a few decades ago. Moreover, a scarcity of formal courses, qualified instructors, and adequate technical dictionaries exists, especially for the less common languages. However, no shortage of translation services is apparent.[13] Translations exist for every form of publication utilized in science and technology—books, volumes of periodicals, technical reports, individual journal articles, papers presented at conferences, and others. In many instances, journals are translated from cover to cover and regularly issued; the first of these, the *Journal of General Chemistry of the USSR* (*Zhurnal Obshchei Khimii*), appeared in an English-language version in 1949. By 1967, 183 foreign-language journals were available in English cover-to-cover translations, 160 of them with U.S. Government assistance. When publications containing selected articles or abstracts were included, the total number of translation serials amounted to 283 in 1967. Table 2 depicts the historical growth of journal translation activity in this country. Time lag from original publication to receipt of an English-language version ranges from four to 18 months.

Although the number of cover-to-cover translation journals greatly exceeds the number of selected or abstracted ones, there is some disagreement about their value. While it is undoubtedly true that much of what is translated is not worth the cost or effort, it is also extremely difficult to decide exactly what should be included or excluded. What is important to the engineer may seem trivial to the physicist. Also, one physicist's (engineer's) trash may be another physicist's (engineer's) gold mine.

Sources of translations vary widely and include individual translators, government agencies, scientific and technical societies, and commercial publishers, all of whom apparently offer this service in response to a specifically expressed need. Table 3 depicts the numbers and sources of English translation serials in 1967.

The practice of obtaining custom translations for the individual user, while satisfactory to that particular user, tends to be wasteful and in-

TABLE 2 Growth of Journal Translation Activity in the United States

Year	Number of Titles Published
1955	55
1958	108
1961	154
1964	224
1967	283

TABLE 3 Number and Sponsors of English Translation Serials Available in 1967 [a]

Type of Journal and Price Range	Number of Journals by Sponsor			
	Government [b]	Professional Society or University	Commercial Publisher	Total
Cover to cover	32	49	102	183
Selected articles or abstracts	12	12	24	48
Scheduled to begin publication in 1967	0	3	10	13
Ceased publication, but back issues available from publisher or in libraries	13	8	18	39
				283
Price range [c]	\$5–\$50 per year, \$3–\$7 per issue for material obtained from CFSTI. Free subscriptions of several journals to certain subscribers.	\$20–\$85 per year	\$10–\$245 per year	

[a] Sources of data presented in this table are References 88 & 165.
[b] Includes governments other than the United States.
[c] Single issues from CFSTI cost \$3.00 each.

efficient when the fraction of the literature covered becomes appreciable. Difficulties faced by technical librarians in identifying and locating available translations encouraged the Science and Technology Division of the Special Libraries Association (SLA) to begin collecting copies of available translations on an organized basis in 1946. By 1953, this collection and its use had increased to the extent that the need for a better system of acquisition, cataloging, and dissemination of translations was recognized and, as a result, the SLA Translations Center was established at the John Crerar Library.* This Center is a cooperative nonprofit enterprise and serves as a depository and information source for unpublished translations. Its objectives are to attempt to eliminate duplication of translation effort, to disseminate information regarding available translations, and to provide copies of translations or refer inquiries to other sources. Since 1956, operating costs of the Center have been almost wholly reimbursed by grants from various government and industrial sources, principally the NSF; however, in 1967, a small service fee was included in the price of each translation to help support the Center. Translations are deposited on a voluntary basis, and industrial participation is encouraged by the preservation of the anonymity of each translation's donor in order to safeguard the disclosure of proprietary interests in various subject areas. A number of periodic publications indicate the Center's holdings:

1. *Author List of Translations*, 1953, and its *Supplement*, 1954
2. *Bibliography of Translations of Russian Scientific and Technical Literature*, 1953–1956 (published by the Library of Congress)
3. *Translation Monthly*, 1955–1958
4. *Technical Translations*, 1959–1967
5. *Translations Register-Index*, initiated in 1967

The principal government agency responsible for providing translations of technical literature is the NSF. The National Defense Education Act of 1958 [111] specifically directs the NSF to ". . . provide for, or arrange for the provision of . . . translations and other services. . . ." The NSF handles its translations program under two different administrative arrangements. Foreign scientific literature of critical interest is made available by direct support of the publication of cover-to-cover or selective translations by U.S. scientific and technical societies. In the case of each such journal, NSF support is intended to be partial and temporary,

* The John Crerar Library recently has assumed responsibility for the SLA Translations Center and has changed the name to the National Translation Center.

continuing only until the publication becomes self-supporting. Although the NSF supported 51 translation serials—41 on a cover-to-cover basis and ten on a selective basis—at the peak of its translation program (see Reference 152), this number had decreased to 21 cover-to-cover translations and six selective serials by 1967. The others had become self-supporting. Whenever possible, commercial translation-journal efforts were encouraged, with the NSF providing financial support in some instances. Other foreign material of basic but not necessarily current interest is translated overseas under the Special Foreign Currency Science Information Program. This program, utilizing PL 480 funds, also provides English abstracts, critical reviews, and bibliographies of foreign technical literature.

While the NSF directs its translation activities toward the needs of the scientific community as a whole, other government agencies undertake such activities primarily to satisfy their mission requirements. The Joint Publications Research Service (JPRS), a component that acts as a service bureau of the Clearinghouse for Federal Scientific and Technical Information (CFSTI), handles the major portion of custom translation work for government agencies. The JPRS was established in 1957 with a small core of professional linguists and currently has contractual arrangements with some 4,000 individual translators. Since it provides translations for all government agencies, its scope is not limited to science and technology; in 1964, for example, this category accounted for only 35 percent of its total output. Individual JPRS reports are available in hard copy from both CFSTI and the U.S. Government Printing Office (GPO) as well as on microfilm from Research and Microfilm Publications, Inc.

Among the large government customers and users of translations are the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the Department of Health, Education, and Welfare (HEW). They announce their translation accessions through *U.S. Government Research and Development Reports* and through their own publications—*Technical Abstracts Bulletin, Scientific and Technical Aerospace Reports*, and *NIH Library Translations Index*, respectively—and make them available through their corresponding document-delivery systems.

Scientific and technical organizations other than SLA have been active in providing translations for the scientific and technical community. Many of the cover-to-cover journals, originally published with NSF support, are now totally the responsibility of such groups as the AIP and the American Mathematical Society (AMS). The greatest number of translation journals, both cover-to-cover and selective, are issued by commercial publishers, as Table 3 shows. The price range for these journals. although higher than that of the government-supported or society publications, does not appear to be an intolerable burden for subscribers, since few of these journals have ceased publication; in fact, the total number has increased each year.

Just as commercial publishers find it profitable to provide translation journals, commercial translation firms provide custom or individual translations for fees ranging from $6 to $40 per thousand words of English. A director of the American Translators Association estimated that the commercial translation agencies in the United States have an annual volume of about $7.5 million.[11] No estimate is available for the scientific and technical fraction of this business. Additionally, there are large numbers of freelance translators providing translations that vary widely in quality and price. The 1956 edition of *Translators and Translations* lists more than 800 government agencies, freelance translators, and commercial firms that serve as sources of translations.

Projects involving automatic processing of foreign-language materials (machine translation) have been supported by various government agencies—DOD, NSF, Central Intelligence Agency (CIA)—for almost a decade. In 1964, the Automatic Language Processing Advisory Committee (ALPAC) was formed under the aegis of the NSF to study the progress and achievements of these projects and make recommendations concerning their future development. The ALPAC's unanimous conclusion was that machine translation at that time was not feasible on a production basis and that further research should concentrate on computational linguistics.

Although the volume of translation activity in the United States is great, efforts at coordinating this activity and providing some measure of control have not been effective. European efforts at establishing national translation centers also have met with difficulties, although international centers, such as the European Atomic Energy Community (EURATOM) and the European Translation Center at Delft (ETC) have achieved some measure of success in their efforts. The ETC was established in 1961 under the sponsorship of the Organization for Economic Cooperation and Development to compile or make accessible translations into major European languages from Russian, Chinese, Japanese, and other non-Western languages. It has compiled a union catalog of translated texts and a collection of primary translations, and it issues a monthly listing of accessions as well as maintaining a file of translators.

In the United States, two organizations have been primarily responsible for making translations of scientific and technical literature available—CFSTI and the SLA Translations Center (currently the National Translations Center). From 1959 through 1966, these organizations cooperated in listing their holdings in *Technical Translations*. The CFSTI disseminated information on translations available through foreign government sources as well as those obtained by the U.S. Government; the SLA listed its accessions from private sources, such as individual translators and industrial organizations. Some commercial firms, for example, Brutcher Technical Translations, also listed their available translations through this medium. As a part of this cooperative effort, the SLA Translations Center received partial support from CFSTI; however, this support ceased in January 1967, and subsequently *Technical Translations* ceased publication. With the support of an NSF grant, the SLA started a successor publication, *Translations Register-Index*, in June 1967, which lists all SLA translations and indexes translations from all available sources.

Current services to announce available translations, though far from adequate, include the following:

1. *Guide to Scientific and Technical Journals in Translation*, published by the SLA since May 1968
2. *U.S. Government Research and Development Reports*, including government translations acquired primarily from Russian and Chinese sources (though not identified as translations in a separate section of the index)
3. *Translations Register-Index*, attempting to cover all translations into English (including the accessions of the SLA Translations Center and government translations, with efforts under way to incorporate the listings of the European Translation Center and the National Lending Library of Great Britain)
4. *Comprehensive Guide to Scientific and Technical Translations*, a cumulative index being compiled by the SLA Translations Center with support from the NSF (that was scheduled for publication late in 1968)

Major inadequacies in the current announcement media are the lack of comprehensive coverage of all available translations, the delay in announcement of available translations, and the failure to provide any mechanisms for announcement of translations in progress.

CHAPTER 5

The Basic Access Services—Document Availability, Bibliographic Control, and Abstracting and Indexing

This chapter reviews the traditional basic services that provide awareness and access to primary scientific and technical information. These services are nonspecific as to particular context or customer category and include document availability, bibliographic control, and basic abstracting and indexing. The aspects examined in this chapter are: (a) scope, coverage, and growth; (b) the nature and extent of cooperative efforts; and (c) economics and utility. The increasingly important custom-tailored, automatic or on-demand services based on the reprocessing and/or consolidation of primary and secondary information are discussed in Chapter 6.

Traditional secondary services in the numerous disciplines of science and technology vary greatly in scope, coverage, and growth. Abstracts of some kind are available in almost every subject field and range along a continuum from the infraindicative to the ultrainformative.* Indexes vary similarly in type, comprehensiveness, and pattern cumulation. In several fields a single service—library, abstract journal, or index—is recognized as the official authority for that discipline; in others, a number of services function under multiple auspices and with varying degrees of co-

* An indicative or purely descriptive abstract states only what the parent document is about; an informative abstract also summarizes the principal facts, ideas, findings, and conclusions; a critical or evaluative abstract provides some assessment of the worth or function of the content. Abstracts typically merge or vary among these types.

ordination. The extent of dependence on government programs also varies widely. In some cases, secondary services are almost entirely independent of the federal agencies that have interests in the relevant subject areas, although the latter may rely heavily on such services. In other fields, the government provides the principal secondary access services.

Cooperative efforts among the various secondary services until recently have been the exception rather than the rule, with most services pursuing their objectives and performing production processes independently. Efforts to standardize on even the simplest matters generally have been unsuccessful. Several major studies represent efforts to find better ways to coordinate and improve the complex of services.

Users often have been critical of secondary services and have complained of their high cost, inadequate coverage, and excessive time lag, while at the same time affirming the need for such services and applauding many of the newer ones that attempt to remedy these cost and time-lag problems. Although there is general agreement on the positive value and utility of these services, hard economic data, particularly on cost–benefit ratios, are lacking. As a result, it is difficult to determine how funds should be distributed among abstracting, indexing, bibliographic description, and other possible means of document identification to obtain the best performance for the investment. We do not know, for a given scientific or technical field, whether it is worth the extra money to prepare an abstract journal instead of an index journal, or to spend a fraction of that money to prepare critical reviews in addition to the index journal. Consequently, little solid information is available to guide the planning of comprehensive systems for improving literature access and use.

In recent years, the development of the traditional secondary services has been characterized by growth in size as well as number, increasing costs and financial pressures on their users, and a particularly pronounced expansion in federally operated services. Knowledge of the nature and composition of the user population of such services and of changes in this population also is increasing. Further, there is growing recognition of the librarian or information specialist as an important middleman in the flow of information from originator to consumer. In their efforts to provide the information required by the researchers they serve, these information specialists depend heavily on secondary publications and services. In many cases, they are the target audiences for such services, since they possess the special experience which enables them to exploit these resources more fully than could the researchers themselves.

A. SCOPE, COVERAGE, AND GROWTH OF ACCESS SERVICES

SERVICES ASSURING BIBLIOGRAPHIC CONTROL AND AVAILABILITY OF DOCUMENTS

The dual functions of ensuring bibliographic control and availability of documents have traditionally been performed by libraries, the oldest of all purveyors of secondary communication services. By assuring both the prompt availability of current information and the completeness of retrospective knowledge, libraries have assisted the scientific and technical community in its research and in scholarly efforts of review and analysis.

The common device utilized by all secondary services in characterizing primary publications is the bibliographic citation which, alone or in combination with a subject analysis, generally is referred to as the document representation or documentation unit of a publication. More specifically, this unit is composed of data elements which describe the work bibliographically (i.e., author, title, number of pages, size of document, and place published) and may be accompanied by identifications of the subject content of the work (index terms, classification notations, subject headings, abstracts, and the like). In a recent study sponsored by the United States of America Standards Institute (USASI) Committee on Library Work and Documentation, more than 400 distinctive data elements for describing the bibliographic aspects and subject content of major publication forms—books, serials, journal articles, technical reports, and conference proceedings—were identified.[14] The selection made from these data elements, their representation, and the ways they are manipulated and formated, as much as the coverage in subject matter and time, give abstracting and indexing publications, library catalogs, and other secondary tools their characteristics and individuality.

Traditionally, the responsibility for characterizing and recording the basic bibliographic aspects (maintaining bibliographic control) of primary information has rested with libraries. (The more extensive subject analysis required for documenting the journal literature has been the principal reason for the development of abstracting and indexing services in parallel with the libraries.) The main tools developed by libraries for this purpose include:

1. Cataloging rules, a set of conventions for characterizing bibliographic aspects of a document
2. Library catalogs, a collection of unit records of bibliographic

characterizations for each document in the library, which may appear in a variety of formats (card catalogs, book catalogs, magnetic tape records) and may be organized in a variety of ways (alphabetically by title, author, or general subject of the document; classed by subject; and the like).

The catalogs of the great national libraries—the Library of Congress, the British Museum, the Bibliothèque Nationale—are of particular importance as bibliographic tools, because these libraries, in accordance with national copyright laws, receive copies of all copyrighted publications registered in their respective countries. The principal (at least in magnitude) general secondary service that the Library of Congress provides is undoubtedly the preparation and sale of its printed catalog cards. An estimated 500 million bits of information are distributed daily to some segment of the approximately 20,000 subscribers to this service. A sizable fraction of U.S. trade books is cataloged by the Library prior to publication, and the catalog cards are available when the book comes out. Some distributors include sets of Library of Congress cards with books they sell to libraries.

Library catalogs are helpful adjuncts to the shelf access accorded U.S. scholars. They are useful for verification of titles, authorship, editions, and contents; indication of the location of at least one copy; and subject bibliographies. Efforts to publish the catalogs of the national and other major libraries in book form, thereby increasing their availability and usefulness to researchers, continue. The adoption of standards for common bibliographic elements and compatible headings would make such catalogs of even greater help to researchers. (See Recommendation B9.) In the United States, the Library of Congress, the National Agricultural Library, and the National Libary of Medicine are attempting to coordinate their respective activities in this area (see Section C of this chapter).

Numerous trade publications issued by and primarily for the book-trade industries serve as additional bibliographic tools for libraries and researchers. Compilations, such as *Books in Print*, *Subject Guide to Books in Print*, and the *American Book Publishing Record* (all by Bowker and Company) can function in much the same way as a library catalog in verifying titles and providing additional information. The *Cumulative Book Index* (H. W. Wilson and Company), which, in addition to works published in the United States, lists all other books in the English language, may be used in retrospective searching as well. Many book and periodical dealers also publish announcement services listing books currently in stock or books in various subject areas (e.g., Blackwell's subject catalogs of new and out-of-print titles or Stacey's *Off the Press*).

Adequate documentation of the journal and report literature has proved particularly difficult, since abstracting and indexing services have adopted numerous and differing practices regarding the selection, manipulation, formating, and representation of the data elements in their citations. For example, the necessity of referring to the same journal title over and over again, especially in discipline-oriented abstracting and indexing services, resulted in various forms of title abbreviations with which only frequent users of particular services are familiar. Such practices are inadequate and confusing for the larger information milieu and hamper cross-disciplinary communication. Whatever the arguments in defense of the variety of formats and information content in secondary sources, there is clearly a need to minimize inadvertent incompatibilities and avoid excessive duplication of effort (see Recommendation A11 and accompanying discussion). Section C of this chapter also discusses current cooperative efforts to achieve more broadly useful bibliographic conventions.

AVAILABILITY OF DOCUMENTS

Traditionally, the large and central research libraries [libraries of major universities, national libraries, large public libraries such as the New York (City) Public Library and the Cleveland Public Library, and private libraries such as the John Crerar Library and the Engineering Societies Library] have attempted to obtain and make readily available copies of all documents of potential relevance to their communities of users. Exemplifying this role is the Library of Congress (LC), the only federal agency with a mandate to collect, organize, and make available materials in all languages and on all subjects for use by any and all groups.[112] This institution, established in 1800, contains 55.5 million items, employs a staff of 4,000, and has some 25,000 exchange agreements with other organizations, both public and private. Its collections in science and technology total over two million monograph titles, and it receives more than 20,000 current journal titles. In fulfilling its obligations (particularly those outlined under Title II-C of the 1965 Higher Education Act), the Library has instituted a National Program for Acquisition and Cataloging (NPAC) to acquire and catalog all current publications of value to scholarship, wherever they may be published. With support of the Library, and staffed primarily by local personnel, Regional Acquisition Centers and Shared Cataloging Centers have been established in a number of foreign countries. The former are concerned primarily with acquiring publications in countries whose National Bibliographies are in an emerging state of development; one such center for East Africa has been established in Nairobi. The Shared Cataloging Centers, in cooperation with the Library's book dealers in a particular country or countries, and utilizing indigenous National Bibliographies, acquire and catalog pertinent publications issued in these countries; ten such centers providing coverage for 22 countries had been established by January 1969. Through another program, LC staff members supervise local personnel in acquiring and cataloging materials in countries where counterpart (PL 480) funds are available. Such centers now operate in five nations and at least one more is planned. Ninety-seven large research libraries in the United States also participate in the program by notifying the Library of additions to their own collections that it has not yet acquired or cataloged.

Because of the size and growth rate of the scientific and technical literature (see Chapter 4, Section A), it is clear that the holdings of any single library will constitute a steadily decreasing fraction of the total resources required by that library's usual clientele. Recent estimates suggest that not more than half a dozen U.S. university libraries acquire as much as ten percent of the materials of scholarly relevance published throughout the world. The expectation that collections can be made complementary by specialization has been justified in only a few special cases (e.g., the Harvard and MIT libraries). The traditional interlibrary loan of documents appears to be losing ground because of practical inadequacies. As a consequence, there is increasingly active development and expansion of cooperative library efforts which include: (a) the sharing and manipulation on an interlibrary basis of such access and bibliographical tools as union lists (see below) and library catalogs; (b) the use of back-stopping interlibrary services such as those extended in the United States by the Center for Research Libraries, the John Crerar and Linda Hall libraries, and the three national libraries; and (c) the use of fast, economic, and *high-quality document-reproduction* techniques, thus making interlibrary use feasible without the actual exchange of materials.

Currently, exploratory studies and projects are under way that will assist in and accelerate the modernization of library procedures and the growth of cooperative arrangements. One example is Project INTREX at MIT, which involves a series of experiments aimed at providing necessary data on user–system interaction in a library environment to guide efforts to design the computer-managed library communication networks of the future. Included among program objectives are the evolution of a digitally encoded, computer-manipulated catalog and display of full text of documents at locations remote from the library. The first experimental text-access system, which was projected for completion in late 1968, is based on the augmented catalog data and texts of 10,000 documents (from the research literature in two specific areas of materials science and engineering), with access planned through three terminals.

The functions of announcement and retrieval are the basic ones of the secondary services; however, finding a citation or abstract—except for the small proportion of adequately informative abstracts—merely initiates the information-transfer process. As the coverage of a given secondary service expands, it tends to include a larger number of citations from sources not readily available to many of its users. Therefore, a number of tools have been developed to assist in locating documents. Among them are Catalogs of Libraries, which identify the location of monographs and serials (on the assumption that the listed documents are, in fact, to be found in the indicated collections). Union lists provide a directory for the titles to be found in the libraries of a particular area and show the libraries that hold any given title. Such lists may include all titles, regardless of subject, or they may be limited to specific subjects or types of publications. In some cases, they include only acquisitions; in others, they give complete lists of holdings, including extinct publications.

The National Union Catalog, A Cumulative Author List, published by the Library of Congress in monthly issues and in quarterly, annual, and quinquennial cumulations, includes all works currently cataloged by the Library and by the libraries participating in the Shared Cataloging Program. In addition, the Catalog includes entries for monograph publications issued after 1955, reported by some 950 North American libraries, and not represented by LC printed cards. Begun in 1968, the retrospective *National Union Catalog, Pre-1965 Imprints* (about eight million titles) is being published over a period of years, thus making available in book form the total National Union Catalog maintained on cards by the Library since 1901.

The most comprehensive of these lists for periodicals is the *Union List of Serials in the United States and Canada* (third edition, 1965), which lists more than 156,000 titles, with holdings in 956 cooperating libraries. Unfortunately, this compilation only includes periodical titles published prior to 1950. Present estimates indicate that there are between 400,000 and 500,000 serial titles in existence today, most of which are for inactive serials. Because of the expense involved in the publication of such a compendium by conventional methods, no further editions will be published. Instead, attempts are being made to update this listing through the publication of *New Serial Titles,* which is issued monthly and cumulated annually and at five- and ten-year intervals. The National Serials Data Program (see Section B of this chapter) is endeavoring to establish a machine data base to characterize this entire file of information.

Other regional and subject union lists of periodicals exist that may be of more value to individual researchers because of their subject slant or the nature of the cooperating libraries. Examples are:

1. *Chemical Abstracts Service: List of Journals Abstracted in CA*
2. *North Carolina Union List of Scientific Serials*
3. *San Francisco Bay Area Union List of Periodicals: Science–Technology–Economics*
4. *The State University of New York (SUNY) Union List of Serials*

The latter, the SUNY List, is being augmented and will eventually include all the major periodical holdings of the State of New York. As a first step, the holdings of the State Library will be added; the next major effort will entail the addition of the New York Public Library's Central Research Library holdings.

The major difficulties encountered in compiling union lists are those of expense and incompatible bibliographic practices. The constantly increasing number of periodical titles in science and technology makes it difficult to undertake the compilation of these lists on a volunteer basis, as was done formerly by members of professional associations and scientific and technical societies.

As the secondary services improve in their efforts to identify relevant literature, they increase the user's problem of locating and obtaining copies of the publications to the existence of which he has been alerted. As a result, a number of abstracting and indexing services have made arrangements to provide copies on demand for all or part of the material cited in their publications. Examples of such on-demand document-delivery systems, operated in coordination with secondary publications, appear in Table 4. Since it is especially convenient for the user to be able to turn to a known source in order to obtain the original publication, it would be helpful if document-delivery systems or depots were clearly identified and established to cover all the significant scientific and technical literature. Such an approach, of course, would have to consider the copyright question because of the impact on the original publishers, especially as the volume and scope of coverage of such an on-demand delivery system increased.

Book dealers and publishers are supplementing their traditional bibliographic services to libraries with more sophisticated acquisition

TABLE 4 Examples of Document-Delivery Systems Run in Conjunction with Secondary Publications [a]

Secondary Publications	Provision of Primary Publications [b] Cited in Secondary Publications
Technical Abstracts Bulletin; Scientific and Technical Aerospace Reports	Any report without release restrictions that is not otherwise available from commercial sources or the Clearinghouse for Federal Scientific and Technical Information (CFSTI)
U.S. Government Research and Development Reports Index	All publications, available from CFSTI or other sources
Index Medicus	All publications—photocopies available to *libraries* from National Library of Medicine
Bibliography of Agriculture	All publications—photocopies available from National Agricultural Library
Chemical Abstracts	Soviet publications held by CAS and abstracted by CAS staff; other material available from Center for Research Libraries
Current Contents (Institute for Scientific Information, Inc.)	All publications
Government Printing Office Monthly Catalog	Most publications, exceptions indicated
Engineering Index	All publications, available from Engineering Societies Library

[a] Additional relevant material appears in Table 16.
[b] Available as original publication, Xerox, microfilm, or microfiche copy for purchase or loan.

and delivery programs made possible by modern data-processing techniques. The Books-Coming-Into-Print (BCIP) program of the Stacy Division of Bro-Dart, Inc., is one example. Libraries participating in this program develop a Standing Order Profile with the assistance of professional librarians and the BCIP Thesaurus and specify other criteria for their custom-tailored acquisitions programs (e.g., specific publishers to be included, instructions on order handling, additional cataloging services desired, estimate of acquisitions budget available). Through this program, libraries automatically can: (a) receive notices of all books to be published in their areas of interest; (b) acquire immediately upon publication all important books; (c) examine "on approval" all books sent; and (d) receive information on additional books considered but not shipped. At the same time, simplified ordering and handling procedures make savings in money and time possible.

ABSTRACTS AND INDEXES: TYPES AND MODES OF PREPARATION, AND THE SIZE AND SCOPE OF SUCH SERVICES

Abstracting and indexing services have been defined as continuing bibliographic services—bulletins, journals, card services, microforms, and magnetic tapes and search services—offered by various types of organizations and containing abstracts and/or references to currently published literature, including periodical articles, pamphlets, books, patents, technical reports, and related materials. Three types of functions fulfilled by abstracting and indexing services are:

1. Current awareness—the routine bombardment of each worker with an appropriate amount of information about what is going on in his specialty and in other areas relevant to his specialty. This information need not be reviewed immediately by each worker, but the flow should be so adjusted that the average worker will review 60–90 percent of it during the first four to six weeks after delivery. Reprocessing and selective dissemination of information are geared especially to the fulfillment of this function.
2. Spot look-up—up-to-date, although not exhaustive, information on a particular topic related to on-going work. Until remote computer access and printout becomes economically feasible, this need usually will be met by a service of comprehensive, at least discipline-wide, coverage.
3. Exhaustive search—covering what is known in a certain area. Such searches are necessary in the preparation of reviews, in initiating new research programs, or in writing a major account of completed work. They require the use of abstracting services with broad coverage and the full panoply of indexing services (including citation and permuted title indexes) as well as major library facilities that afford access to primary information.

The features of secondary services which make them useful for current-awareness purposes may not be appropriate for the other two functions and vice versa. For example, collections of reprinted tables of contents, such as those appearing in the *Current Contents* series, may be very useful for current awareness but very cumbersome for retrospective searching.

Three general types of abstracts that are prepared for somewhat different purposes and require different levels of subject competence for their preparation are: (a) indicative abstracts, which announce the existence of a publication and allow the reader to decide whether he wants to see the original; (b) informative abstracts, which provide substantive material from the original publication, sometimes with the purpose of substituting for the original; and (c) critical abstracts, which review and evaluate the contents of a publication.

The principal forms of indexing used by existing abstracting and indexing services include:

1. Descriptive cataloging indexes (e.g., author, corporate author, report number, contract number) that use elements of the basic bibliographic record
2. Alphabetic subject indexes, in which references are entered under subject terms (cross-references usually are employed to aid the user in locating subject terms)
3. Keyword-in-context (KWIC), keyword-out-of-context (KWOC), and keyword-and-context (KWAC) indexes, in which the key words of a title or abstract appear as index terms accompanied by contextual matter and keyed to a full citation
4. Citation indexes, in which subsequent citations that reference a previous work are grouped with the reference to the original

Other special types of indexes include those for chemical compound formulas or linear notations for chemical structures.

Assemblies of abstracts and indexes vary from traditionally printed, all-inclusive publications, often grouping abstracts in broad subject categories and incorporating supplementary indexes, such as those listed above (e.g., *Technical Abstracts Bulletin* or *Biological Abstracts*), to computer-produced special products, including specialized publications (BIOSIS's *Abstracts of Mycology*), abstracts on magnetic tape (Engineering Index's computerized system, COMPENDEX), and custom searches (CAS's Polymer Science and Technology Custom Computer Searches). Chapters 6 and 7 discuss other examples of these latter types of services and their impact.

In regard to the preparation of abstracts and indexes, there is a trend toward increased sharing of responsibility between authors and secondary services. The requirement that reports be accompanied by abstracts is spreading among government agencies, and regulations and guides for this purpose have been published.[57,61] A 1962 study of scientific and technical journals [85] showed that most of the abstracts that accompanied primary publications were author-prepared, and another study [98] produced evidence that secondary publications make extensive use of such abstracts. By 1961, 60 percent of the papers cited in *Physics Abstracts* were based upon author abstracts. Further, recent estimates suggest that about half the 50,000 abstracts currently carried by *Nuclear Science Abstracts* are author-prepared. Proponents of the author-prepared abstract believe that an author is best able to digest the essence of his paper; critics claim that an author is apt to put into the abstract what he wishes the paper contained.

Similar activities and arguments occur with regard to author-prepared index terms, although the use of such terms is still in the experimental stage. The Institute of Electrical and Electronics Engineers (IEEE) currently is experimenting with author-assisted indexing of papers, and the AIP has utilized author-prepared index terms since 1963. The latter has instigated an extensive series of indexing and classification studies to develop a new faceted classification for physics, together with separate sets of subject index terms for each of the classes. In the future, authors will be expected to use these subject terms to index their papers.

There is increasing activity in the development of thesauri for use as indexing (and retrieval) tools by both secondary services and authors. In the past year or so, NASA, the Educational Resources Information Center (ERIC), and the Department of Defense in cooperation with the Engineers Joint Council (see Section B of this chapter) have issued major thesauri. Additionally, there is renewed interest in classification schemes as indexing tools; the AIP project described above and its recently completed one on the evaluation of the Universal Decimal Classification as the indexing language for a mechanized reference-retrieval system are examples of this interest.

Either the abstract or full text can serve as the source of indexing terms. The prevailing trend is toward an increasing use of the former in the development of subject-matter indexes, a procedure that places a premium on quality abstracting, especially as computer-aided techniques of indexing, which cannot compensate for inadequate abstracting, are introduced (see Chapter 7, Section A).

Growth in the number of abstracting and indexing services in science and technology has been spectacular: In 1900, there was one abstracting service for every 46 primary journals in the United States; by 1930, the ratio was 1 to 24; and by 1950, 1 to 18.[52] Such services also have experienced a rapid growth in volume of items cited, as Table 5 shows. Some indication of the current volume processed by the major secondary services appears in Tables 6 and 7.

Two quantitative measures are of fundamental importance in assessing the performance of the aggregate of abstracting and indexing services: (a) the degree to which these services fail to cover existing information;

TABLE 5 Growth in Volume of Selected Abstracting and Indexing Services[a]

Publication	Number of Abstracts Published c. 1927	c. 1947	c. 1957	c. 1967	% Increase 1957–1967	Estimate for 1968
Applied Mechanics Review			4,245	8,802	107	9,400
Biological Abstracts[b]		21,000	40,061	125,026	212	130,000
Chemical Abstracts[c]	33,000		101,027	240,000	138	240,000
Engineering Index			26,300	56,560	115	60,000
International Aerospace Abstracts			6,770	33,116	389	34,000
Mathematical Reviews			9,200	17,141	86	17,000
Meteorological & Geoastrophysical Abstracts			5,000	9,000	80	10,000
Nuclear Science Abstracts		2,000	14,000	50,000	251	50,000
Psychological Abstracts			9,074	17,202	90	19,500
Review of Metal Literature (*Metals Abstracts* from 1968 on)			8,219	23,800	190	24,000
Tobacco Abstracts			1,798	2,966	65	3,200

[a] Data in this table are based on articles by Arntz[9] and Keenan,[97] on an informal report of BioSciences Information Service of Biological Abstracts, Inc.,[21] and on *News from Science Abstracting and Indexing Services.*[131]
[b] Does not include *Bioresearch Index*, which published 61,784 items in 1967 and had an estimated coverage of 84,000 in 1968.
[c] Major publications only; does not include subsidiary publications, such as *Basic Journal Abstracts, Chemical Titles, Chemical-Biological Activities, Polymer Science and Technology—Patents,* and *Polymer Science and Technology—Journals.*

TABLE 6 Selected U.S. Government Abstracting and Indexing Services

Service [a]	Publishing Organization	Estimated Volume of Service (per year) [b]
Index Medicus	National Library of Medicine	165,000 (1967)
Bibliography of Agriculture	National Agricultural Library	94,238 (1967)
U.S. Government Research and Development Reports (and *Index*)	Clearinghouse for Federal Scientific and Technical Information	90,000 (1967)
Nuclear Science Abstracts	Atomic Energy Commission	47,000 (1967)
Scientific and Technical Aerospace Reports	National Aeronautics and Space Administration	30,600 (1967)
Bibliography on Snow, Ice and Frozen Ground, with Abstracts	Library of Congress	1,200 (annual average)

[a] Services listed by volume of service per year in descending order.
[b] Number of abstracts and/or bibliographic citations.

TABLE 7 Selected Major, Nongovernmental, English-Language Abstracting and Indexing Services

Service [a]	Publishing Organization	Estimated Volume of Service [b]
Science Citation Index	Institute for Scientific Information	350,000 (1967)
Pandex	CCM Information Sciences, Inc.	290,000 (scheduled)
Chemical Abstracts	Chemical Abstracts Service	240,000 (1967)
BASIC	BioSciences Information Service of Biological Abstracts, Inc. (BIOSIS)	125,000 (1967)
Biological Abstracts	BIOSIS	125,000 (1967)
Applied Science and Technology Index	Wilson Co.	77,000 (1963)
Bioresearch Titles	BIOSIS	70,000
Engineering Index	Engineering Index, Inc.	60,000 (1966)
Solid State Abstracts	Cambridge Communications, Inc.	44,000 (1965)
Physics Abstracts	Institution of Electrical Engineers (London)	41,000 (1967)
Biological and Agricultural Index	Wilson Co.	41,000 (1967)
International Aerospace Abstracts	American Institute of Aeronautics and Astronautics	33,000 (1967)
Review of Metal Literature	American Society for Metals	25,000 (1967)
Electrical and Electronics Abstracts	Institution of Electrical Engineers (London) and (from Jan. 1968) the Institute of Electrical and Electronics Engineers	24,000 (1967)
Psychological Abstracts	American Psychological Association	17,200 (1967)
Mathematical Reviews	American Mathematical Society	17,1[illegible]1 (1967)
Index Chemicus	Institute for Scientific Information	10,000 (1967)
Applied Mechanics Reviews	American Society of Mechanical Engineers	9,800 (1967)
Meteorological and Geoastrophysical Abstracts	American Meteorological Society	9,000 (1967)

[a] Services listed by volume of service per year in descending order.
[b] Estimated volume refers to the number of abstracts and/or bibliographic citations.

and (b) the degree to which they overlap in coverage. Data on both gaps and overlap are only fragmentary. The System Development Corporation, in a study of abstracting and indexing services,[168] endeavored to characterize coverage by determining the number of services operating in each of the 178 subject subfields of the COSATI list (issued in 1964 and extended in 1966 [44,47]). Any organization whose services cited some of the literature in a given field were included. For a sample of 30 U.S. organizations publishing abstracts and indexes (including the largest services and those most influential in the scientific community), the number of services per COSATI subfield ranged from two to 18, with a median of 11. These results showed that the areas of coverage of present abstracting and indexing services are fragmented and their boundaries irregular.

A number of other studies also have endeavored to identify gaps in completeness and consistency of coverage. A recent comparison [113] of bibliographies with abstract journals indicated that one fifth of the bibliographic references were not covered by the abstracting journals and that nearly half (47 percent) were covered more than once. An AIP study of 2,246 articles in 19 physics journals showed that five percent (126) of the relevant articles were not indexed in either *Nuclear Science Abstracts* or *Physics Abstracts* and that an overlap of 54 percent in coverage existed between them.[81]

Overlapping coverage among secondary services has both advantages and drawbacks. Multiple printing of the same abstracts is relatively inexpensive and brings information to scientists and technologists that otherwise might be overlooked by them, since no one can use all secondary alerting and reference services. *Biological Abstracts* and *Chemical Abstracts* exchange thousands of abstracts a year instead of preparing them separately, a procedure that is functional and economical. The modern technologies of photocomposition and computer composition (see Chapter 7, Section A) combined with offset printing, though they make the multiple publication of abstracts easy and inexpensive, raise problems of economics and law when carried to the point at which similar, and thus competitive, products result. Such problems have occurred when the broad scope of a large, mission-oriented, federal agency program duplicates sizable portions of discipline-oriented systems.

In addition to the problems of coordination and equitable reimbursement raised by reprinting of secondary material, duplication of intellectual effort through allowing the same publication to be abstracted independently several times is an area of serious concern. Such duplication wastes a kind of time and energy that already is in short supply. Unfortunately, there are no up-to-date and reliable results on the amount of duplication of effort taking place; existing studies not only are outdated, but they generally fail to distinguish between duplication of intellectual effort and multiple printing. Nor is the degree of overlap by subject and publication coverage sufficiently well characterized to assist a user in choosing the particular service or services that are best suited to his needs. For example, a physicist interested in nuclear structure cannot know *a priori* whether to use the nuclear section of *Physics Abstracts,* the physics section of *Nuclear Science Abstracts,* or both. Table 8 gives

TABLE 8 Indications of Overlapping Coverage among Secondary Services[a]

Services	Degree of Overlap
Biological Abstracts (BA) versus *Chemical Abstracts* (CA) versus *Physics Abstracts* (PA)	57% of a sample covered by PA also covered by CA; 40% of a sample covered by BA also covered by CA
BA versus *Excerpta Medica* (EM)	52% of a sample of 95 cardiovascular, endocrine, and psychopharmacologic papers covered by BA also covered by EM
BA versus *Index Medicus* (IM)	54% of the serials covered by IM also covered by BA
CA versus BA	20% of 110,000 items in BA also covered by CA
CA versus *Geoscience Abstracts* (GSA)	20% of 6,000 items in GSA also covered by CA
CA versus *International Aerospace Abstracts* (IAA)	25% of 30,000 items in IAA also covered by CA
CA versus *Nuclear Science Abstracts* (NSA)	51% of 17,600 reports covered by NSA also covered by CA (using in this instance NSA-prepared abstracts); 58% of 27,900 journal articles in NSA also covered by CA; and 73% of 2,630 patents in NSA also covered by CA
CA versus *Review of Metal Literature*	55% of 18,000 items in *Review of Metal Literature* also covered by CA
CA versus *Scientific and Technical Aerospace Reports* (STAR)	14% of 36,?00 articles in STAR also covered by CA
CA versus *Technical Translations*	73% of 24,000 items in *Technical Translations* also covered by CA
PA versus NSA	54% of a sample of 2,246 articles appeared in both PA and NSA

[a] Data in this table are based on reports by Chemical Abstracts Service,[18] Garfield and Sher,[70] Greer and Atherton,[81] and Orr and Crouse.[116]

some indication of the multiple coverage provided by some of the major secondary services.

The importance of time lag—the period that elapses between the publication of primary literature and its notation in secondary publications—varies in different disciplines, though speed of reporting is always desirable. During the period 1964–1966, *Psychological Abstracts* reduced its time lag for "core" journals in this field from roughly 20 to three months.[71] The median over-all time lag between date of primary publication and the date at which *Chemical Abstracts* is sent to subscribers is 14 weeks; however, this time lag is only four weeks for *Chemical-Biological Activities* (CBAC) and *Chemical Titles* (CT).

Coverage of foreign publications typically involves a greater time lag than is true of domestic material, not only because of delays in receipt of issues but also because of the translation skills necessary to process them. According to a recent study of abstracting and indexing services,[163] approximately half (46 percent) of the material acquired by U.S. federal, society, commercial, industrial, and institutional secondary services taken together comes from foreign sources.

Some services treat foreign material in a different way from domestic, and some show no substantial delay in the processing of foreign material. An example of special treatment of foreign literature is the policy of *Psychological Abstracts*. In this field, foreign journals typically are peripheral rather than core sources. Such peripheral literature is cited and indexed upon receipt to provide awareness of its existence; however, it is not abstracted until additional information on its relevance to psychology is obtained or a body of related articles has accumulated. An example of prompt coverage is Chemical Abstracts Service, which maintains a median time lag of three to four months, though 70 percent of its input is foreign.

B. THE NATURE AND EXTENT OF COOPERATIVE EFFORTS

One of the principal reasons generally advanced in favor of improving cooperation and coordination among secondary services, and between secondary and primary services as well, is to reduce wasteful duplication of intellectual effort and the expense incurred in providing duplicate coverage of the same material. Another major reason is to increase the opportunities for improving the performance of specific services through enhancing the speed or comprehensiveness of coverage or reducing costs. In addition, greater cooperation and coordination of services could reduce the number of sources that a user must check in a given field and would assist in deciding when new services are appropriate or feasible.

Factors militating against extensive cooperation and coordination include:

1. Basic conflicts in the goals, incentives, and constraints which influence the various producing organizations (commercial establishments, federal agencies, scientific and technical societies, and others)
2. Fair trade, antitrust, and other legislative acts, which can inhibit cooperative efforts to apportion coverage or to reach agreements on pricing policies
3. Lack of the incentives or resources necessary to effect cooperative arrangements
4. Inertia or pride in service traditions, which inhibits the discontinuation or merging of services
5. The absence of an organization with the mandate and sufficient resources to foster coordination among such services at the national level
6. Technical problems (e.g., different methods of abstracting and indexing, different bibliographic tape formats) and economic problems, which create obstacles to the adoption and use by one service of the products of others

In recent years the federal government has sponsored a number of studies directed toward improving coordination among secondary services. Some of these efforts focused on the design of national systems, especially in major disciplines. Examples of such studies are:

1. AIP study of a national system for physics information [6]
2. American Psychological Association studies of scientific information exchange in psychology [12]
3. EDUCOM summer study on information networks [29]
4. Greer's analysis of coverage and recommendations for improvements of the U.S National Bibliography [80]
5. Robert Heller and Associates' plan for introducing greater cooperation among secondary services and strengthening the role of the National Federation of Science Indexing and Abstracting Services [144]
6. Information Management, Inc., plan for the development of a national chemical information system [86]
7. System Development Corporation studies of national document-handling systems [37] and of abstracting and indexing services [143]

In addition, a number of studies represented fact-finding efforts to identify and resolve problems that hinder cooperation. Among such efforts were: (a) the National Bureau of Standards study of index-language convertibility, cooperation, and compatibility [84]; (b) the study of the Task Group for the Interchange of Scientific and Technical Information in Machine Language (ISTIM)[181]; (c) the Library of Congress MARC Project [19]; and (d) the studies of the Committee to Investigate Copyright Problems Affecting Communication in Science Education, Inc.[188]

Other groups that have been especially concerned with improved coordination among scientific-and-technical-communication activities include such National Academy organizations as the Council on Biological Sciences Information, the Division of Medical Sciences,[89] the Committee on Information in the Behavioral Sciences,[42] and the Committee on Scientific and Technical Communication (SATCOM).

Further, in the Executive Office of the President, a series of special studies was initiated (see Chapter 8, Section B) of which an outstanding example is the report of the Weinberg Panel [178] of the President's Science Advisory Committee.

A variety of mechanisms have been employed to achieve greater cooperation among secondary services; however, all too often the measures explored or adopted have dealt largely with operational aspects rather than with broader underlying issues. As a result, they have not been successful in bringing together the efforts of the numerous organizations and institutions involved in secondary information programs and in directing them toward long-term objectives of comprehensive scope. This section describes some of the principal current cooperative activities.

Programs to Enhance Cooperation in Bibliographic Control and Availability of Documents

The development of bibliographic standards and standard practices among federal and private groups is a major focus of cooperative activities. Table 9 describes a number of such efforts. Two programs currently under way are expected to make significant contributions toward establishing standards that will assist in bibliographic control and document delivery. The first of these is the National Serials Data Program, in which the National Library of Medicine and the National Agricultural Library are cooperating with the Library of Congress. The Program involves the development of a national data store of machine-readable information on all serial publications and, when fully implemented, will

TABLE 9 Examples of Standards Relevant to Secondary Information Services

Standard or Standard Practice	History
Microfiche format for report filming	Jointly established by DOD, AEC, NASA, and Dept. of Commerce for their use in 1964; published by COSATI as a Federal Microfiche Standard in 1965, concurrent with the President's Science Adviser's request that federal agencies takes steps as rapidly as possible to obtain acceptance of the standards within their organizations and by their contractors. Later adopted as standard by the National Microfilm Association and now in widespread commercial use. (Reference 45)
Bibliographic machine record	MARC-1 format established by Library of Congress for pilot project and used by about 25 participating libraries. Revised MARC-2 format adopted by American Library Association as standard bibliographic machine record for information interchange. (Reference 13)
	Subcommittee SC-2 (Machine Input Records) of USASI Committee Z39 (Standardization in the Field of Library Work, Documentation, and Related Publishing Practices) also issued (May 1967) a comprehensive report entitled *The Identification of Data Elements in Bibliographic Records* as the first step in developing USASI standards for "identifying and recording bibliographic and textual elements to be used in machine-readable data systems, in libraries and related institutions and organizations producing information in such institutions." (Reference 56)
Codification of cataloging rules	Anglo-American cataloging rules defined by professional society groups, including the American Library Association, The (British) Library Association, and the Canadian Library Association, with the active participation of the Library of Congress. Now adopted unofficially as the standard for cataloging in many U.S. libraries. (Reference 7)
Descriptive cataloging of reports	Several federal agencies (e.g., AEC) established guides or rules for the proper cataloging description of reports. COSATI prepared such a standard in 1963 and revised it in 1966. The practices have been codified and accepted as general practice for many U.S. technical libraries. (Reference 49)
Documentation units to accompany technical reports	DOD established a requirement in 1964 that all technical reports prepared by DOD offices, contractors, subcontractors, and grantees include a summary page (DD Form 1473) consisting of an abstract and all necessary bibliographic data to describe the report completely. Several agencies (e.g., Office of Education) have made a similar requirement for their technical reports. The practice is being accepted by increasing numbers of producers of technical reports. (References 58 and 61)

TABLE 9—*Continued*

Standard or Standard Practice	History
Standard for periodical title abbreviations	Developed by Subcommittee C-3 (Periodical Title Abbreviations) of USASI Committee Z39 and maintained and updated by the USASI-sponsored, NSF-supported National Clearinghouse for Periodical Title Word Abbreviations, located at Chemical Abstracts Service. (Reference 167)
Indexing language	Individual federal agencies (e.g., Bureau of Ships, Defense Documentation Center) developed thesauri of indexing terms for their own subject fields. A DOD-wide thesaurus was developed later in conjunction with the Engineers Joint Council and has been released for general distribution. This thesaurus will receive widespread use by many technical libraries. (Reference 166)
Abstracting	Several federal agencies have prepared instructions and guidelines to assist in the preparation of abstracts. The Defense Documentation Center also published such guidelines in 1968. (Reference 57)
Subject categories	COSATI established a Subject Category List to be used for the announcement and distribution of technical reports by federal agencies. Several announcement publications (e.g., TAB) produced by federal agencies have used this list; however, its use has not extended significantly beyond the federal sector. (References 44 and 47)

collect data about serials continuously, will file and update information about them, and will make this information available to the research community in a current and useful form. Control of serial literature has been long recognized as a particularly difficult problem because its bibliographic data elements are highly mobile and require constant updating, and titles often are difficult to identify, describe, and locate. Anticipated products from the data store amassed in the course of the program include: an exhaustive identification and unique registry of the world's serial literature; information on holdings and locations for all serials; acquisition and selection tools, such as printouts of accession lists; a basis for cooperative acquisition programs; a data base for standardization; a means for measuring abstracting and indexing coverage, including an analysis of patterns of overlap or gaps in coverage; and the publication and dissemination of special union lists by categories (see Reference 172).

A second major program is Project MARC, the objective of which is the development of a standard machine-readable equivalent of catalog-card data. Project MARC (i.e., Machine-Readable Cataloging) was launched in 1966 in the Information Systems Office of the Library of Congress and is partially supported by the Council on Library Resources. The daily conversion of current catalog data for English-language monographs into machine-readable form is accomplished by keyboarding onto paper tape and processing on the Library's computer system. Data on magnetic tapes have been distributed weekly to a representative group of libraries that are broadly distributed geographically and include a variety of types—school, public, research, and university. Each library is responsible for reporting on the services and products that it develops with these data and the problems encountered in use. In addition to cataloging data normally carried by the Library of Congress printed card, the MARC record includes codes to allow more efficient machine manipulation of data.

Following the 1966–1967 pilot project, a new processing system and format—MARC II—were designed and put into operation. As a result of the library community's general acceptance of this format, the Library plans to initiate a MARC Distribution Service on a subscription basis in 1969. This service will provide magnetic tapes containing MARC records for currently cataloged books in English. The Library also is seeking the most expeditious way to convert its retrospective cataloging records into MARC II format.

As a part of its National Program for Acquisition and Cataloging, the Library of Congress cooperates with 97 large research libraries in acquiring and disseminating catalog data. It supplies these libraries with complete depository sets of LC catalog data in the form of LC cards, thus precluding the necessity for their cataloging the same materials, and they, in turn, provide the Library of Congress with information on publications in their collections that it has not acquired or cataloged. Adaptation of cataloging data acquired through the Shared Cataloging Program also is being examined as a possible step toward furthering international standardization of cataloging practices.

The Task Force on Automation and Other Cooperative Services, organized in June 1967 by the three national libraries (the Library of Congress, the National Library of Medicine, and the National Agricultural Library), is another cooperative venture aimed at improving bibliographic control and availability of documents. Its major objectives are the resolution of incompatible practices in descriptive and subject cataloging, agreement on machine-readable cataloging data formats, establishment of a program to create a machine-readable bank of information on serial publications, and the development of joint catalog-card and book-catalog services. In mid-1968, the three Libraries adopted the

MARC II format and approved a recommendation that will effect greater compatibility in descriptive cataloging; a number of Working Groups currently are studying other areas of cooperation.

The more broadly based Federal Library Committee was established in 1965 to provide for coordination among the approximately 2,200 federal libraries and to consider problems and develop policies relating to their performance.[44] The Committee has identified problem areas needing federal attention, established procedures of interest to federal librarians, and conducted fact-finding studies. One example of the Committee's efforts is a 1967 handbook to provide information to the federal acquisitions librarians in regard to federal procurement practices; it describes devices and tactics that have proved successful and calls attention to special sources of supply.[45] Another example is its 1968 *Federal Interlibrary Loan Code*.[46] Because of the limited charter of this group, it has not been a significant influence in fostering coordination on a national basis; however, it has recommended that all federal libraries accept the MARC II format as the basis for communicating bibliographic information electronically and is taking steps to secure the adoption of MARC II as a federal government standard.

The number of regionally affiliated library groups serving particular geographic and/or subject-oriented communities is growing, and their services are provided increasingly often on a cost-reimbursable basis. Examples of this trend are the developing programs at Stanford University and MIT, and that of the Library Group of Southwestern Connecticut (see Chapter 6, Section C), which now serves the library needs of a local group of industrial organizations. The Regional Communications and Information Exchange is a similar network connecting university libraries throughout the Gulf Coast area (see Chapter 6, Section C). Based on the Library of Rice University (Houston), this program involves the development of centralized bibliographic references and intranetwork location and transfer services. Teletype facilities will link the college and university libraries participating in the program. In addition, Rice University will study and plan for an expanded computer-based regional bibliographic reference service through a coordinated program of regional library acquisition and exchange. Network services will be available to the 18 academic institutions participating in the network and, on an individual fee basis, to outside investigators.[19]

Cooperation among Abstracting and Indexing Services

In our discussion of cooperation among abstracting and indexing services, we will look first at the organizations that foster cooperation, and second, at the areas of cooperation themselves. Scientific and technical societies have been interested predominantly in the information problems of their own members, and their planning generally has been limited to what could be accomplished by a volunteer staff. A significant trend dates from 1958 and the establishment, for the first time, of a full-time staff at a scientific and technical society headquarters (American Institute of Physics) with the specific assignment of finding ways to improve the total information services for the membership of that society. Subsequently, the American Psychological Association developed a similar staff, and more recently, the American Mathematical Society, the Institute of Electrical and Electronics Engineers, the American Chemical Society, and the American Geological Institute have established in-house staffs and/or advisory committees to review and improve their total information programs. The National Science Foundation supports many of these efforts and continues to encourage major scientific and technical societies in the development of such capabilities. Other federal agencies also have assisted efforts of this kind on the part of private organizations when the activities of the latter could support agency missions. The economic aspects of these arrangements are treated in Section C of this chapter.

In addition to internal efforts to improve scientific and technical communication, organizations that operate indexing and abstracting services have increased their efforts toward interorganizational cooperation. In 1964, the American Society for Metals and Engineering Index, Inc., embarked on a cooperative program which has resulted in a common computer-produced indexing system. Now utilized by *Metals Abstracts* and *Engineering Index, Plastics Section,* this system makes it possible to merge these indexes and provides for the preparation and joint marketing of new products based on them.

Another example of interorganizational cooperation is the formation of the Joint Agreement Group (JAG) in mid-1968, which is composed of representatives from the American Institute of Physics, the American Federation of Information Processing Societies, the Association for Computing Machinery, the Institute of Electrical and Electronics Engineers, the American Mathematical Society, the Center for Computer Sciences and Technology of the National Bureau of Standards, and Engineering Index, Inc. The Group is working toward agreements on common definitions of data elements and specifications of tape formats, with the objective of assuring a high degree of compatibility among the participating societies and convertibility with other systems. Other interested organizations include the Technical Information Program (TIP) at MIT, Chemical Abstracts Service, and BioSciences Information Service, Inc. The Group also maintains close liaison with other national efforts to standardize bibliographic tapes, including those of the National Federation of Science Abstracting and Indexing Services, the U.S.A. Standards Institute, and the Library of Congress. (See Reference 3.)

The National Federation of Science Abstracting and Indexing Services (NFSAIS) was established in 1957 as a forum for a group of institutional members representing major noncommercial secondary publishers and has been active since that time with annual conventions, study committees, and work on problems of mutual interest to the group members. It has made a number of useful contributions, such as the publication of the *Guide to the World's Abstracting and Indexing Services in Science and Technology* (1963), and agreements on a character transliteration scheme to be used by most of its members in their publications. Adoption of procedures proposed by the Federation is voluntary (for members as well as other groups). In 1962, the Federation secured NSF support for its sponsorship of a study by Robert Heller and Associates [114] to develop a national plan for abstracting and indexing services (see Chapter 8, Section B). No major action resulted from this study. When it became clear that federal services were not permitted by statute to be dues-paying members of such an organization, these members had to drop out. The remaining members represent private not-for-profit services. Since the establishment of SATCOM, and perhaps encouraged by this action, the Federation has become more active. Because we believe that NFSAIS deserves encouragement and support, we have proposed that it assume leadership in and responsibility for some of the endeavors proposed in our recommendations (see Recommendations B12, C4, and related discussion).

Yet another organization that can be expected to exert a coordinating influence on scientific and technical communication activities is the newly formed Information Industry Association. The Association's objectives are to coordinate the interests and programs of the commercial organizations that create, supply, and distribute information services of all types, particularly those using the more advanced forms of information technology, and to provide opportunities to interact with federal and noncommercial private organizations. Though it is not concerned solely with abstracting and indexing services, the Association has among its 20 members many who are active in this area. The Association expects to establish liaison with other organizations in the information field, including book-industry associations, and has indicated the following areas of particular concern to it: (a) the eligibility of private firms to bid on government contracts; (b) copyright; (c) standards for data interchange; (d) public relations efforts in behalf of the profit-seeking information industry; (e) informative and educational meetings for its members; (f) efforts to bring about uniform policies among government agencies; and (g) the exchange of information among its members about trends and events affecting the orderly development of the new techniques for disseminating information.

Among the federal organizations that take an active part in and exert a major influence on scientific and technical communication is the Committee on Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology. COSATI has taken a leading role in the establishment of practices that foster cooperation and coordination among the abstracting and indexing services operated by federal agencies. Included among its contributions are:

1. The development of the COSATI Subject Category List and its use as a standard for uniform subject headings for major federal technical report announcement and distribution services
2. The development of standards for technical report formats and for the descriptive cataloging of technical reports (the latter, by a happy coincidence, is compatible with the new Anglo-American Standard for Cataloging)
3. The development of recommendations on U.S. government-wide policies for domestic and foreign distribution of abstracting and indexing services and other bibliographic tools, including magnetic tape records, and policies for acquisition by federal agencies of foreign-produced primary and secondary information (see Chapter 9, Section A)

Individual federal agencies have prepared instructions and guidelines to assist their contractors in the preparation of abstracts and indexing terms for technical reports; these guidelines also are utilized by the secondary services of the agencies. Efforts by some interested federal organizations have resulted in a number of very effective consolidations of these secondary information services. One recent example is the *U.S. Government Research and Development Reports Index*, established in May 1965; machine bibliographic records from the AEC, NASA, DDC, and CFSTI are used to prepare a single publication of subject, author, corporate author, and report number indexes for this large and diverse body of literature.

Variations in index terminology and structure rank next to the absence of standards for bibliographic formats as a major problem area. Traditionally, the individual services have produced lists of subject headings or index terms for broad use within their respective domains, with little or no attempt to effect interservice comparability. In an effort to reduce this problem, the DOD sponsored Project LEX, which involved the preparation of one of the most comprehensive thesauri in science and technology.[144] It incorporates the indexing experiences of the principal federal agencies and has been coordinated with the Engineers Joint Council Thesaurus. Accumulating evidence suggests, however, that beyond a certain point the endeavor to achieve universality is apt to yield diminishing returns as a result of inevitable ambiguities in meaning and unresolvable differences in the hierarchical position of various terms in different schemes.

Cooperative efforts, fostered by government and private organizations, also are developing at the international level. Chapter 9 presents a detailed discussion of direct cooperative arrangements together with representative examples.

C. ECONOMICS AND UTILITY OF SERVICES

This final section deals with: (a) trends in costs and pricing of the basic secondary services: (b) relative costs of the various services; (c) forms of support; and (d) the utility of secondary services.

Trends in Costs and Pricing of Basic Secondary Services

Library costs tend to vary directly with acquisition costs and in rough approximation to the latter costs. Because of the generally increasing costs of publications and salaries, recent estimates suggest that library budgets will have to increase about ten percent each year to maintain equivalent levels of bibliographic and document-handling services at constant volume of annual input.

Several general price indexes are available and are reported periodically to indicate the relative increase in prices of primary documents over the years. For example, between 1957–1959 and 1966, the book price index rose from 100 to 150.8.[11] Periodical subscription prices have shown a corresponding steady upward trend The 1967 average subscription price for U.S. periodicals was $8.02, and the price index, based on 1957–1959 prices was 163.0. The comparable figures for 1966 were $7.44 and 151.2. Examples of U.S. periodical prices in science and technology, which are consistently higher than the average, appear in Table 10.

No similar price index is available for secondary publications, but the general trend also has been one of increasing cost to the subscriber. Table 11 shows price increases associated with several specific secon-

TABLE 10 Prices of U.S. Scientific and Technical Periodicals [a]

Subject Field	Average 1967 Price	Index [b]
Agriculture	$ 4.34	163.8
Chemistry and physics	22.35	222.6
Engineering	9.04	167.4
Mathematics, botany, geology, general science	13.75	219.3
Medicine	17.97	181.5
Zoology	12.53	155.8

[a] Data in this table are based on information in the *Library Journal* [148] and the *Bowker Annual*.[24]
[b] Index of 100.0 is equivalent to average price for 1957–1959.

dary publications. The escalation of costs results partly from the general growth in processed volume and partly from increased costs on a per-entry basis.

With the necessary increase in subscription prices to meet increased production costs, the major secondary services are fast becoming too expensive for individual subscribers, and in some instances for the less affluent institutions as well. For example, a large number of colleges with chemistry courses and laboratories do not subscribe to *Chemical Abstracts*. Other publishers have noted similar trends. The situation seems to be one in which many researchers and educators who should have these reference tools are unable to afford them. Special grants and federal funds are available to assist in some of these cases, but many organizations have not taken advantage of them, possibly through lack of awareness or because of the cumbersome application procedures.

Several secondary services utilize preferential pricing patterns in order to maximize subscription incomes, and many of the larger services do so in an effort to encourage academic institutions to continue to subscribe. Scientific and technical society publishers often reduce the subscription costs for their members, thus encouraging subscriptions. At times, however, discount arrangements for individual members have been abused (e.g., organizations pay for subscriptions for individual staff members, with the clear understanding that the purchased copy will go to the organization's library for general staff use), and some publishers have ceased offering such arrangements.

Also in use are flexible pricing practices, which set the price for each facility according to: (a) the number of potential users at that facility, thus providing compensation in proportion to the value of the publication to the organization; and (b) the total library budget for periodicals at the facility, thus providing compensation in proportion to the

Publication	Type of Publisher	1963 Library Subscription Price (USA) [a]	1963 Total Entries	1968 Library Subscription Price (USA) [a]	1968 Total Entries	Increase in Subscription Price, %	Increase in Price per Entry, %
Applied Mechanics Reviews	Society	$ 25	7,000	$ 80	9,426	220	138
Bibliography of Agriculture	Federal	10	105,409	19	111,665	90	79
Biological Abstracts	Society	225	100,862	480	214,000 [b]	113	44
Chemical Abstracts	Society	1,000	165,000	1,550	251,884	55	0
Engineering Index [c]	Society	75	34,000	175	61,231	133	27
International Aerospace Abstracts	Society	60	11,000	33 [d]	36,161	— 45	— 83
Index Medicus	Federal	26	130,000	55	207,000	112	30
Mathematical Reviews	Society	100	13,297	246	15,179	146	113
Nuclear Science Abstracts	Federal	37	33,000	42 [e]	53,507	11	— 30
Physics Abstracts	Society	17	15,000	192	50,477	1,030	236
Psychological Abstracts	Society	20	10,000	30	19,586	50	— 10
Review of Metal Literature [f]	Society	20	12,000	200	23,007	900	412

[a] Price at which available to general public.
[b] Includes *Biological Abstracts* and *Bioresearch Index*.
[c] Annual index only.
[d] Issues only; indexes cost $30.00.
[e] Free on exchange to colleges, universities, commercial publishers, research institutes, and industrial firms.
[f] Currently *Metals Abstracts*.

TABLE 12 Price Differentials of Secondary Services

Publication	Subscription Cost to General Public	Exceptions
Biological Abstracts	$ 800	$640 to individuals, nonprofit and educational institutions
Chemical Abstracts	1,550	$500 grant toward subscription price allowed colleges and universities
Chemical Titles	50	$25 to ACS members, colleges, and universities
Current Contents		
Life Sciences and Physical Sciences	100	$67.50 to educational institutions
Chemical Sciences	100	No exceptions
Engineering Index (monthly)	350	No exceptions
Index Chemicus	900	$550 to educational institutions
International Pharmaceutical Abstracts	75 (to industry)	$30 to others
Science Citation Index	1,250	No exceptions
Permuterm Subject Index	700	No exceptions

facility's ability to pay. Table 12 gives some examples of the extent of pricing differentials.

Relative Costs for Various Types of Services

There is a continuum of possible product forms for secondary publications, ranging from the simplest listing of bibliographic citations to a collection of critical reviews. The secondary publication forms listed below in the order of increasing cost of preparation give a rough indication of some of the points on this continuum.

1. Collected contents pages
2. Simple list of references (bibliography)
3. Title listing arranged in broad groups
4. Title listing accompanied by indexes

5. Title listing with annotations and indexes
6. Collections of author abstracts
7. Abstracts collected in broad groups
8. Abstract collection with indexes
9. Critical reviews

The preparation of these products requires progressively greater levels of skill in foreign languages and subject matter as well as increasing the work of composition and often necessitating special graphic materials, such as mathematical formulas or chemical structure diagrams. (See also Chapter 6, Section D.)

Quantitative data on the relative costs of secondary information-service operations pose persistent problems of interpretation and comparison because of the widely differing circumstances that affect the economics of such programs. Estimates based on "the lore of the trade" indicate that per-entry costs for the production of an abstract journal are from two to five times the per-entry costs of an indexing service and about ten times the per-entry costs of a bibliography.

The COSATI-sponsored study of national document-handling systems in science and technology[87] reported that abstract production costs in eight major nonfederal abstracting and indexing services in 1964 ranged from $8.70 (*Biological Abstracts*) to $33.30 (*Meteorological and Geoastrophysical Abstracts*) per abstract, with an average (mean) cost among these eight services of $18.70. The total number of abstracts included ranged from 6,000 (*Geoscience Abstracts*) to 188,000 (*Chemical Abstracts*), and the total cost of production, from $81,000 (*Geoscience Abstracts*) to $4,904,850 (*Chemical Abstracts*). Major factors in production costs, such as indexing and the number of copies distributed (publication edition), are critical in determining the unit cost per abstract. Such factors vary greatly in quality and quantity, respectively, among services and contribute to the difficulty in establishing comparable cost bases.

The lack of comparable cost bases has hindered the development of cooperative programs to eliminate duplication of effort. While certain programs can be based on mutually beneficial barter arrangements (see the description of the International Nuclear Information System in Chapter 9, Section A), others can be achieved only when equitable payment for services rendered is possible. Under present conditions, it is difficult to arrive at pricing policies assuring such equity; therefore, examples of the outright sale of abstracts or other products among abstracting and indexing services are few.

Each of the major publisher categories—federal agencies, scientific and technical societies, and commercial establishments—faces a different cost picture and must adjust its pricing policies to a different set of factors. Federally operated secondary services tend to derive a significant fraction of input material and processing from activities other than the service operation itself. Provision for such activities typically is made elsewhere in the agency budget. Since user charges are not closely coupled to the full production costs, federally operated secondary services are generally less costly to those users to whom they are available than services in the same field that are privately operated. The subscription prices of *Nuclear Science Abstracts* and the *Bibliography of Agriculture*, for example, are set at figures that cover only the runoff costs for preparing the number of copies required for distribution outside the government and do not include any of the costs of acquiring or processing the primary material. Comparable policies apply to a wide range of services, including publications, translations, and hard-copy delivery.

In comparison with commercially operated secondary services, the costs of those operated by scientific and technical organizations are affected by their tax-exempt status, their ability to rely more extensively on voluntary assistance, and the use of primary materials produced under their aegis in exchange arrangements. Commercial establishments, on the other hand, tend to have a better knowledge of markets, a better marketing organization, and more efficient management practices. In regard to pricing, scientific and technical societies have the option of covering a suitable portion of their secondary service costs through a levy on the membership as a part of the dues.

Forms of Support

Many forms of support contribute to the maintenance of secondary services. Revenues from subscriptions and advertisements constitute the principal source; levies on society membership, industrial support, and federal subsidy are added to these in widely varying proportions. Table 13 depicts some types of secondary services and their sources of support.

A few of the major privately operated abstracting and indexing services, such as *Biological Abstracts, Chemical Abstracts, Metals Abstracts*, or *Psychological Abstracts*, have been supported fully by subscription fees and society revenues. With rising production costs, however, they find this policy increasingly difficult to maintain. Thus, the American Chemical Society has found it necessary to use its reserve funds to support the activities of Chemical Abstracts Service. Individual

TABLE 13 Methods of Direct Support for Aids to Literature Access and Use

Method of Support	Type of Service	Specific Examples
Complete financing by federal government	Review journal	*Drug Digests*
Partial financing by federal government	Index journal Abstract journal	*Index Medicus* *Abstracts of Mycology*
Reader subscriptions	Citation index Abstract journal	*Science Citation Index* *Information Science Abstracts*
Complete or partial financing by nonfederal foundation	Catalog records	Council on Library Resources support of the distribution of catalog records on magnetic tape by the Library of Congress MARC Project
Contribution of volunteer or "underpriced" labor	Review and abstract journals	Volunteer reviewers, referees, editors, or abstractors

scientists tend not to feel the same identification with abstracting and indexing journals that they do with primary journals, which they receive regularly as members of scientific or technical societies. This lack of identification tends to decrease the degree to which they are willing to support such services both personally and professionally.

A number of secondary services are supported fully and directly by industry, through formally established organizations, such as the Technical Association of the Pulp and Paper Industry (TAPPI), the American Petroleum Institute, and the American Iron and Steel Institute (AISI). Other than such instances, industrial support of basic secondary services tends to be limited to specific arrangements. For example, through the initiative of the libraries in establishing special industrial programs, such as Stanford University's Technical Information Service, MIT's Membership Plan for Industry, and Southern Methodist University's Information Service program, some support of library usage in universities has been obtained. Such support is in the form of membership and service fees that amount to very little more than the cost of maintaining the program and do not contribute materially to the library's over-all budget. Industry also gives indirect support to various abstracting and indexing services through corporate membership in sponsoring organizations, information center subscriptions, and frequently, the company's payment of subscription fees or memberships for individual employees.

A major portion of federal support for secondary services is in the form of in-house operation of abstracting and indexing services and related document-delivery systems. Table 14 gives a representative list of examples. Sizable amounts of federal funds in the form of contracts or direct grants from several federal agencies also have been expended in support of such activities in nonfederal organizations—for example, support of *Bibliography and Index of Geology* *—and federal sources are pre-eminent in the support of research and development related to secondary services (e.g., automatic indexing or the establishment of special files). The allocation of federal funds to the support of secondary services results from both the implementation of mission programs of government agencies (DOD, NASA, AEC, NSF, and others) and various legislative programs, including the Higher Education Act of 1965, the Higher Education Facilities Act, the Library Services and Construction Act, the National Defense Education Act of 1962, and the Medical Library Assistance Act of 1965. Sources and amounts of federal support for various secondary activities appear in Table 15.

Arguments against continued or expanded federal support of secondary services in science and technology are based primarily on the thesis that support blunts the forces of selective evolution, thus prolonging the life of services that have lost their value, inhibiting the development of new approaches or techniques, and transferring vital control from the scientific and technical community to the sponsor, with attendant jeopardy of service responsiveness to user needs. Time and again, therefore, it is suggested that the federal government eliminate or drastically reduce its involvement in information services and allow the marketplace to determine the nature, distribution, and cost of such services. Information on this marketplace is fragmentary, but there is some evidence that it deviates in a number of basic respects from the normal behavior of supply and demand economics: Information that is costly to get will not be sought, regardless of its value; and increasingly greater amounts of information will *not* be acquired as prices are lowered to make their acquisition possible. A clearer understanding of the operation of such anomalies is necessary before market forces can be harnessed effectively in the evolution of literature-access services. (See Recommendations E2 and E3, and Chapter 4, Section E.)

Arguments in favor of continued federal support of secondary services point to the pervasive dependence of this country's scientific and technical effort on federal support and emphasize that the task of research and development is not completed until the results are documented

* Formerly *Bibliography and Index of Geology Exclusive of North America.*

TABLE 14 Examples of Federally Operated Aids to Literature Access and Use

Type of Service	Examples
Library services	Three N. .ional Libraries—Library of Congress (LC), National Library of Medicine (NLM), National Agricultural Library (NAL) 1500 or more other federal libraries Project MARC NLM Regional Library Programs NLM *Current Catalog* LC Catalog Cards and Proof Sheets *National Union Catalog* National Serials Data Program Medical Subject Headings (MeSH)
Basic abstracting and indexing services; bibliographies	*Abstracts of North American Geology* *Bibliography of Agriculture* *Geophysical Abstracts* *Index Medicus* *International Nursing Index* [a] *Monthly Catalog of Government Publications* *Nuclear Science Abstracts* *Official Gazette, U.S. Patent Office* *Pesticides Documentation Bulletin* *Research in Education* *Scientific and Technical Aerospace Reports* *Technical Abstracts Bulletin* *U.S. Government Research and Development Reports*
Document-delivery systems	Clearinghouse for Federal Scientific and Technical Information Defense Documentation Center Educational Resources Information Center U.S. Government Printing Office U.S. Patent Office
Need-group services	The federal government operates a large number of services that meet specific mission-determined needs—survey publications, information analysis centers, etc. (see Chapter 6, Sections A, B, C, and E)

[a] Produced by MEDLARS, National Library of Medicine, but printed and distributed by the American Journal of Nursing, Co.

TABLE 15 Examples of Current Federal Support to Nongovernment Secondary Services in Science and Technology [a]

Organization	Service	Funding Agency	Amount[b]	Awarded/ Announced
American Chemical Society	Research and development program for Chemical Abstracts Service	NSF	$ 834,250	FY 1967
American Dental Association	Comprehensive abstract service for dental researchers	NLM	21,340	1968
American Geological Institute	*Bibliography and Index of Geology Exclusive of North America* [c]	NSF	861,000 (24 mo.)	FY 1967
	Planning of an integrated information service in geological sciences	NSF	44,000	FY 1967
American Institute of Aeronautics and Astronautics	*International Aerospace Abstracts,* and related reference services	NASA	1,250,000	FY 1967
American Institute of Physics	Experiments with computers for primary journal composition and a variety of related services	NSF	94,600 (18 mo.)	FY 1967
	Systems planning and operations staff	NSF	138,000 (24 mo.)	FY 1967
American Mathematical Society	Development of computer aids for control of photocomposing machines	NSF	140,302 (18 mo.)	FY 1966
	Plan a study of information exchange and publication in mathematics	NSF	12,200 (12 mo.)	FY 1966

American Meteorological Society	*Meteorological and Geoastrophysical Abstracts*	NSF	243,200 (19 mo.)	FY 1967
	Management and operations study	NSF	19,600 (6 mo.)	FY 1967
American Museum of Natural History	Bibliographic services in ichthyology	NSF	48,000 (12 mo.)	FY 1967
American Library Association	Study to analyze current decision-making activities relative to acquisition of science library materials by small colleges and universities	NSF	52,800	FY 1968
American Psychological Association	Planning and developing a national system for psychology; production of *Psychological Abstracts*	NSF	450,950	1968
American Public Health Association	*Current Bibliography of Epidemiology*	NLM	26,920	1968
American Society of Mechanical Engineers	*Applied Mechanics Reviews*	NSF	175,000 (36 mo.)	FY 1967
Association for Computing Machinery	*Computing Reviews*	NSF	49,500 (12 mo.)	FY 1967
Biological Abstracts, Inc.	Conversion of *Biological Abstracts* to machine-readable form	NSF	243,400 (12 mo.)	FY 1967
	Abstracts of Mycology	NSF	5,000 (11 mo.)	FY 1967
Engineering Index, Inc.	Computerized abstracting and indexing program in plastics and electrical and electronics engineering	NSF	358,800 (12 mo.)	FY 1967
	Information service development	NSF	30,000 (6 mo.)	FY 1967

TABLE 15—*Continued*

Organization	Service	Funding Agency	Amount[b]	Awarded/ Announced
Highway Research Board	Highway research information service	Bureau of Public Roads	$ 125,000 (12 mo.)	FY 1967
University of Michigan	*Language and Language Behavior Abstracts*	NLM	49,800	1968
Universities Associated for Research and Education in Pathology, Inc.	*An Index of Investigative Dermatopathology*	NLM	12,200	1968

[a] Data in this table are based on information in Reference 123, *National Library of Medicine. Extramural Program News,* August 1968, and two National Science Foundation publications [126, 127] dealing with grants and awards in fiscal years 1966 and 1967.

[b] Interval covered by grant in those instances in which clear-cut data were available.

[c] Now *Bibliography and Index of Geology.*

and made accessible. Another justification of federal support is to provide services which are in the public interest, but which private initiative would not be able to sustain.

If we assume that federal support of secondary services will continue and even increase, a major question is that of what form this support should take. Possible alternatives include:

1. Highly centralized government operation of services modeled on the system to which the Soviet Union is committed
2. Subsidies limited to start-up or improvement costs, with support restricted to a specified time period
3. Charges levied on authors for the costs of input operations and on users for the costs of demanded output, under policies that allow the sponsored customer to charge these costs to his contract or grant
4. Direct subsidies to the service for input costs only, with output costs being recovered in the marketplace

In the course of our survey of scientific and technical communication, we have become convinced that the development of more comprehensive patterns of coordination and coherence in our information-service structure will be best achieved by voluntary cooperation under appropriate leadership (Recommendations A1 and A2). As compared with the first alternative mentioned above, this approach will ensure at least comparable effectiveness of performance at substantially lower commitments of manpower and funds. The second alternative is essentially the situation that exists at present. However, the necessarily transient or temporary nature of this type of federal support often prevents the development of stable, self-sufficient, and progressive services and increases the difficulties encountered in realistic long-range planning and budgeting for new or improved services. The choice between and implementation of the last two alternatives require more information regarding costs of input and output than is presently available. It would be highly desirable to have such costs clearly identified, even if the present system of financing secondary services were to continue. Increased cooperation—exchange of abstracts or use of common descriptors—among services (both private and governmental) will depend on the existence and accessibility of such cost information. These latter two alternatives appear to have considerable support among user groups.

Utility of Secondary Services

Obstacles to effective utilization of secondary services result primarily from lack of awareness of the existence of such services, difficulties in gaining access to them, and complexities in their use. Although there is widespread interest in determining the various ways in which scientific and technical information is obtained and applied (see Chapter 4, Section B), relatively little effort has been directed toward increasing scientists' and technologists' knowledge of information sources and ways to use them effectively. This is especially true for secondary services, as indicated in a recent study[102] which measured the diffusion and use of several government-sponsored secondary services (TAB, STAR, NSA, and USGRDR) by U.S. nonfederal, nonmilitary organizations. These services reached only two percent of the U.S. educational and nonprofit research centers, 31 percent of the industrial research laboratories, and less than one percent of the U.S. manufacturing establishments. Five states (California, New York, Massachusetts, Pennsylvania, and New Jersey) contained nearly 50 percent of the population receiving the four services. Eighteen states taken together contained only about three percent of the recipient population. In addition, 80 percent of the respondents in the study who were nonrecipients of the services had no knowledge of any of them.

There is at present no single directory of information sources to lead all researchers to the appropriate secondary services that will meet their needs. The researcher connected with an organization having an effective library or technical information center often can acquire such information through its resources; the researcher in a small college or university or in a small industrial organization has no such recourse. The National Referral Center for Science and Technology within the Library of Congress, which is intended to "provide a single place to which scientists and engineers may turn for advice on where and how to obtain scientific and technical knowledge of any kind" has had uneven success in making its services known or stimulating their use. Numerous "Guides to the Literature of . . ." also exist, but generally they are little known or little-used by researchers.

Instances in which the scientific and technical community has attempted to focus on such educational needs are limited. The COSATI Panel on Education and Training (Chapter 8, Section B) has exerted effort in this area. Additionally, the Planning and Study Conference for a Program on the Use of Information Media, Sources, and Systems in Engineering Education, held in 1966 under the joint sponsorship of the American Society for Engineering Education and Lehigh University, and the Conference for Educators on Systems for Handling Chemical Information, sponsored by the Committee on Chemical Information of the National Academy of Sciences, to be held in 1969, pending adequate funding, provide representative examples of other efforts. There are also isolated examples of courses in the use of information sources, offered either as part of required undergraduate science curricula (notably in chemistry) or as continuing education programs (e.g., the periodic seminars on scientific information and communication for federal scientists and engineers given in Washington and the traveling courses on indexing and abstracting sponsored jointly by Battelle Memorial Institute and the Engineers Joint Council). But to date there has been little concerted interest in such activities on the part of other segments of the scientific and technical community. Our Recommendations B13 and C6 are addressed to this need.

Once a scientist or technologist determines which services will be of use to him, difficulties still may arise in obtaining these services. Because of the high costs of such services, few individuals or organizations can afford to subscribe to all services covering the primary literature of interest. Constraints placed on the procurement of federal secondary services and on the procurement of secondary services with federal funds are particularly numerous. Dependent on contractual arrangements which vary widely from agency to agency, these constraints frequently leave the user uncertain of his status with regard to "need to know." Some of these variations are:

1. NASA provides free services to any organization with a "need to know" in aerospace; DOD provides such free services only to DOD or NASA contractors.
2. NASA contractors have access to the Defense Documentation Center; however, the National Institutes of Health and some other federal agencies do not.
3. Production contracts must include research-and-development components in order for contractors to have access to the Defense Documentation Center.

Frequently an organization's work on a government research-and-development contract requires the purchase of expensive handbooks or data compilations and the use of a variety of federal and private secondary services. If, as is sometimes the case, such purchases are not allowable as direct charges to the project, then an additional financial burden may be placed on the information services of the performing organizations. On the other hand, some contracts and grants specifically allow for the purchase of reference materials by the project staff, but prohibit these materials from being placed in libraries; they are regarded as expendable laboratory equipment, such as chemicals or animals.

Concurrent with the difficulties of obtaining secondary services themselves are the problems associated with gaining access to the documents that they identify, particularly technical reports and other federal documents. Persons wishing to purchase, borrow, or obtain copies of documents from federal agencies discover that there are a multitude of agencies responsible for their sale, loan, or duplication and a wide variety of procedures to be followed. Table 16 illustrates this situation.

A related obstacle to the procurement of federal secondary services and related primary documents is their uneven distribution among libraries. As of 1967, there were 903 depository libraries throughout the United States receiving various selections of government publications. Such depositories are of limited usefulness for science and technology, since they generally do not include the technical report literature. At one time the former Office of Technical Services of the Department of Commerce (now the Clearinghouse for Federal Scientific and Technical Information) established a number of regional technical report centers, principally at university and large research libraries. The operation was abandoned after three years since the use of these centers was at best uneven and required continual effort on the part of the libraries to publicize their existence and services.* Only the one at UCLA has survived; it has become part of the Engineering Library and continues to collect technical report literature with the help of outside funding. Recognizing the need for and importance of having centers available to industry, the Special Libraries Association has established a Committee on Regional Technical Report Centers, which is seeking support for their revival.

The use (or nonuse) of abstracting and indexing services, whether in printed form or in an on-line system, depends in large part on their responsiveness to so-called "human factors." Data from recent studies suggest that when users select information channels, they often act in a manner which minimizes effort rather than maximizing gain (see Chapter 4, Sections A and B). In some studies, accessibility—not technical quality—was the single most important determinant of the extent of a channel's use, though familiarity and experience with a service also were major determinants of channel selection.

Every abstracting and indexing service has its own set of characteristics: level of quality, peculiarities of arrangement, indexing terms, forms of bibliographic citation, and degree of coverage. Services should increase their efforts to define such characteristics adequately and in-

* The decision to close the centers was made by the government. Some centers subsequently were dissatisfied not only because of the decision, but because they had no voice in it.

TABLE 16 Procedures for Procuring Publications from Federal Scientific and Technical Agencies

					Forms of Payment [a]		
Agency	Population Served	Order Direct	Price	Desired from Requestor	Deposit Account Possibility	Coupons (Type)	Announcement Medium
Superintendent of Documents, U.S. Government Printing Office (GPO)	General public	Yes	Varies	Order form; catalog no.	Yes	Yes (GPO)	*Monthly Catalog of Government Publications;* price lists
Clearinghouse for Federal Scientific and Technical Information (CFSTI)	General public	Yes	Hard copy (hc) $3.00 Microfiche (mf) 0.65	Accession no.	Yes	Yes (CFSTI)	*U.S. Government Research and Development Reports* (USGRDR)
Department of Defense (DOD)	DOD contractors [b]	Yes; DDC	Mf free; hc $3.00	AD no.; requestors' DDC no.	No	No	*Technical Abstracts Bulletin* (TAB)
	General public	CFSTI	Hc $3.00; mf 0.65	Accession no.	Yes	Yes (CFSTI)	USGRDR
National Aeronautics and Space Administration (NASA)	NASA contractors [b] or orgs. with "need to know" re aerospace	Yes	Free	Accession no., author, title	No	No	*Scientific and Technical Aerospace Reports* (STAR)
	General public	CFSTI; GPO	Varies	Accession no., AD no., requestor's DDC no.	Yes	Yes (GPO) (CFSTI)	*Monthly Cat. of Gov. Pubs.;* USGRDR
Atomic Energy Commission (AEC)	AEC contractors [b]	Yes	Varies	Accession no.	—	—	*Nuclear Science Abstracts* (NSA)
	General public	CFSTI; GPO; other publishers	Varies	Accession no., AD no., requestors' DDC no.	Yes	Yes (GPO) (CFSTI)	*Monthly Cat. of Gov. Pubs.;* USGRDR
Patent Office	General public	Yes; microfilm available CFSTI	Varies	Patent no.	No	Yes (Pat. Off.)	*Official Gazette, U.S. Patent Office*
Educational Resources Information Center (ERIC–Office of Education)	General public	Yes	$0.04 per page; $0.25, per mf	Accession no.	No	No	*Research in Education*
Library of Congress (LC)	General public	Yes; also GPO and CFSTI	Varies	LC card no., author, title	Yes	No	LC *Information Bulletin*
National Library of Medicine (NLM)	General public	Yes; also GPO and CFSTI	Varies; photocopies, free	LC card no., author, title	No	No	USGRDR, *Monthly Cat. of Gov. Pubs.,* *NLM News*
National Agricultural Library (NAL)	General public	Yes; also GPO, CFSTI, and individual agencies	Varies	Publication no., author, title	Limited	Yes (NAL)	*Bibliography of Agriculture,* USGRDR, *Monthly Cat. of Gov. Pubs.*

[a] Prepayment required in every case for small orders.
[b] Limited or classified material.

form users of any changes (in terminology, coverage, and the like) as they occur, activities that often have been ignored in the past.

Since every service has its limitations in coverage, researchers must be prepared to use many such services. A relevant aspect of the utility of abstracting and indexing services that merits careful study is the rate at which comprehensiveness of coverage increases with the type and number of services employed. Further, no service assures complete retrieval or infallible discrimination; better ways of characterizing and measuring performance on these dimensions are needed. A decisive program of experiments [46] has demonstrated a way of establishing an operating characteristic for a particular indexing vocabulary and associated retrieval strategies by determining the extent to which discrimination decreases as comprehensiveness of retrieval increases and vice versa. For document collections that can be covered by an index-term vocabulary that is not too large (a few hundred to a thousand terms), natural language yields the most favorable operating characteristic. These methods have been employed recently as major diagnostic tools in a comprehensive evaluation of the effectiveness of the MEDLARS program.[103]

The following problem areas deserve special attention from the managers of abstracting and indexing services to assure continuing or increased efficiency and effectiveness of such services:

1. Cost-effectiveness ratios of different types of services (i.e., abstracts versus indexes versus title listings, etc.) are difficult to determine and may vary with different categories of users.
2. Increases and intentional overlaps in coverage may lead to an increase in costs and user effort that is out of proportion to the potential benefit.
3. Gaps in coverage may allow information to be lost.
4. Variations in format and indexing systems may limit the effectiveness of dissemination for inexperienced searchers.
5. When large time lags in coverage (particularly of foreign publications) by abstracting and indexing services exist, they hinder dissemination.

To arrive at the best compromise between utility and costs in the development of systems to assure document availability and bibliographic control, the following areas must receive attention. First, a new and fresh evaluation of potential means for supporting the operation of today's university libraries should be made, and an integral part of such an evaluation should be a careful examination of the need for research on and analysis of academic library activities. Second, the ever-increasing size and cost of libraries and library programs necessitates the development of systems under which library revenues can be brought more nearly in line with the costs of required services (e.g., by offering them insofar as possible on a cost-reimbursable basis). Third, the difficulties in developing and fostering the use of bibliographic tools that ensure effective local access to contemporary technical literature, regardless of its volume and its place of storage, must be overcome. And, finally, comprehensive systems must be capable of flexible responses. The required discrimination in their operation will involve richly structured descriptor languages to characterize the documents and their contents as well as their users. A corresponding pattern of graduated costs for different levels of timeliness and quality in the resulting service also should be incorporated. Our Recommendations E2 and E3 invite the systematic exploration of such problems.

CHAPTER 6

Consolidation and Reprocessing—Services for the User

In using information gleaned from the past work of others, the working scientist or technologist often, perhaps usually, employs it in a form different from that in which it was originally made available. The difference may range from a major intellectual reworking of the information to a mere culling and refiling of documents or clues to documents, but to the worker even the latter can be an important aid to efficiency. Three centuries ago, this "personal store" of information probably consisted of correspondence, notes, and shelved books, doubtless with scribblings in the margins. With the advent of scientific journals at the end of the seventeenth century and of basic abstracting and indexing services in the early nineteeth century, the worker's personal store was expanded to include collections of references and files of reprints. Eventually review articles digesting families of papers, data tabulations, and compendia became available to make increasing quantities of primary information accessible to the worker in forms that he could use more efficiently than he could the "raw" publications of the original investigators.

Even this brief sketch makes it clear that a worker's personal store of information, while necessarily unique and molded by his private tastes and efforts, relies greatly on services provided for him by the scientific and technological community. Besides providing for the primary communication (written or oral) of information and for the existence of discipline-wide access services, the community often condenses and consolidates information for the user or provides him with packages of it preselected to fit his needs. The latter two types of services—consolidation and reprocessing—are the subjects of this chapter. Our thesis is that the importance of these services, in relation to primary and access services, is increasing and will continue to increase for a number of reasons, which include: the total size and rate of increase of all portions of the technical literature; the number of individuals involved; the diversity of their interests; the frequency with which these interests change; and above all, the increasing interrelationships between fields that could formerly have been considered independent. In view of these trends, we feel that the development and timely introduction of appropriate services, mediating between the individual worker and the classical primary and secondary publications, will be decisive for the shape of scientific and technical communication in the next decade or two.

As we have already briefly indicated, the consolidation and reprocessing services to be discussed involve two kinds of activities. The one implied by the term consolidation is the intellectual reworking of primary information: It comprises evaluation, compaction, simplification, and the fitting of isolated items into a general framework. This type of activity, which we shall discuss in Section A, leads to critical reviews, state-of-the-art surveys, critical compilations of data, and finally, encyclopedias, handbooks, and textbooks. Because of the expanding bulk of scientific and technical information, its increasing interrelatedness, and the growing diversity of user needs, this work of consolidation will have to receive an increasing share of the intellectual energy of the scientific and technical community.

The reprocessing activity involves the selection of information especially relevant to the needs of a particular group of users and delivery of this information to them. The selection can be made, of course, either before or after some intellectual reworking of the primary information has taken place, and it may or may not be integrated with such a reworking.

To what extent are these consolidation and reprocessing activities focused on the needs of a particular worker? The answer varies. Some activities—including especially the evaluation of research results and the elimination of those that are wrong or superseded—have a relevance as broad as that of the primary information with which they deal. Others are aimed at a particular class of users, either by virtue of pedagogical level and style (e.g., an exposition of the theory of energy bands in semiconductors for electronic engineers) or by virtue of a particular selection and grouping of materials (e.g., a bibliography of all literature relevant to organic adhesives for metallic surfaces). Now, if it is to be economically feasible to supply such a user-focused service, whether it be intellectual consolidation or repackaging or both, there must be a certain minimum number of individuals with the same or closely related needs. Such a group of individuals, above the critical minimum size, is what we call a need group. A need group may be described in terms of a professional field (such as heat transfer), or a technical mission (such as nuclear-reaction engineering). It is unlikely to be defined by broad organizational affiliation (e.g., Bell Telephone Laboratories). However, in view of the fluctuating, interactive nature of science and technology, it cannot be a fully isolatable group. Its core, to be sure, will consist of those who have a long-term commitment to working with and on the needed information; but many others in related fields will have recurring needs for similar access to this information and therefore from time to time will belong to the same need group. The minimum size required to justify the organization of a special service typically will be about a thousand persons.

In this chapter we discuss first the intellectual consolidation of information, which may or may not involve a specific tailoring of the end product for the needs of a specialized group. The second section deals with information analysis centers, organizations set up to provide both intellectual consolidation and reprocessing services, usually aimed at a particular need group. As further examples of the provision of reprocessed information, Section C discusses some of the varied types of in-house information services supplied by industrial concerns for their employees. These services vary widely in nature, scope, and complexity. With these examples as background, Section D discusses the problem of services for need groups in broader perspective. Finally, in Section E, on information-service networks, we recognize the interdependence of the many and diverse need-group services; they draw upon common groups of basic access services and share each other's products in areas of intersecting concern. This final section relates also to the following chapter on new technologies through the possibilities which the latter offer for enhancing network effectiveness.

A. CONSOLIDATION, CRITICAL REVIEW, AND DATA COMPILATION

The Growing Need

The problems created by the ever-rising flood of scientific and technical information have been strikingly illustrated in individual fields by showing that it would be impossible to keep abreast of all relevant information even if a scientist devoted virtually every waking moment to reading. Among the responses to such pressure is greater specialization. Yet, as Brunning [11] pointed out some years ago, this expedient is not always satisfactory, for the degree to which one specialty impinges on another also is increasing, and with it the amount of information with relevance to any one field of endeavor. Herring[17] contrasts the problem some 30 years ago, when in many fields the conscientious scientist could maintain awareness of most of the information in his own and other relevant specialties, with that in the 1960's, when the amount of relevant information is not only greater but at the same time more rapidly produced. Figure 3 depicts the qualitative difference for the typical scientist. In this figure, the dashed-line curves represent the amount of information relevant to a scientist's field of endeavor, and the solid curves, the amount of information of which he is aware. Though the area beneath the solid curves is roughly the same in the 1930's and the 1960's, their shape is very different; that for the 1960's is much narrower. Conversely, the dashed-line curve representing relevant information in the 1960's is much broader than is the one for the 1930's.

Recognizing the gravity of this problem, the authors of the Weinberg Report[176] strongly urged more concentrated effort in the fulfillment of the vital functions of consolidation and review as a major step toward its solution. The report stated: "We shall cope with the information explosion, in the long run, only if some scientists and engineers are prepared to commit themselves deeply to the job of sifting, reviewing, and synthesizing information. . . . We urge the technical community to accord such individuals the esteem that matches the importance of their jobs and to reward them well for their efforts."

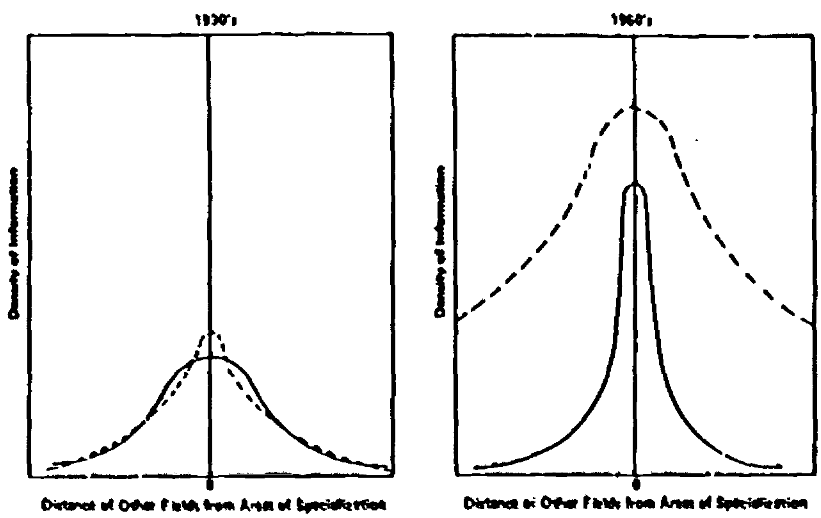

FIGURE 3 Amount of information of which a scientist is aware (solid lines) as compared with the amount of information relevant to his specialty (dashed lines).

The role of the review in coping with the information problem also has been stressed in the international arena. One of the recommendations of the 1961 Pugwash Conference at Stowe, Vermont, gave particular attention to this need:

> We recommend that measures be taken to bring significant work going forward in all countries to the attention of interested scientists. This objective could be served by the publication of international review journals of two types: interdisciplinary review journals written in relatively non-technical language for the benefit of scientists in different disciplines, and more specialized review journals which would keep scientists working in a given area abreast of the work going on in the same or related areas all over the world.[14]

Even more recently, one of the working groups engaged in studying the feasibility of a worldwide information system in science and technology (see Chapter 9, Section C, for a description of this effort) designated as an area of crucial need the development of better mechanisms for review and critical evaluation in science and engineering disciplines.[26]

Response to Need

As the need for consolidation and review has grown, some disciplines have increased their efforts to meet this need. For example, many scientific and technical societies try to ensure the inclusion of a certain number of review and state-of-the-art reports by qualified speakers at their meetings or encourage program committees to schedule sessions based upon lead-off presentations of this type. Data on program content in a series of annual meeting studies in nine science and engineering disciplines[11,12] showed that the percentage of program material devoted to state-of-the-art and review presentations ranged from roughly one fourth to more than half, with heaviest emphasis on this type of presentation occurring in two engineering disciplines. Evaluative comments on these meetings from random samples of attendants confirmed the value of such presentations and in some instances reflected a desire for more of them.

Data assembled in a recent study of a number of disciplines[13] provide further evidence of response to the need for consolidation efforts and suggest that accompanying the increase in volume of primary literature is an increase in the production of reviews. However, the production of reviews falls far short of meeting existing needs, and in some disciplines, such as mathematics, reviews of the state-of-the-art type are relatively uncommon. Though the proportion of review literature across the disciplines appears generally to be increasing in varying degrees, the rapid over-all growth of all forms of primary literature suggests that current reviews cover the output of science and technology much more thinly than they did a few decades ago and that much greater effort must be expended in this direction.

Problems of Production, Access, and Use of Reviews

Incentives and funding typically are identified as basic problems in the stimulation of adequate consolidation and review activities. In regard to the former, lack of recognition, low prestige, and insufficient remuneration are the lot of the review author in virtually all disciplines. The reaction of one review author who participated in a study [8] of the preparation of chapters for an annual review publication is probably not uncommon: "Digesting the material so that it could be presented on some conceptual basis was plain torture; I spent over 200 hours on that job. I wonder if 200 people spent even one hour reading it." In some fields of engineering, peers often do not consider preparation of a state-of-the-art review a real contribution, and there can be a loss of prestige attendant upon involvement in this type of work. In commenting on this problem, Weber [144] mentions that only one review journal in his field can be regarded as a highly successful, high-prestige publication. Recently, the American Society of Civil Engineers has attempted to encourage the writing of reviews by offering an annual State of the Art Civil Engineering Award—a plaque and an honorarium—for which review papers in any of the 14 divisions of the organization can be nominated. It is still too early to evaluate the results of this effort, but experimentation with such measures for enhancing the recognition of review authors is greatly to be desired, and our Recommendation B1 (Chapter 3, Section B) addresses itself in part to this topic.

Additionally, the development of policies and procedures that would facilitate performance of the reviewing function probably would reduce the reluctance of many scientists and technologists to undertake a review and would serve as incentives. The emergence of increasingly effective retrieval tools should aid in the location of relevant material, and the provision of adequate clerical assistance would reduce the routine demands of article preparation. However, the selection of material to be included, its assimilation and interpretation (and evaluation if the review is a critical one), and finally its organization into a meaningful and useful article are time-consuming and arduous tasks, the responsibility for which has to rest almost entirely on the review writer. Some attention to ways in which a group of experts can contribute to the selection and critical evaluation of material, without subdividing a subject area in such a way that the over-all review loses its consistency of treatment and unity of viewpoint, would be worthwhile. Further, the potential of the information analysis centers (discussed in Section B of this chapter) in contributing to the consolidation and review function could be more fully tapped. Possibly of greatest value would be arrangements, such as sabbatical or fellowship programs or liberal leave policies, which would permit the allocation of sufficient, uninterrupted time to the production of a review.

The Weinberg Report [179] emphasizes the challenge and intellectual stimulation presented by the preparation of a high-quality review and compares the relationship of the reviewer to his widely scattered bits of knowledge with that of the theorist to available pieces of experimental data. Consolidating, reviewing, and interpreting the literature are demands considered worthy of the efforts of the most gifted scientists and engineers. Leitch [104] also has pointed out that the production of a truly creative review, which synthesizes data from more than one field and ties seemingly unrelated areas together in a meaningful relationship, is a rare and valuable contribution. As an example of such efforts and their impact, she cites *Food, Health and Income*, by Sir John Boyd Orr, which resulted in the establishment of an international organization and the initiation of certain new services on a national scale in many countries of the world. A recent suggestion (cited in Reference 87) for helping to foster recognition of a comprehensive, critical review as a major accomplishment is to award graduate students a PhD for this type of review when it is prepared under the supervision of a respected scientist and entails a substantial amount of creative synthesis.

A second problem area, not unrelated to incentives, is that of fostering awareness among the organizations sponsoring research-and-development activities of the importance of consolidation and review in promoting the effective use of results. As we have emphasized before in connection with primary communications (Chapter 4, Section E), publication is no longer sufficient to ensure awareness or prompt utilization. The provision of funds for later steps in the transfer chain, steps which facilitate access and effective use, was a major tenet of the Weinberg Report.[179] In the present context, it is the focus of Recommendation B2 (Chapter 3), which advocates the allocation of a larger fraction of resources by supporters of research and development to assist in the preparation of critical reviews and data compilations.

Especially in the case of large-scale, on-going programs of research and development which produce large numbers of reports and publications or technological advances, the responsibility for sifting, evaluating, and consolidating the results to facilitate their application and make clear their implications for other related areas of endeavor is great. The critical review and evaluation function is particularly valuable when the output of a program has been disseminated chiefly in the form of technical reports. Here, quality frequently is uneven, and awareness and access sometimes present problems. Consolidations that bring together in a compact and unified presentation the key findings and major implications of a body of these reports have already proved valuable in those instances in which sponsoring agencies have supported their production. We recommend, therefore, that all major research-and-development programs regard the consolidation function as an integral part of the over-all program of work and allocate funds accordingly (Recommendation B3).

As disturbing as the lack of consolidation and critical review efforts adequate to meet current and projected needs is the inefficient handling of the existing review literature. In a number of disciplines, no effort is made to inform the reader of the existence of reviews, either (a) by publishing regularly recurring special bibliographies of reviews in a discipline, such as the *Bibliography of Medical Reviews;* (b) by allocating a special section of an abstracting and indexing service to reviews, as is done in *Biological Abstracts Subjects in Context* (BASIC); or (c) by use of a special symbol, a procedure employed in *Meteorological and Geoastrophysical Abstracts* to designate certain types of articles (though not specifically reviews). The latter procedure would appear to be an efficient and relatively inexpensive way of handling the identification of review articles.

The finding that only two of 8,601 titles from the *Bibliography of Reviews in Chemistry* contained the word "review" in the title[88] is evidence of the possible difficulty in recognizing such articles. Even the number of references cited (provided in some abstracts and lists of titles) is not always a good way to identify a review. The situation is further aggravated by the diversity of outlets for review material—books, special publications, primary research journals, as well as serial review publications—and by the frequent need for information in the fringe or tangential areas where experience with sources is less than in a scientist's main area of specialization. In view of the frequent expressions of concern over whether reviews actually are used to the extent that they should be, some effort to bring the user's attention promptly and regularly to review literature seems clearly in order. (See Recommendations B1 and B4.)

Hand in hand with improved alerting and access procedures for reviews goes the need for greater attention to educating scientists in the nature and use of the review literature, both as graduate students and later in life. Also, today many reviews do not lend themselves readily to piecemeal use—though the need for certain aspects of a subject area undoubtedly is much more frequent than for the complete story (Recommendation B1).

The review literature presents a number of problems which impede its effective use. First, reviews are of several types and are directed toward the fulfillment of different functions. Yet all too often there is no indication of the level of treatment or the objectives of a particular review. Leitch [106] separates reviews into three general categories. First is the periodic type, which deals with a limited subject area during a particular time interval and usually presents findings, with little or no analysis or critical evaluation. The main purpose of such a review is to inform the reader of current developments in a field. Second, the occasional review discusses a subject broadly and interpretively and need not cover all literature during a clearly defined period, for the author is expected to be selective and critical. The quality of such reviews varies greatly, depending on whether they deal chiefly with opinions or with findings. Third is the analytical or constructive review, which typically is book length and deals with concepts or theories and findings. It is sometimes called the research review and often is undertaken to meet a specific need in an area—for example, to clarify issues and show where more information is necessary or to provide a basis for needed guidelines. It may deal with only one field or may establish or clarify relationships between fields and effect a creative synthesis.

In fact, the review literature is not always easy to categorize. A study [8] of authors of reviews suggests a great deal of variation in treatment and of overlap among the types described by Leitch. For example, one reviewer who had prepared a "comprehensive" periodic review reported having to lop off 200 references at the last minute in order to meet the space requirements imposed by the publisher. Others felt that even in the production of a periodic review, covering the literature during a given period of time, one had to be selective and evaluative and that over the long run the biases of the various reviewers in any one subject area would balance one another. In some subject areas of high activity, it is difficult to find an author who will treat the topic exhaustively and, in such cases, it becomes customary for a review author to preselect and weed his literature to reduce it to manageable size before beginning to digest it. Unfortunately, there is no indication whether the material excluded was omitted by accident or by design. Further, omission of poor-quality or erroneous papers, which is sometimes considered necessary in order to do justice to the better material in the space allowed, may cause scientists and technologists to lose time and money in unprofitable or duplicative work.

An important determinant of scope and treatment is the user group to whom the review is directed. The scientist working at the research front may need a succinct evaluative commentary on recently published material, or at the outset of a new project on a different topic, he may need a comprehensive review with a full bibliography. Those engaged in teaching typically require less specialized reviews than the researcher; such reviews deal with a broad area and highlight the key contributions and references in a field. Reviews covering broad areas in less detail also are valuable in providing users with general knowledge in specialties adjacent to their own. And there is a place, too, for the nontechnical, relatively unsophisticated and superficial type of review, which often is of use to students and laymen. However, to ensure more efficient use, each review should contain some early indication of scope, treatment, and the audience to whom it is directed and should include in its reference list all other reviews of the same area which are more complete and comprehensive.

Some Characteristics of Reviews

Though reviews represent a heterogeneous aggregate of consolidation efforts and tend to vary greatly in number and character from one discipline to another, a few general characteristics have been identified.[66] First, in nearly all fields studied the primary journal appeared strongly predominant as the outlet for reviews, rather than either serial review publications or annual and special publications. This result is known to be seriously biased because of the policies of abstract journals. In most fields, annual review publications and books accounted for a relatively small percentage of reviews, though there were exceptions. For example, in the field of oceanography a majority of the reviews were in the form of privately published books. The language of initial publication of most reviews was English, except in the field of medicine; however, a majority of the articles sampled, with the exception of the engineering disciplines, originated in foreign publications. Finally, although there was great variation in length both within and among fields, the average length of the reviews sampled tended to be in the neighborhood of 20 pages.

An additional and most important characteristic of review literature is that it retains its usefulness over a relatively long period of time. There are many qualitative indications of its slowness of obsolescence, and data from citation studies seem to support this fact. In a sample of physics papers, for example, it was found that the probability for a typical research paper to cite a given review item decays at a very slow rate, falling by only a factor of two each decade. When this finding was checked further by noting the numbers of citations of a sample of review articles in *Science Citation Index* during successive years, there was an increase at least as rapid as the fraction of the source literature covered by this index, a result which indicates that review articles are not soon superseded.

The Compilation of Critically Evaluated Data

All that has been said in the preceding discussion of reviews with regard to increasing need, the allocation of greater effort to fulfillment of this need, and problems of incentives and funding applies also to the compilation and critical evaluation of data. That the generation and dissemination of critically evaluated reference data are essential to the progress of science and technology has long been recognized and has resulted in various sporadic efforts to furnish such data on a comprehensive and continuing basis. As early as 1883, the *Landolt-Börnstein Tables* were published in a single volume of some 300 pages. Subsequently, these tables were updated at varying intervals, the sixth edition appearing between 1950 and 1969 and comprising 26 volumes and 20,000 pages. Other data compilations, first issued around 1910, were the *Tables Annuelles de Constantes et Données Numériques* and the *Kaye and Laby Tables of Physical and Chemical Compounds,* both of which also were updated, the latter as recently as 1966. The International Research Council (predecessor of the International Council of Scientific Unions) sponsored the compilation and publication of the seven-volume *International Critical Tables of Numerical Data in Physics, Chemistry, and Technology* during the 1920's. Plans to supplement and update this compilation did not materialize; however, a large number of compilation and evaluation activities developed in its wake in various parts of the world.

Compilation efforts in the United States received some measure of coordination when the Office of Critical Tables was established in 1955 within the National Academy of Sciences–National Research Council. This Office encouraged the formation of new critical evaluation groups, developed standards, maintained awareness of present and continuing data-compilation efforts, and fostered international cooperation in this area. By 1963, as a result of the rapid growth of research-and-development activities and the consequent expansion of the literature, the Federal Council for Science and Technology (FCST) concluded, on the basis of information provided by the Committee on Scientific and Technical Information (COSATI), that previous compilation and evaluation efforts were inadequate. Furthermore, availability of data was far from uniform. The needs of some fields were fairly well met; in others only uncritical compilations were offered (leaving evaluation for the user); and in still others there were no systematic efforts of this type. Consequently, the FCST recommended to the President's Science Advisory Committee (PSAC) the establishment of a government-wide, coordinated compilation effort. In 1963, PSAC assigned responsibility for the administration of a government-wide program to promote and coordinate systematic data-compilation and evaluation activities in all fields of the physical sciences to the National Bureau of Standards of the Department of Commerce. Accordingly, the Bureau set up the National Standard Reference Data System (NSRDS), the main objective of which was to improve "access by the American technical community to compilations of critically evaluated data on the properties of substances."[26] The plan of operation was decentralized in nature and aimed at involving many organizations and individuals throughout the country. A major goal was to maintain flexible responsiveness to the ever-changing needs of users.

The scope of the program was defined as including only physical phenomena and only "critically evaluated quantitative information relating to a property of a definable substance or system."[25] In effect, NSRDS does not deal with data related to systems of variable or uncontrollable components or data sensitive to unspecifiable details of the structure of a material. Proprietary data, those with limited temporal validity, and those of a very limited commercial interest also are excluded. Included in the Bureau's assignments were the following specific tasks:

1. Operation of a National Standard Reference Data Center at the National Bureau of Standards
2. Coordination of standard reference data activities of the Bureau, the Department of Defense, Atomic Energy Commission, National Aeronautics and Space Administration, National Science Foundation, and other government agencies, all of which could act as components of the National Standard Reference Data System
3. Establishment of standards of quality and of methodology for the production of National Standard Reference Data
4. Promulgation of standards for other functions required to ensure compatibility of all units of NSRDS

In the fulfillment of its assignments, the NSRDS scans the literature to locate data, critically evaluates it, and compiles it in orderly format; it prepares critical reviews on the status of quantitative knowledge in special areas of technical fields; it computes functions derived from standard reference data, values of theoretical functions used to interpret quantitative experiments, and estimated values of unknown properties of important substances; and it provides experimental measurements to fill existing gaps in tables and extend the range of parameters. In addition to carrying out these basic responsibilities, the NSRDS surveys the operation of existing data-compilation and evaluation groups, determines special needs of the technical communities for data, and coordinates government-sponsored activities in this area. The program was not intended to supplant existing activities and sources of financial support but to augment them and to achieve more coherent and productive overall results.

In order to formalize the authority given the Bureau to provide this service, which it had developed over a period of years, and in recognition of the necessity for a strong standard reference data system to foster the effective conduct of the U.S. research-and-development effort, a bill was introduced in June 1966, and subsequently passed by both House and Senate,* "to provide for the collection, compilation, critical evaluation, publication, and sale of standard reference data," [128] with responsibility for the fulfillment of this mandate assigned to the Secretary of Commerce.

The Office of Standard Reference Data, though discovering that "the task of carrying out a critical evaluation is more demanding of both time and intellect than most members of the technical community undertaking this job had thought," [129] has made steady progress toward the realization of its objectives. Since its inception, "the magnitude of the effort required to implement the system has been estimated more closely, procedures for the establishment of data centers have been developed, and relationships with other agencies have been more clearly defined." [129]

A recent effort toward wide-scale international cooperation and coordination of compilation and evaluation activities is the Committee on Data for Science and Technology (CODATA),[80] established in 1966 and sponsored by the International Council of Scientific Unions (ICSU). (See Chapter 9, Section C, for a more detailed description.) Two of the major objectives of this group are: (a) to stimulate scientists and engineers to undertake the task of data compilation and evaluation and to improve the professional status and salary level of those engaged in such work; and (b) to foster awareness of the cost of compilation and evaluation and to encourage subsidies from appropriate sources.

* The National Standard Reference Data Act (PL 90-396) was passed by the House of Representatives in August 1966 and by the Senate in July 1968.

In recent years, compilation and critical evaluation activities have progressed from a stage of disparate, disorganized effort, in which each discipline, and each country, went its separate way and both gaps and duplication were frequent, to one in which numerous parallel efforts designed to serve specialized areas of need are evolving as part of a coordinated national program. Encouraging signs of eventual coordination at the international level also are evident. Adequate funding by supporters of research-and-development projects utilizing and generating such data is essential to the continued development of an effective data system (Recommendation B3). Fulfilling a vital role in the production of critically evaluated data compilations, as well as the production of reviews, are the information analysis centers, treated in detail in the following section.

B. INFORMATION ANALYSIS CENTERS

The present conception of information analysis centers is the amalgam of two principal types of antecedents. The first of these comprises institutions that are organized to manage large data assemblies, often of national or even international scope. They collect data of pertinent kinds, either from documents or by direct observation and measurement, store, critically evaluate, and collate them, and disseminate the results. Through regular publication of tables, charts, and analyses, they provide information useful to particular customer categories and the public at large. Some representative examples, in some instances dating well back into the nineteenth century, are the major environmental data programs (geology, geodesy, weather, tides and currents, for example) and the large social data assemblies, such as those of the Bureau of the Census and of the National Centers of Educational Statistics and of Health Statistics in the Department of Health, Education, and Welfare. Examples in the laboratory sciences are provided by Beilstein in chemistry, dating from the early years of the century, and the Critical Tables program of the 1920's in physics, chemistry, and technology.

The second group of antecedents consists of organizations established during the early post-World War II years to provide information services to the members and managers of teams participating in major research-and-development endeavors. The functions of such organizations were to collect all pertinent publications, government reports, and experimental records; to store, structure, and scan the collection; to critically evaluate and analyze these data; and to offer whatever informational assistance was demanded by qualified users on project teams, whether as a regular routine or in response to specific inquiry. The Chemical Propellant Information Agency, the Infrared Information Analysis Center, the Defense Metals Information Center, the Shock and Vibration Center, and the Radiation Effects Information Center are among the characteristic and better-known survivors of these activities.

The number and variety of institutions subsumed under the term "information analysis center" increased in the years following 1958, thus reflecting both heightened awareness of the need for accruing scientific information and data and governmental concern with its more effective utilization. Formal recognition at the highest level of government of the potential role of information analysis centers dates from 1963, when their functions were extensively discussed and their importance emphasized in the Weinberg Report[17c]:

> The activities of the most successful (information analysis) centers are an intrinsic part of science and technology. The centers not only disseminate and retrieve information; they create new information. . . . The process of sifting through large masses of data often leads to new generalizations. . . . In short, knowledgeable scientific interpreters who can collect relevant data, review a field, and distill information in a manner that goes to the heart of a technical situation are more help to the overburdened specialist than is a mere pile of relevant documents. Such knowledgeable scientific middlemen *who themselves contribute to science* are the backbone of the information (analysis) center; they make an information center a technical institute rather than a technical library. The essence of a good technical information center is that it is operated by highly competent working scientists and engineers—people who see in the operation of the center an opportunity to advance and deepen their own personal contact with their science and technology.

When the Committee on Scientific and Technical Information (COSATI) subsequently established a standing panel to deal with the subject of information and data analysis centers, this panel wrote the following comprehensive definition into its charter:

> An information analysis center is a formally structured organizational unit, specifically (but not necessarily exclusively) established for the purpose of acquiring, selecting, storing, retrieving, evaluating, analyzing, and synthesizing a body of information and/or data in a clearly defined specialized field or pertaining to a specified mission with intent of compiling, digesting, repackaging, or otherwise organizing and presenting pertinent information and/or data in a form most authoritative, timely, and useful to a society of peers and management.

The panel also formulated the following criteria as a means of characterizing and identifying information analysis centers: The key activities of such centers are the *analysis, interpretation, synthesis, evaluation,* and *repackaging of information,* carried out by *subject specialists,* resulting in the production of *new, evaluated information*—in the form of *critical* *reviews, state-of-the-art monographs,* or *data compilations,* as well as *substantive, evaluated responses to queries*—for the purpose of assisting a *community of users more broadly representative than the staff of parent institutes or laboratories.*

PROFILE OF THE PRESENT POPULATION

The aforementioned COSATI Panel took a census of information analysis centers conforming to these criteria and supported wholly or in part by the federal government and published the results in April 1968.[58] While not a 100 percent sample (regional and state information services such as technological or agricultural utilization services are not included), the census lists a total of 112 currently active centers. Inclusion of those omitted and of the smaller number which are supported wholly from private sources would not have added any significant new features to the picture conveyed by this list. Its predominant characteristic is an incredible diversity in size, length of life, and range of services offered. Only 21 of the organizations listed antedate the year 1958; among them are six of the large environmental data programs conducted by activities now combined under the Environmental Sciences Service Agency in the Department of Commerce. An additional 30 date from the period 1958–1963, and a total of (at least) 59 have been established since 1964. (No dates of establishment are available in two instances.) Table 17 provides a rough classification by subject matter of coverage. In addition, there are two agency-wide information activities which in some respects operate in the same way as information analysis centers and, therefore, have been included in the Directory [58]: The Arms Control Technical Information and Analysis Center and the Office of Economic Opportunity Information Center.

When the aggregate of these information analysis centers is broken down in the manner shown in Table 17 a number of significant features emerge:

1. The lone representative in the biological area is the Military Entomology Information Service, which provides a number of effectively custom-tailored services to the Armed Forces Pest Control Board approved users, including an SDI service that delivers automatically on a quarterly basis annotated bibliographies of the latest accessions.

2. The 14 environmental sciences centers group themselves into three classes, the largest of them consisting of ten environmental data-management organizations that are principally concerned with generating various data products for broad user categories. A second group of two centers

TABLE 17 Subject-Matter Coverage of Federally Supported Information Analysis Centers

Subject Matter	No. of Centers
SCIENCES	
Biology (nonmedical)	1
Chemistry	5
Environmental sciences	14
Physical sciences	34
	54
APPLICATIONS	
Education	18
Engineering	22
Foreign areas	2
Medicine and health	14
	56

deals specifically with defense needs and serves a correspondingly restricted clientele. The two remaining activities (National Oceanographic Data Center and Air Pollution Technical Information Center) combine documentation and data-service functions both in generating routinely disseminated information products and in responding to specific customer needs.

3. Of the 34 information analysis centers listed in the physical sciences, 20 are part of the National Standard Reference Data System coordinated by, and with full or partial funding from, the Office of Standard Reference Data, National Bureau of Standards. This broad-gauged program for the systematically organized compilation of competently evaluated data in the physical sciences was planned originally under the coordinating aegis of the Office of Science and Technology and for a number of years was funded jointly by the Department of Defense and the Department of Commerce. In July 1968, legislation was enacted (PL 90–396, HR 6279, 90th Congress) which authorized the Department of Commerce to conduct and fund this program as one of its statutorily assigned missions. The remaining 14 centers operate in nuclear physics (8), material properties (5), and optical radiation (1).

4. The five centers covering chemical information include four that are also part of the National Standard Reference Data System, bringing the total number of component centers in this program to 24.

5. The educational information analysis centers include the extensive National Center for Educational Statistics and 17 of the clearinghouses for particular areas of educational activity under the central Educational

Resources Information Center (ERIC). This system of distributed clearinghouses is another general feature of the information analysis center family. All ERIC clearinghouses participate in providing certain broad basic services based on cooperatively created tools of access to the massive report literature in the field of education. Each of the clearinghouses enjoys considerable autonomy in developing and offering information services on the basis of suitable arrangements with local or national organizations active in its designated area.

6. Seven of the 22 centers in engineering-sciences information deal with specific military technologies and will serve only suitably cleared users. The remaining 15 centers deal with fields of engineering not specifically of military character; seven of these handle nuclear-engineering information, such as nuclear safety, design of radiation shields, and reactor design data, six of them are in mechanics and materials, and two of them provide information services in methods of design and design testing (nondestructive testing, reliability analysis).

7. Both of the foreign area information analysis centers are sponsored by the Department of Defense.

8. In the field of health and medicine, finally, all but three of the centers operate under the aegis of the Public Health Service. Included among the latter are the three massive data-management activities in health statistics, radiological health, and urban and industrial health—all of them National Centers—as well as the data banks of the Cancer Chemotherapy program, the largest of which now contains raw and evaluated data for approximately 240,000 compounds. All of these provide information on accruing data and the results of evaluative analyses through published reports disseminated both routinely and on request.

Also included are the four information service centers of the Neurological Information Network of the National Institute of Neurological Diseases and Blindness *—Brain Information Service; Information Center for Hearing, Speech, and Disorders of Human Communication; Parkinson's Disease Information and Research Center; Vision Information Center. These centers provide not only individual as well as generic bibliographic services, based on an automated storage and retrieval system which makes use of MEDLARS tapes as one of the inputs, but they also give systematic encouragement to the production of authoritative summaries of major topics in the relevant neurological sciences.

* In August 1968, the President authorized the establishment of a separate National Institute of Blindness subject to the discretion of the Secretary of Health, Education, and Welfare and the appropriation of necessary funds by Congress.

The services offered by such centers naturally divide themselves into center-initiated products, both routinely distributed and available on request, and custom-tailored services in response to user demand. In most instances, the former include critical data compilations and bibliographies, as appropriate, and frequently state-of-the-art reports. The larger ones publish regular newsletters or bulletins and may sponsor symposia or conferences. Access aids to relevant computer software (i.e., bibliographies of computer programs) or the software packages themselves rarely are provided. The range of custom-tailored services generally includes response to technical inquiries and consultation, especially on the part of the more recently established centers. A much more limited number of centers offer literature search, bibliographies, or state-of-the-art reports on demand. And no more than a handful provide an SDI service for either full-text documents or bibliographic material. Information on costs incurred and charges levied by centers is rudimentary. Currently, efforts to improve this situation are under way; for example, the Department of Defense is developing for its centers a plan for the orderly transition to a schedule of user charges by fiscal year 1969. The centers will be expected to support their output costs through sales of publications, registration fees for symposia and conferences, and charges for special, on-demand services. The economics of information analysis organizations, however, remains an area most urgently in need of clarification.

Appraisal and Future Trends

In its report of 1963, the Weinberg Panel identified "the specialized information center [information analysis center] as a major key to the rationalization of our information system. Ultimately we believe the specialized [analysis] center will become the accepted retailer of information, switching, interpreting, and otherwise processing information from the large wholesale depositories and archival journals to the individual user. . . . We believe the specialized information [analysis] center should be primarily a technical institute rather than a library. It must be led by professional working scientists and engineers who maintain the closest contact with their professions and who, by being near the data, can make new syntheses that are denied those who do not have all the data at their fingertips." [119] Five years later, our review confirms with greater emphasis the need for activities that function as mediating retailers between the comprehensive basic access services and the ultimate user communities. In the course of the intervening years, however, information analysis centers have shown little indication of fulfilling as universal and paramount a role as the Weinberg Panel predicted and urged. The reasons are many. First, not all types of information can be effectively handled by such centers: No one would think of setting up an information analysis center for topology, for example, despite the vast extent of the literature of the field. Availability of funds for centers has been spotty; often it has been conditioned by the interest of the services performed for a very specific mission of some agency. While recruitment of staff for the centers has not yet become a major problem, it might well become so if the number or sizes of the centers were to be greatly increased. Many, though not all, of the existing centers have rather small staffs of scientific and technical professionals, and unless these are in close interaction with a larger group of workers in the same and closely related fields, their judgments may lack perspective and they may miss opportunities to serve the wider community. Finally, the slow progress of education of the scientific and technical community for effective use of information analysis centers is apt to continue for some time as a limitation of their effectiveness.

Today, the pattern then foreseen has been realized most completely by the information program of the Atomic Energy Commission in the areas of nuclear science and engineering, in which about a dozen such centers provide the kind of services which the Panel's report specified. Official recognition has also been given to this concept by the Department of Defense in its Instruction No. 5100.45 of July 1964, which, explicitly differentiating between information analysis centers and documentation centers or other special libraries, provides for the establishment and coordinated operation of a Department of Defense Information Analysis Center Program. Consequently, some 20 centers conforming to these specifications presently serve the defense community in many fields of science and technology essential for its work. In addition, the Educational Resources Information Center, with its chain of 19 clearinghouses, has now set out along the same path. As far as the physical sciences in general are concerned, as many as 15 of the 24 component activities within the framework of the National Standard Reference Data System appear to limit themselves to the publication of papers which present the results of critical data evaluations. In the medical sciences, finally, information analysis center activities are found in the National Clearinghouse for Mental Health Information and among the component organizations of the Neurological Information Network of the National Institute of Neurological Diseases and Blindness. (The regional dissemination centers of NASA, and the state offices and centers established under the aegis of the State Technical Services Act, which in some circumstances might be thought of as belonging to the family of information centers, are discussed in Section C of this chapter in their role of assisting in the formation of more effective industrial information services.)

In large areas, alternative patterns had already been established—for example, corporate industrial programs in chemical technology and extension services in agriculture—or have since taken shape; in the environmental sciences, for example, the function of retailing information to user groups is performed largely by commercial consulting firms, which make effective use for this purpose of the products of the large governmental geological data programs. In other areas, such as the biological sciences, no significant services of this kind have emerged.

The population of federally supported information analysis centers (and the overwhelming number of them are federally supported) has been unstable; many of them have come and gone, their funding history has been erratic, and their staffing somewhat difficult. Whether this instability has resulted from unsatisfactory performance, ephemeral needs, or disproportionately large budget reductions in low-priority operations is not clear, nor is it possible to give a firm prognosis for the future of the centers currently in operation, especially those established during the last few years. However, if these centers, are to have a fair chance of showing their potential for contributing the kind of consolidation and reprocessing services which we consider so important to contemporary scientific and technical communication, it is necessary that they receive the intellectual support of some responsible and stable group and that their establishment and operation be coupled more closely to the prevailing market for their services. (See Recommendation B14.)

C. INDUSTRIAL INFORMATION SERVICES

The technical information programs, divisions, and centers of the major industrial corporations and business enterprises constitute a family of growing prominence among the information organizations which offer specialized services to well-defined user groups. We have no adequate inventory of those organizations which systematically reprocess and consolidate information in order to assure their scientists, engineers, and managers of prompt awareness, selective access, and a general overview of pertinent literature; however, the 1966 edition of the NSF publication on *Nonconventional Scientific and Technical Information Systems in Current Use* [111] provides a good sample, since the more forward-looking ones inevitably utilize technological and procedural innovations of recent years in their operations. Of the total of 175 such unconventional systems described, 87 were industrial.

Just as information analysis centers include a broad range of sizes and services so also do industrial information organizations. The latter may offer any combination of the following:

1. Technical library
2. Technical report center
3. Patent department
4. Reprographic services
5. Alerting (e.g., selective dissemination of information)
6. Literature and patent searching
7. State-of-the-art reviews
8. Data-bank operation
9. Consulting
10. Technical editing
11. Technical correspondence center
12. Technical meetings
13. Publications clearance
14. Information systems
15. Continuing education

(Papers by Weil,[149] and Jahoda,[91] give a more detailed and comprehensive indication of the functions of industrial information organizations.)

Although corporate information departments are intended primarily to serve various user groups within a company, they also occasionally assist outside groups, such as customers or contractors and affiliates. They usually interface with various types of government, association, and commercial services, both primary and secondary, and supplement and reprocess available basic service products for their own user groups by routing information to interested recipients, preparing special announcements and bibliographies, furnishing document copies, and performing special searches. Moreover, they frequently have responsibility for channeling information from in-house producers to outside agencies through the distribution of reports and the processing of requests for such documents.

Industrial information services vary greatly in the extent to which they use and contribute to innovative procedures. Some have established themselves as pioneers in the field, and the number of those that explore and rely on modern techniques of computerized information processing undoubtedly will grow rapidly. At the time the data for the NSF publication on nonconventional systems [122] were collected, nearly half of the listed systems were computer-based.

With regard to the costs of such corporate information services, no data sufficiently representative to be meaningful have been collected. However, the prevalent trends of growth and technological sophistication leave no doubt that they, too, will show sustained growth.

PATTERNS OF ORGANIZATION AND COOPERATION

The various units, such as a library, patent department, or computer center, that fulfill the information needs of a given company, generally grow up separately and in an uncoordinated manner. There is now a growing tendency toward integration and coordination of services and personnel. For example, the Celanese Research Center has built an information center which brings together the library and the computerized and micrographic information-handling systems. Moreover, counterbalancing a trend toward broader geographic dispersal of the growing corporate subdivisions is greater centralization within a given location. Organizationally, industrial information services usually are administered by the research-and-development department, though they serve other departments as well. The Technical Information Section of Ford Motor Company, which operates as a component of the Scientific Research Staff and exists to serve the research and engineering needs of the company as a whole, provides an illustration. It consists of an Engineering and Research Library and a Technical Information Group, the latter having responsibility for:

1. Selecting, analyzing, evaluating, and indexing both internally and externally generated scientific and technical publications in fields of interest
2. Directing pertinent information to the right people
3. Publishing surveys of current literature
4. Performing specifically requested comprehensive searches
5. Developing effective information-handling techniques

Recently, some industries have attempted to design a so-called total information system [31] which includes information on finance, accounting, management, production control, parts supplies, and engineering data, as well as scientific and technical information. These efforts suggest, especially in companies with large computer capabilities and well-developed scientific-and-technical-information programs, a trend away from the segmented scientific-and-technical-information service and toward integration within a company's multifaceted over-all information system.

Another noticeable trend is the increasing reliance of industrial corporations on information services which represent cooperative or coordinated ventures. These may involve other industries, either informally or through formal information pools (trade associations, consortia, industrially sponsored nonprofit research institutes, and the like); scientific and technical societies; local and university library systems; and federal and state government programs.

Trade and technical associations tend to establish information centers when a group of companies considers that the economic benefits of such an information pool outweigh the proprietary benefits of industrial processing of public information. Some of these information centers have long existed as libraries and have recently strengthened their services through the introduction of modern techniques and by expanding their coverage to include unpublished data. Although some centers are principally for the use of association members, as a membership benefit, others have a public relations function and encourage use by outsiders. A number of trade associations and nonprofit research institutes which are sponsored by several organizations within the same industry, and which would cease to exist without their financial support, devote a percentage of their efforts to the generation of secondary information services. The information services and abstracting publications of the American Petroleum Institute, the Institute of Gas Technology, the Institute of Paper Chemistry, and the Institute of Textile Technology are examples.

The relationship between the information activities of industry and of the scientific and technical societies is a reciprocal one, and cooperative projects between societies and industry are becoming increasingly numerous. As the various basic access services and systems in major disciplines continue to improve (for example, *Physics Abtracts*, Chemical Abstracts Service, or BioSciences Information Service), industry will depend ever more heavily on these services and specialized information products, instead of completely developing such capabilities in-house, provided that they are reasonably priced. Industry also can point out the need for new services and provide the feedback essential to the modification and improvement of existing services.

Two examples of recent efforts to foster industry and scientific and technical society cooperation on a regional basis are the NSF-funded programs at Illinois Institute of Technology (IIT) (see Reference 154) and the University of Pittsburgh (see Reference 155) to link industry and the discipline-wide chemical information system. The IIT Research

Institute is establishing a Chemical Information Center to help industry to learn how to tie the American Chemical Society's computer services and products into the various internal information systems used by industrial concerns. This Center will provide courses to educate potential future users in the nature and capabilities of the chemical information system. The program at Pittsburgh also involves the creation of a Chemical Information Center, using data from Chemical Abstracts Service, which will make information available to professional chemists, small independent industries, and students. After a trial period of some three years, the Center expects to begin using the University's time-sharing computer system. The program includes a user-feedback study, the results of which will be made available to the American Chemical Society for modification and improvement of its nationwide information system.

Industry traditionally has used nearby libraries, especially those of universities, as supplementary sources of access to information. Recently, new patterns of cooperation have been explored. A few pilot projects, some funded under the State Technical Services Act,[119] have made the resources of such libraries available to industry at a price, and industry-library cooperation has been stimulated by programs such as those of Stanford, MIT, and the Library Group of Southwestern Connecticut, Inc. The latter, for example, now serves the needs of a group of industrial corporations in Connecticut, including Dorr-Oliver, Cyanimid, Escambia Chemicals, Polymer Industries, and Perkin-Elmer. Members of the group receive a union list of 2,500 periodicals held by the participating libraries, a directory of 30 libraries' special subject fields, borrowing privileges, and teletype services for locating materials in the ten major Connecticut libraries (including Yale University Library and the State Library at Hartford).

Another noteworthy effort in this area is that currently taking shape in the Texas Gulf Coast region.[120] Rice University, with a grant from the National Science Foundation, support from the Office of State Technical Services, and investments of some $40,000 to date from industry, is establishing a Regional Communication and Information Exchange among 18 Gulf Coast academic institutions. This regional exchange project incorporates certain functions of the Texas Information Exchange, a statewide network organized by 22 universities and colleges. While serving the academic community, the Regional Communication and Information Exchange is also strongly industry-oriented. The program entails development of a centralized bibliographic reference and intranetwork location and transfer system. Outside investigators have access to the services on a fee basis. The project has already proved so useful to industry, even in its early stages, that support from industrial sources is increasing steadily.

Cooperative efforts with federal agencies have been especially important in the development of increasingly competent industrial information-service organizations. Industries which share in the work on large mission-oriented efforts, such as aerospace, defense, atomic energy, and public health, have received assistance, through direct as well as indirect support of pertinent research and development, in the evolution of effective information-management organizations. Moreover, in order to accelerate technology transfer and utilization, several of these agencies have established special information services on which such organizations can draw to enhance the scope and depth of their coverage.

The National Aeronautics and Space Administration (NASA), for example, operates nine Regional Dissemination Centers as part of its technology transfer effort. Using microfiched documents and publications provided by NASA (e.g., *Scientific and Technical Aerospace Reports* and *International Aerospace Abstracts*), or NASA tapes when computer facilities are available, these Centers offer a series of services that include retrospective searching and distribution of publications, specifications, and data for member industrial clients. Fees for membership range from a few hundred dollars for minimum services to about $5,000, depending on the scope and volume of services required. Operating and overhead costs are now partially supported by NASA, but these Centers are expected to gradually become self-supporting, as far as earning the cost of the services they provide. In addition, NASA is encouraging the development of fully self-supporting centers for which they will provide NASA tapes and documents. Evaluation of the Technology Utilization Program (a continuing process for which, in particular, the University of Maryland has a contract) indicates that the program has been very successful to date and serves a function that cannot be handled adequately by the existing fabric of scientific and technical societies.

The program conducted by the Department of Commerce under the State Technical Services Act of 1966 [119] is in many respects complementary to the NASA activities, being directed toward the needs of groups or types of corporations, while the program of the latter centers on needs connected with specific individual efforts. Some 600 projects have so far been initiated as part of the State Technical Services Program, including information-dissemination activities, referral service centers, conferences, workshops, seminars, field visits, and demonstrations. Among the primary goals of the Act is the stimulation and support of cooperative state–university–industry technical service programs to facilitate the use of new technological developments in local business and industry.[18] One example is a cooperative effort involving the University of Vermont Technical Information Center, the Washington-based Office of State Technical Services, about 1,000 Vermont industries, and as many DOD, AEC, and NBS information analysis centers as are appropriate to Vermont industrial technology. "The purpose of the program is to evaluate for one year, on an experimental basis, the feasibility of referring Vermont industries and businesses to selected federal information analysis centers for answers to their technical questions." [110] Funds for the initial year of operation will come, equally, from the federal government and the State of Vermont, with the expectation that the program, if successful, will become a state or regional program in 1970.

Several of SATCOM's recommendations advocate measures that will contribute to the growth in number and effectiveness of corporate information-service structures. These are principally Recommendations B5, B7, B10, and B11. These corporate information-service organizations are emerging as major buyers in the market of basic access services and in this capacity can exercise an increasingly substantial influence on both the direction and momentum of development of the latter. It is important that they function in this role as what may be called "sophisticated buyers"; Recommendation B8 represents our effort to provide additional opportunities for them to do so.

Innovative Services

A number of industrial information organizations, especially in the chemical, drug, and petroleum industries, have been leading innovators. This section describes some of these innovative services, the use of which is either already established or rapidly gaining acceptance in industry.

Systems for the selective dissemination of information (SDI) are being explored and developed by increasing numbers of research-oriented industrial organizations. (The NSF listing for 1966 in Reference 132 includes 24 industrial ones among a total of 42.) Established as separate operations or as one function of a larger organization, they range widely in scope and complexity. An example is the MERCURY system at Bell Telephone Laboratories [11] for the selective distribution of internal technical reports in mathematics, psychology, and computing science to members of the technical staff. Implementation began early in 1966 under the auspices of the Library Systems Department. Prior to that time internal technical reports were distributed initially on the basis of an author-prepared list; others could order copies from a monthly list of titles. For most readers this procedure yielded high relevance but low coverage. The new SDI system, serving 1,500 scientists on a monthly basis, involves computer comparison of individual interest profiles with assigned classifications. It has greatly improved coverage with only a slight reduction in relevance. Another noteworthy project of this kind is that in which 19 industrial companies are cooperating with Chemical Abstracts Service in the development and experimental trial of a large-scale SDI program, the input of which is based on indexes and bibliographic information from *Chemical Abstracts*.

The use of microform systems finally is making some headway in industrial information programs. Modern systems are overcoming resistance to the need for relatively expensive equipment and the former reluctance of many users to switch from the printed page. Until recently, utilization was mainly as storage for documents and indexes and for reference output; now it is becoming a substitute for hard-copy publication. The introduction and experimental trial of microfilm versions of *Chemical Abstracts* in a group of industrial organizations to stimulate familiarity and use were highly successful and showed that, once users became aware of and gained experience with modern equipment, their initial reluctance was overcome and most of them found the microfilm version easier to use and more rapid than the hard copy. The past two years have witnessed increased publication of modern microfilm editions of journals by the American Chemical Society, University Microfilms, and others.

The number of computer-based access and retrieval systems in industry continues to grow. The NSF 1966 survey [111] showed that of 17 such systems developed to perform demand searches, retrospective searches, and data retrieval, 16 were located in industry; of 20 systems which produced only computer-programmed publications. such as accession lists, recurring bibliographies, index and abstract bulletins, catalog cards, printed book catalogs, permutation indexes (KWIC, KWOC, and KWAC), and printed Uniterm records, seven were found in industry; and of 81 systems that performed both types of services, nearly half (37) were industrial. Computer-based information systems currently represent possibly the most flexible tools for the storage, rearrangement, manipulation, and output of recorded bibliographic data, and their versatility is increasing steadily and rapidly with the introduction of remote input–output devices and computer time sharing. Large central bibliographic or data files serving remote or scattered facilities, for example, the General Electric Space Missile Library or the on-line Bolt Beranek and Newman–Massachusetts General Hospital system, undoubtedly will become more and more common.

Together with their function as sophisticated buyers in the market of basic access services, corporate information-management organizations are eminently suited to make another vital contribution to the general development of scientific and technical communication by serving as a proving ground and test bed for novel techniques and procedures. They operate in an environment where services of high quality are of particular importance, where methods of cost-accounting and control are well developed, and where, in the case of the larger enterprises, the activity will tend to be of about the proper size--large enough to give well-designed new technology a chance to prove itself truly competitive with the evolutionarily adapted traditional procedures, yet not so large as to make the cost of installation exorbitantly high. Our objective of enabling industrial information-service organizations to continue to function in this role is an important element in the investigations and experiments that we propose in Recommendations B1 through B10, especially in the area of the computer-based shaping and manipulating of information files in an interactive closed-loop mode (Recommendation B6), or the development of a formal language for file-format description (Recommendation B8). It is a central element, finally, in the thrust of Recommendation B10.

D. THE CONCEPT OF NEED-GROUP SERVICES

The previous sections have described major types of current consolidation and reprocessing activities. Each in its own way facilitates the use of the information recorded in the primary literature and, assisted to a greater or lesser degree by the basic access services, supports activities in scientific research, design and development work, management, and education. Though they constitute ever more essential means of sustaining the personal information structures of individual workers, our survey shows that they do not completely fulfill today's requirements. Therefore, we have given particular attention to the identification of areas in science and technology where such inadequacies are particularly prevalent, and to communities that are least well served. In this section, we summarize our findings, outline possible patterns of service, and raise some of the important economic issues.

Directions of Needed Growth

Today, three factors increase the likelihood that significant need-group services will be provided for a specific group:

1. Substantial size of the group
2. Existence of a federal agency which in the fulfillment of its mission

assumes an especially active role in providing information services in its field

3. Existence of a particularly active industry association or scientific society

As a result, a few of the larger need groups are moderately well served.

There are, however, large areas, especially in the engineering sciences and the biological sciences, that have access to no such consolidating and reprocessing coverage. The professional groups most strongly affected are those in the university community as well as the applications-oriented scientists, technologists, and practitioners. It is unlikely that the information needs that such groups have in common can be met efficiently and effectively by the management of the institutions to which they belong. Therefore, we have concluded that the hand-tailored services of greatest assistance to such groups in coping with their information problems must be established on the basis of common professional interests, rather than common employers, and should involve appropriate societies or mechanisms created for this purpose by the scientific and technical community, including industrial components.

Need-Group Services

Such services could cover the gamut of those offered by various currently existing organizations and discussed in preceding sections. These include, on the one hand, consolidations, such as critical reviews and state-of-the-art reports as well as educational texts and reference handbooks; and, on the other hand, tailor-made indexes—often, perhaps, re-edited to emphasize specific contexts or aspects of relevance—as well as rosters of knowledgeable individuals and appropriate SDI services. The relation between the size of a need group and the range and scope of the services that can be provided economically is a crucial matter which depends on at least three factors:

1. The extent to which intellectual services, such as editing and selection, are furnished on a volunteer, unpaid basis

2. The recognition of the value of the services by their users and by the organizations supporting these users

3. The extent to which the more routine activities of several need groups can be combined to afford economies of scale

Efficient technology and progressive science demand that such services be extended to groups as small as is economically feasible. Cautious management and wise leadership mean that most, but by no means all, of the initial trials will involve groups of substantial size. It is too early to estimate how small a need group can be served efficiently with fairly extensive services, but we are confident that groups of at least a thousand or so can, and should, be so served.

Such activities occasionally have been referred to as tertiary or third-level access services because of their inevitably extensive reliance on the basic secondary tools. In many instances, when coverage of a discipline is provided by a single major basic access service, need-group services of the kind under discussion can be developed and offered by this basic parent, especially for larger need groups. For example, Chemical Abstracts Service has developed a family of specialized services to fulfill particular needs in the field of chemistry. Among these services are: (a) *Chemical-Biological Activities* (CBAC), issued biweekly in printed form or on tape, and providing concise, indexed summaries of research reported in some 600 life-science journals; (b) *Polymer Science and Technology* (POST), also issued every two weeks, offering digests of pertinent articles in 450 journals and patents issued in 25 countries, together with bibliographic information and key-word, molecular formula, and author indexes; and (c) *Plastics Industry Notes*, issued each week to serve persons with management, marketing, and production responsibilities, and summarizing and indexing pertinent information in 30 key trade journals and newspapers. In other instances, such as the field of heat transfer mentioned in Chapter 3, several of the established major basic access services would have to contribute in almost equal measure to a need-group service of adequate span and depth of coverage. Special arrangements are needed in such cases and might well be found sufficiently attractive for commercial operation.

The Institute of Scientific Information provides another example of a wide range of need-group services. The practitioner who requires prompt and adequate information for purposes of orientation typically depends more heavily on these services than does the research specialist who wishes to avoid duplicating work or overlooking work that he should cite.

As a third possibility, the major universities might cooperate in providing a family of need-group services under conditions in which each would actually develop and manage a small number of services while enjoying the fruits of over-all coordinated effort.

Current Innovations

The attempts of the AIP and of the National Institutes of Health to centralize the operation and increase the efficiency of preprint distribution, discussed in Chapter 4, Section D, provide examples of need-group-oriented innovative efforts. Further, the development of formal media devoted to brief, rapidly published reports on current work and giving "who, what, and where" information represent another type of effort to provide an efficient service for which a market clearly existed. An area of especially great activity and experimentation, which stems from the existence of customer networks, is the selective dissemination of information (SDI), discussed more fully in Chapter 7 and in Section C of this chapter. A number of SDI systems, in order to improve their cost–benefit position, are moving toward the use of group profiles rather than individual profiles as the basis for document distribution. NASA, for example, has recently established a pilot service, *Selective Current Aerospace Notices* (SCAN), based on group profiles, which it hopes eventually will replace the individual SDI service. (Group profiles also were the basis for delineating the NIH information exchange groups described in detail in Chapter 4, Section D.) In some fields, however, individual profiles are economically feasible and almost essential to provide the type of service that is required.

An illustration of a special effort to develop custom-tailored services to meet the needs of a clearly defined group is the Stanford Physics Information Retrieval System (SPIRES). Underlying the program is the belief that efforts of discipline-oriented information systems will be directed primarily toward fulfillment of a wholesaler role and that specialized, geographically dispersed projects will be necessary to identify customer groups and provide them with hand-tailored services—in other words, to fulfill a retail function. The project involves a study of the information needs and information-search behavior of about 100 high-energy physicists at Stanford, many of whom are associated with the Stanford Linear Accelerator Center (SLAC). This project, which melds the efforts and approaches of documentation research, computer-science research, and behavioral-science research, is planned as a five-year effort and entails the development of a computer-based on-line reference retrieval system. User priorities determined selection of the data base for input to the system. Highest priority was accorded the SLAC preprint collection, followed in turn by bibliographic and indexing data from *Nuclear Science Abstracts,* journal literature, and the index of reports and preprints from the DESY High Energy Physics Laboratory in Hamburg, Germany. Systems planning focuses heavily on the development of software and applications programming, and close liaison is maintained with the SLAC Library. Interviews with users and studies of user behavior suggest modifications and possible improvements and assist in gearing the system to user needs. For example, it was evident early in planning and development that the data base had to be sufficiently broad to accommodate exhaustive searches for the preparation of reviews and for searches in areas relatively unfamiliar to a researcher; access to core literature was not sufficient for this group. Plans are under way to link the SPIRES system with the Office of Education's Educational Resources Information Center Clearinghouse for Educational Media and Technology, also located at Stanford, and further to augment the data base by incorporating citation indexes in the preprint collection and other needed information.[140]

Another type of innovative service falls in the area of continuing education. The provision of special seminars, workshops, and so-called cram courses, which help to bring scientists and technologists rapidly up to date in their special subject fields or inform them about developments in other areas relevant to their specialties, are crucial in fostering the effective and rapid application of information. An industry-oriented example [156] is a recently initiated program that makes available to industrial research organizations and laboratories a series of intensive two- and three-day seminars conducted by distinguished scientists on topics such as laser applications in particular subject areas, nuclear medicine, polymer characterization, or liquid crystals. This program included a series of 30 seminars in 13 subjects during the winter of 1968–1969 and will be augmented in the near future by an additional 15 subjects as well as the provision of experimental demonstrations and video-tape seminars.

ECONOMIC CONSIDERATIONS

Custom-tailored services responsive to the specific needs of a particular group should establish their acceptability by the quality of their performance in meeting these needs. This suggests that their development will benefit from a certain measure of exposure to the market that prevails for such services. In considering arrangements toward this end, one immediately is faced by the problem that the costs of such services will tend to be relatively high in view of the intellectual work involved in their operation, and that such costs are notoriously difficult to determine in a manner that allows interservice comparison.

In approximate order of increasing costs of preparation, we list the following as characteristic examples of services encountered in need-group operations:

1. Collected contents pages of journals
2. Simple bibliographies
3. Title listings, sorted into broad groups

4. Title listings, accompanied by indexes
5. Title listings, with annotations and indexes
6. Collections of author abstracts
7. Collections of abstracts, arranged in broad groups
8. Collections of abstracts with indexes
9. Special indexes (e.g., *Ring Index*, citation indexes, KWIC, KWOC)
10. Audiovisual aids
11. Surveys and reviews
12. Data compilations
13. All forms of major re-editing or new preparation of text

Very little work has been published on cost-analysis of this range of service operations, thus depriving any cogent market analysis of one of its essential elements.

Under the circumstances, we advocate that the exposure to prevailing market forces of these hand-tailored, and therefore somewhat unconventional, services be achieved through the recovery of output (generally runoff) costs from the customer, while every effort be made to cover input costs by contributions, direct and indirect, from the supporters of the work concerned. (Holding down transfer costs from secondary services is only one form of indirect support.) This general viewpoint is reflected in our Recommendations B7 through B12.

E. INFORMATION-SERVICE NETWORKS

The term information-service network is applied today to a wide variety of structures that form a continuum of sorts. At one extreme we find centralized support and performance of a function for common use, such as the Library of Congress's long-continued preparation of catalog cards, or the National Library of Medicine's preparation of MEDLARS computer tapes. At the other extreme, we find mutual support of an information function through interlinked back-up, such as cooperative arrangements among groups of libraries to enhance the services each can offer and diminish the overlap of their collections. The use of computers and of electrical communication (rather than mail) to handle data and messages within networks makes more rapid service possible and eventually may make expanded services economically feasible.

Networks composed of structures for transmitting and receiving messages have had a long and successful history in communications technology, as illustrated by the telephone and broadcasting systems. The development of information networks to provide for emission, conveyance, switching, and reception is a natural extension of this pattern and one that finds useful application in an ever-widening range of contexts. The airlines, for example, successfully operate extensive interconnecting on-line reservation services. Hospitals have explored the development of a variety of networks to fulfill functions ranging from patient monitoring to the management of health, inventory, and accounting records. The ready availability of data on patients, both within a hospital complex and among geographically dispersed hospitals, offers new opportunities in the areas of diagnosis, patient care, and epidemiological research. Some of the most advanced developments in the design and operation of information networks are now occurring in the area of military command and control. Even in the area of law enforcement, implementation of the network concept is proving valuable. The Federal Bureau of Investigation, for example, has established a National Crime Information Center, with terminals planned in all states and major cities, to provide for input and access to data on stolen items, wanted criminals, and various other types of relevant records and statistics.

The concept of interconnecting structured files of documents and data ranging in scope from the local to the regional, national, or international level has been advocated for some time as a prime objective in coping with the rising tide of information and the more pressing and diverse information needs of scientists and technologists. Thus, in reviewing developments in this area, Swanson [142] states: "It is no longer necessary . . . to ask whether networks can be built. It is time, instead, to ask about the sorts of networks that are needed, and to set about providing the innovative software and the flexible, inexpensive hardware to bring them into being." And the author of another recent review article [83] foresees great advantages from the implementation of the network concept at the national level:

> Perhaps the development in the information sciences field that will do the most to solve the problems that beset scientific information users is the national information network. It will have, through its many supporting components, greater resources and faster access than any of our libraries and information centers could hope to have today. Such interacting groups of information generating agencies, information centers, libraries and switching agencies . . . should be eventually capable of supplying all kinds of data to all comers.

Current tendencies in government, industry, libraries, universities, and scientific and technical societies toward the operation and development of information networks lend support to these assessments of the need for and potential advantages of network efforts. This trend also is fostered vigorously by:

1. Economic factors and time pressures which encourage the sharing rather than the duplication of information resources
2. Technological developments which permit the integration of diverse multimedia inputs and have the capacity to cope with projected increases in volume of information
3. Availability in machine-readable form of increasing amounts of scientific and technical information (see Reference 18 for a discussion of these factors)

For some years to come, technical as well as economic constraints will limit the effective size of hand-tailored information services designed to function in close responsiveness, and with good feedback coupling, to their customers. However, we anticipate the proliferation of such individual services in order to provide adequate coverage of the expanding scientific and technical literature and effective service to increasingly diversified user groups. Only the systematic exploitation of the opportunities which networks provide for multiple access to and sharing of information will keep within practical limits the cost and effort entailed by specialized need-group services.

In contrast to systems composed of a central source that provides certain services to a group of recipients, information networks are reciprocal or bidirectional; each node involves both active input and reception of information. Further, each must afford a directory and switching capability so that users can direct requests to appropriate components and have their messages routed accordingly.

Some indication of the applications and adaptations of contemporary information-processing and communication technology in the realization of information networks follows in Chapter 7. Our concern here is with the roles and functions which these networks can be expected to assume in effectively linking services at the same and different hierarchical levels. This section discusses briefly three areas of network activity: the linking of basic access services, the linking of services designed to serve broad areas of need, and the role of customer networks in the evolution of need-group services.

Service Networks among Basic Access Services

Cooperative library networks, especially for the exchange of bibliographic data and the coordination of various accessioning and processing procedures, have long existed, but their development recently has gained momentum and their scope has greatly expanded. As libraries have brought their efforts to bear on such problems as the development of better indexing schemes, the development of standards and compatible formats, and the application of new media and new technologies, joint efforts have become necessary concomitants of effective library operation. Further, all the major functions of libraries—distribution, processing and availability, and user service—can be enhanced by network applications. A major trend is toward the inclusion of varied types of libraries in one network in order to handle more effectively a growing variety of materials, questions, and needs. As important as improved performance is the factor of economics. A recent System Development Corporation plan,[91] prepared for the National Advisory Commission on Libraries, emphasized the reduction in both duplication and cost of purchasing and processing inherent in network development. Among the network projects specifically advocated in this plan are: (a) an expanded computer-based union catalog; (b) a national bibliography; (c) a national referral and loan network; (d) a national library storage and microform depository system; and (e) development of a prototype network of regional libraries.

The development of a network of regional libraries is now under way in the medical field. Current plans entail the establishment of ten regional medical libraries, backstopped by the National Library of Medicine, to provide prompt awareness of and access to needed materials for U.S. health service researchers, practitioners, and students. Existing libraries with facilities of sufficient depth and scope will be awarded grants, thus enabling them to supplement their resources in order to serve other medical libraries in a given region. To the extent made possible by their strengthened resources, services will include the full range of alerting, reviewing, and archival functions now provided by the National Library of Medicine, fulfillment of interlibrary loans within the region, formulation of MEDLARS searches, and specialist training. Access to regional libraries generally will be through other medical and local libraries, though individuals also will be served directly.

Another noteworthy regional effort is the New England Library Information Network (NELINET), the objective of which is to provide libraries of New England with computer-aided technical processing services. The pilot operation involves five state university libraries, but extension to all universities throughout New England is planned. Services will include instantaneous access to machine-form cataloging information provided by the Library of Congress MARC Project; high-speed production and delivery of customized catalog cards, book labels, and book pocket labels; and search and automated order control for acquisitions.[114]

Recent legislation has encouraged the development of library networks. For example, the Higher Education Act of 1965 has stimulated research into feasible areas of network cooperation, and the Library Services and Construction Act and the State Technical Services Act have resulted in the implementation of a number of cooperative library ventures. Particularly within states, these acts have stimulated an upsurge of cooperative activity tying similar libraries into more effective reference and interlibrary loan networks. Among the states in which outstanding efforts are under way are Washington, Vermont, New York, Pennsylvania, Michigan, Rhode Island, California, and Texas.

Greatly facilitating the development of networks are the efforts of the three national libraries to enhance compatibility of catalog data, serials records, and machine record format. The trend toward widespread acceptance of the Library of Congress MARC II format has been a major step forward. Further, experiments such as Projects INTREX and TIP at MIT (see Chapters 5 and 7, respectively) and the experimental operation of IBM's Administrative Terminal System have promising implications for future library network activities.

A second major area of cooperation and emerging network effort is the exchange of tapes by basic abstracting and indexing services. A number of these arrangements cross national boundaries and, therefore, are discussed in Chapter 9, Section A, which deals with direct cooperative agreements between scientific and technical societies and between mission-oriented government activities. The development of the International Nuclear Information System (INIS) is one example. Further, Section C of the same chapter focuses on efforts of international organizations to enhance compatibility and convertibility and thus to pave the way for worldwide network activities, a major example being the study now in progress of the feasibility of a worldwide science information system.

Within this country, in an effort to reduce the redundancy of products and services and foster more coherent efforts, abstracting and indexing services, especially those serving the fields of biology, engineering, physics, and chemistry, have initiated cooperative arrangements involving the exchange of abstracts and studies of both indexing procedures and overlaps among services. In addition, there is growing awareness of and emphasis on the need to make basic abstracting and indexing tapes accessible to other organizations for use in the development of specially tailored services for various user groups. Recognizing this trend, the management of *Psychological Abstracts*, when converting to a computerized method of printing, employed a process [14] whereby material was encoded on computer tape according to function and could, through the use of appropriate style-manual-type programs, be used to produce other publications, provide other specialized services, or be employed as input to other systems, such as the NIMH Clearinghouse for Mental Health Information, which currently acquires *Psychological Abstracts* tapes. Special projects, such as those at Illinois Institute of Technology and the University of Pittsburgh (discussed in Section C of this chapter) to assist industry and libraries to tie Chemical Abstracts Service products into their own systems, also exemplify this trend.

Networks of Need-Group Services

Characteristic of the services developed to meet the needs of identified interest groups are efforts to use one or more basic access services whose products are necessary for reprocessing and consolidation activities and, ultimately, to interrelate with one another and form still more comprehensive networks. The activities surrounding MEDLARS—itself a vast network with six regional centers throughout the United States and two in Western Europe—provide an illustration. MEDLARS is attempting to develop links with a number of specialized networks to serve more effectively certain special areas of need. One example is the Toxicological Information Program, begun early in 1967, which has four principal objectives: (a) identifying and evaluating information requirements among responsible groups concerned with toxicology; (b) developing a professionally approved terminology for the field; (c) interrelating centers which hold and develop relevant toxicological information; and (d) establishing a computer-based system, utilizing information available from the network as well as from ancillary sources. Experiments with a pilot network are now under way. Development of a common CAS/FDA/NLM data base of toxicologically significant compounds and long-term cooperation with activities of the National Institute of General Medical Sciences in areas such as a pharmacology–toxicology program also are planned.

Another area of need, and one which is a current focus of network development efforts, is that of improved communication among institutions of higher learning. The central purpose of the Interuniversity Communications Council (EDUCOM) is to examine the contributions that networks can make to higher education, scholarship, and science.[117] The first Task Force established by EDUCOM was one on Information Networks. Network planning ultimately envisioned local information centers in colleges and universities to conduct control and switching functions for information stored in or transmitted over them. These centers, by means of time-sharing computer systems, would be the nuclei of local networks including carrels, offices, libraries, classrooms, laboratories, clinics, and hospitals. As a result of Task Force efforts and of a special summer study conference, plans for the development and pilot operation of a coast-to-coast EDUNET took shape. Criteria which guided the planning were:

1. That it be sufficiently extensive to permit access by an appreciable part of the academic community
2. That it be capable of serving a diversity of applications
3. That it provide a full range of communications experience with multiple media
4. That it be expandable to accommodate continued growth and modification (see Reference 118 for further details)

A gradual three-phase development was planned and a pilot network designed that would provide information to augment academic instruction, research, and administration; afford experience in long- and short-distance and scheduled and unscheduled operations; and yield data for evaluation. The network, if successful, is intended to be readily extendable to other institutions and capable of tying into satellite communications when this becomes technologically possible and feasible.

The American Institute of Physics (AIP) provides an example of scientific and technical society efforts toward the development of networks of need-group services. The AIP perceives its role as an information switching center that interfaces with various disciplines (e.g., chemistry, mathematics, electrical and electronics engineering, and biosciences) and with mission-oriented agencies (e.g., Atomic Energy Commission and National Aeronautics and Space Administration) which not only contribute to the production of physics documents but are users of the information contained therein. In planning an information system for physics, the AIP has given special attention to the needs of various user groups and to developing the special media and services that they will require. Among the services available or planned are: provision of copies of cover pages of AIP documents, of microfiche masters for industrial information systems, of microform copies of entire documents, of computer tapes for photocomposition of abstracts, of tapes to update the computer files for Project TIP, and of translations in hard copy. (See Reference 103.)

Customer Networks

Scientists tend to sort themselves into special interest groups and invisible colleges—into relatively small communities which actively communicate with one another through the exchange of preprints, reprints, manuscripts, memos, and technical reports and through person-to-person interaction when circumstances permit. These clusters are essentially small specialized networks in which individual members both transmit and receive information and route their colleagues to other persons or sources that can supply needed information. They also often route out-of-the-way information to interested colleagues. Membership in such a group is relatively fluid; some become attached to other areas and drift away, and newcomers to a field gradually gain admittance. Further, some key individuals typically identify with several such groups and form links between them. Recognition of the existence of such "communicating communities," with common information needs, and identification of some of the information functions fulfilled by such informal means, has resulted in special efforts to supplement and enhance the effectiveness of these informal communication networks. (See Chapter 3, Sections C and D, and Chapter 4, Sections A, B, C, and D, for a more complete discussion of semiformal and informal communication.)

CHAPTER 7

New Technologies and Their Impact

The adaptation of modern computer, communications, and display facilities and the exploitation of rapid and inexpensive means of reproducing existing records are streamlining the processes of document production, access, and use in many vital ways. Numerous procedures and services based on current technological developments are being introduced, either singly or in combination, in the information programs of many government and private organizations, and other more sophisticated ones that involve higher risks are under active exploration. The systematic use of new technologies in document production and distribution as well as in support of basic abstracting, indexing, and bibliographic services makes it possible to handle the escalating requirements of volume and diversity of operation without a corresponding escalation in cost. Additionally and more significantly, new technologies offer opportunities for providing the specialized services demanded of modern information programs that are devised to handle the information needs of well-defined user groups in specific contexts. Examples of the latter are the information programs supporting the missions of government agencies, the corporate information systems of industrial establishments, or the information services of particular scientific and technical need groups.

In the following section we review the principal scientific-and-technical-information-handling processes in which new technologies play an increasingly prominent role. A second section presents a discussion of the concept and contemporary development of information systems that involve the concerted use of such technologies. And the final section deals with the resulting problems of law and equity.

A. THE PRINCIPAL PROCESSES

Document Production and Reproduction

A growing number of both for-profit and not-for-profit publishers are introducing computerized photocomposition into the production of scientific and technical publications. Automatic adjustments of format in text and tables permit significant savings in high-cost labor. Formulas and graphic material can be handled economically now at adequate levels of quality, and good programs for proofreading and editing are being developed. In addition, a machine-readable record of full text is available for any subsequent processing (e.g., the preparation of bibliographies and indexes). Our Recommendation C13 proposes steps for assuring the advantages of resulting economies and higher speed of production to an increasing number of scientific and technical publications.

The principal bottleneck at present is the laborious process of transcribing hard manuscript copy into a machine-readable record with the required freedom from errors. The few organizations able to do this for scientific and technical text are running at capacity, yet the demand continues and increases. Optical character-recognition equipment will help to break this bottleneck, as will the growing use of computer-aided typewriters for initial editing. Current versions of both still fall short in performance, reliability, and cost.

Once material has been prepared and issued, it can be rapidly and inexpensively reproduced by means of techniques and equipment that have been so greatly improved during the last few years that they have led to significant changes in the handling of scientific and technical information. On the basis of a recent study, the Committee to Investigate Copyright Problems has estimated that by 1967 a billion pages per year of copyrighted scientific and technical material were being copied in U.S. libraries.[119] This figure does not include the noncopyrighted publications, such as federal reports, nor does it include the copying done outside the library (e.g., by the reader's secretary using the office copying machine). At least four libraries in the United States copy over five million pages per year.

The cost reduction of copying, particularly in microforms, and the speed and quality of the process have progressed to a point at which the possibility of general use of on-demand *distributing* libraries instead of accountable *circulating* libraries merits serious consideration. Such an approach has been introduced, even in full-scale reproduction, by several large libraries for their loan operations, with photocopies rather than the original copy supplied in response to loan requests. The National

Library of Medicine (NLM), for example, fulfills almost all its requests by duplicate copies of the original (over two million pages in 1967). The Clearinghouse for Federal Scientific and Technical Information (CFSTI) distributes technical reports from the various government agencies, including the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA), in hard copy at a fixed price of $3 each and in microfiche at 65 cents. This provision of full-scale copy or microform delivery from a central collection can greatly increase the availability of many publications and articles that previously were difficult to obtain, provided that prospective readers have been alerted to their existence, content, and accessibility. Currently, a number of secondary services are arranging to provide full-text copies of articles that they cite. (See Chapter 5, Section A.)

The increased use of microform copying during the last few years has been mainly in the publication of parallel microform editions of existing hard-copy works. Data in Table 18, showing the volume of microform production of the major federal document-delivery systems, give an indication of the extent of microform publishing. Complete collections of works, such as those listed in Table 19, are provided as packaged microform collections, generally by private sources. This practice probably will continue to grow during the next several years.

Microform copying is a relatively inexpensive means of reproducing

TABLE 18 Microform Deliveries of Five Major Federal Document Services

	Millions of Copies of Reports Furnished to Requestors in 1967	
Document Services	Hard Copy	Microform
Defense Documentation Center, Department of Defense	1.44 (FY67)	0.26 (FY67)
Clearinghouse for Federal Scientific and Technical Information, Department of Commerce	0.47 (FY67)	0.30 (FY67)
ERIC Clearinghouse, Office of Education	—	0.37 (approximate)
Technical Information Facility, National Aeronautics and Space Administration	2.0 (approximate)	8.0 (approximate)
Division of Technical Information Extension, Atomic Energy Commission	0.72	2.5
TOTAL FOR THESE FIVE SERVICES	4.6 (at least)	11.4

TABLE 19 Examples of Microform Packages Offered by Private Organizations

Collection	Organization	Description
Sweet's	Sweet's Industrial Information Systems, Palo Alto, Calif.	Over 600,000 vendor catalog pages from 5,500 vendors
Visual Search Microfilm Files	Information Handling Services, Inc., Denver, Colo.	One million pages of parts and engineering catalogs from 15,000 suppliers
Annual Reports	3M Press, St. Paul, Minn.	Corporate annual reports
American Prose Fiction	University Microfilms	Almost 5,600 books covering the period 1774 to 1873
Chemical Abstracts	Chemical Abstracts Service, Columbus, Ohio	Over 4 million abstracts published since 1907
U.S. Chemical Patents	3M Press, St. Paul, Minn.	U.S. chemical patents
Thomas Micro-Catalogs	Thomas Publishing Company, New York, N.Y.	Military specifications, USA standards, and other data sheets
Transistor Information Microfile	D.A.T.A., Inc., Orange, N.J.	Basic data on 9,000 transistors, 50,000 diodes and rectifiers, and 4,000 microcircuits
Microfacts Advertising Reference File	Microfacts Corporation, Detroit, Mich.	Thousands of articles from advertising journals and business press, clipped, indexed, and put on microfiche

articles, books, and reports. On a production basis, the cost of making a microform copy of a 50-page report often is quoted at approximately 10 to 25 cents, and this figure soon may apply to volumes of 450-page length. The introduction of ultramicrofiche (one of the many new developments in the area of mass file storage), with more than 50 times greater storage capacity, has made it feasible to provide copies of existing collections or portions thereof—that is to say, new libraries on demand. Moreover, microform copying and storage also permit more reference material to be placed in the office at the fingertips of the individual user. (See Recommendation C12.)

The increase in the volume of copying and the growing variety of techniques for doing so have brought new interest and attention to the question of copyright and to the ways in which the copyright owners are to be protected and compensated. Section C of this chapter presents a brief discussion of this problem.

Document Distribution

Large scientific societies, such as the American Chemical Society (ACS), or major groupings of such societies, for example, the American Institute of Physics (AIP) or the American Geological Institute (AGI), which operate a sizable stable of journals, routinely use computer procedures to keep track of subscribers, subscriber options, and subscriber billings. The same is true of major report distribution centers, for which distribution costs have become comparable with reproduction costs. For example, replacing a charge based on number of pages with a flat charge of $3 per report allowed the CFSTI to streamline its paperwork connected with distribution to such an extent as to make a net saving.

The large-scale exploitation of computer capabilities in such contexts offers the possibility of increased refinements in tailoring subscription packages to subscriber demands. Full-text copies may be ordered on the basis of selectively disseminated announcements, distributed in accordance with a coarse-meshed characterization of customer interests. Or the subscriber might select one of an appropriately constructed number of unit profiles and receive all publications of the source that fall within the scope of his so-determined interest. And, finally, there is the full-fledged selective dissemination of information (SDI) system that "indexes" customer interests and document content from a common vocabulary and distributes material on the basis of a generally computer-executed match. Thus, new material is brought automatically to the attention of user clienteles that may number from several hundred to several thousand (Recommendation C12).

At least 100 such SDI systems, representing various levels of sophistication, are in operation today in government agencies and industrial corporations. Among scientific and technical societies, the Computer Group of the Institute of Electrical and Electronics Engineers (IEEE) stores most submitted manuscripts (those for which the author gives permission) in a central depository and presents abstracts of them on a bimonthly basis. Hard copies can be obtained at cost and are forwarded with an attached reply postcard asking for the reader's evaluation. Although the editor of *Computer Group News*, in which the announcements appear, examines these papers, they are not reviewed by referees prior to announcement. The American Mathematical Society (AMS) has planned a title citation and off-print distribution service covering the Society's journals together with a few others whose publishers are interested in cooperating in this venture. Items will be selected for referral in accordance with an interest profile constructed in terms of *Mathematical Reviews* subject headings. Services rendered will be billed on a monthly basis against a subscription price of $30, with renewal requested when the balance is reduced to about twice the average monthly charge.

For fully automated systems, the cost of operation escalates rapidly with the number of profiles that the system is designed to service. Therefore, in large operations, such as federal agencies, individualized SDI systems frequently are operated manually (mailroom route sheets) and on an informal basis, with staff members looking after one another's awareness needs.

Processing of Machine-Readable Records

The increasing availability of document texts, bibliographic records, and data in computer-readable form is making new services available to users and raising the potential for cooperative efforts between various information programs. These records often are created as a by-product of the regular publication procedures (e.g., tapes for photocomposition equipment), but in some instances they have been prepared primarily to permit many new applications and products to be studied and tested, such as specialized need-group services or those that support critical review and consolidation efforts. In expanding and improving the services based on the use of the machine files, an increasing number of organizations are arranging to provide machine-language copies of the central bibliographic files for parallel use in local and regional facilities. For example, NASA and NLM supply their regional information centers with bibliographic tapes that permit the development of special services for users in adjacent geographic areas. The distribution of the Library of Congress catalog records by Project MARC permits libraries in many parts of the country to use these tape records for purposes of their own. Tables 20 and 21 give some indication of the extent of distribution and availability of machine-readable records.

The reprocessing operations that can be carried out automatically on such machine-readable files for awareness, access, or search purposes vary from those guided by format structure alone to those requiring more or less sophisticated recognition of information content. The former will operate (extract, regroup, etc.) on data elements recognized as pertinent on the basis of the structure-determined fields they occupy (e.g., author's name, or title, or accession number). Though format-determined sort-and-search processes are used extensively in

TABLE 20 Examples of Bibliographic Records in Machine-Readable Form Offered by Private Organizations

Organization	Distributed Records
American Institute of Aeronautics and Astronautics	*International Aerospace Abstracts*
American Petroleum Institute	*Abstracts of Refining Literature* *Abstracts of Refining Patents*
American Society for Metals	*Review of Metal Literature*[a]
American Geological Institute/Geological Society of America	*Bibliography and Index of Geology Exclusive of North America*[b]
American Psychological Association	*Psychological Abstracts*
American Society of Mechanical Engineers	*Applied Mechanics Reviews*
BioSciences Information Service	*Biological Abstracts*
Chemical Abstracts Service	*Chemical Abstracts Condensates* *Basic Journal Abstracts* *Chemical-Biological Activities* *Chemical Titles* *Polymer Science and Technology—* P(atents) or J(ournals)
Derwent Publications, Ltd.	*Farmdoc* *Plasdoc* *Ringdoc*
Engineering Index, Inc.	Electrical/Electronics and Plastics sections of *Engineering Index*
IFI/Plenum Data Corporation	*Uniterm Index to U.S. Chemical Patents*
Institute for Scientific Information	*ISI Source Data Tapes* *ISI Citation Tapes* *Index Chemicus Registry System*
CCM Information Sciences, Inc.	Pandex Airmail Weekly Tape Service
Project URBANDOC, Library, City University of New York	Bibliographic records related to urban planning and renewal
R R. Bowker Company	*Publisher's Weekly* *Forthcoming Books* *Paperbound Books in Print* *Subject Guide to Books in Print* *Children's Books for Schools and Libraries*

[a] Now *Metals Abstracts.*

[b] Now *Bibliography and Index of Geology.*

TABLE 21 Examples of Government-Agency Bibliographic Records in Machine-Readable Form

Organization	Records
Atomic Energy Commission	*Nuclear Science Abstracts* [a]
Clearinghouse for Federal Scientific and Technical Information	*U.S. Government Research and Development Reports and Index*
Educational Resources Information Center	*Research in Education*
Library of Congress, MARC Project	LC Catalog records [a]
National Aeronautics and Space Administration	*Scientific & Technical Aerospace Reports*
National Library of Medicine	MEDLARS tapes for *Index Medicus Current Catalog* [a]
U.S. Geological Survey	*Abstracts of North American Geology*

[a] Distributed to public under specified conditions.

operational systems, information-content-determined processes still are largely in an experimental state.

A number of services, for example, those of the Defense Documentation Center (DDC) and Atomic Energy Commission (AEC), are using computer programs to assemble and format printed descriptive catalog indexes to their abstract journals. This is accomplished by extracting related data elements (e.g., author, report number) automatically from the master machine record and performing subsequent sorting and printing operations. Similar processes have been developed to extract information from photocomposition tapes. Thus, machine-readable records of the full text of several ACS primary journals currently are sent to Chemical Abstracts Service (CAS) to be used in compiling the abstracts and other bibliographic data of this data base. The eventual expansion of this service to provide tapes of 18 ACS journals will make possible less expensive and more timely coverage of a significant fraction of the primary literature. The AIP has similar efforts under way.

Once a master bibliographic file has been prepared in machine form, it is relatively easy to copy selected portions of that file, for example, for particular need groups. One good example is the experimental publication, *Abstracts of Mycology*, produced by BioSciences Information Service as a derivative publication of the basic abstract journal, *Biological Abstracts*, on the basis of machine selection of abstracts tagged with indicators for fungus and lichen.[19] The most significant operations of this type involve programs that subject such files to retrospective literature searches, which—given the prevailing size of such files—

otherwise would not be made. Data fields are scanned for match or nonmatch with a given list of "words" (names, terms, or numbers) that might occur in them, and a record can be accepted on the basis of highly sophisticated logical schemes. (For example, in fields 12 through 24, at least three entries from a given list of five such entries must occur, and none from a second list of three additional possible entries, or the particular record is rejected.) Several organizations (e.g., DDC, NASA, NLM) make on-demand literature searches of this kind to provide prompt bibliographies in specialized subject areas defined by individual users. The economics of such repeated searching, in contrast to one-pass reorganizations and printouts using a wide variety of access mechanisms, deserves attention.

Intermediate processes may involve relatively free-formated records, in which special keys replace field boundaries. Such records can be processed almost as easily as fixed-format records. Other intermediate processes provide challenges almost as great as those of sophisticated content-guided processes.

The objective of the search for and development of content-guided processes is to make it possible for the computer and the human expert to share the intellectual work required in the composition of entries for the access and search systems used in survey and review preparation and in data compilation. Particularly promising among such developments are automatic indexing, machine-aided searching, question-answering systems, and file-reorganization programs (see Recommendations E4 and E5).

Several research efforts have been directed toward developing computer techniques for automatically generating abstracts, extracts, or résumés of original articles. However, the development of such techniques has not yet reached the stage at which they can be put into operation by the secondary services, nor is it clear at this time that they will ever develop to that point. In the long run, our reservoir of knowledge of and experience with the practical architecture of language will be closely related to the sophistication of our efforts in this area. The eventual success of our efforts to exploit modern computer capabilities in handling scientific and technical information will depend substantially on the vigor and originality of our computer-supported research into relevant language habits, whether this area be called linguistics or information access.

Information Delivery: Communication and Display

Modern communications equipment, although available for information service operations, appears not to have been used extensively because of its relatively high cost. With the growing interest in the time-shared use of data bases from remote consoles, the problem of suitable pricing scales and tariffs for carrier services in this kind of data transmission has become a pivotal issue and currently is under intensive study by the Federal Communications Commission.

The two examples that illustrate current thinking in its most advanced form are, on the one hand, the concept of a coast-to-coast inter-university information network, developed by the Interuniversity Communications Council (EDUCOM) under the name EDUNET, and a system of intercommunication for some 20 dispersed computers, currently under development by the Advanced Research Projects Agency (ARPA) of DOD. In principle, EDUNET would permit its member universities to share in all information-processing activities pertinent to higher education, including the traditional use of computers in calculations, computer-aided instruction, automation of library services, and educational radio and television, as well as in the complex managerial operations of the university itself. The time-phased development of a pilot system for these purposes has been planned in some detail by EDUCOM,[19] and the first phase of the Education Information Network is now under way.

The projected ARPA Network will consist of an eastern cluster of eleven and a western cluster of eight closely interconnected computers between which two links will run: (a) from Lincoln Laboratory to the University of Utah, and (b) from the University of Illinois to the System Development Corporation (SDC). All links are 50 kilobit/sec leased lines, there being on the average 2.55 links between any two nodes. The key concept is that of a simple common language for all traffic over the connecting links, with an Interface Maintenance Processor (IMP) provided at each of the network computers to effect the conversion from and to the language of the local computer. The IMP has been designed, its estimated cost amounting to about $20,000 per copy, and a standard format for the network information packet has been devised. As in the case of earlier ARPA-sponsored projects in the development of data-processing networks, this facility is to be provided as an experimental tool to permit the accumulation of experience regarding the problems and the capaibilities of such systems.

High costs and rather widespread dissatisfaction with image quality characterize current display terminals, be they microform readers, facsimile terminals, or computer-managed cathode-ray-tube (CRT) displays. But no real obstacles in the straightforward development of satisfactory image-display systems are foreseen. Project INTREX of MIT (see Chapter 5, Section A) has made a major effort to determine the specifications for a satisfactory terminal and to develop a design that meets these specifications as a part of its plan for a computerized augmented-catalog system for the Institute's engineering library. A completed model currently is being tested. Moreover, industrial requirements for handling graphic material in computerized information systems as well as the swelling needs in education have stimulated industrial development efforts to meet these requirements and have resulted in the appearance of a number of new and varied techniques and systems.

B. THE DEVELOPMENT OF INFORMATION SYSTEMS

In their aggregate, all the technological and procedural innovations illustrated in the foregoing discussion are not ends in themselves. They furnish an expanding range of capabilities to be utilized in designing and operating coherently conceived programs of information services that complement one another in the achievement of broad objectives. With increasing frequency, such service programs are referred to as systems, and the general philosophy that calls for comprehensive coordination in shaping information-handling efforts is called the systems approach. The insights of modern information science and the kind of performance that evolving information-processing facilities can be expected to deliver make such an approach increasingly productive.

A particularly clear and consistent usage of the term, "information system," would reserve this designation for entities possessing the intrinsic ability of discovering, gaining access to, and manipulating all the data that they contain. In the course of an operation—whether initiated by a user, a running program, a clock, or some other means—needed information frequently will not be immediately available by address, and at that point the system must be able to:

1. Establish whether it contains this information in any of the memories of its hierarchy
2. Connect its active memory to that hierarchical level
3. Transfer the data for further manipulation

Systems that use people, or are interactively used by people, frequently secure these data through an inquiry to the user and a subsequent user input. In other words, the user at the terminal is considered the mnemonic hierarchy of last resort for both data and instructions. Such systems, therefore, can comprise many separate machines, only loosely coupled by communication lines for inquiry, access, and transfer. When these so-called systems fall apart into separate systems, for example, a string of separate libraries as opposed to a single library system, the root cause of such separation is generally the inability to discover what data and instructions are contained in another part of the system. More than one system has been impaired by inadequate interrogation or directory capabilities.

ON-LINE INTERACTIVE SYSTEMS

A number of sizable information systems that fully satisfy the above criteria have been developed for the conduct of experiments with on-line access to and searching of large bibliographic files from remote terminals. They provide rapid response to reference queries, thus guiding the formulation of subsequent queries, and several of them provide dialog assistance to help in formulating search questions. Table 22 lists the principal representatives of such systems.

The Technical Information Project (TIP), a part of the Multi-access Computer (MAC) Project at MIT, illustrates the essential features of the currently most advanced efforts in this direction. Indigenous to TIP is a massive bibliographical data file on journal literature in the physical sciences (title, authors, source, and citations for 30,000 papers from 38 journals covering a three-year period), together with a pool of three kinds of programs: (a) maintenance and internal processing programs, (b) search and retrieval programs, and (c) programs filed by TIP users for special and private purposes. In addition, the facilities of MAC for compiling and debugging programs, as well as the public pool of MAC programs, are freely accessible in the operation of the TIP system. The data base can be searched automatically to furnish a selected bibliography. Full text, ordered from a complete microfilm file, can be displayed and printout produced if desired. On the average, for every 100 papers selected by computer search, the user will wish display of full text of ten and order printout for one. Experience with the operation of this system also suggests that as a general rule computer processing should be used primarily on data items tailored for logical manipulation, and the manipulation of interpretative items, such as key words or index terms, avoided.

None of the cited systems as yet makes explicit provisions for the concerted modification by multiple users of the basic data file in the course of its employment, though Project INTREX plans to provide for the utilization of user comments for this purpose in its augmented catalog experiment. Increased efforts to explore such an ultimate form of interactive operation with a data base are needed (see Recommendation E6).

TABLE 22 Representative On-Line Reference-Query Systems

Organization	System Name	Computer Facility	Status
System Development Corp.	MICRO CONVERSE LUCID BOLD CIRC/COLEX ORBIT TDMS	IBM AN/FSQ-32 time-sharing system	Operational at various times
Lockheed	DIALOG	IBM 360/30	Implemented with a storage of over 300,000 document citations from NASA STIP. A continuing service for NASA Headquarters
	CONVERSE		8,000 documents
Bunker-Ramo	NASA-Recon	UNIVAC 1050	2-month operational test at 6 NASA facilities. 6,000 searches made by scientists, engineers, and librarians
Massachusetts Institute of Technology	TIP	IBM 7094	April 1962–present. A continuing service being run as part of Project MAC, using a central computer with 100 remote consoles. Approximately 400 users are served
Stanford University	SPIRES	IBM 360/75	First demonstration in 1968. Planned user population of about 100 high-energy physicists
Data Corp.	Data Central	IBM 360/40	1967–present. A continuing service based on Recon Central of Reconnaissance Div., AF Avionics Lab
Xerox	Datrix		Pilot demonstration with material from *Dissertation Abstracts*
Bolt Beranek and Newman	BIS	DEC PDP-1-D	1965–present. Various document and data files on a user-formated file structure

SYSTEM-STRUCTURED PROGRAMS

The systems approach is not confined to the design and operation of well-coordinated information activities to fulfill specific functions within such information systems as those discussed above. Contemporary programs of information services based on well-defined bodies of recorded knowledge and geared to the needs of identified categories of customers show progressively greater system structure. This trend has resulted in the use of the term, "national system," and to some confusion as to its meaning. The contexts in which a national system, in the sense of some unique and comprehensive system, is either feasible or appropriate are not known; further, national boundaries correspond to no observable lines of demarcation in the fabric of scientific and technical communication. We have today an infinitely varied population of information-handling endeavors, among which the larger ones in particular offer examples of every kind and every degree of system structure. Further exploration and experience in the design and operation of such systems inevitably will require experiments of sizable scope (Recommendation E10).

Three information programs which illustrate both the systems approach and characteristically different ways of employing new technologies are those of NASA, the General Electric Company (GE), and the AIP. The NASA effort comprises two complementary programs, a documentation-oriented Scientific and Technical Information Program and an information-transfer-oriented Technology Utilization Program. The former provides for (a) a wide range of primary publications, from technical reports and memoranda through state-of-the-art reviews, manuals, and handbooks; (b) a comprehensive abstracting and indexing program that covers both the open literature and—insofar as possible—technical reports on a worldwide basis; (c) international exchanges of machine records on NASA publications for comparably formated information on foreign publications; and (d) experimental programs that include pilot operation of a computer-based SDI system and trials with real on-line, search-query operations. Special publications and the operation of Regional Dissemination Centers making use of microfiche documents and the NASA bibliographic record tapes constitute the main elements of the Technology Utilization Program. (See also Chapter 6, Section C.) In short, the system constitutes an entire information universe that embraces widely varying activities, employs and relates in close interdependence all relevant mechanisms and organizations, and serves a large and diverse customer community, typically defined by categories. Effective and timely service, especially in the operation of the abstracting and indexing program, as well as the interchange of information among various program activities, depend to an increasing extent on the use of modern procedures and technology.

The GE program, in contrast, is composed of information activities which, although individually managed, are centrally coordinated to meet the complete range of information needs of the Company's design engineers and, in their aggregate, to have the capability of fulfilling customer requirements. This information structure is based on a so-called "warp and woof" pattern, with the "warp" activities following the lines of company organization and handling mainly the externally acquired information. The "woof" activities are predominantly internal in character and deal with matters of business and technology that cut across organizational lines. They include a wide range of technical, staff, and forecast reports, data files, company publication series, and newsletters as well as an Engineering Materials and Processes Information Service (EMPIS) to provide information on commercially available materials and components, together with all relevant data for their use in commercially oriented manufacturing programs. Additional noteworthy features include a (closely held) Competence Directory for company personnel and a "Dial Com" service that provides for information and data transmission on leased lines by direct dialing via 105,000 telephone units in the United States. The system structure here is one characteristic of what might be termed a complete information environment that serves a broad yet well-defined purpose and a customer organization whose members are individually identified rather than assigned to categories. Bibliographic information on company publications is in machine-processible form, and the EMPIS file, while still in the manual mode, reflects contemporary information-science techniques in its access and search structures.

The AIP is engaged in developing a system which is, in effect, an access structure for the entire body of recorded physics information and derives from the complete intellectual organization of the latter. Its central concept is the elaboration of a comprehensive classification scheme that will operate in conjunction with free-language index terms to provide a road map of the extant literature in physics. The projected system structure is complex enough to require computer management. Such a structure can provide a basis for the development of products and services that provide awareness of or access to the primary sources which the customer, be he individual or institutional, may then subject to further processing.

These three system-structured programs reflect three of the more comprehensive viewpoints conveyed by the term "system": (a) a complex of numerous activities which closely approximates a model at reduced scale of the entire national effort in scientific and technical communication, and which is administered centrally to effect a reasonable degree of program coherence and complementation; (b) a program that merges external and internal sources of information into an array of services designed to give the user the information he needs when he needs it, and in the terms in which he needs it; and (c) a system that derives its order from providing the best possible impedance match with the massive corpus of literature to which it furnishes access on a to-whom-it-may-concern basis.

C. LEGAL ASPECTS: COPYRIGHT

The statutory basis of contemporary copyright practice dates from 1909 and the enactment of a law that has not undergone any major revisions since that time. Its adaptation to emerging problems during the past half-century has resulted largely from its interpretation by the judiciary; however, the rapid technological advances of the post-Sputnik years have brought conflicts arising from the following requirements into even sharper focus:

1. The need to provide for and facilitate the free flow of information by every possible means
2. The need to assure merited recognition and, where applicable, material returns to an author for his efforts
3. The need to protect the equity held by those who venture resources on assuring the availability of information
4. The need to protect the identity and integrity of an author's work

Major problems stemming from these often conflicting goals have become increasingly acute and demand radical revisions of the copyright statutes. Such attempts currently are under way but have met with difficulties, among which are some in the area of scientific and technical information. Although the main issues are reasonably clear, experience is lacking in this transitional stage as to what would be legally sound and equitable solutions.

Scope of Copyright Coverage

The major problem areas, with regard to scientific and technical information, fall into three general categories, the first of which pertains to types of materials and the extent to which copyright coverage is necessary or appropriate for them; for example, reports of the results of federally funded research and educational programs; the form and structure in which information is presented (format) as distinct from its intellectual content; computer programs; and derivative works such as translations. In the matter of copyrighting publications resulting from government-sponsored work, a policy which abrogates the protection of copyright under these conditions would be based on the principle that information developed at the taxpayers' expense should be available freely for anyone to publish or disseminate as he may see fit. Those who support the contrary position have pointed out that publication by private organizations saves the government publishing and distribution costs and provides a product of better quality that is marketed more effectively if the publisher's equity in such efforts is protected by copyright for uses other than those of the federal government. Moreover, in many instances, government financing covers only part of the full and true costs of acquiring new information. In the absence of definition by law of what constitutes a government publication, the policies of individual federal agencies show much diversity, although many of them do allow contractors and grantees to register copyright when it appears that this is in the public interest.

A related area of concern is the availability to potential users of files and data deposited in federally funded data banks or assembled by private organizations under federally funded projects. Precedent suggests that such files should be generally accessible, and it is the current policy of the federal government to provide such access—at a price commensurate with the cost of serving the prospective user. The government regards such a policy as an essential element of responsible fiscal management and, at the same time, a means of providing for equitable treatment of the general taxpayer. Nevertheless, organizations that could use such data in their work, as well as publishers interested in the commercial distribution of related products, continue to encounter difficulties in gaining the necessary access. Examples, such as the publication and marketing by The Macmillan Company of the six-volume set of *Thermophysical Properties of High Temperature Solid Materials,* incorporating the currently available thermophysical data on such materials assembled by the Thermophysical Properties Research Center at Purdue University, show that suitable copyright and financial arrangements can be found for making information of this kind available; their use should be more general.

An issue identified and emphasized by Paul Zurkowski during House hearings on copyright legislation is that of the format of material (i.e., the form and structure in which information is recorded for further processing) apart from and in addition to its intellectual content. In what, since McLuhan, is referred to as the post-Gutenberg era, formating is the key to the new technologies for the storage and dissemination of information. Zurkowski warns, therefore, that care must be taken not only to stimulate authorship but to provide the economic incentives necessary to convert intellectual output into formats that will make it most accessible, useful, and marketable. The opposing faction has suggested that unintentional duplication is much more likely to occur in regard to format than content, and that having independently registered duplicative formats will present problems in clerical identification and allotment of compensation. Proponents point out that there is precedent in British law for such a distinction, that independently achieved duplicative literary efforts can be copyrighted, and that the difficulties involved are minor compared to the potential benefit of providing incentives in the area of formating.

The issue of computer programs presents a number of problems, such as the eligibility of programs for copyright, the types of programs to be covered, the aspects covered, and the way to keep track of the copyrighted and noncopyrighted program portions within any one computer complex. In 1964, the Copyright Office began to accept computer programs for copyright if they contained original work, and proposed legislation is sufficiently broad in scope and expression to allow their continued coverage. Recently, the Patent Office is reported to have registered patents on computer programs. Discussions of proposed new legislation suggest that the Congress views individual elements of programs and broad program outlines as not in themselves works subject to copyright, and that such protection should be limited to over-all intellectual effort and new methods or techniques of performing a particular function, thereby excluding general approaches and specific devices.

A derivative work is one based on some pre-existing work and consisting of outright selections, excerpts, or compilations or of editorial revisions, annotation, elaboration, and other modifications that in themselves constitute an original work of authorship. Derivative works under these definitions may include indexes, concordances, anthologies, transliterations, and abstracts, as well as displays of work on a cathode ray tube for modification or annotation by a user or the translation of work into machine language. Copyright legislation covering such works is an extremely complex problem area of which the abstract provides an illustration. An indicative abstract may serve only as a stimulus to seek the complete text, and such abstracts traditionally have been permitted under the doctrine of fair use. However, a critical or informative abstract, in many instances, may be sufficiently detailed to serve as a substitute for the original article and would seem clearly to constitute a derivative work. Additionally, the preparation of abstracts by computer through the use of sentences of text which contain the highest frequency of key words also falls within the definition of a derivative work. Since abstracts form the major input to many information systems (typically without permission having been secured), even the possibility of their being regarded as derivative works has led to some uneasiness in the community of information-processing organizations. In SATCOM's deliberations on these problems, it was suggested that the making of a summary or abstract, the extent of which is no more than either one fifth of the original work (of the whole or of each significant part), or 200 words in length, be recognized explicitly as not constituting a derivative work. Carefully considered guidelines are sorely needed for the handling not only of abstracts but of other types of derivative works that play significant roles in modern information systems.

Exemptions from Copyright

A second major problem area is that of the interpretation of the judicial doctrine of fair use and the exemption of certain types of copyrighted materials, performances, and displays for particular purposes or under special circumstances. The concept of fair use permits certain exceptions to the rule that copies may not be made of copyrighted materials without permission of the copyright owner. As it proved necessary to adjudicate recurring conflicts through examining the objectives of use, the quantity and value of materials involved, and the extent to which such use would diminish profit or supersede original work, a series of court decisions gradually established to the satisfaction of those who habitually deal with copyright law what is and is not fair use.

At present, the doctrine of fair use is not part of existing statutory law, and there are differences of opinion about the degree and the manner in which legislative language should determine its scope. Some scientists, educators, and librarians go so far as to advocate a precise statutory definition and specifically stated exemptions. Representative statements by authors and publishers, as well as lawyers and legislators, assert that a workable definition of fair use cannot be formulated, and that control should remain in the hands of the courts where each particular set of circumstances can be evaluated. In view of the general state of flux currently characterizing scientific-and-technical-communication activities, the predominant inclination among SATCOM members is to side with this latter position. In the long run, the development of a scheme which defines the so-called natural uses for broad categories of works, and which allows exemption from copyright for uses other than those specifically defined, might substitute in large measure for the traditional concept of fair use, as far as (*inter alia*) scientific and technical information is concerned.

The performance and display of copyrighted works of nondramatic character occur with increasing frequency in connection with modern research and education. Heretofore, such uses in the above contexts did not reach a level that would raise questions of copyright protection. This situation is changing rapidly, and the difficulties of determining the conditions under which the use of computer tapes, films, recordings, and kinescopes, as well as their local duplication, should be subjected to copyright controls are increasing. It is clear that reasonable restrictions will have to be developed in this area to protect the originators of such works, without, at the same time, retarding the development of such new educational techniques as, for example, computer-assisted instruction.

Copyright and New Technology

The applications of new technologies have created a third group of major problems. The issues arising in this context relate to the proper amounts and mechanics of compensation to copyright holders in connection with on-demand document services, computer storage and manipulation of information, and new methods of establishing and maintaining library collections. With the development of photocopying techniques, the provision of hard copy on demand has become a logical extension of service for libraries and organizations engaged in the announcement and dissemination of scientific and technical information. Estimates, based on a limited sample of major research libraries, led the Committee to Investigate Copyright Problems, Inc. (CICP) to state in a recent report [158] that, although no specific program at any one institution is of sufficient volume to damage copyright owners, the cumulative effect is substantial and a legitimate cause for concern. Estimates in the recent CICP study indicate that:

1. More than one billion copyright pages were copied (typically single copies made without obtaining permission) in libraries in the United States in 1967.
2. Nearly all (99 percent) of the journal articles copied were reproduced in their entirety.
3. As much as 85 percent of the material was recently published.
4. As much as three fourths was scientific and engineering material.

Librarians and operators of announcement services not only consider it their responsibility to provide immediate access to hard copy on demand, but assert that it is to the advantage of authors to have their work photocopied and that it has little effect on journal circulation. On the other hand, scientific and technical society and commercial publishers have seen evidence of disturbing financial impact on their publication programs as a result of photocopying. The authors of the CICP study suggest that "a legal guideline, essentially developed for trivial situations, is currently used as the authority for a national pattern of professional and scholarly information dissemination based . . . on the most efficient . . . duplicating devices."[168] Study of the problem and the development of some appropriate guidelines and mechanisms for obtaining permission and/or compensation seem in order.

The basic issue in regard to computer handling of copyright material is not that permission or compensation is necessary but that the appropriate point in computer processing at which to institute such control is carefully chosen. Proponents of the output stage as the point at which infringement would occur, and thus the point at which permission or compensation would be necessary, urge that input does not necessarily cause a loss of sale of a copyrighted work, and the time required for getting permission for input would hamper the development of computerized systems, that many uses would be covered by fair use for which no charge should have been made, and that the transfer of stored information from one system to another could be hampered. Those who support control at the input stage argue that:

1. The unpredictability of computer usage of stored materials makes input the only practical point of control.
2. Obtaining permission would be much easier at the point of input than at the point of output.
3. The integrity and identity of copyrighted works cannot be protected under free input practice.
4. Many copyrighted works, especially of a numerical or statistical nature, would be used in computers with little or no hard-copy outputs.
5. A free input policy would destroy most of the incentive for the production of new and better materials designed for computerized information and educational systems.

The central issue is further complicated by certain erroneous assumptions: for example, that permission would be necessary for all input, that all permitted input would necessitate payment of a fee, and that unreasonable double charges at both input and output stages might be levied.

The provision of on-demand document services by libraries and the development of microform technology to a point at which it is possible to store the publications of an entire technical library in a relatively small space and to duplicate them at comparatively low cost raise serious problems for our present system of incentives and rewards. The implication is that once a master collection has been assembled in this form, it could be used to create new technical libraries on demand and to update their collections with supplemental microform copies. Some simple and effective arrangement for obtaining copyright releases and arranging royalty agreements for each work in such collections will be necessary; however, experimental efforts in this direction have thus far been limited in scope and inconclusive.

Proposal for a National Commission

Before definite statutory language is developed for use in future copyright legislation, we need thorough studies in which data are collected systematically and experiences in the operation of affected information services are evaluated. Legislation [19] has been introduced that would establish a National Commission on New Technological Uses of Copyrighted Works, to be chaired by the Librarian of Congress and composed of 23 members representing the Congress, authors, publishers, users, and the general public. Its purpose would be to study and compile data on the various forms of machine reproduction and then to recommend such changes in copyright law or procedures as appeared necessary on the basis of its findings. Without necessarily endorsing this proposal in every detail, we strongly support the statutory establishment of a national commission to study and report on the implications of copyright principles for the new information-transfer technologies. In the present intermediate stage in the development of information-handling technology, we feel that only a flexible and evaluative approach can provide an adequate basis for future legislation that will satisfy the need for rapid accessibility of information as well as the need to maintain incentives and protect investments in copyrighted resources (Recommendation A10).

CHAPTER 8

National Concern with the Effective Planning and Coordination of Scientific and Technical Communication

This chapter describes existing and proposed arrangements for the continuing over-all assessment and guidance of scientific-and-technical-communication efforts in the United States. The principal objectives of such arrangements are to maintain effective performance and assure reasonable standards of economy. Since attempts to maintain continuing effective oversight necessarily depend heavily on the federal government, most of them have been initiated or sponsored by the government.

Two areas of special concern in planning and coordinating activities are: (a) the comprehensive programs which embrace major information services for entire disciplines, typically operated by private organizations; and (b) mission-oriented programs, which departments of the federal government operate either in accordance with specific legislation or to provide for their own information needs. Our emphasis in this chapter is not so much on the design and operation of individual programs, even those of comprehensive size, as on the determination of their relative scope and the coordination of their mutual interaction.

A. HISTORICAL BACKGROUND

The directives and policies formulated by Lenin immediately following the October Revolution of 1917 are among the earliest instances in which the efficient management and coordination of scientific and technical communication was recognized as a national concern. One of Lenin's first decrees dealt with library procedures and policies, and thereafter he continuously urged attention at the highest level of government to the development of measures that would assure the progress of Soviet science and the utilization of the newest scientific and technical achievements of other countries. As a result of his initiative, the Soviet of Peoples' Commissars enacted a decree in 1921 which dealt with the purchase and distribution of foreign literature and resulted in the establishment of a central institute (KOMINOLIT) for this purpose. Lenin described the functions of this institute as follows:

> The most important task which KOMINOLIT should assign to itself is to see to it that in . . . the large cities of the Republic special libraries shall contain at least one copy of the newest foreign technical and scientific . . . journals and books published between 1914 and 1921, and an arrangement shall be established whereby every periodical publication is received regularly. All activities of KOMINOLIT will be evaluated by me first of all from the point of view of the actual fulfillment of this task. (See Reference 116.)

An upsurge in the development of scientific information activities occurred in Russia following World War II as, under the pressure of increasing scientific and technological effort, scientific information agencies developed in various branches of industry and in scientific institutes. In time this ramified network was found lacking in clear-cut objectives and clearly defined functions; therefore, the Council of Ministers of the Soviet Union adopted a resolution in 1952 to establish a government information service with a carefully coordinated plan and unified system of operation. (A brief description of this centralized information service appears later in this chapter.)

In the Western world, national concern with rapid and efficient communication as essential to the progress of science and technology grew in the decades following World War II as the commitment of government resources to research and development rapidly increased. The legislative acts that established the Office of Naval Research (ONR) (1946), the Atomic Energy Commission (AEC) (1947), the National Science Foundation (NSF) (1950), and the National Aeronautics and Space Administration (NASA) (1957) reflected this concern; each contained specific language related to the stewardship of scientific information. For example, the preamble to the act which became the charter of ONR includes a directive "to provide within the Department of the Navy a single office, which, by contract and otherwise, shall be able to obtain, coordinate, and make available to all bureaus . . . worldwide scientific information. . . ."[2] Increased awareness of the importance of effective communication also led to the development of "national" (i.e., comprehensive, mission-oriented) information systems by a number of government agencies. Examples of major information programs are those of the AEC and NASA as well as the new information-handling procedures and services being developed by the Library of Congress and the National Library of Medicine.

The National Science Foundation Act of 1950, which offered a somewhat broader perspective than did other legislative acts providing for information activities, had particularly important implications for the efforts of private organizations in the communication of scientific and technical information. The Act directs the Foundation as one of its eight specific responsibilities to "foster the interchange of scientific information among scientists in the United States and in foreign countries." [124] To fulfill this mandate, the NSF organized a science information program chiefly involving support of publications programs and translations in the various disciplines, of preliminary studies to lay the groundwork for eventual systems development efforts, and of media and mechanisms for the dissemination of information on federally supported research.

B. RECENT TRENDS AND ACTIVITIES

Growing concern with the adequacy of the national effort in science and technology, culminating in its reappraisal after the first successful satellite launching by the Soviet Union, resulted in increased attention in the legislative and executive branches of the federal government to the management of scientific and technical communication. In 1955, for example, the Senate Committee on Government Operations chartered a special subcommittee, chaired by Senator John E. Moss, to study information operations at all levels of the federal government and to recommend to the Congress solutions for whatever shortcomings were discovered. This subcommittee addressed itself principally to the problem of security regulations and restrictions on the flow of information from both government and nongovernment agencies and to the increasing volume of information which reduced the effectiveness of existing media and mechanisms.

The efforts of this special subcommittee led to a long and thorough investigation by the Subcommittee on Reorganization and International Organizations, chaired by Senator Hubert H. Humphrey. Exhaustive hearings, special studies, and reports pertaining to the management of scientific and technical information, as well as bills proposing legislative action, issued continuously from this subcommittee from 1957 through the early 1960's and yielded the "most comprehensive body of data on scientific and technical information problems ever compiled by a committee of the Congress." [160] Among the activities studied were documentation, indexing, and retrieval practices in government, industry, and discipline-oriented societies; management of information during the long chain of events prior to archival publication; coordination of information on current scientific research and development supported by the U.S. Government, with particular attention to research-and-development projects in the field of electronics; and information handling in relation to federal budgeting for research and development. The Committee on Government Operations also introduced legislation to establish a Department of Science and Technology, to be headed by a Cabinet-level secretary, the responsibilities of which would include various information functions currently in the domain of existing agencies. For example, the new Department would have jurisdiction over the NSF, particular activities of the Department of Commerce, such as the Patent Office, and certain divisions of the Smithsonian Institution. One of its goals would be the development of a complete scientific information program involving acquisition, processing, dissemination, research on improved mechanical techniques of information handling, and regulations governing use. The bill failed to pass, but some of its objectives were accomplished through acceptance of a presidential reorganization plan which called for the establishment of the Office of Science and Technology (OST).

During this same interval, 1958–1963, the House of Representatives also gave serious attention to scientific information exchange. The standing Committee on Science and Astronautics conducted hearings in 1959 on the dissemination of scientific and technical information to determine the degree of integration among agencies within and outside the federal government and to discover those information functions not adequately performed. Subsequently, the Committee extensively studied all aspects of the operation of the NSF and introduced legislation to strengthen this agency. It also shaped and fostered the adoption of the National Standard Reference Data Act, introduced by its chairman, George P. Miller, the objective of which was to ensure that critically evaluated reference data were assembled and made readily available to scientists, engineers, and the general public (see Chapter 6, Section A).

In addition, the House Committee on Education and Labor turned its attention to problems of communication and established the Ad Hoc Subcommittee on a National Research Data Processing and Information Retrieval Center, chaired by Roman C. Pucinski. The main objectives of the legislation introduced by this Subcommittee in 1963 were to avoid unnecessary and costly duplication in scientific research and to assure quick access to all scientific research data. The proposed plan would depend on voluntary cooperation and the utilization of existing facilities; its proponents emphasized that its aim was not to eliminate or replace existing services but to tie them together in a more meaningful information retrieval system. The bill also recommended the strengthening of the NSF's Office of Science Information Service with sufficient funds to exercise more forcefully the authority accorded it by previous acts.

Yet another effort in the House was that of the Select Committee on Government Research, chaired by Carl Elliott. This Committee's fourth report, in a series of ten describing various aspects of government operation, dealt with documentation and dissemination of research-and-development results and especially emphasized timely and continuous dissemination of scientific and technical information. A major theme of the Committee's recommendations was the need for a central institution capable of enforcing the cooperation of agencies with one another and with the central body itself. The report also underlined the important role of a clearinghouse for documentation and dissemination of technological information and the necessity of frequent reappraisal of classification and proprietary restrictions.

Concomitant with congressional study and activity in the area of scientific and technical communication, the executive branch stimulated the development of a number of national plans for handling such information; government agencies, research institutes, and special panels and committees participated in their preparation. These plans identified a number of special problems with which proposed systems would have to cope, such as the handling of classified data and information, the contrasting information needs of discipline- and mission-oriented users, and the necessity of shaping services to meet needs of which users themselves often were unaware. In general, the various plans focused on journals and technical reports as the principal input channels to national systems, and for the most part they ignored the possibility of any differentiation in the needs of various categories of users, such as administrators, researchers, or engineers. There was little agreement among the various plans with regard to the advisability of adopting any of the numerous possible forms and degrees of centralization and coordination.

The first of the planning efforts was that of a panel under the President's Science Advisory Committee (PSAC), headed by W. O. Baker [14] and established in 1958 to assess the problems of scientific information exchange and the operation of the media and services handling such information. The Panel considered two possibilities for coping more effectively with the mounting store of information, one of which was the establishment of a large, highly centralized, wholly or partially government-supported agency, resembling in its basic philosophy the information-handling structure which the Soviet Union had brought into being a few years earlier, and which from this point onward never ceased to figure prominently in U.S. studies of its own scientific-and-technical-information problems. The second possibility involved the development of a science information service of a coordinating type that would stimulate and improve upon the present system by taking full advantage of existing organizations and the specialized skills of those associated with them. The Panel recommended the latter of these alternatives and indicated the NSF as an already existing mechanism for implementing their suggested line of action. They especially advocated effective coordination of effort among public agencies and private organizations to capitalize on and improve existing facilities and techniques. They also urged encouragement and support of fundamental, long-term programs of research and development in the application of mechanical techniques and the evolution of new methods of information handling.

The National Defense Education Act of the same year translated the Panel's recommendations into a mandate for the NSF which expanded its originally assigned responsibilities in the area of communication by specifically authorizing it to implement programs for enhancing the dissemination of information through the provision of abstracting, indexing, translation, and other such services and for fostering the development of new or improved methods of making scientific information available. The Act also called for an advisory body, the Science Information Council, to assist in these efforts. This Act resulted in the creation of the NSF's Office of Science Information Service (OSIS), which set in motion a program of broad scope including: (a) assistance to scientific and technical societies and nonprofit organizations in the operation and improvement of the information services they sponsored; (b) support and encouragement of the development and testing of advanced information services and systems, especially in major scientific disciplines; (c) stimulation and funding of projects dealing with new mechanized methods of organizing and storing information and of programs of research in various disciplines to determine the nature of information needs and the extent to which existing media fulfilled these needs; and (d) collection, organization, and dissemination of information on U.S. and foreign scientific and technological work in order to facilitate and coordinate both government and private efforts in the area of scientific and technical information. The NSF's principal over-all goals were two: first, to stimulate careful planning toward long-term objectives of broad scope in scientific and technical communities; and second, to provide some measure of coordination among scientific-and-technical-communication activities. The NSF has relied on incentives of support to achieve the first objective and has succeeded in guiding and assisting some of the major disciplines in their efforts to develop information services and systems adequate to fulfill not only their own needs but, in some instances, those of closely allied or overlapping areas and mission-oriented endeavors. With regard to the second goal, the NSF facilitated the coordination of information activities through the wide-scale dissemination of information about the scientific-and-technical-communication plans and projects of various disciplines, of government agencies and institutions, and of international organizations.

Further studies of the planning and coordination of scientific-and-technical-information activities took place in 1962 when the President's Science Advisory Committee established a panel for this purpose chaired by A. M. Weinberg, and the President's Science Adviser personally appointed a small task group, directed by J. H. Crawford, Jr., to attack the more specific problems of coordinating the scientific-and-technical-communication activities of government agencies. The latter completed its task sooner than did the Weinberg Panel and issued a detailed report [88] with numerous recommendations before the end of that year. Among its recommendations, two deserve special attention in the present context. Deviating somewhat from the position supported in the earlier Baker Report, the Crawford Task Group advocated centralizing the direction and review of federal information-handling programs in a single agency. In addition, it urged that each government agency engaged in research and development establish within its organization a formal focus of responsibility and authority for agency-wide direction and control of scientific-and-technical-information matters. Though no central coordinating agency was established, implementation of the second recommendation occurred in some of the agencies most heavily involved in research and development, for example, DOD, AEC, and NASA.

The Weinberg Report,[174] issued in 1963, constitutes a milestone for the development of scientific and technical communication in the United States, and several of SATCOM's recommendations address matters which still remain as unfinished business five years after its publication. A point of particular emphasis was that the entire information process must be made an integral part of research and development, and that later steps in the information-transfer chain, such as access and retrieval, are part of the responsibility of the organizations cooperating in the creation of the information. The working scientist, therefore, must share many of the burdens traditionally carried by the documentalist, specifically through better titling, assignment of key words, and preparation of abstracts. Moreover, the functions of recasting, critically analyzing, and synthesizing current findings (in short, the reviewing functions) must receive much more attention, and those who perform such functions should be better rewarded in terms of both remuneration and recognition. The potential effectiveness of specialized Technical Information Centers located in research settings and fulfilling a synthesizing and state-of-the-art compilation function received recognition for the first time at such a high level. Like the Crawford Task Group, this Panel advocated a focal point of responsibility for information activities within the principal research-and-development agencies but specifically recommended that this focal point should be located in the research-and-development rather than the administrative arm of an agency. The Federal Council for Science and Technology (FCST) was the suggested mechanism for keeping the network of government information systems under surveillance and preventing overlaps and omissions. The Panel strongly asserted the importance of preserving the nongovernment communication systems so highly sensitive to user needs and offering a variety of approaches to communication problems; it urged that nongovernment activities be supported, but not dominated, by the federal government and, in this context, commended OSIS on its policies and procedures.

Early evidence of the impact of the Weinberg Report was the FCST's replacement of its former coordinating committee with the much stronger Committee on Scientific and Technical Information (COSATI). The OST provided a secretariat for COSATI, with an OST staff member assigned exclusively to information programs serving as chairman of this Committee. COSATI's charter directs it to develop a coordinated but decentralized information system among executive agencies of the federal government and to cooperate with nongovernmental agencies in the development of national scientific-and-technical-information systems. Two additional directives give substance to its role as a coordinator among federal government agencies: (a) to identify and suggest assignments of responsibility among agencies and to review the resources utilized in their information programs; and (b) to facilitate interagency cooperation at the management level and recommend management policies and procedures for information activities. In these contexts the Committee recommends the adoption of standards, types of methodology, systems, and new programs.

Member agencies of COSATI include the Departments of Agriculture; Commerce; Defense; Health, Education, and Welfare; the Interior; State; and Transportation; the AEC; Federal Aviation Agency; NASA; National Library of Medicine; NSF; OST; and the Veterans' Administration. Participating in COSATI's monthly meetings as observers are the Agency for International Development; Bureau of the Budget; Central Intelligence Agency; Department of Housing and Urban Development;

Federal Communications Commission; Office of Education (HEW); Office of Emergency Planning; Patent Office (Commerce); Post Office Department; Small Business Administration; Smithsonian Institution; and United States Information Agency. The Deputy Librarian of Congress is a liaison member of COSATI.

Seven standing panels and a number of *ad hoc* task groups carry out the work of the Committee. These panels and their missions are as follows:

1. *Operational Techniques and Systems,* which works to improve policies, practices, and programs of on-going federal information operations, such as the Clearinghouse for Federal Scientific and Technical Information or the Defense Documentation Center. Its principal accomplishments include the promulgation of federal microfiche standards, the development of standards for the descriptive cataloging of government scientific and technical reports, and the compilation of the COSATI Subject Category List.

2. *Information Sciences and Technology,* which surveys and reports on pertinent research and development conducted or supported by government agencies. Although nonuniformity persists with regard to the criteria used by various agencies in identifying information science research-and-development activities and the dollar costs of such activities, the more than 2,400 projects reported to COSATI during its second inventory represent an annual level of obligation of more than $100 million. The Panel currently is assembling, in machine-readable form for use in an experimental, on-line system, its third comprehensive inventory.

3. *Education and Training,* which encourages the development of better programs for the education of information specialists as well as training activities for federal scientists and engineers to improve their use of information resources.

4. *International Information Activities,* which concerns itself with policies governing the overseas dissemination of computerized access, search, and retrieval instruments; with identifying qualified Americans for positions in international organizations in the scientific and technical information field; and with other matters related to the international exchange of scientific and technical information.

5. *Management of Information Activities,* which received its charter in February 1967. This Panel develops techniques for evaluating the effectiveness, measuring the benefits, and assessing the costs of information products and services as an aid to program management. A

major object will be to recommend standard procedures for determining and reporting the costs of information functions as well as policies for levying user charges.

6. *Information Analysis and Data Centers*, which also acquired panel status in February 1967. This Panel will review the scope, usefulness, and efficiency of such centers. (Information analysis centers differ from documentation centers in that they fulfill an evaluative and synthesizing function.)

7. *Legal Aspects Involved in National Information Systems*, which continues the work of a former task group, the purpose of which was to study and report on issues resulting from traditional and proposed copyright statutes in the face of modern methods of mechanized information handling. When the task group disbanded in mid-1967, it recommended that a panel be established to carry on this work, a recommendation that was implemented early in 1968.

Several of the various COSATI task forces deserve mention. One that was concerned with journal literature concluded that a computer file, kept reasonably up to date and providing a comprehensive National Serials Inventory, was technically feasible and would be most useful. Currently, the National Agricultural Library, the National Library of Medicine, and the Library of Congress have under way a four-phase National Serials Data Program (see Chapter 5, Section B), the ultimate objective of which is to create a computer-based central store of data on all known serials. Though the initial phase of this program relates only to the present holdings of these institutions, the third phase will entail the addition of worldwide serial literature and the implementation of procedures to keep the machine file current.

Another task group reviewed the function of technical reports and outlined steps for improving the quality and acceptability of this medium of communication (see Reference 54), and a recently established group will deal with the dissemination of information and attempt to improve the availability of reports that result from government-sponsored research and development.

The Task Group on National Systems for Scientific and Technical Information came into being in the fall of 1964 at the request of the President's Special Assistant for Science and Technology and is composed of COSATI members, with the Chairman of COSATI serving also as its chairman. Its charter directs it to inventory and evaluate the resources currently committed to U.S. scientific-and-technical-information activities and to determine the requirements of various user communities.

It also has the responsibility for recommending on the basis of its findings courses of action for government agencies and offering suggestions to private institutions to facilitate the evolution of national information systems. The Task Group made its first report to the President's Science Advisory Committee and the Federal Council late in 1965 (see Reference 46). Basic to its recommendations were certain assumptions that the report stated for public discussion. Foremost among these were: (a) that the federal government has the responsibility for ensuring access to worldwide significant (in the sense of scholarly and professional) literature in all areas of science and technology; (b) that document-handling systems must satisfy a variety of user communities; (c) that proposed systems must begin with the present ones and evolve gradually and flexibly; and (d) that national systems should be reasonably compatible with international procedures and standards. The Task Group's recommendations were the following:

1. The Office of Science and Technology should accelerate its efforts in planning, policy formulation, organization, coordination, and evaluation of the national network of information and document-handling systems in science and technology and should clarify the responsibilities of federal agencies in this area.
2. The OST, in collaboration with federal departments and agencies and other organizations, should develop a comprehensive, coordinated program for acquisition, processing, and announcement of significant worldwide scientific and technical literature, formulate policies with regard to the legislative bases for departmental or agency-sponsored information services, and propose or endorse legislation enabling departments and agencies to assume responsibility for effective information services in particular areas of science and technology.
3. The private sector should be encouraged to formulate and offer for OST consideration plans and programs for the development of the integrated national network.
4. COSATI should stimulate and recommend action in such areas as federal support of experiments in information-science technology and prototype information systems, development of standard processing procedures, and formulation of policies pertaining to the acquisition and dissemination of information at the international level.

The Federal Council, as recipient of these recommendations, asked OST to undertake exploratory operation of a central coordinating mechanism in matters of acquisition, cataloging, and announcement as well as to take action on other recommendations of the Task Group on National Systems. As a result, OST has been seeking a substantial increase in staff to meet these responsibilities.

In 1963, Robert Heller and Associates, Inc., prepared a national information-handling plan[148] for the National Federation of Science Abstracting and Indexing Services (NFSAIS), with special emphasis on secondary information-processing functions. The plan provided for the creation of a central operating unit as a joint venture of 18 existing profession-oriented services. This collaboratively operated "Organization X" would have responsibility for repackaging and processing information from both discipline- and mission-oriented sources in such a way as to meet the ever-changing demands of the mission-oriented category of need. Though eventual savings in operating costs as a result of collaborative effort and the reduction of duplication were foreseen, the framers of the plan recognized that the initial steps would require support from the NSF and recommended that grants be made to the services involved in order to implement such a program. They further recommended that a committee composed of representatives of the services, policy-making officials from the sponsoring organizations, and representatives of the NSF plan and develop a pilot program. With regard to NFSAIS, the plan called for expansion of its membership among all types of abstracting and indexing services and its assumption of a stronger role in representing the industry position and point of view.

Again in 1964, the OST convened an *ad hoc* panel, headed by J. C. R. Licklider, to examine and assess the situation and trends in scientific and technical communication, with special emphasis on the nongovernmental point of view, and to prepare an evaluative progress report.[149] In summarizing their impressions, this Panel commented on the very limited success of the government in persuading the scientific community to cooperate in efforts to integrate public and private services into a unified system and stressed the need to develop guiding principles for the centralization of some functions (e.g., over-all planning, monitoring compatibility, developing standards) and the distribution of others (e.g., abstracting, indexing, synthesizing—tasks involving substantive efforts). They stressed also the need for a clearer understanding of the information needs of generators and users and suggested wider and more systematic use of assessments of user needs as well as the conduct of medium- to large-scale tests of experimental man-machine information systems. The Panel examined in some detail the operation of the National Library of Medicine and the Library of Congress and contrasted the evolution of the former in the direction of a central focus for a system of field-oriented libraries and services in the life sciences with the less forward-moving functioning of the Library of Congress in relation to the natural, social, and engineering science communities that it serves. The possibility of instituting one or more additional national libraries to meet more effectively the scientific-and-technical-information needs in the latter areas was mentioned. Finally, the Panel drew attention to some of the problems resulting from government subsidizing of scientific-and-technical-society-operated, not-for-profit publications. The for-profit publishers whom they interviewed tended to recognize the government's responsibility to disseminate information and to have no objection to the subsidizing of not-for-profit publishers who did not compete with them, but many societies that received subsidies published not only archival journals but magazines carrying news and advertising. Since the society was the fiscal entity subsidized, the subsidy was often viewed as a means of fostering a competing publication, the sponsors of which were favored additionally by the tax structure.

At the present time, interagency operational and policy coordination is the principal objective of most of the work undertaken by the OST and by the FCST's Committee on Scientific and Technical Information. The development of compatible statistical reporting systems by government agencies, the review of classification policies, and the study of the impact of pending patent and copyright legislation on the conduct of federally sponsored research-and-development programs constitute some characteristic examples of areas receiving attention. The NSF's Office of Science Information Service, assisted by its Science Information Council, provides leadership and incentives in the development of information programs by the nonfederal community and tries to assure their adequacy and soundness in support of the country's over-all scientific and technical effort. An exchange of letters between the Director of the OST and the Director of the NSF in 1964 formalized this understanding with regard to areas of responsibility.

Late in 1965, NSF, with OST and COSATI concurrence, suggested to the National Academy of Sciences that a Committee on Scientific and Technical Communication be established under the joint sponsorship of the National Academy of Sciences–National Academy of Engineering in order to review and appraise the complex network of scientific-and-technical-communication activities from the viewpoint of its responsiveness to the current and future requirements of the scientific and technical community. Recognizing the need for and timeliness of such action, the Academies agreed, and with support from the NSF, SATCOM came into being in February 1966.

C. APPRAISAL AND PROJECTION

The activities and efforts of several government organizations reflect federal concern with the over-all guidance and coordination of scientific and technical communication. Two of these, the OST and the FCST, coordinate in two different but complementary ways information products and services and related research-and-development activities among federal agencies. The OST serves both the President's Adviser for Science and Technology and the Federal Council in a staff capacity. Through the performance of its staff role for the President's Science Adviser it has direct responsibility to assist the President in those executive functions that relate to science and technology. Further, the OST staff member assigned to scientific and technical information also chairs the FCST's Committee on Scientific and Technical Information (COSATI), with OST providing the secretariat for COSATI. As a result, OST has a major part in developing and recommending policies and specific action relevant to scientific and technical communication. COSATI has been especially concerned with reducing the diversity of procedures and formats employed by federal agencies and has provided a forum for reaching agreement on such matters as microfiche standards or the descriptive cataloging of technical reports. Additionally, COSATI has provided exploratory studies, background information, and recommendations to assist the Federal Council in the development of policies affecting scientific and technical communication.

Another strong coordinating influence on scientific-and-technical-communication activities at the national level is that of the NSF's Office of Science Information Service, which guides, strengthens, and assists efforts to improve the effectiveness and efficiency of scientific-and-technical-communication services and systems in the private sector. As a result of the NSF's support and guidance, some of the major disciplines have developed information services adequate to fulfill not only their own needs but those of closely allied or mission-oriented endeavors. Additionally, the NSF facilitates the coordination of information activities through wide-scale dissemination of information about scientific-and-technical-communication plans and projects of private and governmental organizations at both the national and international levels.

At this point, a description of the organization which has taken shape in the Soviet Union will add to our perspective. The current Soviet system developed in the wake of a 1952 resolution of the Council of Ministers providing for the establishment of an organization for directing all information services in the Soviet Union. The State Commmittee for the Coordination of Scientific Research in the Soviet Union has responsibility for the general management of the scientific information system. The network includes several All-Union Information Institutes of which the major one for scientific and technical information (VINITI) was established in 1952 under the joint authority of the State Committee and the Academy of Sciences. VINITI's responsibilities include the systematic collection and abstracting of the (open) world literature in the fields of natural science and technology; publication of abstracts, journals, reviews, bibliographies, and spot reports on timely topics; and the organization and development of research directed toward improving the methodology of science information services. Other All-Union institutes cover, respectively, medical and medicotechnological information, agriculture, construction and architecture, and the patent literature. At successively lower levels of the information hierarchy are information institutes and bureaus in the various republics, in economic regions, in specialized disciplinary fields, and in industrial enterprises. The Soviet system is based on and organized around a two-way flow of information. All printed information is processed centrally and flows downward to serve all channels of the country's information services; conversely, specialized information agencies at the lower levels extract, assess, and synthesize information received directly from the laboratory bench or the design and development section and channel it upward from there throughout the system. The Soviet information system differs in three major respects from the pattern that currently prevails in the United States, and in some respects from even the most highly coordinated arrangements that have been proposed. First, there is a central comprehensive mechanism for creating access tools. Second, a unified administrative apparatus staffs all levels of activity in the area of scientific and technical communication and provides a comprehensive hierarchical structure for the careers and advancement of information specialists. And third, information specialists at key points stimulate a direct flow of information on on-going scientific and technical work from the workbench upward, an arrangement that is feasible only in an economic system in which the concept of proprietary information does not enjoy the same pre-eminence as in ours.

In contrast, scientific and technical communication in the United States presents the characteristic heterogeneity of a system which has evolved by fits and starts through adaptation to locally perceived needs and opportunities. Decisions occur at numerous points with a considerable degree of autonomy and often are made by members of the scientific and technical community who serve as volunteers in the management of information services. This dispersed system of decision is a source of great strength as long as it functions reasonably well; however, the expansion of information services to meet the needs of increasingly diversified user groups and to cope with the rapidly growing store of information raises serious questions about our country's ability to maintain high-quality services in the future under such unstructured coordination and leadership.

To convert at this time to a highly centralized, comprehensively planned, developed, and operated national system for recording, structuring, and distributing scientific and technical information not only would be extremely costly, but would not ensure improved performance. Voluntary cooperation and coordination are of overriding importance if the characteristic sources of strength in the conduct of our scientific-and-technical-communication functions are to be preserved. Our Recommendations A1 through A5, and E10, provide the essential framework for realizing this objective. Foremost among them is the creation of a Joint Commission on Scientific and Technical Communication, responsible to the Councils of the National Academy of Sciences and the National Academy of Engineering (see Chapter 10), and acceptance of a basic philosophy of shared responsibility between the government and the private organizations—both those for profit and those not for profit—for the development and maintenance of an effective scientific-and-technical-communication network.

D. BASIC SUPPORTING POLICIES

Three conditions have fostered a recent trend toward direct operation of basic access services by the government: first, the assumption of current awareness functions by services that formerly served only as depositories or reference sources; second, the opportunities to extend U.S. information programs into other countries on a work- and cost-sharing basis; and third, the availability of funds under government agency mission budgets to initiate such services and merge their costs with those of the activities that they support. The trend receives further impetus from the failure of abstracting and indexing services in a number of disciplines to meet fully the demands placed upon them. The scientific and technical community has begun to view with alarm the expanding role of the federal government in the operation of basic access services, a trend which it perceives as potentially jeopardizing the community's control of discipline-oriented services or systems and gearing what should be a long-term stable and orderly evolution to the vagaries of federal budgets in science and technology.

As the first of several basic, guiding principles aimed at clarifying the relative roles and responsibilities of the government and private organizations, we advocate that all government-sponsored scientific-and-technical-information programs intended primarily to serve persons outside government service, or government employees whose activities are similar to those outside, should be managed in whole or in part by the appropriate societies, by institutions jointly created by such societies, or in some instances by commercial organizations (see Recommendation A3). As a corollary, government agencies, in developing their mission-oriented information programs should use, under arrangements of equitable reimbursement, the privately operated basic information services that can serve as component elements in such programs and should upgrade such services when necessary rather than instituting their own in competition.

We feel that placing the intellectual management of primarily discipline-oriented services in the hands of the appropriate societies or groups of societies, when these exist, provides the insight and guidance generally essential to the effective operation of such services. Scientific and technical societies can enlist the efforts of highly competent and interested members who frequently will serve on a voluntary, part-time basis. Many qualified individuals who feel an obligation to assist with the communications programs of their respective fields of science and technology would not perform similar work on a full-time basis in a government organization, or would do so only for a high rate of compensation. Further, the scientific and technical community places great emphasis on continuity and the need to ensure the steady evolution of a field in spite of the pressures of shifting fads and fluctuating budgets. In addition, management by appropriate societies affords a division of roles and responsibilities which results in more effective performance in the public interest. The government, in securing, subsidizing, creating, or guiding scientific-and-technical-information services, acts as agent of the people and, therefore, must continually review and evaluate the adequacy of such efforts. When the government seeks to provide these services to the public, rather than to secure them for the public, the substantive experts who should fulfill the role of public advocates and ensure the maximum value and responsiveness of the services often are employed in an operating role which sometimes detracts from or obstructs their power of deliberate review in the interest of the public. When scientific and technical societies provide the necessary services, operating as they inevitably must with government assistance, their performance can be carefully monitored and assessed by the contracting or supporting government agency in the best interest of the public.

The unique attribute of commercial publishing houses stems from the fact that their survival and growth are tied directly to their ability to understand and serve users' needs. This ability has important applications in the service of the interests of both scientific and technical societies and government agencies and should be utilized.

Another area in which policy and guidelines need to be more firmly established is that of ensuring that originators and users of information as well as the sponsors under whose aegis they work share in an equitable manner the responsibilities and costs of the dissemination of information. A central theme of the Weinberg Report [170] was the need to consider the information process in its entirety—from generation through retrieval—as an integral part of the research-and-development effort. Publication alone does not complete the job of making the results available to the society for whose use they were acquired. With the expansion of the body of recorded information, the likelihood that all the information which could be of use in a given operation will have its origin in the geographic, temporal, or disciplinary neighborhood of this potential point of application decreases. The condensation of information for use in announcement and awareness services, its consolidation through critical review and synthesis, and its preparation for storage and manipulation in computer-managed structures which provide for search, retrieval, and selective dissemination—all these—are now as much a part of the research-and-development process as the initial publication of results.

In 1961, the FCST recognized and endorsed this principle at least in part by issuing a policy statement which allowed page charges as direct costs under research-and-development agreements of government agencies and standardized the procedures and conditions for applying the policy. The exploration of modifications and extensions of this policy and their trial are urgently needed. In order to establish conditions which will facilitate exploration along these lines, we call upon the FCST to extend its 1961 policy statement on the subject of page charges in support of initial publication to embrace as integral to the sponsorship of research and development the processing of the information so generated for access, consolidation, and use (see Recommendation A4). This recognition in principle should be supported by practical guidelines governing the allowability as direct charges under research-and-development contracts and grants of equitable amounts for the use of such processing services and the work load imposed on them in connection with sponsored work.

A third area requiring attention and appropriate action relates to the slowly knitting, massive, mission-oriented programs of recent years which deal with major social concerns, such as natural resources, education, transportation, pollution, and urban problems. The role of science and technology in the resolution of these problems is not yet clear; therefore, the nature and scope of the information programs that they will require only gradually will become apparent. The policies and practices identified as essential for the effective operation of scientific and technical communication are particularly important in relation to this new range of national endeavors. Adequate data bases and information systems substantially more extensive than those that have heretofore supported our major scientific and engineering efforts will determine to a large extent our success in marshaling the full potential of science and technology for these purposes. Economic, demographic, and sociological information will have to be readily available and used in complete integration with engineering, geographic, and other relevant kinds of information. We urge, therefore, as a matter of policy, that agencies that sponsor major programs of research, analysis, and field experimentation in such contexts as resources management, environment control, transportation systems, and urban renewal regard the development of the information systems that their scope and impact require as one of their paramount tasks (see Recommendation A5). Information-management activities should receive special and early attention at a high level in order to assure continuity and authority in their administration, and existing institutions and pertinent resources in both government and private organizations should be utilized in information-program development. An effective start was the establishment of the Educational Resources Information Center (ERIC) by the Office of Education as part of its broad program. The Department of the Interior has considered possible steps toward the development of a more effective information system, and the Departments of Transportation and of Housing and Urban Development have begun the planning of such programs. Such efforts should receive the encouragement, support, and cooperation they require from other government departments and from the scientific and technical community.

A final policy consideration is the role of the federal government in providing incentives for exploratory innovations and experiments, particularly those involving large populations and large stores of information. Such experiments frequently involve a capital outlay or a financial risk that would be excessive for a private organization, particularly when the experiment involves large-scale use of advanced technologies. Such innovative experiments often are not priority requirements in connection with specific mission-oriented systems and, as a result, may be difficult to justify in such contexts. Yet, if scientific-and-technical-communication endeavors are to meet the new and increasing demands of the coming years, these experiments must be undertaken promptly and not on a subcritical scale. Further, there is need for coherence and continuity in their planning and administration. We feel that the federal government should establish and fund a single group to plan a unified program of critical experiments of operational scale in scientific and technical communication and to find, guide, and support contractors in the conduct of these experiments (see Recommendation E10). The Committee considers it of importance that in planning and directing the conduct of this program the designated government group provide encouragement and incentives to the participation of the industrial–commercial sector.

We consider the NSF, because of its mandate and experience, a suitable agency to assume responsibility for the proposed program, provided that the Foundation should find it feasible to operate under the indicated stipulations. In its projected program plans, the NSF has placed major emphasis on the development and operational testing of new or markedly improved information services and has planned to increase its budget allocation for such activities to some 70 percent in 1972 (as compared to 20 percent in 1966). One model example of the type of innovation envisioned is the Chemical Information Program undertaken by Chemical Abstracts Service with support from several government agencies under the leadership of the NSF. Other examples are the comparison of machine-aided indexing techniques with traditional forms of wholly human indexing (Recommendation E4), the exploration of on-line interactive modification of information files in computer systems (Recommendation E6), or the development of a formal language for the description of file structure (Recommendation E8). Recent legislation has broadened the Foundation's authority in support of applied research in general, thus strengthening its mandate to function in the proposed role.

CHAPTER 9

International Cooperation in Scientific and Technical Communication

Increased attention in the United States and other countries to national arrangements for the planning and coordination of scientific-and-technical-information activities has been accompanied by an increase in the number and diversity of international efforts toward facilitating access to the world's scientific and technical literature. These efforts are of three major types:

1. Direct cooperative arrangements between discipline-oriented institutions or mission-oriented government agencies to improve coverage and economy by sharing the work and products of information-handling activities
2. The cooperative stewardship and dissemination of the information generated by large international research programs, such as the International Geophysical Year
3. Programs and studies sponsored by international organizations to integrate the efforts of many countries and effect technical and economic improvements in the processing and dissemination of information

The international organizations that sponsor or participate in efforts of the latter two types may be governmental, such as those of the United Nations or the Organization for Economic Cooperation and Development (OECD), or they may be scientific and technical societies, such as the International Council of Scientific Unions (ICSU), the International Federation for Documentation (FID), the International Federation for Information Processing (IFIP), or the Council of International Organizations in the Medical Sciences (CIOMS).

The development of international cooperation in scientific and technical communication presents two major challenges, each of which raises its own characteristic problems. The first relates to stimulating greater coordination among the information-exchange efforts of the developed nations; the second is to foster the evolution of mechanisms which will assist the developing world to gain access to and derive benefit from pertinent bodies of such information. The achievement of both objectives is in the long-term interest of the United States. In the next decade or so, the burden on this country of providing a complete suit of availability structures for the world's scientific and technical literature would grow to massive proportions, while the fraction of its own contribution to this total would inevitably shrink. Consequently, U.S. participation in arrangements directed toward international coordination in the handling of scientific and technical information is essential—a point which the President's Science Adviser emphasized in a recent address [89] when he stated:

In developing our information system we must also learn how to cooperate on an international basis more effectively. The United States has no monopoly on scientific and technical information, nor on information analysis centers. You . . . must learn how to incorporate information drawn from the entire world into your activities. You must learn how to make use of centers of individual specialists in other countries. You must view yourselves as participants in a worldwide activity common to all developed nations.

This chapter briefly reviews and gives examples of the main types of cooperative efforts, both to inform about them and to stimulate their more extensive use. We consider all of them important, and our main concern is that of reducing the barriers to their effective use.

A. DIRECT ARRANGEMENTS

The development of a national service that attempts to satisfy the information requirements of a particular discipline will of necessity assume an international dimension. For example, only one third of the papers and one fourth of the patents covered by *Chemical Abstracts* in 1966 originated in the United States, and nearly half of the articles abstracted were in languages other than English. More than 50,000 of the subscribers to American Chemical Society publications are located in foreign countries, a figure which does not include some 25,000 copies of these publications which the Soviet Union prints photo-offset and distributes. In addition to an abstracting staff in their main office, Chemical Abstracts Service (CAS) depends on more than 3,000 outside abstractors, a third of whom work in foreign countries. More than 100 are in Japan; they prepare abstracts from about 800 periodicals and help to identify and locate obscure publications in which relevant articles occasionally appear. Similar groups work in Australia, Italy, and other countries. The Soviet Union supplies CAS with its chemical journals for abstracting and indexing in return for subscriptions to *Chemical Abstracts*.

Even closer and of longer standing is the cooperation of CAS and the Chemical Society of London. Under this arrangement, CAS is recognized as the abstracts publication in this field for the United Kingdom, and the Chemical Society has established an information center, one function of which is to test and adapt CAS computer-based services to the needs of British scientists and engineers. CAS has also participated in a series of discussions with a group of German firms in regard to cooperation in a number of areas ranging from exchange of analysis sheets to agreements on data formats and storage and use of CAS magnetic tapes by the German firms.

Another noteworthy example of international cooperation is the merger of the *Review of Metal Literature*, formerly published by the American Society of Metals, and the British publication, *Metallurgical Abstracts*, formerly published by the Institute of Metals. The resulting new international journal, *Metals Abstracts*, is mutually and equally administered, edited, and financed by the two participating organizations. Among the main considerations that led to the merger were: (a) avoidance of unnecessary duplication; (b) elimination of competition and the establishment of a strong, unified product; and (c) enhancement of sales potential. As a result of pooling the resources and staff experience of the two organizations, coverage and organization of content have been improved and subscription rates reduced. The new publication already is enjoying wider distribution and greater utilization than did its two predecessors.

The production of *Electrical and Electronics Abstracts* (EEA) (formerly Series B and C of *Science Abstracts*) also provides an example of international cooperation and involves the joint efforts of the Institute of Electrical and Electronics Engineers (IEEE) and the London-based Institution of Electrical Engineers (IEE). The IEEE has responsibility for indexing, classifying, and editing abstracts of its own publications and, by 1969, plans to send its contribution in magnetic tape form for direct input to the journal. Classification and indexing schemes and other product decisions are developed jointly through an IEE–IEEE policy committee. At the present time, plans are in progress for joint distribution of magnetic tapes covering the entire bibliographic record of EEA. In addition to this cooperative endeavor in the international arena, the IEEE sponsors a translation program and publishes a Spanish-language journal for its Latin American members.

The evolution of innovations in information handling and steps toward systems development in the field of physics also have involved close cooperation between the United States and the United Kingdom. Summarizing joint plans in a letter to the Director of the IEE early in 1966, the Director of the American Institute of Physics (AIP) indicated that: "It is our intent that we develop together a concept of a total information system for physics." The AIP has cooperated with the London-based IEE in the publication of *Physics Abstracts* (Series A of *Science Abstracts*) for decades and is represented on the IEE Editorial Advisory Committee, thus participating in decisions affecting coverage and the organization of material. Close cooperation at the working level ensures the smooth and efficient merging of U.S. material, derived from AIP primary publications, with the IEE-prepared remainder. Currently, parallel and closely coordinated experiments in computer-based photocomposition are in progress which should further expedite the production of *Physics Abstracts*. The AIP acts as distributing agent in the western hemisphere for both *Physics Abstracts* and the recently launched *Current Papers in Physics*, a current-awareness serial in newspaper format that covers the current issues of some 700 physics journals by bibliographic citation of individual papers. Studies of the use and effectiveness of the latter also have involved closely coordinated joint efforts of the AIP and the IEE.

An additional illustration of the international scope of the AIP's planning efforts was an experimental study to ascertain the feasibility of a preprint-exchange service in theoretical high-energy physics. The sample for this study included all known theoretical high-energy physicists throughout the world. Other than fulfilling its primary purpose, this study provided a wealth of data on worldwide information-exchange patterns and practices, both formal and informal, in this subfield.

The information programs of a number of mission-oriented government agencies also are international in scope. For example, the National Aeronautics and Space Administration (NASA) affords current access to technical report literature generated not only in the United States but also in foreign countries through its semimonthly *Scientific and Technical Aerospace Reports* (STAR). Some 300 exchange agreements, of which the one with the European Space Research Organization (ESRO) is an example, provide foreign coverage. The agreement with ESRO involves the exchange of NASA tapes and microfiche for compatible fiche and tape records of about 1,000 reports each year. Complementing STAR's coverage is that of *International Aerospace Abstracts* (IAA), operated by the American Institute of Aeronautics and Astronautics under contract to NASA, which covers the world's scientific and trade journals, books, and meeting papers in the aerospace field.

The Atomic Energy Commission (AEC) participates in a number of cooperative projects with Canada and the nations of Western Europe, which typically involve the exchange of both personnel and information on a regular basis. For example, through the International Atomic Energy Agency (Vienna), the AEC conducts institutes, plans training courses, organizes exhibits, leases apparatus, and consults. Particularly noteworthy in the present context are the efforts of the AEC in the development of an International Nuclear Information System (INIS), under whose terms participating countries or groups of countries scan their own literature, decide on input items, and write machine-readable bibliographic citations and subject terms (in English) for deposit in a common pool. In return, the participants may draw on this pool for the establishment and operation of their own national nuclear information services, among which *Nuclear Science Abstracts* figures as the U.S. service. Cooperative efforts also include arrangements for generating nuclear information services in developing countries.

A final example of international efforts related to U.S. Government information systems is the extension of MEDLARS to medical libraries in foreign countries, which is going forward under the auspices and with the assistance of the Organization for Economic Cooperation and Development (OECD). The arrangement involves the introduction of MEDLARS search technology into the libraries of a number of interested member countries of OECD, which, in exchange, are expected to provide the National Library of Medicine with approximately 50,000 indexed citations per year, derived from their own national biomedical journal literature. Two overseas MEDLARS computer-operation, -test, and -training sites already are in existence—one in Sweden and one in Great Britain.

Recognizing the increasing participation of mission-oriented government agencies in international arrangements for the exchange of scientific and technical information, the Federal Council for Science and Technology recently issued a policy statement in order to achieve unified practices among agencies entering into such arrangements. It encourages the evolution of compatible U.S. and foreign information systems and fosters the establishment of networks through which the worldwide scientific and technical literature will flow routinely. The preamble reflects the basic tenor of the policy statement [62]: "The U.S. Government seeks the widest possible dissemination of knowledge, in particular, the open exchange of scientific and technical information." A number of guidelines for attaining this objective follow, of which some samples are:

1. With suitable provisos, U.S. Government agencies shall generally seek a reasonable return, in the form of either publications, information, materials, services, or money.

2. Preference shall be given to multilateral arrangements where the latter are as effective as bilateral arrangements.

3. The participation of qualified U.S. citizens in the official structure of international information-exchange organizations shall be encouraged.

4. Lead agencies in subject-matter fields such as nuclear energy, agriculture, or health have primary responsibility for meeting the objectives of these policies, subject to foreign policy guidance from the Department of State and with responsibility for keeping other agencies informed of any significant developments in their relationships with other countries or international organizations.

These policies provide a firm framework for direct arrangements of cooperation on the part of federal agencies; comparable encouragement and guidelines for such activities in the nonfederal sector are needed (see Recommendation A7 in Chap).

The few examples of disc... and mission-oriented cooperative efforts briefly indicated in this section are intended to stimulate exploration and experimentation in those organizations which thus far have not appreciated the feasibility or potential of such cooperative arrangements. Some fields, such as oceanography, which are characterized by extensive international research programs and related organizational activities, may find little here that is new; others, we hope, will give serious consideration to implementation of our Recommendation A6 (see Chapter 3).

B. INTERNATIONAL PROGRAMS OF COOPERATIVE RESEARCH

Cooperative international research programs, such as the International Geophysical Year (IGY), the International Hydrological Decade (IHD), or the International Biological Program (IBP), provide an opportunity for the exchange of scientific and technical information on an international scale and require the cooperative stewardship of data in order to make it accessible to all who take part in the program as well as to all those throughout the world who have an interest. This section shows some of the ways in which such international research programs have responded to both these challenges.

One of the earliest and most successful of the international research programs was the International Geophysical Year (IGY), which set the pattern for and stimulated many of the subsequent efforts of this type. Typically, such programs are sponsored by member unions of the International Council of Scientific Unions (ICSU), often in conjunction with the United Nations Educational, Scientific, and Cultural Organization (UNESCO). In the case of the IGY, the International Union of Geodesy and Geophysics was the ICSU union chiefly involved. A U.S. National Committee, organized and staffed under the National Research Council of the National Academies, generally plans, coordinates, and assists in various aspects of U.S. participation. Interested agencies and departments of the U.S. Government maintain liaison with the Committee or actively participate in the implementation of research efforts with the advice and guidance of the Committee. In some instances, an organizational structure already exists within the Academies that can readily undertake the channeling of U.S. effort; in the case of the IGY, the U.S. National Committee for this purpose was newly established in 1952. Because of the continuing activity generated by the IGY, the NAS subsequently created a Geophysics Research Board in 1960 to develop and coordinate U.S. contributions to the International Year of the Quiet Sun (IQSY), the Upper Mantle Project (UMP), the World Magnetic Survey (WMS), and the International Years of the Active Sun (IASY), and to take responsibility for the terminal activities of the IGY as well as for the publication program which resulted from it. These programs proved to be powerful stimuli to interest and activity in relevant disciplines and resulted in a flood of information and data, essential not only to the continuation of the work in progress but having implications for and applications in other not directly related efforts. As a result, the national coordinating committees of such programs must function also as broad-based channels in the informal communications network of the affected disciplines.

The formal information activities of the U.S. National Committee on IGY provide good examples of those engendered by participation in worldwide research efforts. This Committee, of necessity, functioned largely as a pioneer, meeting each new problem as it was recognized. By the end of the active IGY period, some 10,000 books, articles, reports, manuscripts, and memoranda dealing with the various aspects of the program had accumulated: Cataloging this collection and making items from it available to interested persons became important activities under the aegis of the U.S. National Committee. Additionally, it undertook the monthly publication of an *IGY Bulletin*, which, at the close of the IGY, became the medium for reporting the U.S. contributions to subsequent international endeavors of geophysical research (IQSY, WMS, UMP, the

Antarctic Research Program, and others). (To reflect its broader scope, its name was changed to the *IG Bulletin*.) The Committee also sponsored and produced a series of 13 educational films and a set of science-education teaching aids to disseminate knowledge gained from the research.

In addition to the dissemination efforts of the U.S. National Committee on the IGY, an ICSU Special Committee published *Annals of the IGY*, a 44-volume series prepared through the cooperative efforts of many scientists throughout the world and dealing with such things as the history of the IGY, research reports, conference proceedings, data compilations, and catalogs.

To cope with the data generated by the IGY research program, three World Data Centers were established, each of which collected a complete set of data: World Data Center A in the United States; World Data Center B in the Soviet Union; and World Data Center C, distributed by disciplines in Australia, Japan, and eight countries of Western Europe. With the termination of the IGY, the functions and responsibilities of these centers were extended on a continuing basis to other activities, such as the International Year of the Quiet Sun. These centers accept data from the participating research teams; process, announce, disseminate, and provide on-site access to data; and exchange data with other centers of the complex. Through a World Data Center A Coordinating Office, the National Academy of Sciences exercises over-all responsibility for the Center's eleven subcenters which are located at suitable institutions throughout the United States.

Increasing emphasis on the information aspects of international geophysical research programs has resulted in their receiving special attention in the early planning stages rather than as specific needs arise. For example, the exchange of information and supporting services is one of five major areas of activity planned for the initial phase of the International Hydrological Decade (IHD). The U.S. Committee for the IHD provided five specific directives in this context: (a) indexing and abstracting of documents pertaining to the IHD should be carried out by authors; (b) national and international library exchanges of publications on hydrological research should be encouraged; (c) 200-word summaries of current U.S. hydrological research projects should be sent to the Science Information Exchange (Smithsonian Institution); (d) the American Geophysical Union's *Journal of Water Resources*, the American Water Resources Association's *Hydata*, and several other journals partially devoted to hydrologic research should be utilized as publication media for reports of IHD research; and (e) standardization of instruments and units, compilation of multilingual terminologies, preparation of handbooks on methods, and comparisons of instrument effectiveness under different environmental conditions should be carried out in order to ensure adequate collection, interpretation, and analysis of data for the IHD. Similar concern for information handling is apparent in the efforts of the ICSU Committee on Space Research (COSPAR). One of its six organizational working groups has as its specific purpose the international exchange of data and publications through World Data Centers in the United States, Europe, and Japan.

Of the various international research efforts currently in progress or planned, one of special utility to developing nations is the International Biological Program (IBP), which will address itself broadly to the bio-aspects of productivity and human welfare. The U.S. program involves two major clusters of studies dealing with "Environment" and "Man," and assigns top priority to: (a) an analysis of the ecosystems in six contrasting regions; and (b) studies on the ecology of migrant populations, on adaptation to hostile environments (jointly with Canada, Denmark, and France), and on evolutionary mechanisms of various plants and animals (with South and Central America). The problem of information and data management has been recognized and has received attention in workshops on systems analysis held by the planners of the "Environment" and "Man" portions of the program. Additionally, proposals directed toward developing a system for rapid transmission, storage, and retrieval of information generated by the program have been reviewed. So far, detailed considerations have been limited to the information requirements of the program management and have not touched on the broader question of how to adapt or supplement existing information-handling activities in order to make the information generated by the IBP generally accessible and useful.

C. EFFORTS OF INTERNATIONAL ORGANIZATIONS

International endeavors to facilitate and coordinate the exchange of scientific and technical information generally have been sponsored by various governmental (e.g., UNESCO, OECD) and nongovernmental (e.g., ICSU, FID) international organizations, frequently as joint efforts. As early as 1949, the Department of Exact and Natural Sciences of UNESCO convened a conference at which eleven ICSU unions were represented to consider problems of scientific abstracting. The conference recommended the creation of a coordinating committee of ICSU to foster cooperation among existing abstracting services. As a result, the ICSU Abstracting Board came into being in 1952. In subsequent years, this Board has worked steadily to secure the adoption of certain uniform policies and procedures among major journals in various participating disciplines and countries. Initially, the Board concerned itself with publications in the field of physics; subsequently, it enlarged its scope to include chemistry, then biology, and recently, earth sciences. The members of the Board represent international unions, the management of the principal secondary publications in different languages, and the International Council itself. Its activities are jointly supported by ICSU, UNESCO, and NSF. Among its main accomplishments are: (a) spreading the policy of requiring the preparation of author abstracts for published articles in accordance with rules and standards which it has promulgated; (b) obtaining cooperation among journals in the prompt distribution of tearsheets and proofs of titles and abstracts to be published; (c) proposing for adoption standard procedures for abbreviation, classification, indexing, and abstracting; and (d) negotiating or facilitating the exchange of primary materials or proofs among countries. As an example of the latter activity, the ICSU Abstracting Board was instrumental in negotiating an agreement in 1954 for the regular exchange in galley proof of six Russian and eight U.S. journals in physics. In later years, most member countries have negotiated direct exchange agreements on their own, but the Board lends its aid whenever such assistance is desired. In addition, the Board has urged revision of the Universal Decimal Classification system (in cooperation with FID), obtained the assistance of editors in circulating information on significant nonperiodical literature in various countries, and conducted a number of special studies, such as a survey of the organization and functions of abstracting services in different branches of science and technology. Possibly its most useful function is that of serving as a forum where representative producers and users of information can meet with announcers of information to define and discuss problems and explore possible solutions.

Another ICSU-sponsored activity attempts to stimulate international cooperation in the assembly of easily accessible, critically evaluated reference data. This problem is a long-standing one among both technologists and researchers, and it reached an acute stage by the early 1950's in the upsurge of scientific and technological activity that followed World War II. Several countries launched or expanded efforts in the area of compiling up-to-date quantitative data, but no country was successful in meeting all its needs. As a result, the National Academy of Sciences early in 1964 urged ICSU to undertake the task of coordinating the many individual efforts in this area. (The predecessor organization of ICSU had sponsored the publication of a set of international critical tables for physics, chemistry, and technology in the 1920's, and this former involvement as well as ICSU's broad scope made its choice most appropriate.) An ICSU working group reviewed the problem and recommended a year later that the Council accept this responsibility. Consequently, the Committee on Data for Science and Technology (CODATA) came into existence in January 1966; it includes representatives of ten unions of ICSU and of nine leading nations, several of which already were engaged in such efforts. The central office was temporarily established in the United States at the National Academy of Sciences, with transfer to permanent quarters in West Germany occurring in late 1968. CODATA began its work by assessing the existing situation—sources, capabilities, and needs. Its major objective is to foster the production and distribution of compendia and various types of collections of critically selected numerical and other quantitatively expressed data on properties of substances on a world-wide basis. Currently, it is attempting to promote the adoption of standards and a uniform editorial policy in the handling of data and has formed task groups on computer applications, fundamental constants, chemical kinetics, and key values for thermodynamics. A special objective is to stimulate young scientists and engineers to engage in data compilation and evaluation by improving salaries, working conditions, and the professional status of such work. In addition, the Committee attempts, through conferences and visits between centers, to encourage greater interaction among data specialists in various fields and to foster the closing of existing data gaps. CODATA hopes also to increase recognition and acceptance of the necessity for subsidies, probably long-term ones, to promote not only production but fullest utilization of critically evaluated, quantitative data.

Three other nongovernmental organizations especially active in information exchange at the international level are the International Federation for Documentation (FID), the International Federation for Information Processing (IFIP), and the Council of International Organizations in the Medical Sciences (CIOMS). A U.S. National Committee for FID was established in 1959 and has had some success in stimulating FID to take a broader and more active role in the field of scientific and technical communication. For most of its long history, FID (established in 1895) has devoted its efforts and attention chiefly to the Universal Decimal Classification (UDC) system; it assembled and widely disseminated information on this system, encouraged the American Institute of Physics project on evaluation of UDC as an indexing language for mechanized reference-retrieval systems, and established a network of study groups for revision of UDC. But in 1959 FID began a greatly expanded program of activities, including studies and experimentation in such areas as linguistic problems in documentation, copyright problems, compatible standards and classification procedures, development of special information centers, and aid to developing nations in document and information handling. IFIP is a much younger federation of professional interest groups particularly concerned with the coordination of research and education in information processing. The organization has sponsored a number of conferences and symposia in this area, focusing on the evolution of compatible methods and techniques of information handling and training procedures. CIOMS was established in 1949, with the principal objective of coordinating international congresses and other meetings in the field of medicine and allied sciences. In addition to fulfilling this function effectively and publishing the *Calendar of International Congresses of Medical Sciences,* CIOMS has organized a number of outstanding conferences and symposia, offered short postgraduate courses, and recently turned its attention to the standardization of medical nomenclature.

An international body of a different nature also active in the area of information exchange is the Organization for Economic Cooperation and Development (OECD), established in 1961 to replace the Organization of European Economic Cooperation. At present it has 22 member countries, including the United States, Canada, Japan, and Western European nations. The OECD countries provide three fourths of the world's information output and comprise a relatively homogeneous group; therefore, they offer an ideal starting point for a coordinated information network and possibly could provide a pattern for worldwide collaboration and cooperation. OECD emphasis is on policy; in the field of information its main objective is that of assuring the recognition of information policy in each country as an integral part of the over-all government policy for science and technology. Toward this end, the Ministers of Science and Technology at a recent meeting, in March 1968, recommended that each country establish an office with responsibility and resources for advising and assisting other government departments and private institutions in the conduct, support, and development of information activities and for encouraging and facilitating the development of a coordinated network of information services. An Information Policy Group reflects OECD's own concern with the more effective communication of scientific and technical information and advocates: (a) identification of policy issues and priority areas for international consideration and cooperation; (b) cooperative development of new information systems that will serve the largest possible number of users, with optimal points of geographic access, and will provide for an equitable sharing of responsibility for input and training for use; and (c) a concerted approach to common problems of standards, user charges, etc. The Information Policy Group makes no effort toward implementation of its recommendations but sees its role as pointing the way and fostering attitudes that will facilitate coordinated efforts. It tends to work through nongovernmental international organizations and through mission- or discipline-oriented activities of worldwide scope. Its working panels reflect the major areas of emphasis in Policy Group activities: economics of information; information services in chemistry; biomedical information networks; nuclear-science information; and standards. Member countries share information on the ways that each of them organizes and administers its national information services, training in information services, and critical data handling. In addition to fostering such interaction, the Policy Group recommends ways of handling the clearinghouse function for report literature and unpublished documents in European countries and is preparing a compendium of the information activities of the principal international organizations.

Problems of scientific and technical communication also have received intermittent attention for a number of years at the Pugwash Conferences on Science and World Affairs. During the Stowe Conference in 1961, certain recommendations were made with regard to: (a) reducing the number and improving the quality of journals throughout the world; (b) instituting standard formats for the presentation of scientific papers; (c) formulating a standard system of annotation of published papers, readily amenable to machine manipulation; (d) instituting internationally coordinated regional depots for storage and retrieval of information published in brief papers for rapid access; (e) consolidating the abstracting and indexing services carried on independently by many countries; (f) publishing nontechnical and specialized international review journals; and (g) relaxing postal regulations to facilitate a free flow of scientific publications among countries. The immediate results of these recommendations were negligible, though some new review publications appeared, and the ICSU Abstracting Board intensified its continuing effort toward coordination of abstracting and indexing services. Early in 1964, the information problem appeared again on the agenda of a Pugwash Conference, this time in connection with the difficulties experienced by underdeveloped countries in obtaining technical information that they needed. Later in the same year, yet another Pugwash Conference recommended that UNESCO or ICSU undertake the necessary studies to provide a foundation for the development of a coordinated, unified, international scientific and technical information system.

A joint UNESCO–ICSU Committee subsequently drafted a proposal to study the feasibility of a worldwide science information system based on achieving compatibility among existing and prospective information storage and retrieval programs. The Committee indicated certain conditions which supported the need for and practicability of this kind of effort. For example, individual countries had developed information programs to meet their particular requirements, but had made virtually no effort to assure coherence and compatibility among such programs, a situation further complicated by the use of different automated storage and retrieval systems by different disciplines within a country. Next, although it was economically possible and justifiable for large technologically advanced countries to provide for their own information requirements, the less-developed countries were in no position to mount similar efforts, and failure to meet their needs further increased the existing technology gap. Third, an overwhelming proportion of the existing scientific information appeared in six of the world's principal languages; therefore, achieving rapid interchangeability of information among these languages and translation to other "user" languages was a reasonable objective. Finally, voluntary coordination and standardization in regard to key-word vocabulary in various disciplines, translation into certain key languages, indexing procedures, and types of hardware employed would be essential in the development of a worldwide science information system. The Committee also stated that the working scientist, as a principal user, had a responsibility to work with the data specialist and professional documentalist to help to identify the needs that an information system must fulfill. As a step toward converting into action the main ideas expressed in the proposal, the UNESCO–ICSU Joint Committee has created a number of working groups to study the following specific problem areas: standards for the transfer of basic bibliographic data; research needs for a worldwide science information system; internationally acceptable abstracting formats and procedures; evaluation, compression, and organization of scientific information; indexing and classification; language problems related to the communication of scientific information; and needs of developing countries. Through the studies and efforts of the working groups, the Joint Committee plans in the next two years to encourage and facilitate steps toward voluntary coordination and standardization among existing and planned independent science information services. In conjunction with OECD's endeavors to rationalize information policies within its member countries at the national level and with the efforts of ICSU, through its Abstracting Board and Committee on Data, this most recent UNESCO–ICSU venture has the opportunity to make substantial contributions.

D. APPRAISAL AND CONCLUSIONS

A long list of obstacles faces any endeavor to improve arrangements for communicating scientific and technical information at the international level. Great inhomogeneity in the relative development of national services exists; the diversity of languages and the persistence of statutes and policies which affect the free flow of information raise problems; some individual systems are not prepared to cope with the volume incident to international exchange or lack the organizational resources to create and maintain the necessary relationships; suitable standards are as yet nonexistent; and, finally, educated manpower, in both the developed and the developing countries, is insufficient to meet current and projected needs. Under these circumstances, SATCOM views with satisfaction the numerous efforts, which presently are under way, to overcome these difficulties.

The United States contributes in three essential ways to these efforts. First, it offers intellectual support through the ideas and experience of its representatives, who participate in the planning and organization of such activities. Second, it contributes technologically, through the development and application of systems and subsystems (e.g., MEDLARS or the CAS Chemical Compound Registry) that are assuming increasingly important roles in the development of international networks. Third, the United States assumes a substantial share of the financial responsibility for such efforts. For example, the United States supplied slightly more than half the total yearly budget of CODATA during its initial two years of existence and now contributes, through payment of dues, roughly 30 percent of its annual budget; it provides through the NSF one third of the total annual budget of the ICSU Abstracting Board; and it makes a voluntary contribution equal to its regular dues to COSPAR, which constitutes one eighth of the total budget of this activity, as well as funding relevant research through its mission-oriented agencies.

The scope and variety of the international efforts of this country's public and private agencies are in keeping with the interests and the stake which the United States has in the development of increasingly effective international systems for the management of scientific and technical information; therefore, we strongly urge that even greater encouragement and support be accorded them. International arrangements, by their very nature, evolve slowly. If we want to assure the kind of scientific-and-technical-communication system in coming decades that will sustain our research-and-development efforts without imposing an intolerable burden, immediate action is necessary.

In regard to direct cooperative arrangements, major scientific and technical societies and mission-oriented government agencies must encourage the managers of their information programs to explore and develop ways to make access and transfer worldwide in scope, with the work of input and training for use shared among countries (Recommendation A6). Moreover, there should be explicit involvement, through exploration and direct professional contacts, in the problems encountered by the developing countries. In addition, scientific and technical communities should be able to rely on appropriate administrative support as well as encouragement in such endeavors from the federal agencies that shape and foster this country's foreign relations in science and technology (Recommendation A7).

The intent of the recently promulgated policy of the Federal Council for Science and Technology on international information exchange is to give added impetus to government-agency efforts to develop cooperative arrangements in a mission-oriented context. SATCOM urges those engaged in such efforts to show appropriate restraint and sensitivity in relation to foreign indigenous efforts in order to permit the latter eventually to become real contributors, operationally as well as intellectually, rather than smothering them by the massive competition of our resources.

In regard to international cooperative research programs, the stewardship of information and data generated by these programs does not always receive the early and explicit attention that it deserves (Recommendation A8). Sponsors of international research efforts should insist that the following two features become a matter of policy in the central management of any international research program:

1. From the beginning of program planning, information and data-handling operations incident to the conduct of research should receive attention. Planning in this context should include: (a) identifying the requirements for special information systems, (b) determining their design and cost, (c) appraising the impact of the program output on existing information activities in the affected disciplines, and (d) exploring the extent to which the latter can meet, perhaps with modifications, the requirements of the program.
2. Any international cooperative research program directly related to natural or human resources (the probable orientation of most future programs) should plan and provide funding for a special effort to make the resulting information available to less-developed countries in forms in which they can use it effectively.

Of particular current concern in this connection is the International Biological Program (IBP). Present preoccupation with the information storage and retrieval systems for the use of particular program phases should be extended to a comprehensive consideration of the information-handling aspects and implications of the Program as a whole. The need for such over-all planning is great, since the biological sciences have yet to achieve in many respects the degree of organization which will enable them to cope effectively with evolving demands. Additionally, the information problems of less-developed countries, aside from what will accrue to those who actually participate, deserve more attention by the IBP planners.

International efforts to permit increased integration of information systems should emphasize to an increasing extent the elimination of present and avoidance of future incompatibilities. Though standardization can resolve many such problems, other approaches require exploration at this as well as the national level. Further, in order to foster cooperative international endeavors and to give them the scope and vigor that they require, SATCOM urges that the U.S. delegations organized in such contexts include knowledgeable representatives of the relevant nongovernment services likely to be affected (Recommendation A9).

CHAPTER 10

A Joint Commission on Scientific and Technical Communication

As a result of the need for improved planning, coordination, and leadership at the national level, *we recommend the establishment of a Joint Commission on Scientific and Technical Communication, responsible to the Councils of the National Academy of Sciences and the National Academy of Engineering* (see Recommendation A1 in Chapter 3, Section A).

A. MISSION AND ILLUSTRATIVE PROBLEM AREAS

The Commission is to be conversant with activities in scientific and technical communication and to provide guidance useful to public and private organizations in the development of more effective scientific and technical communication. It also should be responsible for leading the private sector in the coordination of its interests and programs and in the development of broad and farsighted plans. Therefore, its mission should entail:

1. Serving the scientific and technical community by fostering coordination and consolidation of its interests in the handling of scientific and technical information
2. Serving the government by providing representatively comprehensive and authoritative information and advice on the activities, needs, and ideas of the scientific and technical community in this field

To fulfill this mission, the Commission should identify needs and requirements and actively stimulate efforts to explore appropriate arrangements for cooperation and coordination. It must review and contribute to the broad planning of scientific-and-technical-information activities and would expect to assist the federal government in building and adapting a framework of policy for the effective operation of scientific and technical communication. It also would provide a forum for the timely and broad-gauged review of current acute issues.

In recent years, increasingly effective organizational mechanisms have fulfilled these functions in relation to the scientific and technical information-handling efforts of federal agencies. However, no effective mechanism exists at the present time for facilitating interaction between the government structure and the activities of private organizations—both those for profit and those not for profit—in this field. The emergence of a coordinating institution of broad scope and representation in the private sector is necessary for the development of such interaction. To fulfill this role will be one of the primary objectives of the proposed Commission.

The extreme complexity of the entire scientific-and-technical-communication system is such as to expose it today, and with increasing severity tomorrow, to the unforeseen disruptions and crises so characteristic of large aggregates of activities, the interdependence of which is not fully understood and which are not well-coordinated. Some crises already are upon us (e.g., the page-charge issue); others lie ahead. They will require continuing efforts on the part of the Commission.

For the near future, we believe that stimulating and expanding the reprocessing and consolidation of scientific and technical information is the most important thrust in making such information effective for those who use it. The need for sifting, evaluating, and consolidating the rapidly accumulating store of information and data in the various scientific and technical disciplines is urgent. If more detailed analyses bear out our broad estimate that the current effort invested in reviews, state-of-the-art summaries, and critical data compilations is only a small fraction of the requirement, then this problem certainly merits the Commission's immediate efforts. Consequently, we have directed a number of recommendations toward this end (see Chapter 3, Section B), three of which indicate specific responsibilities for the proposed Commission: (a) The Commission should give special attention to assisting the growth of need-group information services; (b) the Commission should explore ways for systematically extending the use of the capabilities afforded by major information analysis centers in the transfer of technological information; and (c) the Commission should consider the steps that might be taken to afford easier and more effective access to particular reviews appropriate to a user's specific need. In addition, the Commission should foster awareness of the need to support consolidation efforts and to educate potential users.

Another problem that we consider of comparable importance is the development of a substantially more coherent pattern of cooperation among the many and diverse secondary information services. Efforts to develop such a coordinated pattern involve not only subtle technical problems, especially in regard to standards and convertibility, but require the establishment of realistic pricing and funding policies for such services.

The problem of pricing and funding is a pressing and pervasive one that will require careful study and continuing effort on the part of the Commission A basic tenet of the Weinberg Report [170] is that research is not complete until the results are made available. This availability includes not only publication but later steps in the information-transfer chain that provide for alerting and access and for consolidation and review, all of which are essential to the effective utilization of the knowledge generated by research and development. With regard to the initial publication of results, the page-charge policy was one attempt at practical implementation of such a principle, and issuance of a recommendation by the Federal Council for Science and Technology (FCST) in 1961, allowing the assessment of some part of the cost of publication (through page charges) against the original research funding, resulted in widespread acceptance of this responsibility among government agencies. Many scientific and technical societies, however, were slow to accept this policy, and page charges were never universally levied. Recently, under present budget constraints, many institutions are discontinuing the voluntary honoring of page charges and, as a result, some journals face the threat of bankruptcy. Yet this crisis represents only one aspect of the problem. In contrast to primary publication, there has never been an effective mechanism through which resources available for the operation of secondary information services were coupled directly to over-all expenditures on science and technology. And, in spite of the strong emphasis in the Weinberg Report, review and consolidation efforts still are far from adequately supported. There is crucial and immediate need (a) to foster recognition of the responsibilities of producers and sponsors of research-and-development work for the processing of the information so generated, and (b) to develop new and feasible mechanisms of implementation.

Another area for Commission attention pertains to the way in which the opportunities for innovation afforded by advanced technology might be explored. The Commission should urge the priority of large-scale experiments and the participation of qualified scientists, engineers, and practitioners in these efforts. Further, it should foster the application of the results of such experiments in contexts other than the particular ones in which they are obtained.

A final illustration of problem areas that require immediate Commission attention and study is one pertaining to limitations on the export of unclassified information. Restrictions on the publication of much graduate-student research generated under federal contracts have resulted from varying interpretations of the Export Control Act and the Munitions Control Act, and such restrictions are increasing. Should this trend persist, it could greatly hamper the communication of the results of a substantial portion of the newest research and development work.

B. OPERATION AND STRUCTURE

Members of the Commission would be appointed by the Presidents of the National Academy of Sciences and the National Academy of Engineering. The Academies would employ and house the staff of the Commission, and the Commission would be responsible to their Councils, though in the everyday conduct of its work, it would deal with the Presidents of the two Academies and their staffs.

The Commission would communicate through the Presidents of the National Academies to: (a) the membership and leaders of the scientific and technical community; (b) scientific, technical, and educational societies and institutions; (c) for-profit organizations; (d) the relevant foci for scientific-and-technical-communication activities in the federal government, especially the Office of Science and Technology, the FCST's Committee on Scientific and Technical Information, and the NSF's Office of Science Information Service; and (e) other supporters of science, technology, and information services.

Effective liaison must be maintained, especially with federal agencies, and special efforts will be necessary to ensure that current concerns receive thorough airing from the respective viewpoints of the government's requirements and the capabilities of private organizations—viewpoints that hopefully will become less and less often at odds with one another.

Commission membership should include as broad a representation as feasible of the major scientific and technical communities and the principal kinds of organizations engaged in related information-handling activities, as well as representatives of the Councils of the National Academies and liaison members from the principal government activities. Such coverage could be provided by a membership of about 20. Additionally, the Commission should continue to draw upon the advice and assistance of the nearly 200 Consulting Correspondents whom SATCOM has assembled (see Appendixes A and B).

Initially, the Commission would need to establish a number of *ad hoc* committees and task groups to study major problem areas. As areas requiring long-term, continuing attention were identified, suitable standing committees, with responsibility for the development of pertinent programs of activity, could be created.

The Commission could be especially helpful in suggesting directions and setting priorities for new efforts in research and exploratory innovation. To do so, it would need to develop a basic conceptual framework for the evolving pattern of scientific and technical communication from which to derive guidelines for future efforts and criteria for appraising current ones. In addition, through its activities, committee structure, and Consulting Correspondents, it could provide a national forum for the critical review and appraisal of professional work in the field of scientific and technical communication. Finally, the influence of such a Commission could help to ensure in the scientific and technical community a heightened sense of participation in proposing, shaping, and implementing pertinent policies and should decrease the possibility of sterile endeavors.

C. DISCUSSION OF ALTERNATIVES

Four considerations prompted us to suggest the two Academies as the optimum location for the proposed Commission.

1. A principal and continuing concern will be that of ensuring that the scientific-and-technical-communication system is increasingly responsive to the contemporary pattern and requirements of science and technology; therefore, the Commission should be located where a maximum of knowledge and expertise in regard to the latter is readily available to it.

2. The National Academies, together with the National Research Council, come as close as any existing organization to embracing the representative organizations, groups, and individuals whose efforts depend on or influence the shape of scientific and technical communication.

3. The kind of interaction with the federal government envisioned for the recommended Commission is in complete accord with the legisla-

tion under which the Academies are chartered and which led to their establishment.

4. The present broad, diverse, and long-term involvement of the Academies, and of the numerous divisions of the National Research Council, in scientific-and-technical-communication activities (see Section D of this chapter for examples of Academy information activities) suggests that they would be a most appropriate location for the proposed Commission.

As one alternative, we considered the creation of an independent National Advisory Commission on Scientific and Technical Communication, the membership of which would bring together both high-level representatives of the federal government and outstanding citizens. Either appointed under the aegis of the White House, or under arrangements jointly responsive to the legislative and executive branches of the government, such a Commission could be related to the President's Science Advisory Committee through assignment of the staffing function to the Office of Science and Technology. It seems unlikely, however, that any newly created, independent commission could equal the prestige and authority of the Academies in the scientific and technical communities to which its efforts would be principally addressed. Nor would a newly created independent agency have the broad representation and heavy involvement in scientific-and-technical-information activities that characterize the two Academies and the National Research Council. The latter is specifically charged with:

> . . . developing effective means of utilizing the scientific and technical resources of the country . . ., promoting cooperation in research . . . in order to secure concentration of effort, minimize duplication, and stimulate progress . . ., and to gather and collate scientific and technical information, at home and abroad, in cooperation with governmental and other agencies. (See Reference 119, page 7.)

To fulfill these objectives the Academies and the Council channel participation in international research programs; cooperate in the planning of national and international meetings, conferences, and symposia; sponsor a large number of scientific-and-technical-communication programs and projects; and support a broad publications program.

Another alternative is the establishment of an agency within the federal government with broad executive authority, and perhaps even an extensive budget, to which responsibility for the supervision and regulation of the scientific-and-technical-information system would be assigned, a concept which has been proposed and extensively discussed under the designation of a "capping agency." (See Reference 37.) We do not consider it advisable at this time to create a new federal agency or to empower an existing one with the responsibility to supervise and regulate the national aggregate of scientific-and-technical-communication activities. It is doubtful that such a course would produce gains in either effectiveness or economy commensurate with the losses contingent upon reduced monitoring and control of input to its communication systems by the scientific and technical community. Additionally, much of the initiative and ingenuity contributed by private organizations to the solution of information problems might be stifled if all major ventures in response to emerging needs and opportunities had to pass through the filter of a single government agency. It was just such concern with assuring the involvement of and interaction with the scientific and technical community which, on OST–NSF initiative, led to the creation of SATCOM itself and its location in the NAS–NAE structure. (See Reference 62.)

D. ROLE OF THE COMMISSION IN THE TWO ACADEMIES

A multiplicity of information-exchange activities offering numerous opportunities for mutual assistance have already been undertaken by the Academies. Their varied and extensive responsibilities in this area provide a further reason for the proposed location of the Commission. Each of the Divisions of the National Research Council is deeply involved in the dissemination of scientific and technical information in its field, through formal reports and as part of the informal communication network. Additionally, almost all of them conduct one or more activities specifically aimed at improvements in scientific and technical communication. The Division of Biology and Agriculture, for example, is engaged in the preparation of a roster of agricultural specialists with foreign-area experience and in staffing a Council on Biological Science Information. The latter has responsibility for recommending steps toward a more coherent information-transfer network among its disciplines. The Division of Behavioral Sciences sponsors a Committee on Information in the Behavioral Sciences, which recently reported on information needs in this area and the technology for satisfying them. This Committee emphasized that coordinating mechanisms are essential in the development and maintenance of a decentralized national information capability and also recommended the establishment of a coordinating mechanism similar to SATCOM within the Academies, with broad disciplinary representation from the behavioral sciences and the responsibility for fostering cooperation and coordination in this area (see Reference 42). Since 1947, there has been a committee in the Division of Chemistry and Chemical Technology, currently known as the Committee on Chemical Information. This Committee deals with technical problems in the storage, retrieval, and use of chemical information and has conducted studies on chemical codes, chemical notations systems, and nonconventional methods of handling chemical structures employed in the United States and foreign countries; on the rationale for their use; and on their effectiveness. The Highway Research Board of the Division of Engineering operates an automated information service that covers not only the technical report literature in this field but maintains a file of short reports on work in progress, thereby fulfilling the practitioner's need for information on "who is doing what and where." These various activities provide but a few examples of the nature and scope of the Academies' involvement in scientific and technical communication. (See Reference 135 for further details.)

Additionally, the Office of the Foreign Secretary, through its responsibility for organizing the bodies that coordinate U.S. participation in international programs of scientific cooperation, has developed a substantial stake in the information activities pertaining to such programs. Such activities include the publication of special media for dissemination, the assembly of all documents generated by such programs, and the supervision of data-center operation and coordination.

Within this steadily growing web of diverse information activities, the proposed Commission can be especially effective. It could assist in defining the nature and scope of new communication activities that would be appropriate for Academy sponsorship as well as developing a coherent pattern of Academy participation in the field of scientific and technical communication. In this context, it should be alert to opportunities for new projects in scientific and technical communication and recommend appropriate points of attachment where special interests and capabilities exist.

APPENDIX A

SATCOM'S Objectives and Activities

Three major objectives of SATCOM's investigations and related activities were:

1. To gain a comprehensive overview of the current state and required evolution of scientific and technical communication
2. To stimulate increased participation among individuals and institutions in national planning for the improvement of scientific and technical communication
3. To function as a forum and clearinghouse on currently acute issues relevant to scientific and technical communication

To accomplish the first of these objectives, SATCOM systematically reviewed and analyzed a representative sample of information programs operated by private organizations and government agencies. Included were major programs of the scientific and technical societies, such as those of the American Institute of Physics, the American Chemical Society, the BioSciences Information Service of Biological Abstracts, Inc., and member organizations of the Engineers Joint Council. Consideration of government-agency programs embraced not only agencies operating broad-scale information activities, such as the National Aeronautics and Space Administration and the Atomic Energy Commission, but also those involved in the department of policies affecting scientific and technical communication, such as the Committee on Scientific and Technical Information (COSATI), the Office of Science and Technology (OST), and the National Science Foundation (NSF). Two COSATI-stimulated studies dealing with national document-handling systems [37] and with abstracting and indexing services [103] received special attention. Information services developed by private for-profit organizations, for example, those of McGraw-Hill, Inc., and the Institute for Scientific Information, also were examined, as well as such industrial information systems and services as those operated by the General Electric Company and the Ford Motor Company. Study of the programs of both academic and private libraries, of the National Library of Medicine and the Library of Congress, and of the plans and activities of the Interuniversity Communications Council (EDUCOM) focused on some of the basic library concerns and problems, especially those of large research libraries, and on efforts toward their solution or improvement.

In addition to the international projects and programs of societies and mission-oriented government agencies, the Committee kept informed on the activities of international organizations, such as the International Council of Scientific Unions and the Organization for Economic Cooperation and Development, through close liaison with the Office of the Foreign Secretary of the National Academy of Sciences.

Other topics receiving special study were modern information-handling techniques (e.g., Projects MAC, TIP, and INTREX) and such legal issues as those pertaining to questions of copyright.

Further, the SATCOM Secretariat accorded high priority to maintaining close contact with a number of activities in the National Academy of Sciences and the National Academy of Engineering dealing with scientific and technical information to inform such groups of SATCOM endeavors and to indicate to SATCOM the nature of these groups' efforts and concerns. Such groups included: the Council on Biological Sciences Information, Committee on Brain Sciences, Committee on Information in the Behavioral Sciences, Committee on Chemical Information, and the Highway Research Information Service.

To stimulate the increased participation of the scientific and technical community in planning for the improvement of scientific and technical communication, SATCOM organized a broadly representative group of Consulting Correspondents (see Appendix B), consisting of about 200 key individuals in this field. They included not only persons actively engaged in information-handling activities but those holding administrative, research, design-and-development, teaching, and other responsibilities relevant to scientific and technical communication. A conference held in November 1967 was the means employed to inform them about SATCOM's activities and objectives and to afford them an opportunity to raise questions and offer comments and criticism. Working papers prepared by SATCOM members and dealing with various problem areas of particular concern to the Committee were circulated to the Consulting Correspondents prior to the conference and served as a basis for much of the discussion and interaction that took place. Subsequently, additional comments and suggestions relative to this material and to points raised during the conference were received by mail. Since this conference, SATCOM has maintained close interaction with its correspondents, often circulating material to them for criticism and feedback, and they have influenced the Committee's thinking in regard to problems in the following general areas:

1. The national planning of scientific and technical communication, especially the formulation of policies affecting funding arrangements and of guidelines for the development of international agreements
2. The development of models and mechanisms to bring together numerous small-scale activities in larger coordinated systems and networks
3. The possibility of stimulating greater cooperation and coherence of effort, especially among abstracting and indexing services, to reduce inadvertent duplication or gaps in coverage and to further the evolution of specialized services for well-defined user groups
4. The evolution of appropriate funding and pricing policies in the face of difficulties resulting from the nonstandard operation of supply-and-demand economics for scientific and technical communication
5. The need for educational efforts to stimulate awareness of the economic realities inherent in scientific and technological work and to foster flexibility among managers and workers in adapting work patterns to the ever-changing stock of available information services

Consistent with its third broad objective (to function as a forum on currently acute issues relevant to scientific and technical communication), the Committee established four *ad hoc* Task Groups, two of which were its own, and two joint efforts with the NAS Committee on Science and Public Policy and the OST, respectively. Through its participation in the activities of these Task Groups, the Committee gained as much in added knowledge and insight into the complexities of scientific-and-technical-information problems as it contributed to the resolution of acute issues.

AD HOC PANEL ON THE DEPARTMENT OF THE INTERIOR INFORMATION PROGRAMS

The first of these Task Groups was organized to assist the Office of the Science Adviser to the Secretary of the Interior in reviewing the scientific-and-technical-information problems faced by that Department and to suggest appropriate mechanisms through which the Department could marshal the experience and resources of pertinent scientific communities to advise it on the management and long-term structure of its scientific-and-technical-information efforts. The membership of this special panel included the following:

JOHN C. CALHOUN, *Panel Chairman*
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Maynard Hufschmidt
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The panel indicated high-priority functions that should receive early attention, and it suggested organizational arrangements that would ensure the necessary focus and continuity of effort. Through its interaction with the Department of the Interior staff, SATCOM gained greater familiarity with the information requirements and programs of the Department as well as good rapport with its staff, which will facilitate continued productive interaction.

TASK GROUP ON TOXICOLOGICAL INFORMATION

A second SATCOM Task Group was formed to work with the National Library of Medicine in designing a comprehensive computer-based system for the handling of information on toxicology. The Committee charged this Task Group with (a) ensuring that the prospective system would make the best use of existing privately operated or government-agency information services that deal with the effects of chemical substances on biological systems, and (b) advising on ways in which the system could be made maximally responsive to user needs and user feedback in the development of the structure and content of its services. This Task Group is still an active body, with further meetings and interaction planned, and includes the following:

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NATIONAL ACADEMY OF SCIENCES PANEL ON THE APPLICATION OF COPYRIGHT ON COMPUTER USAGE

In response to a request to the NAS from the Chairman of the Subcommittee on Patents, Trademarks and Copyrights of the U.S. Senate Committee on the Judiciary, the NAS Committee on Science and Public Policy and SATCOM cooperated in the appointment of a panel to study and report on the impact of copyright on computer usage. Members of the panel were:

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University of Chicago
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The panel's findings were reported in late 1967 [120] and emphasized the multiplicity of ways in which computer information processing involves dealing with copyrightable material and the insufficient coverage of many vital aspects of computer information processing under the proposed copyright revision bill. Among the problem areas to which the panel directed particular attention were the appropriateness and scope of copyright coverage for computer programs; the appropriate point to apply copyright protection to material converted to machine-language representation for computer processing; the effect of copyright restrictions on the evolution of on-demand distributing libraries; the use of copyrighted material in computer-assisted instruction systems; the computer preparation of derivative works; and the rights of a copyright holder in relation to new works resulting from the use of computer programs. The panel concluded that the copyright problems raised by the computer are so complex that further intensive study by a specially designated governmental body was advisable, and it supported the general proposition of legislative action to create a study commission on copyright law.

TASK GROUP FOR THE INTERCHANGE OF SCIENTIFIC AND TECHNICAL INFORMATION IN MACHINE LANGUAGE (ISTIM)

The Task Group for the Interchange of Scientific and Technical Information in Machine Language (ISTIM) was established by the President's Special Assistant for Science and Technology to examine closely the problems and possible mechanisms for facilitating the exchange of bibliographic information in machine language between major systems. Since so complex an investigation would require the joint efforts of federal and nonfederal organizations, it provided an opportunity for a pilot experiment in cooperation between these two communities. The membership included, in addition to a chairman, seven representatives of government agencies and seven from private organizations.

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SATCOM was requested to identify and support the seven nonfederal members as well as two full-time professional staff; COSATI advised on the selection of the federal members, and they and two full-time staff were supported by the OST.

The Task Group's principal objectives were to define and recommend for adoption a minimal set of basic standards, a minimal set of standard codes, and one or more compatible formats for the interchange of machine-language representations of bibliographic descriptions. In addition, it was to recommend appropriate organizational arrangements to increase the usefulness of these recommended standards and to assist in their future development. A third objective was to identify key problems and suggest a program to develop solutions. The group was successful in identifying a limited set of common codes and standards needed as a basis for the more efficient sharing of machine-readable bibliographic information between data files, and it recommended augmentation of the United States of America Standards Institute (USASI) Committee on Library Work, Documentation, and Related Publishing Practices (Z39) to provide general supervision of the interchange of bibliographic records and to formulate additional needed standards. Rather than selecting a standard format structure from several candidates, the Task Group suggested that this responsibility could be better handled by the USASI Committee Z39. The definition of a minimal set of common data elements was recognized as requiring much additional study and was described in the Task Group's final report [144] as an "important organizational and intellectual challenge to the bibliographic community."

The records of SATCOM's Task Group activities and minutes of its meetings were made as complete and informative as possible to provide useful background material and perspective for any future efforts of like character in this area. This material gives a detailed description of SATCOM's work and complements and supplements the content of the final report.

A. EVOLUTION OF THE SATCOM REPORT

As the main lines of SATCOM thought and effort developed in relation to its three principal objectives, the Committee organized into seven Area Review Groups, which functioned as working panels in the following subject areas: (a) advanced concepts in the transfer of information; (b) primary communications; (c) secondary information services; (d) research libraries; (e) copyright issues; (f) standardization and coherence; and (g) review literature. These various Area Review Groups issued working papers describing the results of their studies and recommending needed policies and action. Their efforts, which were reviewed by the Consulting Correspondents at the November 1967 conference, marked early steps in the evolution of the Committee's final report.

The scope and organization of this report became more clearly defined during a week-long writing session held in July 1968. As the report took shape, drafts were circulated to SATCOM members and to the Consulting Correspondents throughout the fall and winter of 1968 for additions, suggestions, and criticism; meetings held during this interval also focused largely upon its modification and revision.

The report presents the findings of SATCOM's three-year survey of scientific-and-technical-communication activities and the conclusions and recommendations engendered not only by its studies but by interaction with representatives of scientific-and-technical-communication activities of both governmental and private organizations. Active involvement, through its Task Group responsibilities, in certain major problem areas also influenced the development of the final report. In addition, the NAS Committee on Science and Public Policy and the NAE Committee on Public Engineering Policy, as well as members of the Councils of the two Academies, reviewed drafts of the report and made valuable inputs to it.

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APPENDIX C

A Guide to the Content of Specific Recommendations

RECOMMENDATIONS ON "PLANNING, COORDINATION, AND LEADERSHIP AT THE NATIONAL LEVEL" (CHAPTER 3, SECTION A)

		PAGE
A1	Proposes the creation of a Joint Commission on Scientific and Technical Communication, responsible to the Councils of the NAS-NAE, to stimulate greater effort toward coordination among private organizations and facilitate their interaction with the government.	22
A2	Outlines a philosophy of shared responsibility among government and private organizations for the effective communication of scientific and technical information and emphasizes reliance on the private sector.	27
A3	Advocates (a) the management of public information programs by appropriate societies, federations of societies, or commercial organizations; and (b) a policy directing the use of appropriate privately operated services in mission-oriented government information programs.	28
A4	Advocates increasing the scope of the 1961 page-charge policy statement to include the processing of information for access, consolidation, and special use.	30
A5	Urges the assignment of high priority in new mission-oriented government programs (particularly those dealing with major social problems) to the development of the required information systems.	31
A6	Encourages managers of scientific and technical society information programs to develop arrangements for the international exchange of information.	32
A7	Urges government assistance and support of society efforts to achieve international cooperative agreements relative to scientific and technical communication.	33
A8	Suggests early attention in international cooperative research programs to the development of means of handling the typically large quantities of data and information generated.	34
A9	Urges the inclusion of representatives of relevant nongovernment information activities in U.S. delegations to internationally managed information endeavors.	34

RECOMMENDATIONS ON "CONSOLIDATION AND REPROCESSING—SERVICES FOR THE USER" (CHAPTER 3, SECTION B)

RECOMMENDATIONS ON "THE CLASSICAL SERVICES"
(CHAPTER 3, SECTION C)

RECOMMENDATIONS ON "PERSONAL INFORMATION COMMUNICATION" (CHAPTER 3, SECTION D)

RECOMMENDATIONS ON "STUDIES, RESEARCH, AND EXPERIMENTS" (CHAPTER 3, SECTION E)

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Abbreviations Used

ACS	American Chemical Society
ADI	American Documentation Institute (now American Society for Information Science)
AEC	Atomic Energy Commission
AGI	American Geological Institute
AIAA	American Institute of Aeronautics and Astronautics
AIChE	American Institute of Chemical Engineers
AIP	American Institute of Physics
AISI	American Iron and Steel Institute
ALPAC	Automatic Language Processing Advisory Committee
AMS	American Mathematical Society
APA	American Psychological Association
API	American Petroleum Institute
ARL	Association of Research Libraries
ARPA	Advanced Research Projects Agency
ASIS	American Society for Information Science (formerly American Documentation Institute)
ASME	American Society of Mechanical Engineers
BA	*Biological Abstracts*
BASIC	*Biological Abstracts Subjects in Context*
BCIP	Books-Coming-into-Print Program
BIOSIS	BioSciences Information Service of Biological Abstracts, Inc.
BJA	*Basic Journal Abstracts*
CA	*Chemical Abstracts*
CAS	Chemical Abstracts Service
CBAC	*Chemical-Biological Activities*
CCM	Information Sciences, Inc.—Subsidiary of Crowell, Collier and Macmillan, Inc.
CFSTI	Clearinghouse for Federal Scientific and Technical Information
CIA	Central Intelligence Agency
CICP	Committee to Investigate Copyright Problems, Inc.
CIOMS	Council of International Organizations in the Medical Sciences

CLR	Council on Library Resources, Inc.
CODATA	Committee on Data for Science and Technology (ICSU)
COMPENDEX	Computerized Engineering Index
COSATI	Committee on Scientific and Technical Information (FCST)
COSPAR	Committee on Space Research (ICSU)
COSPUP	Committee on Science and Public Policy (NAS)
CRT	cathode ray tube
CT	*Chemical Titles*
DDC	Defense Documentation Center
DESY	German Electron Synchrotron
DOC	Department of Commerce
DOD	Department of Defense
EDUCOM	Interuniversity Communications Council
EDUNET	Educational Information Network
EEA	*Electrical and Electronics Abstracts*
EJC	Engineers Joint Council
EM	*Excerpta Medica*
EMPIS	Engineering Materials and Processes Information Service
ERIC	Educational Resources Information Center
ESRO	European Space Research Organization
ETC	European Translation Center
EURATOM	European Atomic Energy Community
FCST	Federal Council for Science and Technology
FDA	Food and Drug Administration
FID	International Federation for Documentation
GE	General Electric
GPO	U.S. Government Printing Office
GSA	*Geosciences Abstracts*
HEW	Department of Health, Education, and Welfare
IAA	*International Aerospace Abstracts*
IAC	Information Analysis Center
IASY	International Years of the Active Sun
IBM	International Business Machines
IBP	International Biological Program
IC	*Index Chemicus*
ICSU	International Council of Scientific Unions
ICSU AB	International Council of Scientific Unions—Abstracting Board
IEE	Institution of Electrical Engineers
IEEE	Institute of Electrical and Electronics Engineers
IEG	Information Exchange Group
IFI	Information for Industry, Inc.
IFIP	International Federation of Information Processing
IGY	International Geophysical Year
IHD	International Hydrological Decade
IM	*Index Medicus*

IM Press	International Microfilms Press
IMI	Information Management, Inc.
IMP	Interface Maintenance Processor
INIS	International Nuclear Information System
INTREX	Information Transfer Experiment
IQSY	International Year of the Quiet Sun
ISI	Institute for Scientific Information
ISTIM	(Task Group for) Interchange of Scientific and Technical Information in Machine Language
JAG	Joint Agreement Group
JPRS	Joint Publications Research Service
KWAC	Keyword and Context
KWIC	Keyword in Context
KWOC	Keyword out of Context
LC	Library of Congress
LEX	DOD Project to Provide a Defense-wide Technical Thesaurus
MAC	Multiple Access Computer Project
MARC	Machine Readable Cataloging Project
MEDLARS	Medical Literature and Analysis Retrieval System
MESH	Medical Subject Headings
NAE	National Academy of Engineering
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NAL	National Agricultural Library
NBS	National Bureau of Standards (DOC)
NDEA	National Defense Education Act
NELINET	New England Library Information Network
NFSAIS	National Federation of Science Abstracting and Indexing Services
NIH	National Institutes of Health (HEW)
NIMH	National Institute of Mental Health
NLM	National Library of Medicine
NPAC	National Program for Acquisition and Cataloging
NRC	National Research Council
NSA	*Nuclear Science Abstracts*
NSF	National Science Foundation
NSRDS	National Standard Reference Data System
OE	Office of Education (HEW)
OECD	Organization of Economic Cooperation and Development
ONR	Office of Naval Research
OSA	Optical Society of America
OSIS	Office of Science Information Service (NSF)
OSRD	Office of Standard Reference Data (DOC)
OST	Office of Science and Technology

PA	*Physics Abstracts*
PHS	Public Health Service (HEW)
POST-J	*Polymer Science and Technology—Journals*
POST-P	*Polymer Science and Technology—Patents*
PSAC	President's Science Advisory Committee
SATCOM	Committee on Scientific and Technical Communication (NAS-NAE)
SCAN	*Selective Current Aerospace Notices*
SDC	System Development Corporation
SDI	Selective Dissemination of Information
SLA	Special Libraries Association
SLAC	Stanford Linear Accelerator Center
SPIRES	Stanford Physics Information Retrieval System
STAR	*Scientific and Technical Aerospace Reports*
STIF	Scientific and Technical Information Facility (NASA)
TAB	*Technical Abstracts Bulletin*
TAPPI	Technical Association of the Pulp and Paper Industry
TIP	Technical Information Project
TR-I	*Translations Register—Index*
UDC	Universal Decimal Classification
UMP	Upper Mantle Project
UN	United Nations
UNESCO	United Nations Educational, Scientific, and Cultural Organization
URBANDOC	Special project, City University of New York
USASI	United States of America Standards Institute
USGRDR	*United States Government Research and Development Reports*
USGS	United States Geological Survey
WMS	World Magnetic Survey