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Science Abstracting Services--Commercial, Institutional and Personal

FOSTER E. MOHRHARDT
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LIBRARY TRENDS, a quarterly journal of librarianship, provides a medium for evaluative recapitulation of current thought and practice, searching for those ideas and procedures which hold the greatest potentialities for the future.

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Introduction

FOSTER E. MOHRHARDT

Abstracts were originated to provide scholars with a convenient means for coping with increasing quantities of publications. Now abstracts themselves have become so voluminous that specialized indexes often replace the use of abstracts by those who need up-to-date and speedy access to publications.

Heavy investments of intellectual effort, money, time, research, and development are being expended in the “science information” field today. Too much of this effort is centered about the “mechanics” of information storage and retrieval, and too little has been dedicated to the intellectual processes basic to any good information system. This issue of Library Trends attempts to provide a general background for exploring today’s world of abstracting and indexing.

A notable impetus was given abstracting and indexing development in this country as the result of the 1957 success of Sputnik. A National Federation of Science Abstracting and Indexing Services was established. Congressional, scientific, library and documentation leaders at once focused attention on abstracting and indexing problems, and hopes were high for wide-scale national and international cooperative activities. Perhaps the enthusiasm of the moment prevented a full realization of the highly complex nature of this intellectual activity and the serious problems facing any major efforts at effective national or international solutions.

The most noticeable accomplishments of the past decade have been the developments of new services, the improvement and expansion of long-established services, and the successful application of computer techniques to abstracting and indexing work.

Although librarians have been the major users of abstracting and indexing services, there has been all too little dialogue, feed-in or feedback between those who design and operate the services and the librarians as users. In the past decade there is in evidence a recogni-

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tion of librarians as primary users, and also the recognition of librarians as a source of highly valuable critical information and advice to these services. This volume of *Library Trends* is one indication of the involvement of libraries in the total development of abstracting and indexing work.

The National Federation of Science Abstracting and Indexing Services, after an initial spurt of action, has declined into a semi-dormant group. Its problems have been diverse and in many cases insoluble. Yet the Federation has a proud record of accomplishment and deserves a place in this volume. Unfortunately, the author who was to prepare this chapter was unable to do so. Hence, the editor has pieced together a variety of informative notes that will serve at least as a basis for a future more expert and definitive report.

One of the basic philosophical and practical problems in the abstracting-indexing area is the proper structuring of subjects for inclusion in any service. The relationship between what are called "discipline" and "mission-oriented" services has been widely discussed. The two experts who are most concerned with this problem are Scott Adams and Dale Baker. Although they have not always been in complete agreement in discussions of these two types of services, they have reached in their chapter a common base for future discussions and activities. The "Summary of Trends" at the end of their article is of basic importance to all concerned with information activities.

Two of the most knowledgeable experts in the physical sciences information field are Pauline Atherton and Stella Keenan. An article by Pauline Atherton appeared in the April 1967 issue of *Library Trends*. That article, together with Miss Keenan's in this issue, provide one of the most comprehensive and valuable representations of information services for any specialized scientific field. Those interested in general background information in the abstracting-indexing area will find Miss Keenan's introduction a highly valuable contribution. In handling each of the specialized services she provides reference librarians with valuable guidance.

Again the scope of the chapter by Louise Schultz is much broader than is indicated by the title. She gives much valuable, stimulating and practical information concerning the entire abstracting-indexing field, and demonstrates the complexities of providing access in a specialized scientific area.

For decades, *Chemical Abstracts* has been considered one of the basic tools in any significant scientific reference library collection. The
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dialogue between librarians and abstracters is forwarded through the chapter by the two specialists from Chemical Abstracts, Fred Tate and James Wood. Although based primarily upon their experiences at Chemical Abstracts, they show the interdependence of libraries and specialized reference services.

Much interest has been shown by the library profession in the newest major development in scientific literature indexing, the Science Citation IndexR. The chapter by Morton Malin provides a general, practical and broad introduction to this specialized concept. Dr. Garfield, who designed and developed this new index, had extensive library experience prior to developing this new tool. Librarians have recognized the comparison between the science citation concept and that of law literature indexing, but we have needed an article such as this directed toward librarians and their specialized interest.

Farthest from the background experience or knowledge of most librarians is the area of subject index production. Charles Bernier presents librarians with an authoritative, understandable and useful background, based on his extensive experience in abstracting production, library management and commercial science information. His comments on the problems of production can be most useful to librarians.

James L. Wood, Head Librarian of Chemical Abstracts Service, in his second contribution to this issue, proposes a cooperative venture between librarians and abstract producers. The analyses prepared by Chemical Abstracts of the broad field of chemical journals will be most valuable to library administrators and to reference librarians.

The Committee on Scientific and Technical Information in the Executive Office of the President contracted with the System Development Corporation for A System Study of Abstracting and Indexing in the United States. Andrew A. Aines, the senior officer of the COSATI staff, was asked originally to prepare a chapter which would critically evaluate the System Study. Unfortunately, this proved to be impracticable; however, he has provided us with a chapter giving general guidelines and information basic to the rationale for national information systems. The System Development Corporation report on abstracting is obtainable as Document PB 174 249 from:

Clearinghouse for Federal Scientific and Technical Information
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

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Some broad generalizations may be made about what has happened to abstracting and indexing during the past decade. First, we note the recognition now given by those interested in scientific research and development to the problems and potentials of these services. Next, we record the enterprising, imaginative and energetic development of new, expanded and personalized services by a variety of organizations, companies, and professional bodies. Third, we observe the amazing expansion of government supported and operated indexing and abstracting services into a variety of scientific areas.

As a supplement to this issue, attention must be called to the Library Trends issue on “Bibliography” published in April 1967 which contains several significant articles relating to abstracting and indexing. Although some mention and touch upon the services covered in the present volume, they serve as supplements to the present articles, with very little or no overlap.

Those who are knowledgeable in this area as a whole, as well as those who have specialized interests in a particular field, will recognize the deficiencies of the present volume and the fact that some important subject areas have not been given proper recognition. This is due in part to the difficulties encountered in structuring a volume over such a broad spectrum of knowledge, and in part to the difficulties encountered in the ultimate attainment of chapters which had been optimistically anticipated. The editor hopes, nevertheless, that this volume may provide an interim guide to those who need information and guidance in this highly important area.
Mission and Discipline Orientation in Scientific Abstracting and Indexing Services

SCOTT ADAMS
AND
DALE B. BAKER

"Science has outgrown its organization along well-delineated disciplines of the past."
Jerome Wiesner

"Contemporary science with its methods and means is completely unlike the science of the last century or even of the first part of this century."
A. N. Kosygin

It is the argument of this paper that the organization of scientific abstracting services reflects the organization of sciences themselves; that scientific institutions are undergoing fundamental changes as a result of large-scale public funding; and that, as a result, new "mission-oriented" requirements are generating new services which conflict with earlier discipline-oriented ones. While no one yet (and certainly not the authors) has clearly visualized an optimum organization of scientific abstracting and indexing, the authors submit that a better understanding of the forces at work in the society, and an informed use of modern technology, may contribute to the ultimate solution of what has become a complex and frustrating problem.

Definition of Discipline and Mission. The two terms, discipline and mission, applied to the organization of scientific activity are in common usage, yet definitions appear to be loose and imprecise.

It would be well at the outset to attempt working definitions. "Discipline" has a Websterian definition of "that which is taught; a branch

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of knowledge; also, a course of study.” For the purpose of this paper, a discipline will be defined as a body of knowledge empirically organized for purposes of transmission through teaching. A discipline in science is an academically transmitted corpus of knowledge, and a discipline-oriented abstract service reports on its accretions. The schema for the organization of the *International Catalogue of Scientific Literature* provides an excellent conspectus of the classic scientific disciplines both as they existed at the turn of the century, and as they have been used traditionally for purposes of organizing abstracting.

“Mission” (from Latin *mittere*: to send) has as its Websterian meaning, “That with which a messenger or agent is charged; an errand, esp. a political one; a commission.” Popularized by the military establishment (a review of the *U.S. Government Manual* will show the defense agencies to have “missions” while others have “purposes”), a mission at the government level is a formally stated series of purposes authorized by public law. Thus the Department of Commerce has as its purpose “to foster, promote, and develop the foreign and domestic commerce, the manufacturing and shipping industries, and the transportation facilities of the United States.”

Mission statements exist at all levels of government. Among the agencies supporting research and development, a bureau (with its own mission) defines missions for the programs which it undertakes to advance its work. Programs in turn operate or support projects which relate to the accomplishment of a mission. Thus, the National Cancer Institute (NCI) has as one of its missions the functions of collecting and making available information on cancer. The National Cancer Chemotherapy Service Center, a program unit of NCI, has as one of its missions the provision of information services to advance the chemotherapy program. To this end it originated and currently supports an abstracting service, *Cancer Chemotherapy Abstracts* (1960-).

While the above suggests that mission-oriented science equates with government-supported science, or with applied science and technology, this is not entirely the case. The National Foundation for Infantile Paralysis, a voluntary health agency, supported mission-oriented scientific activities directed toward the conquest of polio, and in support of them sponsored *Poliomyelitis Current Literature*. Further, it should be noted that the government agencies engaged in mission-related science support much basic as well as applied science. Auger notes that in an age of “oriented fundamental research” classic distinc-
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tions between basic and applied science have lost their meaning.4

"Mission-oriented" research today can include both "basic" and
"applied." Its distinguishing characteristic is its relatedness to the solu-
tion of problems encountered as science proceeds toward publicly-
identified social goals.

Social Function of Science. At the root of mission-oriented science is
the philosophy of Francis Bacon who viewed science as a means by
which man can obtain mastery over nature.5 In this century, the de-
velopment of this philosophy through the pursuit of science to achieve
social goals has been accelerated in all advanced countries through
awareness of the increased economic power inherent in this doctrine.
The massive increases in the employment of public funds to advance
science demonstrate political recognition of this truism.

In the United States the social goals shaping public funding for sci-
ence may be traced to the Constitution, and to the body of public
law establishing the Federal agencies. The national defense, the health
of the people, the economic growth of the nation (to name a few)
are the goals of agency missions, and hence of mission-supported sci-
ence in the United States. In the Soviet Union, the establishment of
a State Committee for Coordination of Research 6 represents an effort
to orient Soviet science and technology to the economic development
and welfare of the Soviet state. With variations in approach, all devel-
oped countries today provide examples of political organization to
orient national scientific programs to the social goals of the state.

Missions and Interdisciplinary Science. Since mission-oriented science
is directed to the solution of complex problems in a society rather
than to the advance of knowledge in an academic field, it has en-
couraged interdisciplinary efforts. Accomplishment of a scientific
mission involves the assembly of teams of scientists from various disci-
plinary areas who appear to create their own synergy. Assembly of
scientists from different fields speaking different private languages of
science, occasions a communication problem at the heart of mission-
oriented science; in a real sense, the need for new formal communica-
tion media, interdisciplinary symposia, specialized journals, and, of
course, indexing and abstracting services, represents an extension of
the basic needs of newly assembled groups of scientists from various
fields working on a common problem to communicate better with
each other.

A phenomenon of our times is the emergence of new fields, such as
oceanography, to which potentially many disciplines will contribute. Being new, mission-oriented interdisciplinary fields are under rapid development; the interplay of the disciplines is dynamic. New and temporary combinations may emerge only to disappear.

Discipline-oriented science presents classic, relatively consistent and continuous forms and requirements; mission-oriented science encourages new organizational forms of unproven stability and indefinite duration. The conversion of scientific institutions from the former base to the latter is a dynamic and stressful feature of the twentieth century scientific revolution.

Postwar Growth of Mission-Oriented Science. While the concept of scientific missions antedated World War II (Rogers and Clark were mission-oriented), it was not until the Federal government mobilized science in the national defense, through the Office of Scientific Research and Development (OSRD), that mission-oriented science began to flourish. OSRD contributed two major new dynamic forces to American science: first, the accentuation of scientific missions and objectives relating to the defense and survival of the American society; and second, the cooperative interrelationships it pioneered between the academic communities and governmental sponsorship of science. The effects of these forces have been far-reaching.

On the dissolution of OSRD, Dr. Vannevar Bush was invited by President Roosevelt to recommend policies relating to the role of science in American life. His report, *Science, the Endless Frontier* is basic to an understanding of the scientific revolution in the United States. The single national research foundation proposed by Bush was never realized. Instead, the mission-oriented Federal agencies (the Department of Defense [DoD] agencies, Public Health Service, the Atomic Energy Commission) were successful in establishing their own grant and contract programs, and the National Science Foundation (NSF) was created to support basic research independent of the particular missions recognized by the government. This compromise became national policy through Executive Order No. 10521 of March 17, 1954, in which President Eisenhower determined that "the Foundation shall be increasingly responsible for providing support by the Federal Government for general-purpose basic research through contracts and grants. The conduct and support by other Federal agencies of basic research in areas which are closely related to their missions is recognized as important and desirable specially in response to current national needs, and shall continue."
Mission and Discipline Orientation in Scientific Abstracting

The tremendous increase in funding of science through the mission-oriented agencies has been well-documented elsewhere. In the health field alone, total Federal expenditures increased from 0.1 billion in 1935 to 5.1 billion in 1965—an increase of 5000 percent. Total Federal expenditures for research and development increased from 74.1 million dollars in 1940 to 15,209.6 million dollars in 1965. Departmental breakdowns are given as follows.

<table>
<thead>
<tr>
<th>Department</th>
<th>1940</th>
<th>1965</th>
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<tr>
<td>Department of Defense</td>
<td>$26.4 million</td>
<td>$7,107.1 million</td>
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<tr>
<td>Atomic Energy Commission</td>
<td>77.0 (1943)</td>
<td>1,449.3</td>
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<tr>
<td>National Aeronautics and Space Administration</td>
<td>2.2</td>
<td>4,870.6</td>
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<tr>
<td>Department of Health, Education and Welfare</td>
<td>2.8</td>
<td>810.0</td>
</tr>
<tr>
<td>Department of Agriculture</td>
<td>29.1</td>
<td>193.9</td>
</tr>
<tr>
<td>Other</td>
<td>13.6</td>
<td>668.7</td>
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One effect of funding of this magnitude for science has been to create "big science" as described by Price. Price concerns himself with magnitudes, rather than with the impact of "big science" on the organizational forms of scientific institutions. Both quantitative increase and change in organizational requirements are related in the current problems of abstracting when it is viewed as a scientific institution. Recognition that "big science" has a dual impact on abstracting and indexing has been slow to come. The concurrent need to adapt to large volume and at the same time to new forms constitutes a highly complex problem for the scientific communities in the universities, industry, government, and scientific and technical societies.

"Big Science" and Volume of Scientific Publication. The latest worldwide census by Gottschalk and Desmond showed that there were some 35,000 scientific and technical serials being published in 1962. While Bourne seemed to agree with this estimate, a later unsubstantiated estimate by Hutton indicated that there may be 60,000 to 70,000 periodicals of importance.

Most estimates agree, in principle, that the overall increase in published scientific papers is above 5 to 6 percent, compounded annually. Price points out that these rates indicate a doubling of volume, on an accumulative basis, every fifteen years. NSF estimated the annual number of scientific and technical articles to be 1,700,000 in 1964. Other estimates range from one to two million articles per year while a Russian estimate suggested that there may be 4.5 million articles per year. A later study by the System Development Corporation (SDC)
estimated conservatively that 2,573,000 individual items were abstracted or cited by 220 abstracting and indexing publications in 1966.

Indexes and Abstracts. Organization of the literature in such a way that all worthwhile documents will be available and retrievable has long been an objective of secondary information services. According to the recent SDC report,\textsuperscript{10} 56 percent of the total literature covered by abstracting and indexing services (an estimated 1,440,000 papers in 1966) is covered by abstracts, and the remainder by citations (1,133,000). This report showed that for 1962 scientific societies in the U.S. produced 58 percent of the abstracts, 21 percent were produced by agencies of the Federal government, 8.5 percent by commercial information firms, 8 percent by industry, and 4.6 percent by other institutions. Relative production volumes of index items in 1962 were: 37.9 percent societal, 32.3 percent Federal, 20.3 percent commercial, 5.4 percent industrial, and 4.1 percent institutional.\textsuperscript{17} Thus, those services which tend to preserve discipline orientation (societies and other institutions) produce both abstracts and indexes, while mission-oriented services (Federal and commercial), which tend to be devoted largely to technology, also tend to produce more indexes than abstracts.

Discipline-oriented services make information available on no fixed time scale; they are prompt, but also archival. The emphasis in this decade has been on timeliness in reporting the literature. The studies by the International Council of Scientific Unions (ICSU) for 1963 and for 1965 show that the major international discipline abstracting services have a lag period of from three to eight months, with a median of about five months, between date of publication of the original paper and the appearance of the abstract. This is not so slow as many believe but also not so prompt as the services would wish to be. Accordingly, in recent years discipline-oriented services have developed many variations of rapid alerting services both in discipline and mission fields (e.g., B.A.S.I.C. and Chemical Titles) to speed up delivery to the user of abstract-index reference tools. These special services have usually utilized computers, thus lending support to the belief that computer technology holds the real solution to the discipline-mission problem.

Changing Science and Technology. While the prompt reporting through secondary publications on the increasing volume of scientific publication constitutes an economic problem of considerable magni-
tude, the organization or packaging of services to meet the requirements of evolving science and technology constitutes an intellectual and logistic problem of great complexity. This latter problem is complicated by the rapidity of development of the newer fields of science, by their instability, and their interdisciplinary character.

Chemistry, as a well-documented example of a traditional discipline, stands midway between physics and the biological sciences, and shares the conceptual framework and practical applications of both. As a basic science, chemistry is a dynamic discipline, changing and evolving with any natural phenomenon it may be called upon to interpret. It grows in terms of how much is known; it changes in terms of its own definition and scope. Knowledge begets knowledge, and compounded with all that man has learned since he first became intrigued by the nature of matter and the transformations of which it is capable, this basic science has become a cornerstone of technological advance. As research both broadens into other fields and deepens into the fundamentals of chemistry itself, the frontiers change daily.

One can point to "the various sciences of biochemistry, geochemistry, chemical physics, atmospheric chemistry, molecular biology, and astrochemistry [which] attest to the importance of chemistry to the community of scientists." Chemistry, at the same time, is basic to the complexes of scientific activity organized to achieve social goals—the national defense, the nation's health, nuclear energy. To achieve prompt reporting on the literature related to specific objectives, multiple specialized abstracting services have been created in such fields as air pollution, prevention of deterioration of materials, and pharmaceutical chemistry.

There are a limited number of disciplines, but an unlimited number of missions. But it is important to remember that the information utilized by missions is contained within disciplines. Computer technology, design and use, for example, is a mission drawing primarily from information generated in the fields of mathematics and electrical engineering. Solving mission information problems with information derived from its discipline bases is both a logistic and an intellectual problem.

Recognition of the Challenge. The Royal Society's Scientific Information Conference of 1948 provided scant recognition of the new mission-oriented requirements for indexing and abstracting. The conferees, rather, were largely concerned with technical questions, although they...
revived once more the ideals of international cooperation on which the *International Catalogue* was founded. UNESCO sponsored a conference in October, 1947, on abstracting and indexing in the medical and biological sciences and a further conference on science abstracting in 1949. Both of these conferences were more concerned with technical questions of formatting of abstracts, standards, and with potential international cooperation than they were with the restructuring of abstract services for developing interdisciplinary fields.

Growing from the UNESCO Conference, the International Council of Scientific Unions (ICSU) Abstracting Board (ICSU-AB) was created to provide surveillance for scientific abstracting in fourteen fields represented by ICSU. In 1952 the ICSU-AB devoted its attention to abstracting in physics; in 1956 to chemistry; in 1962 to biology; and in 1965 to astronomy. The ICSU approach, deriving from the classic interests of its constituent international scientific societies, has been consistently academically and discipline-oriented. Its objective is “through international cooperation, to improve the quality of scientific information and the acceleration of its distribution among scientists.”

In general, efforts at the international level during the 1940’s and 1950’s reflected the concern of existing services to effect economies through cooperation and standardization, which might lead to the improvements of classic forms of abstracting services.

Over the past ten years, however, there has been increasing concern in U.S. government circles with questions relating to the organization and support of abstracting services, as well as with the classic concerns with format standardization and mechanisms for voluntary cooperation. This concern stems from the following considerations:

1. that the growth rates of the literature to be covered by the services threaten to outstrip the private resources available; 2. that Federal funding for mission-oriented services, to fill new needs which the government has brought about, may be creating imbalances and unnecessary duplication of effort; 3. that a rapidly developing machine technology can contribute to solutions; and 4. that comprehensive, economically healthy, integrated abstracting and indexing are essential to the science information needs of the communities of scientists who comprise the national science effort.

Successive hearings before committees of the Congress, as well as consideration by subcommittees of the President’s Science Advisory
Committee, testify to the continuing Federal concern with this problem. Doubtless this interest was heightened by reports descriptive of the solutions the All-Union Institute of Scientific and Technical Information (VINITI) was attempting to find through the creation in 1953 of the comprehensive, centrally managed abstracting system, the Referativnyie Zhurnaly.21

In the United States the NSF which, as we have seen, has a basic concern with balancing support for discipline-oriented research with that of the mission-oriented agencies, took the initiative in identifying problems relating to the coexistence of abstracting services supporting the disciplines and missions. In 1957, it aided in the establishment of the National Federation of Science Abstracting and Indexing Services and in 1961-62 supported this organization in the conduct of a study by Robert Heller Associates Inc.22 The Heller Plan called attention to the relationships which might be created between the large discipline-oriented abstracting and indexing services and the smaller mission-oriented services funded or sponsored by government agencies. The status report on scientific and technical information of the Committee on Scientific Information 23 (the predecessor of COSATI) again focused attention on the need to improve the coordination of Federal programs for support of specific abstracting and indexing services.

The latest comprehensive study of scientific and technical abstracting and indexing is the System Development Corporation's report previously cited.18 Under contract from the National Science Foundation, and working closely with the COSATI Task Group on National Systems for Scientific and Technical Information, the SDC study addressed itself to the following issues:

(1) the role of abstracting and indexing services in the national system of scientific and technical communication; (2) the current status and problems of the services; and (3) actions which should be initiated by the Federal government to help bring about desired improvements.

The resulting report provides a valuable analysis of the status and sponsorship of abstracting and indexing, poses for the first time in a systematic way questions which must be answered to reach solutions, and explores a series of mechanisms ranging from laissez faire to a Federally operated Capping Agency by means of which abstracting and indexing services might be developed as a sub-system of a national scientific and technical information system. Recognizing the complexity
of governmental and private interests involved, the SDC recommendations call for further studies and discussions.

**Solutions at the Molecular Level.** The abstracting service for each major discipline and mission has evolved its own definition of the field or scope of coverage. On three occasions in the history of ICSU-AB, attempts have been made to coordinate the subject arrangements and indexing of the abstracting journals in the field of physics along the lines of UDC. Uniformity of field definition among the British, French, German, and Russian services was never reached. The Russians and French used a much broader definition of physics than the Germans, British and Americans, so that today the *Referativnyi Zhurnal* and *Bulletin Signalétique* abstracting services cover as many as three times more papers in their services than the *Physikalische Berichte* and *Physics Abstracts*. Through the years, virtually all of the major abstracting services have grown with careful culture and nurture, but their growth has been completely autonomous and with little coordination of subject content on a national or international basis.

Working parties on scientific documentation at a UNESCO meeting in Moscow, November, 1963, considered it urgent that harmonization of glossaries, keyword lists, descriptor lists, and thesauri should be attempted for science and technology. Regional bodies were visualized for North America, Latin America, Western Europe, USSR and Eastern Europe, and the Afro-Asian countries. To date, this UNESCO effort has not come to fruition. Definition of the subjects and standardization of the material to be covered in the various mission and discipline-oriented services are both necessary and important to achieve compatible, coordinated information services on a world-wide basis.

Evolving from DoD-wide technical thesaurus in the early 1960's were two important activities. First, COSATI in 1964 issued a list of subject fields to be the official government-wide technical vocabulary for document announcement, handling, and retrieval. The twenty-two subject areas of the lists include the names of the most of the traditional disciplines of science and engineering. The list also includes mission-oriented subject areas such as atmospheric sciences, energy conversion, materials, methods and equipment, military sciences, missile technology, ordinance, and space technology, thus strongly implying a dichotomy between the disciplines and the missions. This COSATI list has a very limited definition of chemistry, for example, so that one must look for fundamental studies on combustion under propulsion,
Mission and Discipline Orientation in Scientific Abstracting

for isotopes under nuclear science, for solvents under materials. Categorization in the medical sciences is similarly underdeveloped.

Impact of Modern Methods of Handling Information. The power and flexibility of the new information storage, retrieval, and dissemination techniques that have been developed, or are being developed, are having a tremendous effect on abstracting and indexing methodology, both in the missions and in the disciplines.

Major discipline and mission abstracting and indexing services are in the process of acquiring dynamic and flexible information-processing and disseminating capabilities. The use of the computer and graphic devices to repackage information may well be the most important development of the decade that will affect the capability of the abstracting and indexing services to meet user requirements. Further, the new information technology may be the basis on which more effective and efficient coordination among missions and disciplines can be achieved.

One of the early efforts toward mechanization of abstracting and indexing was started by the American Chemical Society (ACS) in 1946 through the activities of its ACS Committee on Punched Cards. In 1955, the Chemical Abstracts Service (CAS) started its own research and development program to attempt to use machines in the handling of abstracts and indexes. In 1957, the American Society of Metals undertook with Western Reserve University to establish a group to abstract and index material for publication and to encode it for mechanized retrieval. The first computer-produced index publication, Chemical Titles, appeared in 1961 after several years of research and development. The National Library of Medicine (NLM) supported studies relating to indexing mechanization as early as 1948, while its operational system, MEDLARS, started in 1964 after more than three years in development. MEDLARS, which produces Index Medicus as well as 100,000 pages a year of specialized bibliographies, also makes 4,000 demand searches a year through its system.

Likewise, Biological Abstracts has undergone great changes in recent years, in a program which has become known as the BioSciences Information Service of Biological Abstracts (BIOSIS). A new index, the BioSystematic Index, was achieved through its computer program. BIOSIS has over 500,000 titles, references, and index entries in machine form.

Consideration of a modernized physics information system, includ-
ing abstracts and indexes, was defined in 1966 by Van Zandt Williams, Hutchisson, and Wolfe. The American Institute of Physics established a program of author-produced abstracts and indexes and worked with the British *Physics Abstracts* to produce a machine-based weekly publication of titles in the field of physics.

By 1964, research at CAS had yielded some powerful new techniques so that a five-year program was initiated, designed to implement fully a computer-based system by 1969. By 1965, a sophisticated, computer-produced information service, *Chemical-Biological Activities (CBAC)* was launched in its biweekly publication form. Starting with the first of 1966, CBAC became available also in magnetic tape form and as a search service to be conducted on CAS computers. Based on two years of experience with CBAC, a new service, Polymer Science & Technology (*POST-J* and *POST-P*) was launched in 1967.

CBAC and POST and MEDLARS all illustrate how new computer-based techniques make possible breaking through the interfaces between discipline- and mission-oriented services with no loss of speed or effectiveness.

In a computer-based system, information selected in a single intellectual analysis of the source documents, and analysis combining both abstracting and indexing, is put into a unified machine-manipulative store through a single keyboarding. Then from the unified bank of information, material appropriate for special-subject alerting and retrieval publication can be drawn, largely by computer programs.

The principal reasons behind the shift to computer-based abstracting and indexing services which apply across the board in science and technology are:

(1) the growth of the literature, increasing at an exponential rate for over twenty years, requires the most modern equipment and technology to cope with the flood, now and in the future; (2) traditional methods of abstract and index processing require too much scarce and expensive manpower devoted to redoing accomplished work; (3) the patterns of information use by scientists and engineers have been changing toward more selective requirements; (4) users need more timely and responsive information services; and (5) packaging in conventional forms and repackaging for multiple mission-oriented products is economically feasible. This flexibility for meeting both present and future requirements provides the potential for solving the discipline-mission problem.
Mission and Discipline Orientation in Scientific Abstracting

Relationships to Other Developments. Basic to the achievements of the goals of abstracting and indexing services is definition of the interfaces between disciplines and missions and construction of the bridges necessary for efficient and effective transfer of information among the services. Mission-oriented services tend to decrease information flow across mission borderlines because of their specialized nature. On the other hand, because information of consequence to missions is included within the scientific disciplines, and because of new systems capabilities, information flow from disciplines to missions is enhanced.

An example of interdisciplinary programs to increase information flow across subject borders is the current collaborative effort between the NLM and CAS in the handling of chemical compounds. Chemical data processed for the Drug Literature Program of the MEDLARS system is directly compatible with the techniques used to build the store of compounds in the Chemical Compound Registry System at CAS. Other CAS programs are active with the American Institute of Physics and the American Institute of Chemical Engineers to build additional bridges to help solve the interdisciplinary coverage problem.

The studies and programs by national groups are expected to help point the way to improved cooperation necessary to achieve the interlinking of the developing abstracting and indexing services. Interlinkage of information systems must take into account several facts: (a) large and small systems are often not interchangeable, (b) interlinkage must be created between large and small systems to assure effective interaction, and (c) information is usually delivered to the user through local, often small, information-handling systems. The smaller, localized information systems tend to be mission-oriented in view of the specialized interests of a local community of users. Existing information resources, as subsystems of a comprehensive network of limited but larger systems which are primarily discipline based, can slowly but surely be tied together in logical patterns to satisfy our future needs for information.

The Heller plan proposed a single clearing house, Organization X, through which abstracts prepared by discipline-oriented services might be repackaged and marketed to mission-oriented services. The SDC report suggests that some variation of the Heller proposal which might provide for joint Federal-private participation might be a feasible compromise. What is in fact in process of evolution is not a single Organization X, but a series of lower-case organization x's, each of which, as a service responsible for macro-disciplinary areas, is attempt-
ing to develop mission-oriented services, through the computerized repackaging of its products.

Summary of Trends

1. The revolution in science, primarily caused by increased public interest and public funding, is having major effects on scientific institutions which are being converted from traditional discipline to mission orientation. Abstracting and indexing, viewed as a scientific institution, have been affected by this revolution.

2. Increased basic concern with the problems of coexistence of abstracting services in support of the disciplines and in support of missions has led to comprehensive studies which recommend a network of the various abstracting and indexing services.

3. The number of abstracting and indexing services (about 1,850 in 1963) is growing with the increased growth of the literature. While few new, large, discipline-oriented abstracting services appear to be developing, more mission-oriented services are starting each year than are being terminated.

4. There is an increasing emphasis on defining and standardizing coverage of abstracting services, both mission- and discipline-oriented, for the purpose of achieving understanding, compatibility, and coordination of the abstracting efforts.

5. Major discipline- and mission-oriented abstracting services are systematically transforming from traditional formats to more flexible information-processing and disseminating programs.

6. New computer-based techniques of abstracting and indexing make possible multiple, interlinked processing of information across discipline borderlines with no loss of speed or effectiveness.

7. By recognizing that the scientific and technical abstracting and indexing problem is in reality a multitude of different, interacting problems to which there is no single, all-purpose answer, we have begun to construct a powerful framework to satisfy our future needs for information.

References


Mission and Discipline Orientation in Scientific Abstracting

of the Royal Society of London; with schedules of classification.) London, 1898.


17. Ibid., p. 15.


SCOTT ADAMS AND DALE B. BAKER


The National Federation of Science
Abstracting and Indexing Services*

ALTHOUGH THE National Federation of Science Abstracting and Indexing Services (NFSAIS) has been decreasingly active in the past two years, it has provided since 1958 a focal point for abstracting and indexing interests.

One of the founders was Miles Conrad of Biological Abstracts, who reported soon after its founding:

The possibilities of cooperating with one another and coordinating our respective activities [have] for years seemed very attractive to many of us whose responsibility it is to abstract and index the literature of science and technology. However, it took the advent of the sputniks to provide the dramatic impetus required to take real and tangible action that might lead to such coordination. At a meeting on December 9, 1957 the representatives of a number of abstracting and indexing services in different fields of science and technology agreed to hold a conference to consider common operating problems and the possibilities of cooperation and coordination.

Through the good offices of the National Science Foundation funds were provided Biological Abstracts with which to organize and call together representatives of the major abstracting and indexing services of the United States for a conference on January 29, 30 and 31, 1958 in Philadelphia. These services, listed below, serve virtually all of the major sciences and technologies:

Aeronautical Reviews
Applied Mechanics Reviews
Bibliography of Agriculture
Biological Abstracts
Chemical Abstracts
Current List of Medical Literature
Engineering Index

* Compiled by Foster E. Mohrhardt from various publications of the National Federation of Science Abstracting and Indexing Services and other sources.

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Mathematical Reviews
Meteorological Abstracts
Nuclear Science Abstracts
Psychological Abstracts
Review of Metal Literature
Technical Abstract Bulletin (ASTIA)
United States Government Research Reports (OTS)¹

Other services that have been associated with the Federation include:

Bibliography & Abstracts on Electrical Contacts
Corrosion Abstracts
Environmental Effects on Materials and Equipment Abstracts
Fire Research Abstracts & Reviews
GeoScience Abstracts
Index Medicus
International Aerospace Abstracts
Scientific and Technical Aerospace Reports
Tobacco Abstracts
U.S. Government Research and Development Reports
Wheat Abstracts
Sociological Abstracts

It is an association of autonomous and independently managed corporate and government bodies. In joining together in a Federation the organizations have signified their willingness to cooperate with one another in order to further the interest of science and technology without sacrificing their prerogative of independence.

Headquarters were originally in Washington, D.C., but the Secretariat is now handled by Biological Abstracts in Philadelphia. It has functioned through working groups specializing in such problems as:

1. Unification of abstracting methods within the Federation.
2. Reduction of duplication.
3. Terminology in the field of scientific and technical information (this work is carried on jointly with the ASA).
4. Financing of information services.
5. Unification of entry forms for journals.
6. Centralized subscription to periodicals (special attention is paid to publications of the socialist countries) and exchange of publications between members of the Federation.
National Federation of Science Abstracting and Indexing Services

7. General questions of mechanization of information work.
8. Raising of qualifications of information workers.
9. New technology in the preparation of abstract journals, shortening of time of their issuance, etc.

A forum. The Federation by means of its annual, special working group, and committee meetings has enabled the directors and the professional staff of member and nonmember abstracting and/or indexing services to meet and establish a working relationship with their counterparts. New methods, techniques, and processes are discussed along with preliminary research results. These forums have also enabled Federation members to benefit from the advice of professional science information experts from industrial, governmental, and educational institutions.

A unique opportunity is provided for both government and non-government personnel at the management and working levels to sit down together and focus their attention on mutual problems and the methodology of information processing.

A central office for conducting surveys and research projects. Through the Secretariat, the Federation conducts central projects that could not be carried out by any individual service. The Federation has been involved in projects including the following:

2. The compilation and publication of a Federated List of Serials Covered by the Members of the Federation. This contains the titles of 17,000 serials with annotations indicating the degrees of coverage provided by each member service.
3. A proposed inventory of the world's scientific and technical periodicals.
4. A proposed unique journal article coding system.
5. A proposed design of a study of the utility of different kinds of published indexes under various conditions of usage.

A standards producing and publishing group. The Federation has produced bibliographic standards for the abstracting and indexing community. A standard for modern Russian to English transliteration

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has been published. A draft standard for the definition of an abstract has been evaluated, as has a standard for bibliographic citation. Another effort involves discussion for compatibility of systems used by member services publishing permuted-title indexes of the keyword-in-context type. The Federation is also represented on the USASI Z-39 Committee and many of its sub-committees.

A national spokesman for the industry. The Federation through its Secretariat obtains a consensus of the views of the members of the abstracting and indexing community and states these views to government and non-government planners, administrators, and legislators.

A negotiating and surveying agency. The Federation has sent survey teams to the USSR, Poland, the Netherlands, Denmark, and Japan to appraise portions of their secondary information systems and has reported upon them. It has enabled the "decentralized" U.S. services to talk at the same table with the generally more "centralized" foreign secondary information organizations.

An educational and public relations office for the abstracting and indexing industry. The Federation has planned a program by means of which colleges and universities will be encouraged to teach the use of secondary services to all their science and technology undergraduates.

A secondary-service information center. The Federation has served as an information center for all persons wishing to obtain knowledge about secondary information services in science and technology.

An organization for encouraging and engendering interservice cooperation. The Geological Society of America reported:

Through the Federation, the American Meteorological Society obtained the cooperation of the American Chemical Society in developing its work in permuted title indexing. The American Meteorological Society in turn has cooperated with the American Geological Institute in developing its permuted title indexes and also in its use of the Universal Decimal Classification. The American Society for Metals/the Engineers Joint Council-Engineering Index cooperation was also engendered by participation in NFSAIS activities. The need should be stressed for close cooperation among those working in
National Federation of Science Abstracting and Indexing Services

the rapidly developing field of scientific and technical information communication.2

A statistics collecting and disseminating agency. The Federation collects and makes available statistics from its member services. It also distributes and publishes coverage and cost data to the industry and to those interested in initiating new services.

A centralized acquisition unit. One of the principal advantages observed by the Federation team of 1959 which visited the Soviet VINITI was the efficiency inherent in a centralized acquisition system. The desirability of forming such a system in the U.S. under Federation aegis has been debated many times by the membership without fruitful results. A program was initiated to test in a small way the utility of such an enterprise. The Federation has conducted for its membership an airmail exchange with mainland China and is receiving about fifty-two generally high-quality primary journals. These journals are redistributed by photocopy to the membership. The Federation published a tables-of-contents journal which will enable its members and others to order photocopies of Chinese articles from the Federation as they need them.

Proposed areas of Federation activities. In addition to the items mentioned above, the following topics have been suggested for Federation attention:

1. Creation of groups for establishing standards for: (a) abstracts, (b) journal titles, (c) transliteration, (d) citation style.
2. Conduct of training programs (such as short courses and summer institutes) in the effective use of available abstracting and indexing services for scientists, science administrators, documentalists, information officers, librarians, and for teachers in library schools and the newly developing curricula in science documentation.
3. a. Research on user requirements, which continues to be a major need. There is an inadequate measure available to us, at present, of the differences in individual requirements for information and the manner in which these individual differences may be translated into a working information system.
b. Provision of overall information on coverage by primary source and subject so that the NFSAIS could tell an inquirer which member service covers any given field.
c. Development as a reference and statistical center; maintenance of census-type data on the growth and distribution of literature, costs, personnel, etc.
d. Conduct or sponsorship of user studies based on existing products of a wide range of services, or based on needs without reference to existing services and tools.

4. Study of the relationship between abstracting and indexing services and specialized information centers, and recommendations as to how these two types of information retrieval organizations can best integrate their functions and supplement each other.

In conclusion, the comment of Raymond E. Jensen, executive secretary of the Federation, may be cited:

The Federation has in recent years tended to represent the private sector rather than the federal sector. The impact of this change has as yet not been fully recorded. The Federation has functioned as a viable and productive organization in the past, but its future is in doubt, if participation in its affairs is not expanded by increased membership.

References

2. Information provided by Raymond Jensen, Executive Secretary of NFSAIS.
Abstracting and Indexing Services in the Physical Sciences

STELLA KEENAN

In order to examine the information picture in the United States, the Federal Committee on Scientific and Technical Information (COSATI) has divided the field into document handling and information handling systems. A major report on the document handling activities was prepared for COSATI by the System Development Corporation in 1965. This was followed by a study of abstracting and indexing services conducted during 1966. In this report abstracting and indexing services are regarded as a document representation subsystem which forms part of the total document handling system.

Colonel Andrew Aines, Acting Chairman of COSATI, said at a meeting in early 1967 that it was his personal opinion that there had been a basic philosophical change in the functions of abstracting and indexing services. If these services are considered on a spectrum ranging from archival publications to selected dissemination of information services (SDI), he felt that abstracting and indexing services are moving toward the SDI end of the spectrum. In examining secondary services, the following can be identified as the spectrum:

(a) Archival publications covering a given subject field, intended primarily for retrospective searching.
(b) Sectionalized publications which cover a smaller field in great depth.
(c) Current awareness publications intended for rapid announcement and dissemination of published material.
(d) Mechanized searching tools—such as microfilm tape; direct console access to a computerized store, etc.
(e) Specially "packaged" publications in which material from other

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publications is collected to satisfy the needs of a special group of users.

(f) Selective dissemination of information where material of interest is distributed on an individual basis to users, based on an interest profile.

It should be noted that the six types of service listed above are not mutually exclusive.

At the present time the major national societies are interested in establishing integrated information systems for their respective disciplines. In reviewing the activities of major abstracting and indexing services it is noticeable how many of these are vitally involved in the plans for such integrated systems. An abstracting and indexing service, by the very nature of its operation and product, is an important repository of the significant information in its field or a record of where such information can be found.

Abstracting and indexing services have to cope with an expanding primary literature; for example, the physics literature has increased since 1960 by 77 percent. The average rate of increase is consonant with a doubling of the literature every seven years. This increase in primary publications causes a resulting increase in the size of the secondary publication. The growth of some of the major services can be seen from the following figures taken from a recent National Federation of Science Abstracting and Indexing Services report.

**TABLE 1**

**NFSAI S SCIENCE INFORMATION SERVICES PROVIDED IN 1966** 8

<table>
<thead>
<tr>
<th>Abstract Services</th>
<th>Number of Abstracts Published</th>
<th>Estimated for</th>
<th>% Increase over 1957</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1957</td>
<td>1965</td>
<td>1966</td>
</tr>
<tr>
<td>Applied Mechanics Reviews</td>
<td>4,245</td>
<td>7,900</td>
<td>8,200</td>
</tr>
<tr>
<td>Engineering Index</td>
<td>26,300</td>
<td>50,000</td>
<td>55,000</td>
</tr>
<tr>
<td>International Aerospace Abstracts</td>
<td>6,770</td>
<td>26,850</td>
<td>33,000</td>
</tr>
<tr>
<td>Meteorological and Geoastrophysical Abstracts</td>
<td>5,000</td>
<td>9,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Nuclear Science Abstracts</td>
<td>14,042</td>
<td>48,118</td>
<td>50,000</td>
</tr>
<tr>
<td>ASM Review of Metal Literature</td>
<td>8,219</td>
<td>13,214</td>
<td>21,500</td>
</tr>
<tr>
<td>Scientific and Technical Aerospace Reports (NASA)</td>
<td>26,897</td>
<td>30,000</td>
<td></td>
</tr>
</tbody>
</table>

* Selected member services of NFSAI S only.
Abstracting and Indexing Services in Physical Sciences

In this paper selected services will be discussed briefly with emphasis on those publications which demonstrate the change in the nature of secondary publications. Other physical sciences, such as chemistry, are treated elsewhere in this issue.

Physics. The major abstracting journal in physics is *Physics Abstracts* (Section A of *Science Abstracts*) published monthly in London by the Institution of Electrical Engineers (IEE). This is an archival publication, carrying over 38,000 abstracts in 1966. Abstracts are listed once under a subject heading. Subject and author indexes are provided semi-annually and cumulate periodically. A companion publication to *Physics Abstracts* is *Current Papers in Physics* published twice-monthly since January, 1966. It is a rapid announcement of approximately 90 percent of the articles which later appear in *Physics Abstracts*. It is published in newspaper format and contains author, title, and reference arranged under the broad subject headings used in *Physics Abstracts*.

These publications are good examples of the way in which secondary publications form part of an integrated information service. The American Institute of Physics (AIP) and the Institution of Electrical Engineers (IEE) have for many years maintained a close cooperative relationship. At the present time AIP is studying the elements of an information service for physics while the IEE is setting up an Information Service for Physics, Electrotechnology and Control (INSPEC) in Great Britain. *Physics Abstracts* and *Current Papers in Physics* have been studied closely by both organizations working in conjunction. A user study on current awareness methods and *Current Papers in Physics* has been conducted in the United Kingdom and the United States simultaneously. This study has useful information on the current awareness requirements of the physics community. The subject arrangement of *Physics Abstracts* is being studied and it is hoped that a method of organizing physics information can be developed which will be used by the AIP in its primary journals, and by *Physics Abstracts* in the secondary publications.

Another current awareness service in physics is *Current Contents; Physical Sciences*, published by the Institute for Scientific Information (ISI) in Philadelphia. This journal contains contents pages of journals in space, electronics and the physical sciences. A tear sheet is provided as an additional service. *Current Contents* is the product of a broad-based commercial service, which publishes many science information tools such as *Science Citation Index* and the ASCA Alerting Service.
For additional information on ISI publications refer to the article by Morton V. Malin in this issue.

The major mission-oriented service in physics is *Nuclear Science Abstracts* (NSA) published by the Atomic Energy Commission. Published monthly, NSA covered over 47,000 abstracts in 1966. Indexes are available quarterly with cumulations. Especially useful is the Report Number Index which is also issued quarterly and cumulates regularly.

In addition to the subject indexing used in the published NSA index, material is also indexed using the Euratom Thesaurus. The bibliographical citation and both indexing records are processed in machine readable form.

One aspect of cooperative development should be mentioned in connection with NSA. The AEC announced two years ago that developed countries should undertake to cover the nuclear physics literature published within their geographic area. Bilateral agreements have been made with some countries such as Canada, Japan, Scandinavia and the United Kingdom who are preparing the published material produced in their countries for inclusion in NSA.

The AEC is represented on a working group formed in Vienna in December, 1966, by the International Atomic Energy Agency to explore the concept of an International Nuclear Information System (INIS). This system expects to provide a sophisticated, computer-based information processing system for rapid announcement and retrieval of nuclear physics information.

*Aerospace.* The major publication is *Scientific and Technical Aerospace Reports* (STAR) published by the National Aeronautics and Space Administration (NASA). Like NSA, this is a mission-oriented publication covering the report literature dealing with the science and technology of space and aeronautics. Several years ago a cooperative agreement was made with the American Institute of Aeronautics and Astronautics (AIAA). It was agreed that AIAA would restrict the coverage of *International Aerospace Abstracts* (IAA) to journal and other non-report literature. This arrangement provided complimentary non-duplicating publications in this field. In 1966 both STAR and IAA published 30,000 abstracts each.

Unlike all the secondary publications mentioned so far (with the exception of *Current Contents*), a "back up" service is available. The material in STAR can be obtained from the Clearinghouse for Federal Scientific and Technical Information (CFSTI). Material cited in IAA can be obtained from the AIAA.
Abstracting and Indexing Services in Physical Sciences

STAR and IAA input is also processed for machine retrieval. An additional indexing step provides for the assignment of deep indexing terms. The indexing record is matched by computer with interest profiles. Material is distributed on an SDI basis to approximately eight hundred participants. Established initially as an individual service, NASA has recently established a pilot project to study group dissemination of information with the initiation of SCAN (Selected Current Aerospace Notices). It is hoped eventually that the group SDI service will replace the individual SDI system.

Engineering. The main U.S. source of engineering information is Engineering Index. In 1966 approximately 59,000 items were indexed. A pilot program on two sections of Engineering Index has been in progress for several years. The sections under study are electrical engineering and plastics. A vocabulary using the Thesaurus of Engineering Terms published by the Engineers Joint Council (EJC) as a base has been developed, and material is deep indexed for a mechanized retrieval system. (Deep indexing is the assignment of additional indexing terms for greater specificity than is normally allowed in a printed index.) An experiment on SDI service using the tapes produced in the pilot program is being conducted by Engineering Index staff in conjunction with staff at Diamond Alkali.

Electrical and Electronics Abstracts (Section B of Science Abstracts) published monthly by the IEE, London, contained 21,322 abstracts in 1966. This publication is arranged under subject headings as is Physics Abstracts and the UDC classification number is printed with the abstract; the subject arrangement used in EEA was initially derived from the UDC schedules. IEE also publishes a companion current awareness journal, Current Papers in Electrotechnology. Appearing in newspaper format, it provides a rapid announcement of 90 percent of the material in the parent abstract journal and the same broad subject headings are used to arrange this material.

In June 1966 the IEE launched Section C of Science Abstracts, Control Abstracts. Published monthly, this covers all aspects of control and automation including cybernetics, the electrical, electronic, mechanical, pneumatic and hydraulic aspects of automatic control, computers and all applications. At the same time a companion awareness publication, Current Papers on Control, commenced; it is published monthly along the same pattern as the other two current awareness journals published by IEE. These publications, together with Physics Abstracts, are the IEE's INSPEC (Information Service for Physics, Electrotechnology and Control) publications. In addition the IEE is
running an experimental SDI test in the field of electronics. This test was started under the auspices of the National Electronics Research Council (NERC) and was transferred to the IEE in 1966.

**Metallurgy.** The major tool in this field is *Review of Metal Literature* published monthly by the American Society for Metals (ASM). 21,000 items were covered in 1966. The ASM was one of the first to be involved in an automated reference retrieval system. Working in conjunction with Western Reserve University, the Metals Documentation Service of ASM was developed in the late fifties and became operational in January, 1960. At this time a semantic code vocabulary developed. This was followed by the establishment of the Research Associates Program in which companies used the Metal Documentation Service and provided feedback to the ASM on the efficiency of the system. A cooperative program with IBM and Engineering Index was initiated to develop a monthly author and subject index which was first published in 1965.

The ASM’s central information retrieval service was discontinued in May, 1967, and negotiations for a decentralized retrieval system are in process at the time of writing (October, 1967). As one of the first organizations to develop a mechanized retrieval system, ASM has provided pioneer experience in the information retrieval field in the United States.

The other major service in this field is *Metallurgical Abstracts* published by the Institute of Metals, London. As noted above for *Electrical and Electronics Abstracts* this is a publication which uses the UDC scheme to arrange material. Input from this publication has been used by the American Institute of Physics in its study of the mechanization of the Universal Decimal Classification and evaluation of its performance as an indexing language.

**Mechanics.** The principal publication in this field is *Applied Mechanics Reviews*, published monthly and carrying 8,214 items in 1966. This publication reviews world literature in applied mechanics and related engineering sciences. In addition to the annual author and subject index, an experimental index known as WADEX (Word and Author InDEX) has been produced for AMR. Entries are printed under designators which may consist of authors’ names and words in the title.

**Petroleum.** The petroleum industry in the United States is served by the American Petroleum Institute's Central Abstracting and Indexing Service (CAIS), which publishes *Abstracts of Refining Literature*
Abstracting and Indexing Services in Physical Sciences

and Abstracts of Refining Patents. Approximately 13,000 items appear yearly in each of these publications. In addition to the alphabetical subject indexes, a “dual-dictionary” coordinate subject index is supplied for manual use and computer tapes are available for in-depth searching. API publications are priced on a sliding scale based on the assets of the subscribing company. Additional services available from API are microfilm sets of abstracts and of the “dual-dictionary,” and an author affiliations index for the Abstracts of Refining Literature.

A recent interesting development involves the use of CAIS facilities by the API’s Committee for Air and Water Pollution. Using the computer programs and the subject authority list developed by CAIS, and adding as many terms as are necessary to cover the air and water conservation field, a monthly bulletin is published—Subject Index to Current Literature on Air and Water Conservation. This index covers approximately two hundred documents per month. It is a good example of how a computer program designed for a larger information retrieval system can be used to produce an economical tool for a select group of people.

The publications listed above are some of the major services which specialize in a given area of the physical sciences. There are, of course, many general secondary publications which are useful to research workers in the physical sciences. These include Technical Abstract Bulletin (TAB) published by the Department of Defense, Fast Announcement Service from the Clearinghouse for Federal Scientific and Technical Information, and Government-Wide Index to Federal Research and Development Reports, published by the U.S. Department of Commerce. Other more general publications are Applied Science & Technology Index, published by the H. W. Wilson Company; British Technology Index, published by the (British) Library Association, and many others.

In addition to these, there are many specialized abstracting and indexing services covering a specialized subject field. These include such services as Laser Abstracts, Solid State Abstracts, Tobacco Abstracts, etc. It should also be remembered that many research workers use the abstracts section in the primary journals. An example of such a journal is Journal of the Acoustical Society of America. The best way to locate an appropriate service for a given field is to use the Guide to the World’s Abstracting and Indexing Services in Science and Technology prepared by the National Federation of Science Abstracting and Indexing Services in 1963.
Conclusion. In examining secondary services in the physical sciences it would seem that Colonel Aines’ suggestion that these services are changing in their philosophy is correct. The Institution of Electrical Engineers (IEE) with the establishment of INSPEC (Information Service in Physics, Electrotechnology and Control) is experimenting with the computer composition of the secondary publication. This process is operational at the American Psychological Association where Psychological Abstracts is produced by computer. The IEE’s program will link directly with the American Institute of Physics’ program to produce primary journals by computer composition. The development at the American Petroleum Institute where a broad-based indexing system has been used to produce a special publication for a small group of users is significant, as are the experiments with SDI being conducted by Engineering Index and the National Aeronautics and Space Administration.

Concentration is on the rapid dissemination of information by current awareness and SDI services. Computer tapes will soon be available from several organizations, following the lead of Chemical Abstracts. It seems that as the computer technology improves, dissemination in many different forms will become possible with rapid access to stored data. Developments at the Institution of Electrical Engineers and Engineering Index are significant in the area of the physical sciences. In other disciplines, notably chemistry and biology, the same trends are noticeable and will continue as the major professional societies proceed to develop integrated information systems to serve their own disciplines. The secondary publication will form an integral part of such information systems.

References


New Developments in Biological Abstracting And Indexing

LOUISE SCHULTZ

Current issues facing abstracting and indexing services serving scientists in biology, medicine, and agriculture bring into sharp focus the pressures which result from accelerating needs and from the impact of contemporary technology on document preparation and control. Nonetheless, the patterns of publication of scientific literature which we may describe today have been shaped during the past two hundred years. The eighteenth century saw the introduction of primary journals and the nineteenth century the introduction of secondary announcement media. In data graphed by Conrad, the ratio between primary journals and abstracting services has decreased steadily during the twentieth century. The demand appears to be rising for correlations and selected announcements of portions of a given body of primary sources, and this demand can be met only by an increasing variety of abstracting and indexing services. One of the factors behind the creation and growth of such services is the interdisciplinary nature of scientific research and technological development. There is a growing interdependence between those doing research in the life sciences and those working in the physical sciences and mathematics.

A Decade of Change. We are nearing the end of a decade in which the rates of increase in the literature, in the population of scientists and technicians, and in the academic population in general have forced not only those who must cope with the literature but also those who are responsible for the investment in research itself, to recognize the role played by the literature and its handlers in the scientific advancement of the nation and the improvement of man's environment.

Accurate counts are not available of the numbers of primary journal

articles and, therefore, of the unique potential sources for the creation of abstracts or indexed representations for subsequent secondary announcement. As an indication of the changing picture, in 1957 something over 50,000 articles were represented in Biological Abstracts, whereas in 1967 something over 200,000 items will be represented there. Accumulatively, from an annual rate of 45,000 items, the ten-year period has brought under bibliographic control more than 1,000,000 documents concerning the life sciences.

During this period the attention of the executive and legislative branches of the Federal government has focused on problems of the exchange of scientific information. This attention has resulted in several comprehensive studies that have provided (1) an awareness of the weaknesses of available services, and (2) recommendations for corrections that do not ignore the delicate but pragmatic balances between information-seeking and use-behavior and cost effectiveness of investments in elaborate systems. (A comprehensive survey of the entire literature is provided in National Document-Handling Systems for Science and Technology.) Stemming from the recommendations of the Weinberg report that the scientist's role in the distribution of scientific literature must be expanded, the past two or three years have seen the creation of several non-governmental organizations whose goals include strengthening the interface between scientists and the appropriate elements of the Federal government.

In the biological sciences, the organization of the Council of Biology Editors represents an effort by the private sector to coordinate certain common aspects of the primary journals. Together with the medium for exchanging information about the problems and techniques of primary journal publication, the Council of Biology Editors has also created the opportunity for closer liaison between primary and secondary services dealing in the biological literature. Journals whose editors belong to the CBE show a discernible trend toward increased publication of abstracts in conjunction with full articles, for the use of abstracting services.

In a sense paralleling the activities of the Committee on Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology, a committee on scientific and technical communication (SATCOM) has been established within the framework of the National Academy of Sciences-National Academy of Engineering. The committee is chartered to compare the activities of the private sector with those of the Federal government in the distribution of
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scientific information. Methods for promoting more effective relationships between information systems are to be studied. Although their charter is broadly applicable to all science, one of SATCOM's initial efforts was directed toward the major services in biology: the National Library of Medicine's MEDLARS system and the techniques and products of BioSciences Information Service (BIOSIS).³

Under the sponsorship of the Office of Science Information Service of the National Science Foundation, BIOSIS organized a conference held in late 1965 to "arrive at a clearer definition of the total information requirement of biologists; and . . . to stimulate a more enlightened and continuing interest by participants in both the problems and the potential of a unified communications system."⁹ Approximately a year later, the Council of Biological Sciences Information (COBSI) was organized under the aegis of the National Academy of Sciences; it comprises representatives of the American Association for the Advancement of Science, the American Institute of Biological Sciences, the Council of Biology Editors, and the Federation of American Societies for Experimental Biology.¹⁰ Other organizations active in the dissemination of biological information are being considered as possible additions to the Council.

Parameters of Abstracting and Indexing. In the generalized system structure comprising input, processes, and outputs, abstracting and indexing may be considered to constitute (1) coverage and acquisition, (2) editing and indexing, and (3) publishing and distributing.

In discussing new developments in the abstracting and indexing services serving biologists, we recognize that current technology is most effective in support of the mechanical aspects of production. Thus, in terms of selecting items to be included in the service (coverage) and in negotiating for the acquisition of such items, contemporary data processing technology is, at present, only really useful for areas such as record keeping.

For those systems in which the full text of abstracts is entered into a data processing system, certain of the mechanical aspects of editing can be assisted by automatic data processing; techniques exist providing for automatic imposition of certain mechanical editing rules. The large services in the biological sciences have not yet widely implemented these techniques; however, the American Psychological Association is introducing them into the production of its abstracting journal.¹¹
Data processing support in publishing and distributing is also exemplified by the system being developed at the American Psychological Association, in which a photocomposition system is driven by a magnetic tape record prepared from perforated tape records of abstracts and citations. The use of computer-produced records to drive both linecasting and photocomposition equipment in the preparation of scientific literature was discussed comprehensively in the symposium on electronic composition in printing conducted by the Center for Computer Sciences and Technology of the National Bureau of Standards on June 15 and 16, 1967 at Gaithersburg, Maryland. While the capabilities of the equipment and its particular applications are not relevant here, it is worth noting that the conference was attended by more than five hundred people involved in some way with the preparation of scientific literature who recognize the potential and the need for application for such advanced techniques.

Impact of Technology. The demands of a data processing system for explicit, rigidly formatted information are the core of the increased interest in standards for the description of documents, machine records of which are to be prepared for some application of data processing support in the preparation or distribution of scientific literature. Whether the product is available publicly or whether it is prepared for use entirely within an organization such as a large pharmaceutical company makes no difference; the systems of the various abstracting and indexing organizations have been developed independently and without uniformity. As a result, the diverse practices and policies of the organization which does the data processing are one source of variation in the descriptions of documents being "reannounced." Although "equivalent" or only trivially different to the human user, these efforts do not facilitate interchangeability of machine records.

The committee of the U.S.A. Standards Institute (USASI) on library work, documentation, and related publishing practices has a subcommittee whose aim is to develop a matrix "to express the bibliographic data, elements, media, and use observed . . . in mechanized library systems, new codes for descriptive cataloging, bibliographic style manuals, abstracting and indexing services, [and] filing rules." In addition to a common basis for minimum criteria in describing a document, the USASI is also interested in providing standards for abbreviation of those elements of the document description that are widely used, e.g., periodical title abbreviations.
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Through the medium of the National Federation of Science Abstracting and Indexing Services, relations between the principal nonprofit secondary announcers of scientific literature have become closer. However, despite participation in forums concerning standardization of document descriptions, and creation of exchange agreements providing for use by one of the texts of abstracts published by another, the differences in indexing techniques and vocabularies remain and are the reason for the relatively insignificant actual exchange that takes place.

Where one or more of these services is supported by data processing systems, any opportunity for exchange of the machine record depends critically upon the joint design of the standards for the machine record. One of the few examples of the exchange of a machine-readable record has been that of the Fisheries Branch of the Food and Agriculture Organization in Rome, Italy, and the Aquatic Sciences Information Retrieval Center at the University of Rhode Island. Manuscript for the Current Bibliography for Aquatic Sciences and Fisheries was prepared on tape-perforating equipment in a format facilitating data processing manipulation of the entries.

Among the techniques used in indexing the biological literature, Baxendale lists prescriptive indexing in which the indexer uses "an explicit glossary of labels and maps the statements of the document onto the prescribed descriptive labels," a variation of which is the "concept list"; "data type" glossaries, such as that of the Engineers Joint Council, in which types of terms are designated; and "keyword," based on selection of words from designated portions of the document description such as the title. The application of data processing support to the announcement of biological literature has contributed to the emergence of keyword (in or out of context) indexes generated mechanically from strings of words such as titles and/or additional natural language elements. Baxendale sums up their development thus:

One factor leading to their [keyword indexes] development is the belated adjustment of conventional indexing and classification tools to changing patterns of need, to changing terminology, and to new technology. ... The second factor is the relative simplicity and practicality of computer manipulation of each of these forms of indexing ... Although, in their present rather primitive form, these indexing methods have their inherent qualitative limitations, they are often an acceptable compromise with practical exigencies.
Terminology control for creation of an index may be considered to be implicit in the semantics of the phrase and is demonstrated by the syntax of an entry in a conventional index and mechanically by the syntax in a title, where the index is generated from words in the title. Control is most commonly exercised in the de facto creation of a thesaurus or glossary prescribing acceptable index tags or terms and indicating the relationships between such terms where these have been considered in the creation of the vocabulary.

Among the biological literature handling systems, the one which demonstrates the problems and techniques of creation and use of a controlled vocabulary specified by thesaurus is the MEDLARS system, in which the vocabulary is that of the Medical Subject Headings (MeSH) list. The MeSH thesaurus was developed to provide for publishing Index Medicus and is “a dynamic thesaurus which attempts to respond to new needs of usage, research, and publication. New headings are added annually; unused headings are deleted, provisional headings are maintained for use by indexers and searchers. . . . Analysts use MeSH terms of maximum specificity. Intermediary or general terms (e.g., LIVER DISEASES or ENZYMES) are assigned only when there are no MeSH headings for the specific concept discussed . . . [and] an average of eight headings are assigned to each article.”

The importance of terminology control, and its connection with technology, is acknowledged in other fields. For agriculture, for example, Task Force ABLE reported: “When plans were made for issuing the preliminary edition of the subject heading list, arrangements were made for punching paper tape to be used later . . . [in the] hope that possible automation of the Bibliography of Agriculture subject index will make available a comparable tape for use in compiling a unified thesaurus.” The commitment to controlled vocabulary is also illustrated by the following:

The vocabulary method selected by the chief of the Pesticide Information Center and its staff is very important since the vocabulary structure and content are critical features of the whole . . . system. Nothing can be retrieved from either the journal or the mechanized system if it is not accurately and consistently indexed.

The entries in an index created by a machine or by machine-like selection from the string of words constituting titles or other given portions of text representing a full source document may be considered uncontrolled in terms of the system handling the entries. (In terms of the creator or user of the title, both the use of individual words and
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combinations of nominatives in appropriate syntactical relationships cannot be truly uncontrolled if communication is to be effected by the transfer of such strings of words.) In a very large system, the difficulties of an uncontrolled indexing vocabulary center around (1) the size of the vocabulary, (2) the inconsistency of authors in respect to the specificity or generality with which they have “described” the contents of the source document by means of its title, (3) the variations in usage of individual word tags, and (4) the dynamic aspects of synonomy in a system with a large basic vocabulary.

BioSciences Information Service compromises between these difficulties and the inflexibilities (and equally inconsistent application) of a controlled indexing vocabulary through a combination of indexing techniques. The range of “control” of the input vocabulary extends from “none” (represented by authors’ titles, in the Biological Abstracts Subjects in Context [B.A.S.I.C.], a permuted context index), through “nominal” (represented by guidelines for augmenting the contents of the latter index), to “dynamic-but-tight” (the concept classification tags represented by the names of the sections in which Biological Abstracts is organized), and finally to the essentially “prescribed” hierarchy of organisms, the names of which represent entries in the taxonomic index (Biosystematic).

The activities of secondary announcers and distributors of scientific literature formerly were limited to the publication of an announcement journal. Proliferation of the specialized information centers serving the needs of a small, usually well-defined, user group and capable of offering services other than conventional cumulative republication, has contributed to a re-evaluation by the large secondary services of both the potential and the problems of expanding services beyond publication. In Figure 1, the relationships among some of the principal tasks in a comprehensive, data processing-based secondary service are modelled.

Technology is modifying the techniques for creating the textual “image” to be published by offering a choice between (1) the storage of the record as character strings in machine manipulable form, and (2) storage of the image (either as copies of the printed citation and/or abstract, or else in microform). The motivation in storing the machine manipulable record may be to search it directly and in full or merely to reproduce the contents of the item selectively in preparing derivative publications, individually tailored bibliographies, or demand and current awareness retrieval services.

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Except in the case in which the mission of the retrieval system can justify the expense of on-line cathode ray tube displays of the contents of the machine record, reproduction for human use of the contents of the announcement involves operation of a line printer, nominally at six hundred lines per minute. Where the item to be reproduced consists, on the average, of two hundred words, the cost of reproduction from an image file rather than from machine-readable files becomes more attractive in terms of cost of storage and reproduction. An image storage system offers reproduction of a page bearing some four thousand characters (including special characters, line drawings and half tone illustrations not reproducible on a computer line printer) in twenty to thirty seconds.
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Where the full record rather than an index or other referent is to be searched for retrieval, storage capacity and processing time constitute the principal limitations to machine-form storage of full records. That is, if the machine record is in a serial storage medium such as magnetic tape, processing time is proportionate to the size of the file. However, where the storage medium is random access or quasi-random access, processing time decreases but the cost of storage and storage maintenance rises.

Products of exploitation of the machine record fall into several categories: publications derived from the total machine record according to specifications of an identified user group; retrieval and delivery of reproductions of images of announcement records in response to individual search specifications; and analytic reports on the basis of which trends in biological research can be predicted so that literature handlers can acquire and make available the information which will be most useful to future biological research. The chief aim is to serve the individual biologist from a vastly expanding literature, at a time when needs for information are changing dynamically as new fields in the life sciences are recognized and become the focus of research. Services being offered by large secondary literature handlers in biology who are using data processing in the preparation of indexes and abstracts for publication are exemplified by the techniques for exploiting the machine record at BioSciences Information Service.

On the basis of machine selection of abstracts tagged with the taxonomic categorization of fungus and lichen, BioSciences Information Service has initiated an experimental publication called Abstracts of Mycology, being made available as a separate and produced as a derivative publication of the basic abstracting journal, Biological Abstracts.

In a separate experiment, BIOSIS is examining the possibility of a closer liaison with, in this case, the ichthyologists in assembling a rich machine index to the literature of interest to a particular group. While Biological Abstracts will continue to announce, as rapidly as material becomes available through routine channels, papers in ichthyology, the machine record created in conjunction with publishing an abstract or citation of such an article will be augmented by terms provided by the ichthyologists. The resulting enriched machine record will be available for individual search services to ichthyologists or others and will be the basis for assembling at some regular interval, perhaps yearly, a bibliography for the field to be distributed under the auspices of
the American Museum of Natural History in New York, the joint participant in this experiment with BIOSIS.

Assuming this latter experiment develops to the degree anticipated by BIOSIS and the AMNH, it represents a paradigm for a series of relationships between the secondary announcement service organization and individual subject specialist groups. We may consider this the contemporary expression of the commitment by the subject specialists, for their mutual benefit, to analysis of the contents of their own literature, in an environment in which control of the record of that literature has become a specialty to which is applied modern technology of publishing and machine manipulation of text.

A third area of exploitation of a machine record of biological literature is typified by individual retrieval services resulting in delivery to an individual requester of a subset of the material published, which is judged to meet his expressed needs. In early summer 1965, BioSciences Information Service entered into an experimental program with the Walter Reed Army Institute of Research (WRAIR) to determine the feasibility of performing searches of the material published in Biological Abstracts, on the basis of the indexes which had been prepared in machine readable form as an adjunct of publication. These are B.A.S.I.C. (a keyword in context index), CROSS (a coordinate posted index in which the vocabulary consists of the names of the sections in which Biological Abstracts is organized), and the taxonomic categories of organisms discussed in papers announced in BA.

Progress in the experiment as it developed into an operational service has been described elsewhere. In general, the experiment with WRAIR involves Electrowriter terminals for communication of requests to BIOSIS. The Electrowriter is an electro-mechanical device that generates an electronic "signal" by the mechanical motion of a pen writing a message on the transmitting terminal. The signals are transmitted by phone line to drive a pen at the receiving terminal to replicate the message. Figure 2 illustrates the system relationships.

At BIOSIS, a biologist analyzes the message received within the framework of (1) the structure of the indexes to Biological Abstracts, Bioresearch Index, and Bioresearch Titles; (2) a reference library accessible to him; and (3) the staff of biologists at BIOSIS who represent the specialties of the life sciences. In analyzing the incoming message from WRAIR, the biologist, whom we call a strategist, determines what combination of manual and computer searches is most appropriate to identifying the subset of the entire machine-supported
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file (more than $\frac{3}{4}$ million items by late 1967) that may be appropriate to the message. The available file represents items announced since September 1959. The machine file will ultimately include index records for items announced in Biological Abstracts, Abstracts of Bacteriology, and Botanical Abstracts since 1917—a total of nearly two million items.

The incoming message, referred to as the search specification, is expanded into a strategy comprising the set of computer file searches and manual searches based on the vocabulary determined by the strategist. The list of keyword access points, and the names of the files involved in performing a given search is referred to as the strategy. A listing of the strategy is made available to the requester along with delivery of a set of copies of the abstracts and/or citations identifi-
fied as responsive to his inquiry message. Corresponding to the machine file of indexes, a 16 mm. microfilm file has been prepared. Abstracts identified as appropriate are reproduced on a microfilm reader printer and packages of abstracts are post-edited by a qualified biologist, in most cases the search strategist, prior to shipment of the package to the requester.

In addition to service to three Electrowriters of the Army Medical Research and Development Command (one at the Walter Reed Army Institute of Research, one at the Letterman Hospital in San Francisco, and one at STINFO [Scientific and Technical Information] headquarters in the District of Columbia), the system is regularly servicing the Division of Biologics Standards of the National Institutes of Health. Individual searches are processed for other requesters at the prices quoted by BIOSIS after preliminary analyses of the search specifications. At BioSciences Information Service, the search service has been developing from a minimally automatic to an increasingly computer-based system. Considered essential to the system are the procedures and criteria for post-editing the results of machine or mixed manual-machine identification of abstracts.

Partly in support of the search services to a particular user group, BIOSIS has begun the machining of full abstract text (not of Biological Abstracts however) in order to study the structure and problems of automatically indexing and searching such full records. As soon as economically feasible, BIOSIS expects to create the entire contents of all its publications on devices that produce a machine-manipulable record simultaneously as a by-product of the production of the publication. With this machine record, and the experience gained before that time on the basis of the experiment with full abstract text machining, BIOSIS will implement plans for additional automatic data processing support to the generation of indexes. Further, in conjunction with the machining of full records, BIOSIS will develop a guide to the vocabulary of the biological literature, both to help the individual using the published indexes and as the basis for the machine index to the total machine file.

BIOSIS plans to study the feasibility of automatic assignments of the tags constituting the CROSS vocabulary, based on the occurrence of words in and added to the titles. The preliminary study of this problem is to be made in conjunction with a research program developed mutually by BIOSIS and an industrial chemical manufacturer to which duplicates of the tapes of the B.A.S.I.C. and CROSS indexes to BA
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are supplied. Already experienced in providing their chemist population with selective listings of the literature of chemistry (from Chemical Titles), this organization is interested in examining the combination indexes that include both the keywords and the concept categorization of CROSS, for services to their biologists.

Among the technological developments expected to have an impact upon the handlers of scientific literature are the opportunities for long distance communication, particularly between data processing systems. On the assumption that such communication is technologically and economically feasible within the foreseeable future, the Interuniversity Communications Council has established the effort known as EDU-COM. Successful realization of a network between universities, for the exchange of both administrative and scientific information in digital form, suggests a potentially wider outlet for the products of a scientific literature handling organization, as well as additional direct contacts with potential users of that literature.

The establishment of regional search centers for the use of the MEDLARS computer based data file can be considered a network. Although communication from the individual requesting information is limited to his access to a regional search center, the fact that each of the search centers duplicates the information created at a central point (the National Library of Medicine) may be considered to constitute a network-like connection between the centers. Decentralization of the search service results in development of individual search programs at each individual center, to exploit the data processing equipment available there. Regional MEDLARS centers have been established at the University of California Medical Center, Los Angeles, the University of Colorado Medical Center, Denver, the University of Alabama Medical Center, Birmingham, and international center in Brussels. Copies of the machine record are also available in France and in Stockholm for local processing by the national information services of those countries.

With the generation of a multitude of computer-processed records of the literature of biology, concern is rising about the techniques that may be required to enable users fully to exploit such records locally. The Institute for Library Research (ILR) at the University of California has faced the problem of the role of the university library system in coping with new media being produced by secondary handlers of literature. As part of the program to clarify both the policies of the university system and the research necessary, ILR conducted a symposium in May, 1967, to consider the following questions:

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1. Does the individual university researcher need information services from the newer media such as data processing system records?

2. Does the individual campus of a large university system need to set up local service on such media, or should the campus participate in intrauniversity or interuniversity networks, or should such services be acquired from their sources in more conventional forms?

3. Is the university library an appropriate center for the management of such services?

4. If the library is an appropriate center, does it have the capability for managing such services, or what additional requirements are demanded to achieve such a capability?

5. How does the university library, as the local manager of such services, handle the problems of incompatibility between media from a variety of sources?

While it is not appropriate for a provider of these media to speculate on the conclusions to be drawn by the ILR, the library community should be aware that these questions are being examined. A report summarizing the comments of a group of users and creators of biological information and of biological information services is scheduled to be prepared as a result of that meeting.

Conclusions. A number of factors are influencing biological abstracting and indexing activities, and also the plans for new services and products. Among them are:

1. the increase in world population and, therefore, in the population of the world's biologists;
2. the attendant increase in the world's biological literature;
3. the increased competition among nations for improvement of human environment, together with exploration of new environments;
4. the focus of the Federal government of the United States on the importance of scientific literature for future advances, and resultant Federal policies;
5. increasing awareness among users that they should take the responsibility for adding their own contributions to a system, in forms suitable for transmission to their contemporary and future peers.
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6. the realization that information, as much as "hardware," is a support tool to be planned for, paid for, and exploited; and
7. the introduction of new equipment and techniques for handling literature, and the investment by both the Federal and private sectors in the introduction of such techniques and equipment into the processing of scientific literature.

The long-range plans implicit in the above factors represent, in themselves, a departure from the former assumption of responsibility only for compiling and publishing information about the scientific literature. With unprecedented enthusiasm and imagination, abstracting and indexing services have seized on the capabilities of automatic data processing and pressed them into the service of speedily making known work in the life sciences. Relieved of mechanical bottlenecks to document management, they are improving the ease and consistency with which the individual can select from the most comprehensive biological data base those items of particular interest in his professional work.

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Libraries and Abstracting and Indexing Services - A Study In Interdependency

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There was a time, during the first half of the nineteenth century, when the major abstracting and indexing efforts in the United States were carried out by librarians. It was the individual librarian who described the contents of his own library, for during this period few specialized content-analysis services were needed. However, by the middle of the nineteenth century, the charge of performing the abstracting and indexing function began to shift from the librarian to special-subject interest groups. Shera cites two reasons for this. First, "libraries had developed as local, autonomous agencies, built upon the premise that each community could own all the books that its citizens needed, and that the organizational machinery within each such library would be sufficient to insure access to the contents of the local library" (this was becoming less true as the nineteenth century progressed), while "the second major reason for the breakdown of the libraries' machinery for providing content access [lay] in the rapid development of the journal as an important form of publication." ¹ The bibliographic control which libraries applied to books did not, and still does not, lend itself to the serial and report literature.

To comprehend the import of Shera's second reason, one need only look at present-day statistics. Gottschalk and Desmond ² reported in 1963 that there were 35,000, plus or minus 10 percent, scientific and technical serials being published. Urquhart, at the National Lending Library (NLL), has recently written that the NLL currently receives some 21,000 scientific and technical serials. He estimates that "the total number of current serials at present being published in the world is about 26,000." ³

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Regardless of the absolute number of scientific and technical journals published today, it is an acknowledged fact that the number is too great for each library to acquire and index the total scientific literature. The latter has become the function of the secondary publication profession—the abstracting and indexing (A&I) services. Although the relationship between the library and the A&I service varies from situation to situation, the association is actually much closer than either most librarians or A&I service producers realize. When the basic purpose of the library—to provide users with information or documents—is viewed alongside the basic purpose of the A&I service—to make users aware of the available literature—it becomes apparent that abstracting and indexing are merely extensions of the over-all library function.

Rarely do data contained in secondary publications serve as substitutes for the originals. Abstracts, index entries, title listings, and other forms of document representations are merely highly organized and detailed guides to lead the user back to the originals that the libraries are expected to furnish. In addition to acting as guides, document representations also provide the user with a means of appraising the value of the available literature, its relevance to his area of interest, and his need for the original. Shipman has stated (and others have substantiated his findings) that over 93 percent of all new chemical information is contained in serials. It is the A&I service that provides the library and its users with content analysis of the serial, technical report, dissertation, and patent literature.

A&I services perform an exceedingly important library function, and they, in return, receive considerable support from the libraries they serve. Through their subscriptions, libraries provide a substantial portion of the A&I services’ operating revenues. As subscribers, the libraries also serve as bibliographic retailers of the information contained in the printed A&I publications.

In addition, not all libraries have abandoned their A&I programs. Several continue to function as abstracting and indexing services in addition to their traditional library work. All three of the national libraries, for example, are deeply involved in the production of indexes or abstracts designed to disseminate content-analysis information of a significant portion of the literature they acquire. The National Library of Medicine (NLM), the world’s largest biomedical library, devotes substantial portions of its resources to its Medical Literature Analysis and Retrieval System (MEDLARS). MEDLARS, a computer-based
information system, is designed to cope with the tremendous growth of biomedical literature and the corresponding information requirements of health scientists, practitioners, and educators. One product of MEDLARS is Index Medicus, a comprehensive monthly, subject/author index to articles from approximately 2,400 of the world's biomedical journals. MEDLARS also produces recurring bibliographies or periodical lists of citations in specialized medical-subject areas. These are compiled at regular intervals from data in the MEDLARS store and are printed for distribution to organizations working in the specialty fields. The MEDLARS data base can also be rapidly searched to provide answers to complex reference questions which cannot be effectively handled by the existing printed indexes and catalogs.

The National Agricultural Library (NAL) is also one of the major A&I services in this country. Its Bibliography of Agriculture, issued monthly since 1942, provides indexes by subject and author to all important books and articles acquired by the library in agriculture and related sciences. Over 110,000 items are indexed annually and widely disseminated to agricultural workers in every part of the world. NAL also publishes the Pesticides Documentation Bulletin. This bi-weekly index to the multi-disciplinary pest-control literature is disseminated not only to personnel in the Department of Agriculture, but also to other Federal, state, private, and industrial organizations. It is a computer-produced permuted title index issued in three parts: a keyword index, a bibliography, and an author index.

The Library of Congress, in addition to issuing catalog cards that can be considered "skeleton" abstracts (bibliographic data plus subject headings), issues the Monthly Index of Russian Accessions and Arms Control and Disarmament, to name but two of this library's secondary publications.

In addition to these national libraries, many others, including those of an academic, governmental, public, and industrial nature, disseminate information on the the contents of various segments of their collections. For example, the Research Information Service of the John Crerar Library in Chicago prepares and publishes Leukemia Abstracts, a monthly publication that since 1953 has been distributed gratis to organizations and individuals actively engaged in leukemia research.

A unique way in which libraries support abstracting and indexing efforts is the very generous contribution made by major libraries in the United States and abroad to the List of Periodicals Abstracted by Chemical Abstracts. Every five years since 1922, these libraries have
provided the "Key to Library Files" data for these lists. Presently, some four hundred of the world's major resource libraries are together contributing over one million dollars in effort to the Chemical Abstracts Service's (CAS) *Comprehensive List of Periodicals for Chemistry and Chemical Engineering* by furnishing information on their holdings of scientific and technical journals, conference and symposia-type publications, and patent specification collections.

As has been stated before, the basic functions of an A&I service are two: to provide organized access to the available literature and to provide a means to appraise this literature. However, over the years, an ancillary function has developed—that of aiding libraries gain access to original documents. In most libraries, a serious gap exists between a document reference and the document itself. For example, in 1961, CAS conducted a survey to obtain source guide information for the 1961 *List of Periodicals With Key to Library Files*. Data accumulated during this survey indicated that of 334 U.S. and foreign libraries serving chemistry, only eleven U.S. and two foreign libraries maintained subscriptions to over 30 percent of the over 9,000 serials that were then being abstracted by *Chemical Abstracts*. Of the eleven U.S. libraries, only three subscribed to over 50 percent of the serials, the largest subscribing to only 5,256. Of the institutions polled in the survey, 65.5 percent of the U.S. and 71.1 percent of the foreign libraries subscribed to fewer than 1,000 of the serials that contained substantive chemical articles. Kruzas substantiates these results, for in his statistical analysis of the libraries listed in *Special Libraries and Information Centers*, he notes that 76 percent of the libraries reporting maintained fewer than 300 serial subscriptions.\(^{11}\)

The comparatively small number of periodicals held by any one library is the cause of one of the most frequently heard complaints from the users of A&I services. Both scientists and the librarians serving them complain that cited originals are either unobtainable from local resources or that the time required to obtain them is excessive. In order to circumvent this dilemma, libraries rely heavily upon interlibrary lending to acquire original documents or facsimiles thereof from other libraries, or in some cases, from the A&I services themselves.

Different A&I services approach the document-access problem in different ways. Some have arranged with major source libraries to provide users with copies of originals. For example, the John Crerar Library in Chicago furnishes photocopies of abstracted articles to the users of *Biological Abstracts*, while the Linda Hall Library in Kansas
City, Missouri, performs a similar service for the users of Applied Mechanics Reviews. Other A&I services perform this function themselves. The American Institute of Aeronautics and Astronautics (AIAA) publishes International Aerospace Abstracts, an A&I journal, under contract to NASA. AIAA members and U.S. and Canadian NASA centers may borrow publications from the Technical Information Service of the AIAA without charge. Libraries of government agencies and of academic and non-profit institutions of both countries may borrow abstracted documents for a period of two weeks by paying the return postage and insurance. Microfiche and/or photocopies are supplied for a fee to all others who request them.

Complementing International Aerospace Abstracts is NASA's Scientific and Technical Aerospace Reports (STAR), a comprehensive A&I journal for the report literature on space and aeronautics science and technology. Van A. Wente described this program in this manner:

Accessibility is the final key to the information system designed for NASA. The acquisition of documents from all parts of the globe as well as from U.S. sources large and small, often yields documents in single copies that would be difficult if not impossible for many users to obtain by normal means. Before such material is announced, the central facility prepares and distributes microform copies. . . . To achieve maximum decentralization, the microfiche permits carrying this accessibility even farther than the 100 or so locations initially receiving it. Because it is a high quality transparency in a unitized form, microfiche may serve as a reproducible master at each location.12

In keeping with this philosophy, NASA automatically makes available copies of the reports it abstracts in STAR to its offices, centers, contractors, grantees, consultants, other U.S. Government agencies and their contractors, and U.S. libraries that maintain a collection of NASA documents for public reference. A similar approach is used by Derwent Publications of London, England, the publisher of Plasdoc, a plastics-patent documentation and retrieval system. Among several options available to the subscribers of Plasdoc is one that automatically provides copies of abstracted or indexed specifications, in addition to detailed abstracts and punched cards for manual and machine retrieval of information.

The American Society for Metals makes available to users of the Review of Metal Literature copies of abstracted articles. The exceptions to this service are government-issued and classified reports, com-
commercial translators' work, articles from copyright-restricted journals, and those articles originally abstracted in the Referativnyi Zhurnal, Metallurgia. The Chemical Abstracts Service, on the other hand, will supply photocopies of the Soviet literature abstracted in Chemical Abstracts. The CAS service is limited to Soviet literature because it is not copyrighted. At this time, CAS has no similar service for copyrighted literature.

The Institute for Scientific Information in Philadelphia and the Engineering Society in New York also provide copies of abstracted articles. The former furnishes articles torn from the source periodical, while the latter supplies photoprint or microfilm copies of articles abstracted in its Engineering Index.

Abstracts of U.S. patents published in the weekly Official Gazette of the U.S. Patent Office are backed up with microfilm copies of the full patent specifications and drawings. These are available by subscription from the Clearinghouse for Federal Scientific and Technical Information (CFSTI). Full-size copies of individual patents are available directly from the U.S. Patent Office.

The National Library of Medicine functions as a library's library. Over 80 percent of the requests filled by NLM are for copies of articles that had been indexed in Index Medicus. These are supplied as photocopies, although occasionally the originals are loaned. The National Agricultural Library will similarly provide copies of any article indexed in its Bibliography of Agriculture and the Pesticide Documentation Bulletin.

Several A&I services maintain regional depositories of the documents they cover and provide copies of these documents to users on demand. Many of the world's patent offices deposit copies of granted patents in both domestic and foreign libraries. The patents announced in the patent offices' gazettes or journals are available not only to those who visit the depository libraries, but also from other libraries in the form of loans or reproductions from the depositories. The U.S. Atomic Energy Commission backs up Nuclear Science Abstracts with a similar service.

Dissertation Abstracts, the publication of University Microfilms, is an A&I service for doctoral dissertations from some three hundred U.S. colleges and universities. Copies of the dissertations are deposited with University Microfilms who then make available both microfilm and Xerox copies.

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sells copies of reports announced in U.S. Government Research and Development Reports and the Government-wide Index to Federal Research and Development Reports. The latter is an index to the unclassified reports announced in Nuclear Science Abstracts, Scientific and Technical Aerospace Reports, Technical Abstract Bulletin, and in their own U.S. Government Research and Development Reports. Reports can be ordered directly from CFSTI by accession number and title. The Defense Documentation Center provides Department of Defense contractors and other qualified users with copies of the report literature abstracted in their Technical Abstract Bulletin.

One unique way in which an A&I service assists libraries is demonstrated by the H. W. Wilson Company's policy of having the librarians select the lists of periodicals to be covered by the various Wilson indexing services. Applied Science & Technology Index, for example, is a subject index to approximately 158 periodicals chosen by the subscribers to the Index. In this manner, the subscribers determine coverage and adjust their serial-acquisition policies in order to maintain the indexed originals. This interplay between the user librarian and the A&I service benefits both parties. The service does not have to arbitrarily establish a list of monitored journals, and the libraries obtain coverage for the serials that they believe the most useful. The drawback to this method is that any A&I service that limits its coverage to a fixed number of periodicals does so at the expense of comprehensive coverage.

Nearly all of the A&I services, however, could benefit by more user participation in the selection of material to be abstracted and indexed. There are, undoubtedly, many serials in the "underlap" area (those not covered) that would warrant coverage by one or more of the A&I services. These would be added if the services were aware of both the existence of the serial and of the desire of librarians to have it covered. Several other A&I services have taken an approach similar to the H. W. Wilson Company. Recently, the National Library of Medicine established an advisory panel to direct the selection of biomedical serials to be covered by MEDLARS. Both the abstractors and section editors for Chemical Abstracts suggest journals for coverage. The National Agricultural Library solicits advice from users throughout the country to guide in up-dating and improving the Bibliography of Agriculture. The intercourse between user and publisher tends to satisfy the objectives of both.

The preceding remarks should not be interpreted as meaning that
only the A&I services have directed themselves to the problem of document acquisition. The library community has long recognized that in the information transfer cycle, its most important contribution is to provide the cited documents, both current and historical, to users of A&I services. To fulfill this duty, local libraries obtain documents they do not hold via interlibrary loan borrowing and photocopy procurement. Were it not for the fact that through his local library the user of the A&I service can gain access to the full range of primary source publications cited by the A&I services, the entire structure of the information transfer process, from author to reader, would be greatly endangered, if not totally ineffective. As only a single example of interlibrary cooperation: in 1956, with National Science Foundation assistance, the Midwest Interlibrary Center (now the Research Center for Libraries) and its member libraries began a program to acquire among them every serial abstracted in Chemical Abstracts and Biological Abstracts. Emanating from this project was a list entitled Rarely Held Scientific Serials in the Center for Research Libraries (1963). This list, which has been updated several times, has been widely distributed so that the availability of these hard-to-obtain serials is generally known.

The user’s link between the secondary services and the library’s resources is the bibliographic citation, a reference intended uniquely and unambiguously to identify a specific document. Most A&I services cite publications by abbreviated titles to save space. However, different A&I services use different abbreviations and often entirely different forms of the title. The linkage is weakened further by the fact that most libraries maintain their serial files according to corporate entry. Thus, the abbreviated title used in abstract journals or indexes must often be translated into the full title and then retranslated to a corporate entry before the user is even able to determine if his library has the document he desires.

A&I service editors are frequently asked by librarians to adopt the American Library Association cataloging rules, or more recently, the Anglo-American cataloging rules. These are said to be “standard.” However, most major resource libraries modify the ALA cataloging rules to fit their own cataloging situations. In some instances, they are even tailored to fit the cataloging practices of individual divisions and departments within the same library. Because of the various cataloging rules followed, Library of Congress printed records will often show as many as three entry forms for the same publication,
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depending upon the catalog or list being searched. For example, a
given Russian title may be cited in the Monthly Index of Russian
Accessions one way, in New Serial Titles another way, and in the
printed LC catalog a third way.

The difference between one library's cataloging practices and those
of another is not basically the result of inconsistency. Cataloging is
done by analogy with the rules and examples found in the various
editions of the cataloging codes. As a result, a body of ad hoc decisions
develops in each library. If the A&I service tried to follow the ALA
or Anglo-American cataloging rules, whose adaptation would they
follow? This lack of compatibility between these two major systems
is time-consuming and therefore costly. It may even obstruct access
to the document. When document procurement involves an interli-
brary loan request, the faulty linkage between the citation and the
document becomes even more of a deterrent to efficient and effective
retrieval. The link further weakens when the preciseness required by
computer systems is considered.

Efforts are being made to assist the A&I services and libraries in
their attempt to standardize bibliographic citations. The 1963 American
Standard for Periodical Title Abbreviations\textsuperscript{17} culminated nearly two
decades of effort on the part of librarians and A&I service producers
to develop a common language for periodical title abbreviations. By
1968, most major A&I services in the United States as well as primary
journals will be using this Standard. The subsequent establishment of
the National Clearinghouse for Periodical Title Word Abbreviations
(NCPTWA) by the United States of America Standards Institute's
(USASI, formerly American Standards Association) Sectional Com-
mittee Z39 on Library Work, Documentation, and Related Publishing
Practices has furthered standardization in this area. In December
1966, the NCPTWA issued a "Revised and Enlarged Word-Abbrevia-
tion List" for the Z39.5 Standard.\textsuperscript{18} This list contained nearly six
thousand title words or word roots and their abbreviations. It is being
kept up to date by the NCPTWA through quarterly supplements. The
first two such supplements appeared in April and August of 1967 and
contained 126 title words or word roots and their abbreviations that
had been requested from the NCPTWA during the first quarter of
1967.

At best, the American Standard for Periodical Title Abbreviations
offers only a partial solution to the problems caused librarians by the
A&I services' use of title abbreviations. Many secondary publications,
especially those published in Europe, follow the periodical title abbreviations published in the *World List of Scientific Periodicals*, 1900-1960. The philosophy behind *World List* abbreviations is very different from that behind the American Standard. In the *World List*, any given word may be abbreviated several different ways in different titles so as to make each title abbreviation unique. But in the American Standard, any given title word has only one abbreviation. In the latter, should two strings of title word abbreviations be identical, they are distinguished from one another by adding the publication site.

Another periodical title abbreviation gaining acceptance is The American Society for Testing and Materials (ASTM) Coden. These unique five-character representations for periodical titles are especially useful for the machine-readable data bases being developed by the A&I services. In 1961, with the publication of *Chemical Titles*, the first computer-based current alerting service, the Chemical Abstracts Service recognized the need for a very compact journal title representation. The Coden system developed by Charles Bishop and assigned to ASTM, was adopted to serve this end. As CAS developed additional computer-based services, it required a more refined, expanded, and reliable Coden system. As a result, CAS developed two independent checking features: the first, a machine-calculated check character, validates the Coden itself; the second assures that the proper Coden has been applied by correlating the Coden, the volume number, and the year of publication. Routine use of this type of error-detection procedure has guaranteed the reliability of the CASCoden system, a fundamental requirement because the original journal reference is the keystone of the CAS information system.

The use and arrangement of volume number, issue number, year, and page data also require standardization. For printed A&I service publications, standardized arrangement of these data is not as important as is the certainty that sufficient data is included in the citation easily and unambiguously to identify the document being cited. If machine-readable records produced by different A&I services are to be compatible, however, both the format and content must be standardized. The USASI Sectional Committee Z39, Subcommittee SC-4 on Bibliographic References (chaired by Maurice F. Tauber of the Columbia University School of Library Service) is developing an American Standard for Bibliographic References. This forthcoming Standard should provide the needed guidelines for standardization of these data.
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In November, 1966, the USASI Committee Z39, Subcommittee SC-10 on the Arrangement of Periodicals, submitted the final draft of a proposed American Standard for Periodicals: Format and Arrangement.\(^{20}\) A revision of Reference Data and Arrangement of Periodicals, Z39.1-1943 (1959),\(^{21}\) this Standard advocates printing a bibliographic strip across the foot of the cover page of each serial issue. The strip would contain the title of the periodical abbreviated according to the American Standard for Periodical Title Abbreviations and the ASTM Coden with complete volume, issue, and date data. The American Chemical Society has already begun publishing the ASTM Coden with the machine-calculated check character on the covers of many of its publications.

For all the need, it is not likely that either the A&I services or the libraries will change their citation and cataloging in the near future. Therefore, some correlation guides must be developed to allow the A&I service user to translate a periodical title abbreviation easily into the form of entry used in library files. One effort in this area is the CAS Comprehensive List of Periodicals for Chemistry and Chemical Engineering (\(CL\)). This list will contain these four forms of title representation: (1) the full title exactly as it appears on the journal, (2) the full title abbreviated according to the American Standard, (3) the ASTM Coden for the title with machine-calculated check character, and (4) the title cataloged according to the ALA cataloging rules. The Comprehensive List should serve as a useful correlation tool since it will cover not only some 14,000 currently published scientific and technical periodicals, but also an additional 15,000 entries of former titles, discontinued serials, and congress-proceedings volumes. The fact that the serials listed in the \(CL\) contain a significant portion of the world's scientific and technological literature presages its general value and use. The Serials Data Program of the Library of Congress\(^{22}\) will have similar correlation characteristics, also for the full range of serials.

Correlation guides are also needed between serial titles printed in non-Latin alphabets such as Cyrillic and oriental, and their Latin-alphabet equivalents. These would be especially helpful to those A&I services which cite large numbers of Russian and Japanese papers and to libraries which utilize such foreign-language A&I services as the Referativnyi Zhurnal. The ability to correlate rapidly different transliterated schemes is also required. This problem is especially apparent to those dealing with Chinese serial literature where entries are commonly found in both the P' in-Y'in and Wade-Giles transliteration schemes.

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For bibliographic standardization efforts to be successful, the interests of all affected parties must be considered and the standards themselves must gain wide approval and use. Unfortunately, organizations concerned with standards usually have very limited resources to devote to the promotion of their work. Thus, the promotion of USASI Z39's standards has been left largely to those who developed and use the standards. The American Standard for Periodical Title Abbreviations (Z39.5) has been publicized by the R. R. Bowker Company by their reprinting it in part in Ulrich's International Periodicals Directory23 and in the 1965 Bowker Annual of Library and Book Trade Information.24 It has also been reprinted by Biological Abstracts25 and has been recommended by the Council of Biological Editors.26

Once bibliographic standards are developed and used, they must be kept up to date. The ASTM has attacked this problem by operating a Coden clearinghouse for a number of years. It is possible for anyone desiring Coden to obtain them either by mail or by telephone or from Coden for Periodical Titles.27 The NCPTWA, mentioned above, provides abbreviations for periodical title words not included in the American Standard or its Revised and Enlarged Word-Abbreviation List. Interestingly enough, over half of the requests received by the NCPTWA are not for periodical title word abbreviations, but for guidance on establishing the complete abbreviated titles for serials and monographic works that A&I services and primary journal editors want to cite. The Library of Congress' New Serial Titles and the National Library of Medicine's Current Catalog also function as standards clearinghouses. Many libraries depend on these two publications for serial-cataloging guidance just as they depend on the LC catalog cards.

Implied throughout this discussion, although never stated, is the crux of today's information-handling difficulties—the proliferation of the scientific and technological literature. Many of the difficulties faced by both libraries and the A&I services would be of a less critical nature if the information base which both must handle were smaller.

However, the literature is large and increasing every day. Therefore, means must be developed and used that will allow the libraries and the A&I services to perform their individual and combined functions in an efficient manner. The approach many A&I service publishers have taken in an effort to solve their problems has been the adoption of computer-based systems. This adoption and utilization of computers and other mechanized processing techniques by the A&I services will continue and will be intensified. The amount of literature to be proc-
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essed, i.e., abstracted, digested, indexed, or listed; the economics of processing and dissemination; and the ever-growing size of the data store that must be frequently searched dictate that new methods be found and implemented for coping with these problems. Recent advances in computer technology now make it possible to develop complete systems for handling the input, storage, and output of data bases. These can be expected to lead to the complete conversion of A&I services to information-handling centers. Such changes in the A&I services will have far-reaching effects on the reference services libraries will be able to render to their clientele.

This shift is already having an effect on libraries. Computer-based information services provide more rapid dissemination of current-awareness information than do the manual systems. Users of these services subsequently turn to libraries to provide documents more rapidly. Mechanized A&I data bases offer libraries the potential to expand present services and to develop entirely new ones.

Mechanization of data-handling procedures is not the total approach taken by the A&I services in their effort to speed up the transfer of substantive information. Other techniques are being initiated to decrease the time between initial publication of an article in a primary journal and the time its abstract appears in a secondary document. For example, air mail is replacing the slower surface mail to speed primary publications from the generator to the processor. Many editors and publishers are providing the A&I services with advance copies of their journals. The American Institute of Physics, for example, currently sends page proofs to several different A&I services. Today, over 75 percent of the papers abstracted by the Chemical Abstracts Service are received at its Columbus offices in advance of publication and via express mail. Technical reports, for coverage in STAR, are ordered by NASA when the research contracts are first announced in the Commerce Business Daily. Abstracts for Nuclear Science Abstracts are now being prepared by the agencies responsible for the original research, thus enabling the publishers of Nuclear Science Abstracts to reduce their abstracting workload and speed up the dissemination of these abstracts.

Primary and secondary publishers are also cooperating to develop integrated data base techniques. The Chemical Abstracts Service is currently editing and enriching the author abstracts of papers to be published in American Chemical Society primary journals. These abstracts are entered into the CAS system prior to their publication and
held for immediate release upon assignment of the primary journal's volume, issue, and page numbers.

The System Development Corporation has estimated that, in 1966, the cost of preparing more than two and a half million document representations by A&I services was in excess of $50 million. This expense could be reduced if more informative author abstracts suitable for republication were available to the A&I services. This has long been recognized. In 1963, the Weinberg Report suggested "that every paper be accompanied by an author abstract that is acceptable to the editor of the journal, and that each editor insist (perhaps by detached reviewing) on abstracts the form and characteristics of which best serve the users in the particular field served by the journal."

However, before authors can prepare abstracts acceptable to the A&I services, standards for abstract preparation are needed. Numerous organizations and agencies have attempted to develop these guides and provide them to contributors and editors of primary journals. The International Council of Scientific Unions—Abstracting Board, for instance, has distributed over 100,000 copies of the UNESCO "Guide for the Preparation and Publication of Abstracts." The United States of America Standards Institute, Sectional Committee Z39, has been working on an American Standard for Abstracts for the past several years. Many editors and publishers, recognizing the importance of informative author abstracts, require that their authors prepare abstracts of their papers. These are then subjected to the same reviewing procedures as the papers themselves. As a result of these efforts, increasing numbers of good author-abstracts, suitable for use by the A&I services, are now appearing in the primary literature.

In some cases, especially in the engineering fields, indexing information is also published with the original contribution. This technique, called source indexing, is widely used in the report literature and is being implemented by the American Physics Institute, American Institute of Chemical Engineers, Society of Automotive Engineers, and the Society of Plastics Engineers. The technique requires close cooperation between the secondary and primary publishers in the development, application, and maintenance of vocabulary-control guides.

In the future, the A&I services should be able to utilize the computer tapes produced by primary-journal publishers for the composition of their journals via computer-driven photocomposition devices. This approach will provide direct input to the secondary systems without the re-keyboarding and reverification of data.
The A&I services are also speeding up their own abstracting efforts. Author abstracts not sufficiently detailed for direct use are being used as the basis for developing more detailed abstracts, thus reducing abstracting time. There is also a trend away from decentralized volunteer abstractors to full-time professionals, thus enabling the services to schedule their work flow better, and to reduce further the time lag between the publication of the original work and the appearance of the abstracts and indexes. Further reductions in A&I processing time are being realized by the integration of the intellectual steps of abstracting and indexing and by minimizing redundant clerical operations.

Edited data, once entered into a computer-based system, can be manipulated and printed out in a variety of formats at incredibly high speeds. Computer-driven chain and bar printers are now capable of speeds ranging up to 1,100 lines-per-minute. The new photocomposition devices such as GRACE (Graphic Arts Composing Equipment), used by the National Library of Medicine; the Photon, used by the NASA facility; and the Linatron, used by the Government Printing Office, produce high quality, camera-ready copy at speeds ranging up to 1,000 characters per second. Chemical Abstracts Service, in cooperation with International Business Machine Corporation (IBM), has installed a modified IBM 2280 photocomposition device that can compose whole pages of intermixed text and diagrammatic material at a rate in excess of 1,000 characters per second, while the Minnesota Mining and Manufacturing Company's Electronic Beam Recorder system, although limited to 64 characters (with an option for an additional 64 characters), produces up to 20,000 lines per minute on a 14 x 14mm. dry silver microform.

These new techniques substantially reduce the time lag between the publication of the original document and the dissemination of content-analysis information. For example, the normal publication time for Chemical Abstracts is now fourteen weeks. Accelerated acquisitions, express processing, and more rapid printing are expected to reduce this over-all cycle to four weeks for the CAS computer-based publications.

The faster dissemination of document-content analysis by the A&I services is already having its effect on libraries. They are now asked to provide their clientele with more prompt access to the cited originals. To meet these demands, libraries must receive primary-source documents more promptly. They must also speed up their processing
of the documents. In addition to the pressures placed on libraries by the increased speed of A&I services, the greater depth of indexing provided by computerized services also results in a corresponding increase in document requests. Thus, libraries must more rapidly make their collections available and be prepared to handle a greater volume of transactions.

Libraries cannot be self-sufficient and must rely upon the principle of shared resources in order to fulfill many document requests. Each year, for instance, the Chemical Abstracts Service adds more serials to its coverage than the average industrial and small academic library receives. The procedures used to transfer documents or facsimiles between one library and another are desperately in need of improvement. That improvement is possible. A researcher anywhere in Great Britain today is able to obtain a copy of a document within three days from the 21,000-title collection in the National Lending Library. In the United States, unfortunately, the time between request and receipt of a document which must be obtained from another library is measured not in days, but in weeks or months. The need for improved document-handling systems in the U.S. has been clearly stated by the Federal Science Council's Committee on Scientific and Technical Information in their Recommendations for a National Document Handling System.

Accelerated acquisitions programs, improved internal processing, and modernized techniques for increasing the efficiency of shared resources are an absolute necessity. If libraries do not keep pace with the information-handling innovations, their clientele will increasingly rely on other sources of supply, and library support will be channeled off to other recipients.

The library's role in the new computerized information-handling environment is in no way limited to document provision. It is generally recognized that the reference service in major research libraries is now less adequate than it was at the turn of the century, and this in spite of the fact that the resources of these libraries have doubled several times during the past sixty years. The library community recognizes its problems and is seeking better methods of servicing its clients' requirements. A recent survey of 6,150 libraries and information centers revealed that 1,130 or 18.4 percent were using or planning to use electronic data processing equipment. The majority of the four hundred major resource libraries participating with CAS in the preparation of the Comprehensive List of Periodicals for Chem-
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istry and Chemical Engineering are also now using or are planning to use computers or related equipment.

The machine readable data bases being developed today fall into two categories: (1) library records such as card-catalog entries and serial-holdings entries, and (2) computerized indexes to provide detailed access to the published record, particularly the serial literature. Many major library-record compilations currently produced are either already derived from machine-readable data bases or are being converted from manual to machine systems. Examples of these are the British Union Catalogue of Periodicals (incorporating The World List of Scientific Periodicals), the Comprehensive List of Periodicals for Chemistry and Chemical Engineering, and the National Library of Medicine Current Catalog. Potentially, the most significant development in the area of machine-readable library records is the Library of Congress' MARC (Machine-Readable Catalog) Project. MARC, which can be labeled an A&I effort performed by a library, is designed to supply centrally produced bibliographic data via magnetic tape to the library community. Rapid dissemination of machine-readable catalog data to research libraries should reduce the large-scale duplication of intellectual effort involved in traditional library cataloging and should speed up the availability of systematic bibliographic data on new publications.

From the user's standpoint, speed and the substantial increase in indexing depth provided by the new A&I tools is most important. Prior to the advent of computerization, one could expect four to six subject index entries per article. Today, computer index files based only on article titles, e.g., Chemical Titles and Bioresearch Index, provide about six useful entries per article, as do the MEDLARS tape files. Magnetic tape index files such as CAS' Polymer Science and Technology, the NASA files, and the Derwent Information Services (Ringdoc, Farmdoc, Polydoc, etc.) provide fifteen to twenty useful index points per item. Search files based on citation indexing can be considered to have an "index density" of about fifteen entries per item, since that is the number of references in the average journal article.

Many complex problems are associated with the utilization of A&I service-produced mechanized data bases. Libraries must have access to computer facilities, money to subscribe to the tape services, and, most important of all, they must have competent staff to deal effectively with both the library clientele and the computer staff.

The wide variety of hardware and software used today compounds
the difficulties. Mechanized data bases have been developed inde-
pendently. Different organizations having different missions use a
wide variety of computer configurations, computer languages, and in-
put conventions. For instance, the tape services available from the
Institute for Scientific Information are written for the IBM 1401 and
7040 series computers, while the tapes available from CAS are for
the IBM 360/40 and 360/50 computers. A survey conducted by CAS
of the computer configurations available to the cooperating libraries
indicated that although many libraries intend to use IBM 360 series
computers, their present configurations vary widely. The SLA Docu-
mentation Division and ALA Library Technology Project survey showed that over seventy different computers are already in use by libraries.

Financing the use of computer indexes is also a major problem. Although most computerized information services sell custom searches from a central office, it is natural that libraries should seek their own computers in the same manner that catalogs, bibliographies, and ab-
stracting and indexing tools are put with the collection to aid in
searching it. However, there are ways of reducing the costs. These
are exemplified by remote, direct computer access via typewriter or
cathode-ray tube console and shared computer access (multi-pro-
gramming). Nevertheless, the local application of computer index files
greatly increases the expense of library operations.

From the research librarian's point of view, mechanized access to
selected portions of the over-all collection presents other problems. Mechanized searching services are not available for the social sciences or humanities to the extent that they available for science and tech-
nology. In addition, even those available for science and technology
are almost totally limited to serial, technical report, and dissertation
literature. Thus, the research librarian finds himself in the position of
being able to offer services to one segment of his clientele that he
cannot offer to another. Yet the cost of these services will be supported
by a sizeable part of his total budget.

There is little doubt that the capital investment and operating ex-
penses involved with computer-based services will initially represent
amounts that far exceed traditional costs. It would not be surprising
to find computer and computer-related costs greatly exceeding the
annual expenditures for books, serials, and binding; these latter costs
normally amount to 39 percent of academic-library operating ex-

defense.
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The financial problems thus raised place library objectives and library administration in an entirely new perspective. The major costs of searching for information and of using a library for research purposes have traditionally been paid for by the user; for it has been he who has taken the time to perform the searches. Any radical change in this arrangement implies corresponding changes in attitudes of the users and the organizations which libraries serve. Both the individual researcher and his organization must reappraise the value of information before libraries can bear the increased costs of computerized access to the content of library collections.

The use of computer data bases in libraries introduces several other difficulties. Two major ones are obtaining trained library staff with appropriate subject backgrounds, and finding trained data processing and computer systems staff oriented to information handling. The latter is rapidly becoming the top priority problem in modern libraries and information services.

Whether libraries utilize all or only parts of the full range of machine-readable records that will become available in the next few years is dependent on many factors, some of which have been referred to. That these new data bases present complex problems is undeniable. Also undeniable is the fact that advanced technology has given the library community a rare opportunity—not only to provide higher levels of existing services, but also to allow imagination alone to limit its new services. The proliferation of scientific and technological literature and the demands for the dispersal of its content dictate that the library and the A&I communities cooperate fully to develop an integrated information dissemination system to satisfy the needs and desires of tomorrow’s clientele.

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The Science Citation Index*: A New Concept In Indexing

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The various indexing systems presently in existence have one basic goal: to provide researchers with access to the information they require. The stimulus for development of more sophisticated systems has, of course, been the need to probe the growing mass of information documents. Developers of indexing systems are, consequently, concerned not only with establishing a tool which provides access to ideas but also one which can deal with a large mass of information. The user's interest in indexing systems is similar since his requirement is to be able quickly to extract serviceable ideas from a mass of documents which may contain information of importance to him.

The purpose of this paper is to discuss citation indexing and its present application as exemplified by the Science Citation Index*, published by the Institute for Scientific Information as a new, unique, and necessary tool for scientific work. It is necessary, therefore, to describe briefly, and in general terms, the nature of conventional subject indexing systems in order that a basis for contrast between these and citation indexing can be obtained. For those who wish to read extensively on the subject of indexing, references are provided at the end of the paper under the section "Additional References."

Indexing Systems

Indexing, as used in this paper, refers specifically to methods which have been developed for organizing large files in such a manner that the content of the file can be retrieved. The form in which the content appears is basically immaterial, as is also the form in which the re-

retrieved information appears. By way of illustration, a book can be a file and an index to a book can be considered a method for organizing this file to extract information. At the other extreme, a library is also a file and a subject catalog is used to organize such a file for access to its content. Since different types of files and the requirements of the users of these files vary, different methods of organization have been attempted. The various indexing systems which have been developed reflect attempts to provide comprehensive and relevant retrieval of information.

The methods used in indexing range from the relatively straightforward systems of providing bibliographic data, well described by conventional library rules for descriptive cataloging, to more sophisticated attempts to establish dictionaries and other hierarchical systems which by assigning words, terms, descriptors or other language elements, will lead the person to the desired information. Conventional indexing systems have generally followed the procedure of assigning words or subject headings to a document to describe its content. Common methods in these systems consist of choosing words from the titles of articles or books, leaving out common or functional words. An improvement on this basic approach is to choose words from the text and to add to this list synonyms of these basic words; or to provide definitions for words spelled the same but having different meanings. Further refinement results when, in addition to providing variants, attempts are made to establish generic relationships between the indexing terms. Thesauri generally follow these methods.

As a further step towards reducing ambiguity, some indexing systems have established functional or syntactical relationships between the terms used to describe the content of a single document. Role indicators are sometimes assigned to the index terms to show the application of each term. These methods begin to move indexing systems away from derived methods, i.e., those solely dependent on deriving terms from text to those methods which depend on assignment of index terms based on authority lists. These latter schemes may or may not use hierarchical structuring.

Since an assignment index or classification scheme usually represents a particular viewpoint, the classification schedule or list of descriptors may organize a body of information in such a manner that it reflects only the needs of one type of user. It is not necessary, however, to restrict the indexing of a particular item to a single approach or point of view. A collection of material can be analyzed from several points
of view and a group of indexing terms synthesized to provide this capability for the system. This is often called "facet analysis" or relational indexing. The method used is to combine in a prescribed manner the terms derived from separate indexing examinations. Ranganathan's colon classification scheme and the work done by the members of the Classification Research Group in England are outstanding examples of this method of indexing.\(^1\)

Citation Indexing

Citation indexing represents an entirely new approach to the problem of file organization and does not depend for its indexing technique either upon word derivations from text or upon word assignment. A citation index is an ordered list of cited articles, each of which is accompanied by a list of citing articles. The citing article is identified as a source, the cited article as a reference.\(^2\)

In such a system there is no need to provide index terms either from the text or by assignment since the indexing system employed makes use of association of ideas to establish the relevancy of material in a document rather than the arbitrary authority of an indexer. Because citation indexing does not rely on word assignment, nomenclature, or terminology, it spans the gap between the subject approach of the cataloger and the subject approach of the information seeker without need to rely on any application of a directed artificial language to describe the subject matter in a paper. The subject matter is described by the direct association that exists between authors, for when one author cites the work of another, he is associating his subject matter with that of the cited author.\(^3\) In general, a citation implies a relationship between a part or the whole of a cited paper and a part or the whole of the citing paper. By following the subsequent citations, the history of an idea can be traced: where and how it has been applied and whether it is sustained, rejected, or absorbed into later work.

The scientist is not interested only in obtaining specific information; browsing is also important to researchers who must keep alert and stimulated. Easy browsing should depend upon relationship of ideas rather than classification, and such relationship is provided by references which an author makes to earlier articles. This is usually achieved by assembling a bibliography of references to a special topic. Such bibliographies, although useful, are deficient because they only establish links going backward in time. Through the use of citation indexing, these references can be reorganized to provide the additional capability
of tracing the same topics forward in time and thus satisfying both the browsing instinct of the researcher and his need for specific information.4

The concept of citation indexing is not new, having been used for nearly three-quarters of a century by the legal profession in the form of Shephard's Citations, an index to legal cases. The system provides a listing of individual American court cases, each case being followed by a complete history written in a simple code. Listed under each case are publications that have referred to the case, other court decisions that have affected the case, and any other references that may be of value. This type of listing is particularly important to the lawyer because, in law, much depends upon precedent.5

Citation indexes may be specific to one subject area such as the Genetics Citation Index™, or they may be produced as indexes to material appearing in one journal, the most notable example being volumes 1-31 of the Annals of Mathematical Statistics. An index may also be multidisciplinary in nature, covering all fields of science as exemplified by the Science Citation Index®.5

Citation indexes can be produced using a simple system of coding entries in order to conserve space, or they can be prepared to provide more or less complete bibliographic histories for each item. Arrangements of entries are also flexible in citation indexing. They can be by author, by journal, or, if specific to a particular journal, by initial page of the cited item.

Science Citation Index®

The Science Citation Index®, the only regularly published citation index in science, is prepared by computer and cites source authors as entries. In May of this year, the 1966 SCI® was published, making the fourth complete annual accumulation. To provide proper background, it is worthwhile to summarize the content of the 1966 SCI® before describing its make-up and discussing its uses.

The SCI® uses, as its basic input, selected journals covering all the major and sub-disciplines of mathematics, the life, physical, and chemical sciences and, to a large degree, engineering. In the 1966 SCI® approximately 100 subject areas in these disciplines were covered by the journals providing the input to the system. During the year, 1,573 journals from forty-two countries were processed. The number of journal issues processed totaled 12,444 and the number of source journal items processed totaled 273,870. Total citations to journal and
non-journal articles amounted to 3,063,180. Over one million unique authored items are cited in the 1966 SCI².

The SCI² is a calendar year index, which means that, with minor exceptions, all specific issues of journals published and available during the time period covered by any edition of SCI², are included. Journal selection has placed an important emphasis on the multidisciplinary journals in order to provide the broadest coverage and to enable the searcher to obtain information across disciplines. Each journal receives comprehensive treatment so that doubts as to whether any particular article was indexed are eliminated. Comprehensive treatment also means processing all material that has substantive information. All possible useful items, including editorials, book reviews, letters, meeting reports, critical reviews, and so on, are processed leaving nothing to chance; only ephemeral items such as advertisements and news notices are omitted.

As was stated previously, arrangements for citation indexes can vary. As an illustration, let us return to an earlier example: Shephard's Citations. This particular index is organized by law cases to provide access to the volumes in which cases are reported. Thus, the citation 301 U.S. 356 is a reference to the case reported in volume 301 of the United States Supreme Court Reports on page 356. This reference becomes fixed for all future time and will appear in legal documents in the form noted. Statutes are cited by chapter and section number or by article, chapter and section number of the publication in which they appear. Ch. 16, Sec. 24, N.J.R.S. would thus refer to Chapter 16, Section 24, New Jersey Revised Statutes.

A lawyer wishing to locate a case or cases for his authority first obtains a suitable case to fit his need. He then refers to Shephard's, using this case as his starting point, where he will find as his authority the subsequent cases that have cited it. The type of arrangement he would find would follow the fictional illustration shown below:

<table>
<thead>
<tr>
<th>101 Mass. 210</th>
<th>(starting case)⁷</th>
</tr>
</thead>
<tbody>
<tr>
<td>112 Mass. 65</td>
<td></td>
</tr>
<tr>
<td>130 Mass. 89</td>
<td></td>
</tr>
<tr>
<td>165 Mass. 210</td>
<td></td>
</tr>
<tr>
<td>192 Mass. 69</td>
<td></td>
</tr>
<tr>
<td>205 Mass. 113</td>
<td></td>
</tr>
<tr>
<td>221 Mass. 210</td>
<td></td>
</tr>
<tr>
<td>281 U.S. 63</td>
<td></td>
</tr>
<tr>
<td>35 H.L.R. 76</td>
<td></td>
</tr>
</tbody>
</table>

[378] LIBRARY TRENDS
Tukey describes another type of index, *Annals of Mathematical Statistics*, in which a coding system is used. The code provides the year, code for the author’s last name, volume number, journal code and initial page of the cited and citing article. A sample illustration is given below:

<table>
<thead>
<tr>
<th>Cited</th>
<th>Citing</th>
</tr>
</thead>
<tbody>
<tr>
<td>31PRN 23BMTA 11</td>
<td>34TRR 5AMSX 324</td>
</tr>
<tr>
<td>31PRN 23BMTA 23</td>
<td>58SKE 29AMSX 60</td>
</tr>
<tr>
<td>31PRN 23BMTA 114</td>
<td>39MCY 10AMSX 337</td>
</tr>
<tr>
<td>32PRN 24BMTA 404</td>
<td>50GRS 21AMSX 27</td>
</tr>
<tr>
<td>32 &quot; &quot; &quot;</td>
<td>52MSN 23AMSX 126</td>
</tr>
<tr>
<td>&quot; &quot; &quot;</td>
<td>59HRR 30AMSX 9800</td>
</tr>
<tr>
<td>32FLR 24BMTA 428</td>
<td>36RTZ 7AMSX 144</td>
</tr>
</tbody>
</table>

The first two digits are the year, the next three letters represent the author’s last name, the next set of digits are the volume number. The letters following the volume number indicate the journal and the last set of digits are the initial page of the article.

The *SCI*’s arrangement provides more complete bibliographic information than the two systems described. The *SCI* also provides anonymous citations and patent and corporate indexes. Moreover, it is in effect three major indexes containing in its eight volumes a *Citation Index*, a *Source Index*, and a *Corporate Index*.

1. The *Citation Index* of the *Science Citation Index*. The *Citation Index* provides indexing entries to the current literature by means of the ordered listing of all items cited during a current year. It is arranged alphabetically by cited author and within this arrangement chronologically by cited year. A citation to a reference contains the author’s name and initials, the cited reference year, the publication name, volume, and page number. Under the name of each cited author appears the source article citing this work. This line is arranged by citing author’s name, publication, code identifying type of source item, citing year, volume and page. Only the first author for both the cited and citing articles are given in the *Citation Index*. While reference years may be any year in recorded history, the source year is always the current year. The form of the source article, i.e., letter, editorial, book review, etc. is indicated by a code appearing just before the source year. Asterisks flanking the reference year identify the first reference line and usually the first year cited for a given author. Dashed
lines indented under the reference author specify other cited works published by the same author.\textsuperscript{6}

The Citation Index contains a section for anonymous items (no personal author specified for the cited work). These items are arranged alphabetically by the titles of the cited publications. Within each title the arrangement is chronological by year of publication, and within each given year by the reference volume and page number.\textsuperscript{6}

The Patent Citation Index of the Science Citation Index\textsuperscript{R} is a listing of foreign and domestic patents that have been cited or referred to in any of the foreign or domestic journals covered by the SCI\textsuperscript{R}. The index is arranged in numerical order by patent number and usually provides also the year of issuance, the inventor's name, and country.

The following illustration shows the arrangement of the Citation Index.

![Figure 1. Arrangement of the Citation Index.](image)

2. The Source Index of the Science Citation Index\textsuperscript{R}. The Source Index provides a complete author index to the current literature and a full description of each citing item. This Index contains all source items processed for the SCI\textsuperscript{R}, arranged by author. The entries include
Science Citation Index®: A New Concept in Indexing

all co-authors of items (maximum of ten), journal name, title, volume, page number, year, type of item (review, letter, correction, etc.) number of references in the bibliography of the source, the issue number, part or supplement number, and the ISI accession number for the journal issue, followed by the title of the article. Cross-references for every co-author are provided, even though the primary entries only list a maximum of ten. The “see reference” refers the user to the first author, journal, volume, and page. Anonymous source articles appear at the beginning of the Source Index and are arranged by journal, volume and page.6

Typical Source Index entries are illustrated below.

Figure 2. Typical Source Index entries.

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3. The Corporate Index of the Science Citation Index®. The SCI also contains a Corporate Index in which all items published in the source journals processed are listed under the organization where work was performed. The Index will indicate under each organization the names of staff who have authored articles indicating journal, volume and page.6

Undertaking a Search in the SCI®

Using the Science Citation Index® is a relatively simple affair. In a citation index the subject of a search is symbolized by the starting reference rather than a word or subject heading. Searching, consequently, is independent of special nomenclatures or artificial languages. The searcher starts with a reference or an author he has identified through a footnote, book, encyclopedia or conventional word or subject index. He then enters the Citation Index section of the Science Citation Index® and searches for that particular author’s name. When he locates the author’s name, he then checks to see which of several possible references fits the particular one that he is interested in. Under the year, journal, volume and page number of this particular reference, he then looks to see who has currently cited this particular work. Having noted the bibliographic citations of the authors who are citing the work with which he started, the searcher then turns to the Source Index section and obtains the complete bibliographic data for the works which he has found.

Citation indexing is highly specific, but a search may also be readily expanded in order to build a more extensive bibliography for a particular inquiry. For example, having found a number of source articles, the searcher can use the bibliographies of one or several of these as other entries into the Citation Index; this process is called “cycling.” Since authors frequently write more than one closely related paper, additional articles by the author of the first starting reference can also be used as entry points and citations to these articles can be examined to obtain additional information. The Source Index itself may yield relevant current articles by a given author, even though they may not cite any of the known starting references.

The fundamental question one can answer quickly through the Citation Index is where and by whom has this paper been cited in the literature? The SCI® is also used by scientists to determine whether their work has been applied or criticized by others. It can facilitate feedbacks in the communication cycle. Any author may choose to
ignore the citations to his own work and still use the Index to retrieve publications which cite work by other scientists. The SCI can be used to identify scientists currently working on special problems or to determine whether a paper has been cited, whether there has been a review of a subject, whether a concept has been applied, a theory confirmed, or a method improved. Because indications of corrections are published in the SCI, it is useful as an aid in following particular articles. Only the user's imagination limits the extent to which the SCI can be a useful tool for the scientist and librarian.

The usefulness of the SCI can best be illustrated by conducting a hypothetical search.

The interest of the searcher is in life-like forms in meteorites. He has a starting reference, an article by Harold C. Urey published in Science, 1962, Volume 137, pages 623-628. To determine what other work has been done in this particular area, the searcher goes to the Citation Index and looks under Urey identifying the '62 Science article. Indented under this particular citation is a citation to a work by Mueller, G., that appeared in Nature, 1965, Volume 205, page 1200. Moving from the Citation Index to the Source Index, one looks under Mueller, finds the particular journal, year, volume and page reference and there sees that Mueller published a letter in 1965 with the title "Interpretation of Micro-Structures in Carbonaceous Meteorites." If the searcher is interested in obtaining even more information than this one particular reference, he can now obtain Mueller's article, look at the ten references that are given and using each reference as a starting point, enter the Citation Index once again. Since the probabilities are very high that if Mueller cited Urey's paper, the other papers that he would cite would also deal with the question of life-like forms in meteorites, then one can expect that the additional references will yield more current source articles on this particular subject.

The procedure of cycling permits the searcher to go backwards and forwards in time because, to cite the Urey-Mueller example again, he has begun with a past citation and moved forward to a current citation. If he follows through and uses the references in Mueller's paper as other starting points, then he is again going backward in time; and when he finds the current citations to these particular references, he has moved forward once again.

Citation indexing has found applications in other fields. It can be used by librarians in selecting journals for collections, and it is useful for certain types of sociological research. However, it is less
Lifelike Forms in Meteorites

Are fossils present in carbaceous meteorites? The evidence is suggestive but as yet inconclusive.

Harold C. Urey

At a meeting held 1 May 1962 at the New York Academy of Sciences, a group of Workers presented evidence
than the 1500 particles per milligram claimed by the Forbush group
are in fact not those that there

UREY HC-62-SCIENCE-137 623

CITATION INDEX SECTION

SOURCE INDEX WITH TITLES

Figure 3. Hypothetical search of the SCI².

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the intent of this paper to discuss the multiple uses of citation indexing than to present the general ideas behind the development of this indexing technique and its basic use.

General Comments

Relevancy of information obtained through use of citation indexes and the SCI* in particular, is generally very high. A citation does not suffer from failure to include descriptive terminology—rather it is a brief representation of the content of the documents it identifies. Those who have studied citation indexes know that only a small number of reference citations are needed to isolate a particular document from all others in a collection.11

Irrelevancy or "noise" can be eliminated in using citation indexes by careful selection of references as access points. In particular, if narrow specificity is desired in a search, the starting reference should be one which deals with only one subject.12 Another method of reducing "noise" is to apply the concept of bibliographic coupling to the search. This involves recording sources obtained from the index which have two or more starting references in common.

Citation indexing has advantages that conventional indexing systems do not supply. A major advantage is the fact that there is no terminology problem and there is no need to guess how an indexer might have indexed a particular item. Multidisciplinary coverage is another distinct benefit afforded by citation indexes such as SCI*. Of importance too, are the speed and convenience which citation indexing provides to the searcher. Searches have been conducted using SCI* on a variety of subjects and have yielded excellent results, some of which are available from the Institute for Scientific Information upon request. Carol Spencer12 reports on an experiment using SCI*, Chemical Abstracts, and Index Medicus to develop a bibliography on the drug thalidomide. The results of the experiment showed that, for a period up to eight hours, an SCI* search yielded the highest number of references of the three indexes. Many searches take only a few minutes; consequently, several hours of searching will yield relatively complete bibliographies.

A citation index also has the advantage of being self-organizing. Each new reference to an old paper and each new citation modifies the previous store of information. The system is constantly being upgraded by current information, which in turn helps bring old information up to date.18

JANUARY, 1968
MORTON V. MALIN

Conclusion

The crucial fact that must be faced by both the user of information and the librarian is the continuing growth in the number of documents reporting the results of scientific investigation. Concomitant with this growth are the continued needs of the scientist to search narrow areas, and to browse effectively. Association of ideas provides an effective means for coping with the information explosion by providing focused access and ample browsing capacity. Classification of a field changes rapidly, but the relationship of one article to another changes little. The relationship between articles is provided by references authors make to earlier works, and a citation index is the best means for establishing this continued relationship both forward and backward in time.4

References

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12. Spencer, Carol C. "Subject Searching with Science Citation Index: Preparation of a Drug Bibliography Using Chemical Abstracts, Index Medicus, and Science Citation Index 1961 and 1964," American Documentation, 18:88, April 1967.
Science Citation Index®: A New Concept in Indexing

ADDITIONAL REFERENCES


The reader is also referred to the excellent bibliography covering the subject of indexing that can be found in the footnotes to Chapter 2 in Bourne, Charles P., Methods of Information Handling, New York, J. Wiley, 1963.

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Subject-Index Production

CHARLES L. BERNIER

Production of subject indexes has gradually, and quite unintentionally, become complex, principally because of job simplification, quality standards and control, the large number of languages, and the size and complexity of the present literature. Processes used in the production of subject indexes may not be obvious from examination of the final product.

The forms in which indexes appear to the user vary greatly. However, principles of production, up to the time of storage, are similar. Subject indexes may appear in any of the following forms: books; unpunched cards with one index entry per card; punched cards for optical coincidence with one indexing term per card; edge-notched cards with an abstract, extract, or reference and with all index terms coded into the periphery; computer tape with document codes following the term codes; computer tape with strings of term codes for each document; and associative memories that are content-addressable and approached by parallel rather than by serial searching. Associative retrieval is largely outside of the scope of this article since it is a technique used to avoid indexing.

Since a subject index provides guides to subjects reported by authors, the first function of indexers is to select subjects. Documents, published articles, books, motion pictures, phonograph records, letters, telegrams, computer tapes, conversations, conferences, debates, dialogs, microfilms, stage productions, and other media of rational communication have subjects that can be indexed.

Not all subjects may be selected for indexing. For example, it may be the established policy of the indexing organization that only novel, emphasized, or extensively reviewed subjects be indexed because it is assumed that the index user does not need or want subjects brought to his attention on which no new work is being reported by the

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author. The user presumably does not want to be referred by the index to a paper, only to find that he must turn to another to read, in adequate detail and more accurately presented, material which he may have known all along, i.e., material which is "old" to him. Subjects in which authors have themselves invested effort and study may be indexed, and not subjects derived from others. Subjects outside of the scope of the index may be omitted.

Subjects may be complex, and there may be several in the same document. The number of subjects and their complexity are under control of the author and not of the indexer, index publisher, or index user. The indexer, nevertheless, can separate compound subjects into simple ones in order to provide more effective guides to them.

Titles of technical documents can sometimes be excellent guides to subjects; however, many titles generalize. Differentiation between generalization for the sake of brevity and generalization proposed by the author is an important function of the indexer.

It has been found relatively easy for indexers to drift into indexing words used by the author rather than subjects upon which the latter is reporting. The difference between word indexes and subject indexes needs to be understand and remembered. Of course, subjects reported by the author are indexed by means of words; however, this does not create a word index. Words are windows through which subjects are seen. In general, the more words used, the more specifically a subject is seen. The more precisely words are used, the more accurately it is seen. Word indexing leads to omissions, and unnecessary and incorrect entries. Subject indexing is also different from extraction of data, whether numerical or verbal.

Once a subject has been selected, the next step is to paraphrase it, either in the words of the author or in standardized index terminology. The paraphrase becomes the embodiment of the subject. Experienced indexers may carry paraphrases in their heads. Paraphrases often consist of two to ten words; they do not have verbs, avoid repetition, use prepositions, and accurately express the subject. The title of a technical document may be suitable as the paraphrase of one subject. Usually more than one paraphrase is required to cover all of the subjects in a technical paper. Sometimes compound subjects can be combined into one paraphrase suitable for indexing. The complexity of the subject is usually fully expressed in the paraphrase.

After the subject has been paraphrased, the indexer chooses guides to the paraphrase. The guides consist of several words and a reference
number or code. The first word or term is equivalent to a subject heading. Following these are usually modifying phrases or subheadings. After the words in a guide are translated into standard index terminology, the guide becomes an index entry. Terms for the guide are as specific as are warranted by the author and are often the words of the paraphrase. If the author generalizes, so does the guide. Not all terms in a paraphrase are suitable as lead terms in a guide because they may be too general or may lead the user to entries under a subject heading that would be too heterogeneous. The subject heading “Review” would not be suitable as a guide to the paraphrase, “Review of Steel Manufacture in Toledo.” However, “Review” would be suitable as a lead term for a guide to the paraphrase, “The Art of Writing a Review.” In the first instance, the author is writing about “steel manufacture”; in the second, about “review writing.” Most paraphrases require more than one guide. The exact number depends upon the complexity of the paraphrase. Indexing policy may eliminate some guides. The modifying phrases following the lead term usually contain other words of the paraphrase. Usually the paraphrase can be reconstructed from the lead term and the modifying phrase. It is not possible to write rules that prevent use of certain words as lead terms in guides because authors can and do study words. These words are necessary as lead terms. The reference following the modifying phrase guides users to the document indexed.

After a guide to a paraphrase has been chosen, the next step is to translate it into standard index terminology. Standard terminology eliminates scattering among synonyms or among different generic headings in the index. Scattering of related entries is a serious fault of poor indexes. If there is no systematic nomenclature available, then “See” cross-references are used to guide users from synonyms to the subject heading chosen. For organic compounds, for example, a standard nomenclature does exist; many cross-references can thus be avoided. The synonym chosen to be the subject heading is usually the term in most common use. In this way indexes track usage. The standard terminology used in an index may appear in the form of a dictionary, word list, standard list of subject headings, subject-authority list, or a thesaurus. Indexing under a “more general” term occurs when the vocabulary is limited in size so that specific terms must be indexed under “more generic” terms. An example is the indexing of “Toyo-mycin” under “Antibiotics.” It is apparent that if the biomedical literature has upwards of 60,000 terms in it and if the subject-heading list
Subject-Index Production

has only 6,000 terms in it, then indexing under "more general" headings must occur. All indexing of a "more specific" term under a "more general" one confuses generalization reported by the author with the generalization that meets the needs of the indexing system, unless special provision is made to separate these two kinds of generalization. Some indexing organizations permit "posting-up," or indexing also under a "more general" heading as well as under the "more specific." It seems more judicious to carry the relationships among general and specific terms in a thesaurus (manual or computerized) as a way of facilitating generic searches. Relationships shown in a thesaurus are relatively permanent in fields of science and engineering, and are similar to those found in *Roget's Thesaurus*.

Once the index entry has been created, it is recorded on an index card or slip of paper—one entry to a slip or card—to enable alphabetization.

In all kinds of indexing, errors are made. Most errors are made in subject indexing. In the field of chemistry, for example, 15 to 20 percent of an experienced indexer's entries are regularly changed. Of these changes, perhaps under 5 percent represent serious errors, such as omissions or incorrect headings. Index entries are checked by experienced indexers to reduce these percentages of error. Changed cards are then reviewed by indexer and checker to improve the indexing by eliminating errors introduced by the checker. Discussion of the changes is a form of corrective feedback. The incorrect reference numbers are corrected by a special check.

Card indexes or those published in the form of books or journals require alphabetization. Subject indexes are often alphabetized letter-by-letter rather than word-by-word. The complicated rules used for ordering of numbers and special symbols used in certain disciplines are often recorded in the introduction to the index. Commas are used to interrupt alphabetization for the purpose of bringing similar entries together.

During indexing, the indexer cannot predict accurately the number of entries that will occur under a given subject heading, nor the content of related modifying phrases in the completed index. Because of this, index editors are provided. Editing brings similar entries together, eliminates dangling and circular cross-references, picks up errors that have slipped by both indexer and checker, speeds indexing by permitting more leeway in coining modifying phrases, and enables informed splitting or combination of headings. Unwanted subject head-
nings are crossed off and double indentions are made. For published indexes, indexers can function as index editors. Index editing is checked by other editors, preferably by those with more experience. Cross-references are selected during editing, often by means of an inverted cross-reference system. The index editor sees an entry and indicates on the inverted cross-reference that the corresponding cross-reference is to be used. An inverted cross-reference is simply a cross-reference alphabetized at the heading to which reference is made. For example, the cross-reference, “Iron. (See also Steel.)” has the corresponding inverted cross-reference, “Steel. Iron. (See also —.)” Inverted cross-references give indexers control of the index at all times. After cross-references have been justified during editing, they are inserted into the index and unwanted headings are crossed off. Subject-index cards for a published index can be shipped to the printer sooner than otherwise if the editing is preceded by a “first survey” during which the cross-reference and inverted-cross-reference systems are applied. The first survey helps avoid transfers from headings later in the alphabet to earlier positions on galley proof. During the first survey, small headings can be edited and special problems identified and labeled, and large headings bundled for editing later after the cross-reference system has been applied.

Type set directly from index slips eliminates errors introduced by copying the cards onto sheets. Indexing organizations photocopy the cards on high-speed microfilm cameras in order to protect them in the event of loss. Monotype composition is often used for technical indexes because it enables correction of individual type sorts, insertion of nonstandard type sorts, and use of type sorts most familiar to the user. Printing introduces errors that are eliminated by reading galley and page proof. The index publisher checks the galley proof against the index cards to ensure their correctness. Changes made on galleys are checked on page proof. Schedules are useful in speeding index production since sources of delay often then become visible, allowing improvements to be made.

Indexers should have formal education or experience in the subject field in which they index in order to save the time that they would require to learn the field bit-by-bit. An indexer who does not know the field tends to make more serious errors than one who knows it well. Also, one who knows the field can work much faster than one who does not. It is not necessary or desirable that the indexer be as highly specialized in the field of science, for example, as is the scientist who
Subject-Index Production

carries on laboratory research or development. Since the new indexer is a subject specialist, he usually comes to the indexing organization without training in indexing. Such training is often obtained through coaching, during which the indexing is checked by an experienced coach who discusses changes with the new indexer.

Indexers earn salaries about equivalent to those of their colleagues in the subject field itself. The chance to keep informed about new developments has proven an especially attractive inducement to scientists.

Indexers have found that dictation of the index entries is more efficient than typing index cards or writing them longhand. Magnetic recorders are used to enable immediate correction to be made by erasure so that the transcriber is not overburdened with corrections. Typewriters are now available with chemical and other special keyboards to facilitate typing such things as numerical subscripts. Other keyboards designed for use with chemical literature enable typists to learn touch-typing of structural formulas for organic compounds.

Files are required for index cards and fire protection is provided in the form of vaults or fire-proof files. Special forms for indexing and entry into computers are available. The descriptive cataloging needed on some of these forms can be done by those who do not know the subject field.

It has not been found worthwhile to key-punch subject-index cards just for the purpose of alphabetizing them since the index slips or cards can be alphabetized by hand more rapidly than by machine.

Indexers use thesauri, dictionaries, or other standard word lists, including the indexes of earlier years. Standard reference works in the fields of alloys, bacteriology, chemistry, physics, and the like are invaluable in standardizing terminology and training the indexer in ancillary fields.

Sloping desk boards are used for draping galley proof while it is read or checked. Card holders for proof checkers attach to the proof boards. Index slips may be color-coded to represent different years of an abstract journal or index to other serial publications. Line composers are used in printing indexes to facilitate cumulations. Computer-operated composing machines offer great promise. Such machines have many fonts, a wide range of point sizes, automatic justification of right margins, automatic hyphenation, computer-controlled editing, and fine quality. With such machines, users can have a large number of fonts and can avoid the queer circumlocutions used to overcome deficiency
of type sorts. Many type faces (some more legible than others), formats, and papers are available for published indexes. Proper indentation of modifying phrases, double indentures, and subheadings also make it easier for the user to find what he wants, while running heads in larger type speed page location. Durable paper can now be purchased.

Although this article is primarily concerned with subject indexes, many of the observations apply to other kinds. Since authors tend to specialize, author indexes can serve as guides to remembered documents and subjects. Indexes to names of corporate authors or to sources of revenue for the work documented are also useful. Indexes to patent numbers are invaluable if one has only a patent number at hand. Taxonomic indexes aid in generic searches for classes of organisms. Molecular-formula indexes help the organic chemist who has not had the time to learn systematic organic nomenclature. Although classified indexes aid in generic searches, a better approach is often through the use of an automated thesaurus that enables selection of all species of a genus, parts of a whole, etc. Classified indexes may require subject guides for users who do not know the classification system and do not have time to learn it. Indexes to ring structures of organic compounds, which can also serve as generic indexes, have been produced. Citation indexes, long produced for legal use, are now available for science. Chemical-group indexes have been produced to aid searches for all compounds within the same groups. Indexes of notations, ciphers, matrices and sets have been proposed and developed. Their use should aid the chemist interested in synthesis of compounds and in correlation of physical and biological properties. Correlative indexes enable correlation of subject headings (descriptors) to increase selectivity lost by elimination of modifying phrases; Cartesian coordination of holes in cards provides one form of correlative index, the coordinate index.

Subject indexes have qualities that are independent of users, although these characteristics do affect use. Most of the qualities are subtle and invisible to the user. Completeness of indexes is one desirable quality. A policy, therefore, that limits the number of entries may eliminate guides to subjects. Or indexers may omit entries inadvertently and checkers may fail to pick them up; similarly abstracts may omit subjects that would normally be indexed and the indexers may not detect the omissions. Freedom from scattering of similar entries is a prominent quality of excellent indexes. Scattering, often among
synonyms or among modifying phrases, is avoided by provision of needed cross-references and by rules for writing modifying phrases. Thesauri are used for guidance, as are notes published in the index or its introduction; nevertheless, guidance external to the index burdens the user. Freedom from error in indexes should be sought during production, and correctness applies to the subjects selected as well as to the reference numbers. Indexing of what is novel, emphasized, or extensively reviewed produces indexes with desirable characteristics. Technical quality of production should also be high, for poor typography and printing may lead to the inference that more important and less visible qualities are also inferior. Format, too, can affect use, while price must of course be considered. An index priced too low may not be taken seriously, while too high a price may reduce use by limiting availability, even though loss of information or delay in obtaining it may often be far more costly than even the most costly of indexes; the cost of “not knowing” needs measurement.

The cost of index production has usually been unfavorable to prompt, efficient communication. It is as difficult to “prove” the value of indexes to the technical literature as it is to prove the value of proposed research and development. In demonstrating value of indexes, one must consider alternate routes to information and the cost of delays in these routes. The value of research and development to the society in which we live is now widely accepted and may be several orders of magnitude greater than its cost. The cost of research and development may be three orders of magnitude greater than is the price of bibliographic control, including production and use of indexes.

There are a number of unsolved problems in the production of subject indexes. Support, which is dependent on appreciation of the value of indexes, is such a problem. Appreciation may depend on a keen awareness of the value-cost-price relation just discussed. Those who authorize resources for indexes need written justification for such support and it has been exceedingly difficult to write adequate justification for excellent indexes.

Quality control in production of subject indexes is another continuing problem that depends, in part, on the appreciation of the value of such control. Since it is not superficially apparent that subject indexes may differ greatly in quality and since it may take users years to discover, for example, that more than half of the valid index entries have been omitted from an index, it is very difficult to gain this appreciation.
Another problem, that of delays in production of indexes, is often amenable to the therapy of dollars and scheduling. An estimate of the cost of such delays would be useful as additional justification—over and above the complaints of users—for their elimination.

Effective generic searching continues to be a problem, especially in published indexes built to the maximum specificity. Searching among a multitude of specific headings is a chore. Theoretically, an automated thesaurus with all genus-species and other relations built in, and with controllable generic searches available, should solve this problem. Another possible solution is a small, generic thesaurus. There is no doubt that thesaurus construction, updating, and use, need improvement and greater understanding. Indexes using these external controls should have more accurate and comprehensive relations, shown more promptly.

Computer-produced indexes of as high a quality as those produced by a human indexer are not yet available, although associative retrieval, especially from abstracts in English, appears to be a promising method. Automatic indexing depends upon the ability of machines to select subjects or their surrogates, to paraphrase them, and to provide useful guides to them. Frequency or infrequency of use of a term in a document is not a suitable criterion for selection as an index term, because authors do not deliberately repeat terms (or introduce them once only) in order to make the indexer or computer choose them for the index. The principal purpose of research on automation of indexing is to find means of saving the time of human subject-authority indexers and of improving the economic viability of much indexing.

When the full contribution of subject indexes to our civilization has been calculated, it will probably turn out that the price of the finest and most expensive indexes is extremely low when compared with the total production cost of the material indexed (including the cost of development and research) and with the value of this material to our civilization.

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Subject-Index Production


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A Comprehensive List of Periodicals For Chemistry and Chemical Engineering

JAMES L. WOOD

The very large volume of literature that is pertinent to chemistry and chemical engineering is scattered throughout the literature of science and technology. To gain effective access to this literature, the user of chemical and chemical engineering information has come to depend upon two types of services—the abstracting and indexing services to make him aware of pertinent literature, and the libraries to supply him with the documents he needs.

No single library has been or can be expected to maintain current subscriptions and back files for all of the services, patents, technical reports, dissertations, books, and so on, needed to satisfy fully the document requirements of users of chemical and chemical engineering literature. According to Kruzas only 35 of 1,480 college and university libraries reported subscribing to more than 2,000 periodicals when he collected data for the Directory of Special Libraries and Information Centers between August, 1961, and February, 1963. During this same period over 8,000 periodicals were being monitored for coverage by the Chemical Abstracts Service. As a result, most libraries depend upon other libraries to supply documents through interlibrary lending, and thus there is a great need for bibliographic tools that provide library holdings data. But, just as the literature of chemistry and chemical engineering itself is scattered, so are the bibliographic and document source location data scattered throughout a myriad of bibliographies, union lists, and catalogs. Moreover, these lists and catalogs are most often organized geographically and only rarely by discipline. An exception has been the quinquennial List of Periodicals Abstracted by Chemical Abstracts, which has since 1922 included data identifying libraries that received the listed periodicals. Data for these lists have

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been generously contributed by a wide range of academic, public, private, government, and industry libraries, and publication of the lists has been undertaken by the Chemical Abstracts Service (CAS).

As a culmination of these past lists, CAS and the library community are now developing a Comprehensive List of Periodicals for Chemistry and Chemical Engineering, which will be a computer-based file of data on the source material of these two disciplines. The list will not be limited to material that has been abstracted in Chemical Abstracts (CA), but will include nineteenth- and twentieth-century journals published before CA began. Some four hundred libraries are contributing data to the list, the publication of which is again being coordinated by Chemical Abstracts Service. The Comprehensive List, together with the associated computer programs and files, will become an important bibliographic tool not only for the users and suppliers of chemical and chemical engineering information, but also for science and technology as a whole.

The first List of Periodicals Abstracted by Chemical Abstracts was published in 1908. This edition and the four revisions that succeeded it contained entries for the periodicals abstracted by Chemical Abstracts at the time of publication of the lists. The purposes of these early editions were: (1) to assist the user of CA to learn the complete titles of periodicals, which were cited in CA only in abbreviated form; and (2) to furnish the names and addresses of the publishers of the abstracted periodicals.

Beginning with the 1922 edition, the List of Periodicals was greatly extended with data designating selected libraries in the United States that currently received the abstracted periodicals. These data were generously contributed by 172 libraries. Subsequent quinquennial editions of the List reflected the growth in the number of periodicals covered and the increased number of cooperating libraries. For the 1961 edition of the List, a total of 334 U.S. and foreign libraries furnished library source-guide data.

To understand what these lists represent, consider the following dimensions of the chemical and chemical engineering literature. Estimates of the total population of the world's current scientific and technical serials range from 26,000 to 35,000 to 50,000. Depending upon the figure selected as a base, the Comprehensive List's approximately 14,000 entries for current serials pertinent to chemistry and chemical engineering represent between 28 percent and 54 percent of the full range of the current scientific and technical serials.
In addition to the current serials being published, there is a similar number of defunct serials and some 4,000 volumes of papers presented at scientific and technical meetings that contain chemical and chemical engineering literature. The total number of new serials and monographs containing such information has steadily been increasing at a rate of some 500 to 600 per year. These serials and monographs are published in more than 100 countries and over 50 languages are presented.

The number of serials containing chemical information has increased from some 8,000 in 1956 to over 11,000 in 1966, and from all indications this number will continue to increase at a similar rate in the future. Figure 1 shows the growth of the chemical and chemical engineering literature since 1907 based on the number of titles in the various editions of the List of Periodicals.

The relative contributions of various journals—that is, the "scattering" of chemical and chemical engineering papers throughout the liter-
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ature—is revealed in data from a computer-based inventory of the original sources of articles abstracted in CA. This scattering is shown by the graph in Figure 2. Accumulated data for the past four years show that 25 percent of the abstracted papers were published in only 50 journals, 50 percent of the total were from 250 journals, 75 percent were from 850 journals, while 90 percent came from slightly over 2,000 journals. The remaining 10 percent of the abstracts came from an additional 2,500 journals. However, in order to locate this final 10 percent, CAS must monitor an additional 9,000 journals each year. Even though the majority of the papers abstracted by CAS are to be found regularly in fewer than 300 journals, CAS has found papers suitable for abstracting in over 12,000 journals and 3,500 monographs during the past five years.

This is not to imply that the periodicals listed in the CAS lists are useful only to the users and suppliers of chemical and chemical engineering literature. The content of the recent Lists and the Comprehensive...
sive List reflects a significant percentage of serials covering the full range of science and technology. Studies made at CAS indicate that a high percentage of the serial literature pertinent to chemistry and chemical engineering is also highly pertinent to fields such as biology, medicine, nuclear science, physics, geology, and so on. Thus the CAS periodicals lists have found wide application in many types of libraries. Over 21,000 copies of the 1961 edition of the List of Periodicals have been distributed to institutions and individuals.

These data underscore the increasing necessity of a bibliographic tool such as the Comprehensive List designed to assist the users and suppliers of chemical and other scientific and engineering literature to locate the documents they need. The Comprehensive List will build upon the experience of previous Lists of Periodicals, but will offer several new features. The Comprehensive List will include for the first time: (1) entries for periodicals not abstracted by CA; (2) a sixty-year cumulation of information on titles that have been abstracted; (3) expanded bibliographic aids and library-holdings data. In addition, the list will for the first time be computer-based.

Previous editions of the List have included entries to all serials and conference proceedings volumes covered by Chemical Abstracts, and have thus included almost all of the titles pertinent to chemistry and chemical engineering since 1907. Nevertheless, in planning the Comprehensive List, CAS considered the inclusion of data for serial publications related to chemistry and chemical engineering that had not been abstracted by Chemical Abstracts, primarily those issued early in CA's history or before CA began publication. A survey of Beilstein's Handbuch der organischen Chemie revealed some 300 pre-1907 titles not covered by CA. The coverage of the literature of pure and theoretical chemistry from 1830 through 1940 by Chemisches Zentralblatt (CZ) was particularly outstanding, and CAS added approximately 500 journals covered by CZ prior to 1940 which had not been covered by CA. The information from both these sources will be included in the Comprehensive List. An additional list of approximately 100 excellent but now defunct nineteenth-century chemical journals was included in the Comprehensive List.

All told, the Comprehensive List will include approximately 24,000 entries for journals, and 3,500 entries for monographs, including titles covered by Chemical Abstracts, Chemisches Zentralblatt, and Beilstein, as well as some nineteenth-century chemical journals that were never covered by any of these services. This extension makes this new
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publication truly a Comprehensive List of Periodicals for Chemistry and Chemical Engineering.

The second new feature of the Comprehensive List will be its collection of data from the fourteen previous editions of the List of Periodicals. None of these editions has been fully cumulative; that is, previously published information about discontinued periodicals, monographs, and title changes was not always carried forward from edition to edition. As a result, all fourteen editions must be searched to obtain complete data on journals abstracted in CA. In contrast, the Comprehensive List will reflect the sixty-year history of all previous editions of the List of Periodicals, thus bringing together between one set of covers pertinent bibliographic data and document source information for the substantive literature of chemistry and chemical engineering.

The Comprehensive List will include much more data than did previous editions of the List of Periodicals. The new list will bring into a single source much valuable bibliographic data in considerable detail that is now only partially available from a large number of bibliographies, union lists, and individual library files.

The following data elements will be included in the entries in the Comprehensive List: (a) the full title of the publication; (b) the title abbreviated according to United States of America Standards Institute (USASI) standard Z39.5; (c) the American Society for Testing and Materials (ASTM) Coden for the publication; (d) a translation of the title into English if the language is other than English, French, German or Spanish; (e) the languages of publication and summaries; (f) the history of the periodical with references to any former titles; (g) current frequency and volume number data; (h) the price; (i) the publisher’s address; (j) the title cataloged according to ALA cataloging rules; and (k) a key to the holdings of some four hundred cooperating libraries for each title.

The Comprehensive List will contain in addition to bibliographic data on serials, monographs, and patents with library holdings, a number of useful indexes. One index will give the names and addresses of the participating libraries, with codes indicating their loan and photocopy services. Addresses of leading academic and commercial publishers, sales agents, and patent offices, will be included in another. An especially useful index feature will correlate the Z39.5 USASI title abbreviation with the form of entry for the serials cataloged according to ALA cataloging rules. The Comprehensive List will also include a
list of frequently used periodical title word abbreviations following the USASI Standard Z39.5.

Perhaps the most significant feature of the Comprehensive List—one that will add immeasurably to the improvements noted above—will be the List's computer base. By utilizing the computer as a storage, search and retrieval device, CAS has built into the Comprehensive List system a much greater degree of flexibility than exists in any of the union lists today. Whereas previous editions of the List of Periodicals have been manual files converted through conventional typesetting methods to a printed volume, the Comprehensive List will be produced from a computer file of data through the CAS photocomposition system, which offers a full range of type styles and quality comparable to conventional typesetting.

This shift to a computer base has several important implications. File maintenance will be simplified. It will be much easier to update the file, so that less work will be required to prepare the data for an updated Comprehensive List or a supplement. In the past, after each List of Periodicals was printed, the type was melted down and lost. Revised editions have required complete reentry and reverification of all the data regardless of whether any of the data had remained unchanged. By switching to a computer base, it will be possible to reissue a revised Comprehensive List at any time without complete reentry of data. Maintenance of the computer-based system requires only the replacement of data which changed and the input of new entries. The computer-based system is therefore much simpler to keep up-to-date than a manual system. Such a system spreads the maintenance load evenly over the full period of operation. In contrast, the old system involved periodic reentry of the entire file and consequently caused high peaks in workload and monetary expenditure on the part of both the participating libraries and CAS.

Another powerful advantage the computer system will offer is the capability to search the file either to answer specific questions or to produce specialized listings of data. Since each of the bibliographic elements in each entry can be identified by the computer, users can select or repress any combination of elements to produce a wide variety of listings. For instance, one might list the journals in the Comprehensive List file that are held by a given library or a group of libraries within a region, or, conversely, construct lists of journals not held in specific areas. One could also list journals by language, by country of publication, by frequency of publication, or by type of
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journal. Similarly, the computer-based Comprehensive List is designed so that it can be expanded. For example, users could expand the Comprehensive List data base to include additional bibliographic data elements, entries for new or not previously listed journals and additional library holdings data. Thus, Comprehensive List tapes can be the basis of automated serials files for individual libraries.

It is evident that the Comprehensive List will serve librarians in many more ways than merely identifying which libraries hold which journals.

As a final point, it should be emphasized that the computer-basis of the List will in no way affect the printed version. The primary output of the computer system will be a printed Comprehensive List to

Legend:

1. Full title with abbreviation in bold face.
2. ASTM Coden with check character.
3. Former title with ASTM Coden and check character.
4. Languages of publication and summaries.
5. History of publication.
6. Frequency of publication.
7. Current volume number and year.
9. Publisher's address.
10. Title cataloged according to ALA cataloging rules.
11. Library holdings data.

Figure 3. Typical entry for the Comprehensive List.
be distributed in the same way as previous editions of the *List of Periodicals* have been. Use of this printed version will not require any user to have access to a computer. However, for those who do have access to a computer and do wish to make use of the computer version of the *List*, the programs and computer file will be made available on a subscription or fee basis. The system is being developed for IBM 360 computers. The programming is being done in PLI.

A typical entry in the *Comprehensive List* will appear as shown in Figure 3. The important features of each entry are noted by the circled numbers and identified in the figure legend.

Not all entries will contain all of this data. In general, the *Comprehensive List* will distinguish three kinds of publication: (1) current serials, (2) monographs, and (3) defunct serials. The data elements to be included for each type of entry are indicated in Tables 1, 2, and 3.

### TABLE 1
DATA ELEMENTS TO BE INCLUDED IN CURRENT TITLE ENTRIES IN THE COMPREHENSIVE LIST

a. Complete title and subtitle in original language of publication. Original titles in non-Roman alphabets will be transliterated into the Roman alphabet.

b. Title abbreviation according to the American Standards Association, USASI Z39.5 (1963) "American Standard for Periodical Title Abbreviations."

c. Five-character Coden plus a machine-calculated check digit.

d. English translation of complete title if title is in a language other than English, French, German, or Spanish.

e. Reference to former title if there was one.

f. Languages of publication.

g. Languages of summaries of papers.

h. Volume number, issue number, date of first issue published.

i. Frequency of issue publication and number of volumes per year.

j. Current volume number and year.

k. Price.

l. Identification of publisher.

m. Title listed according to ALA cataloging rules.

### TABLE 2
DATA ELEMENTS TO BE INCLUDED IN ENTRIES FOR MONOGRAPHS (CONGRESS AND SYMPOSIA PROCEEDINGS VOLUMES) IN THE COMPREHENSIVE LIST

a. Complete title and subtitle in original language of publications. Original titles in non-Roman alphabets will be transliterated into the Roman alphabet.

b. Title abbreviation according to the American Standards Association USASI Z39.5 (1963) "American Standard for Periodical Title Abbreviations."

c. Five-character Coden plus a machine-calculated check digit.
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d. English translation of complete title if title is in a language other than English, French, German, or Spanish.
e. Frequency for meetings of established frequency.
f. Which meeting it is if one of a series.
g. Place where meeting was held.
h. Date of meeting (month, day, and year).
i. Number of volumes.
j. Editor's name.
k. Price if volume is in print.
l. Identification of publisher.
m. Title listed according to ALA cataloging rules.
n. References to previous meetings of same group if entered under different titles.

**TABLE 3**

<table>
<thead>
<tr>
<th>DATA ELEMENTS TO BE INCLUDED IN ENTRIES FOR DEFUNCT SERIALS IN THE COMPREHENSIVE LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Complete title and subtitle in original language of publication. Original titles in non-Roman alphabets will be transliterated to the Roman alphabet.</td>
</tr>
<tr>
<td>b. Title abbreviation according to the American Standards Association USASI Z39.5 (1963) &quot;American Standard for Periodical Title Abbreviations.&quot;</td>
</tr>
<tr>
<td>c. Five-character Coden plus a machine-calculated check digit.</td>
</tr>
<tr>
<td>d. English translation of complete title if title is in a language other than English, French, German, or Spanish.</td>
</tr>
<tr>
<td>e. Reference to former title if there was one.</td>
</tr>
<tr>
<td>f. Languages of publication.</td>
</tr>
<tr>
<td>g. Languages of summaries of papers.</td>
</tr>
<tr>
<td>h. Volume numbers, issue numbers, dates of first and last issues published.</td>
</tr>
<tr>
<td>i. Title listed according to ALA cataloging rules.</td>
</tr>
<tr>
<td>j. Reference to successor if entry is for a former title.</td>
</tr>
</tbody>
</table>

CAS began work on the *Comprehensive List* in early 1965 by establishing the file of serial and non-serial titles to be included in the computer-based file. This file currently consists of the full titles, USASI Z39.5 abbreviated titles, and ASTM Coden for approximately 14,000 current serial titles, 10,000 titles of discontinued serials or former titles, and approximately 4,000 monographs. Another computer file under development contains the entries for these titles cataloged according to the *1949 ALA Cataloging Rules for Author and Title Entries*. On September 1, 1967, this file contained entries for 13,500 of the currently published titles and 3,000 of the discontinued and former titles. The file also contained the publication history for the majority of these 16,500 entries. From these tapes, computer-printed "Comprehensive List Checking Editions" were produced for the libraries to use in recording their holdings.

_JANUARY, 1968_
The libraries will be working with these checking editions throughout the last quarter of 1967 and the first half of 1968, checking their holdings of each listed title and transcribing this information onto the check sheets. A great deal of effort will go into this project, and so the checking procedure has been made as uncomplicated as possible. In general, libraries will indicate only the date their file of a title begins and, if the title is not currently received, the date it terminates.

Fragmented holdings will be recorded only for rarely held titles, and pre-1956 defunct titles will be checked only in a selected number of major resource libraries. But, even though the job has been made as simple as possible, the cooperating libraries will together contribute an estimated million dollars in effort to developing the holdings data.

As the checking editions are returned to CAS, the data will be keyboarded, input to the computer, checked for accuracy, and then added to the Comprehensive List data bank. According to the present schedule, the final "camera-ready" copy will then be computer-composed and sent to the printer by November 1968 with distribution of the Comprehensive List of Periodicals for Chemistry and Chemical Engineering scheduled for late December 1968.

Plans are currently being made to keep both the bibliographic and selected parts of the library holdings in the Comprehensive List data base up to date. Libraries participating in this updating program will be able to receive in either machine-readable or printed form a complete record of all the changes in the data base in return for their inputting data on the changes in their collections. These updated tapes and printed supplements will also include the full range of file input generated by the CAS Library, where currently over one thousand serial and conference proceedings volume titles are being added annually to the file.

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8. ALA Cataloging Rules for Author and Title Entries. 2d ed. Chicago, ALA, 1949.
The Promise of National Information Systems

ANDREW A. AINES

It is now generally accepted that we are embarked on the development of a number of national systems for scientific and technical information which will ultimately produce "a coherent array" of information subsystems with the capacity to intercommunicate. If there is any skepticism about or argument against this thesis, it is usually centered in the "when" and the "what," rather than the "why" and "how." The existence of a number of incipient and growing information subsystems provides ample evidence that there is at present a benevolent environment which may be compared to a solution favorable to the growth of crystals—in this case, information systems crystals.

What are some of the reasons for this belief?

Most obvious, of course, is the arrival of the most sophisticated of mechanical data processors, the computer. This interesting piece of equipment has shown an amazing talent to extend man's memory and his ability to manipulate rapidly masses of stored data, and to react to his signals from near or far. Formal and informal information networks are certainly possible without computers and they do exist, de facto, employing telephones, long lines transmission, television, radio, and other electronic devices, but computers add a powerful new dimension to communications networking.

Illustrative of progress is the experience of a project supported by the Advanced Research Projects Agency at the Massachusetts Institute of Technology known as Project MAC (Machine-Aided Cognition), which has shown that a scientist or engineer or student can enter a direct conversation with a time-shared computer to obtain information. Moreover, multiple access to the computers, both remotely and simultaneously, by a number of individuals has been amply demonstrated. It is the view of at least one observer, H. G. Dammers of Shell...
Promise of National Information Systems

Research, Limited, that if "the time has now come to treat information retrieval by computer as an economical and practical proposition, it is not because all the theoretical problems have been solved. It is because of the very rapid increase in the availability of computer capacity—at least 50 per cent per annum during the past two decades—and associated with this a drastic decline in the cost of computing power." Dammers argues that "the main merit of computer systems, however, is undoubtedly their great adaptability, circumventing the threat of obsolescence which hangs over the great majority of conventional information systems."

It is no longer difficult to document the growth of computer-based information networks in education, industry, commerce, law, weather, medicine, health, defense, intelligence, libraries, space, oceanography, crime detection and control, and in many research and development programs in and out of government. Yet it is widely believed that we are only on the threshold of the development of computer applications.

The parallel development of micro-photography is also making it possible to process masses of data, removing the formidable obstacle previously presented by the need for material to be readable by eye if it was to be useful. With the arrival of the technical capability to move automatically from eye-readable print to magnetic or paper tape to computer language to microform and back to eye-readable print, and procedural variations from one mode to another, yet another new dimension was added to the practicality of networking. The development of new photographic films and techniques makes further reduction of print possible. A commercial process with a 150 to 1 reduction ratio from print to microfiche is now being marketed.

There is little need to expand on the theme of what has been termed the "information explosion," but without the phenomenon of more and more people producing and reading more and more literature, even the magnificent technological progress in communications would not underwrite the development of information networks. The current increase in traffic and the high probability that the increase will materially expand in the future should be cited as the most important reason for the potential growth of networks. Particularly in science and technology, there is little likelihood that the exponential rise will flatten out in the foreseeable future. This expectation is bolstered by the growing concern demonstrated by all nations to increase their investments in research and development, hence in science communications. Since the United States, with only about 6 percent of the world's...
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population, is supporting about 40 percent of the world's research and development, it is patently obvious that as other nations put more of their gross national product into research and development, the world literature output will keep pace with the increase in the number of scientists, engineers, managers, and others involved.

Fortunately, another development has emerged to make it possible for us to structure new programs to solve many of our information problems. The emergence of the systems or operations analysis approach permits the blending of opportunity, resources, and needs into potential information networks. The growth of a unique national bank of talent, trained to the highly exacting demands of systems and operations analysis, advanced systems planning, programming, budgeting, problem-solving, and dynamic management of complex operations, is a vital ingredient necessary to progress in this field.

Another reason for expecting information networks to grow more rapidly results from the continued proliferation of specialization in science and technology, a phenomenon that demands better information systems lest it degenerate into a modern Tower of Babel of the sciences, at the very time that societal problems and complexity demand an integration of all knowledge and better intercommunication for the common good. The availability of linked networks with common language and fairly uniform communications techniques gives us a fighting chance to overcome some of the disequilibrium resulting from the spectacular specialization evident in science and technology in the last two decades. While the return of the universal scientist may be impossible, the construction of well-designed information networks will at least, through expert translation and repackaging of scientific and technical data, reduce the growing alienation.

In the last few years, scientists and information experts have publicly expressed their concern about the viability and future of the learned or scientific journal. Some of the same concern is now being shown for abstracting and indexing journals. This concern is largely a result of the continual expansion of these important announcement publications, which came into existence largely because an even earlier proliferation of literature made reading all the articles in learned journals a physical impossibility for busy scientists and engineers. While flat prediction of the future discontinuation of journals is based less on fact than on strong conviction, today there are constant complaints (and admissions) that journals are often more archival than current. This is borne out to some extent by a growing body of ex-
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experiments in the selective dissemination of information, in the growing exchange of preprints, and in the continuing attempt by the learned journals to reduce the time from receipt of articles to their fully refereed publication. While there is little expectation that much can be done to improve dramatically the traditional canons of publication, it is quite possible that new information networks can do something to overcome the problems of growing literature coverage, exploding production costs, and the attendant slowdown resulting from the administrative burden of handling large publication programs with part-time, though public-spirited, contributors.

The suggestion has been made that "computers will handtailor journals for the needs of individual users." In a way, selective dissemination of information is a precursor of such a system, and the interest of more than one professional society, deeply involved in communications, in marketing this kind of service is an interesting straw in the wind.

Another reason supporting the expectation of the development of national information systems is the growing international interest in the development of world-wide systems for handling scientific and technical information. Logically, there is little chance for the success of an international information system without the development of sound national subsystems. A number of organizations are seeking to exploit the opportunities offered by improved scientific communications to improve international relations and underwrite international progress in science and technology. Among these organizations are the International Council of Scientific Unions (ICSU), the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the Organization of Economic and Cultural Development (OECD), and others. Significant steps are being taken in a number of professional and other fields, such as chemistry, nuclear energy, health, documentation, physics, highway research, and space, to name but a few.

In a world that Marshall McLuhan believes will before long become a "global village," the importance of improved communications as a binding force can hardly be over-estimated, especially as populations increase, science and technology expand, education increases, and national efforts to develop and improve information systems draw more support and resources.

The need to help underdeveloped nations develop, construct, and operate information-processing systems that will help them make their way and live in harmony with the more advanced nations of the world
is a responsibility the developed countries cannot ignore. Unilaterally and through international organizations, one may expect the United States to take a leading role in assisting the developing countries to achieve modernity through better information systems.

While a number of *de facto* information networks in a variety of fields already exist, there are also a number of networks in the making. One prototype project has been proposed by the Interuniversity Communications Council (EDUCOM) to link a group of more than sixty universities in the United States and Canada for the exchange of information about science, technology and the education process. According to a news release, "the network will be used for dialogue between scientists and other users for mutual solution of their problems." The proposed program, which is known as EDUNET,

envisages an eight-month start-up period of a prototype system in which specifications and charges will be established. This will cost $500,000. Then follows a year in which the network is set in motion on a narrow-band basis of digital and voice information at a cost of $3 million. Finally, there will be another one-year period for testing and moving the network into high gear for image transmission, including television. This will cost $5 million. The first step will consist of establishing system research laboratories in the U.S. West Coast, Midwest, and East Coast—each with a time-shared computer. These will handle information among the universities in their respective areas and, in addition, there will be five switching points that will take care of universities too remote to use the three computers directly. With expansion, EDUNET will be available to any EDUCOM university or government agency.

One of the most compelling reasons to support the prediction that national information systems are drawing near is the amazing proliferation of information networks in industry. Virtually all large corporations and many medium-sized ones (especially those that are geographically dispersed and that offer a wide range of products and services) are moving rapidly to develop better internal and external communications systems.

According to Merrill M. Flood, "At least one of our largest manufacturing corporations operates an internal network that makes it possible for each of its offices equipped with a teletypewriter to use several company computers at various points in the country. The interaction between the person at the teletypewriter and the remote computer is essentially instantaneous in both directions with the user receiving
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exactly the same service were he at the computer." 5 Flood concludes, "Those with a teletypewriter on the telephone system have all the equipment necessary to make full and effective use of several major computing installations in the United States." 5

Another revealing trend is the arrival of the information utility network. Not only are organizations like Western Union and American Telephone and Telegraph Company moving in this direction, but large computer manufacturers like IBM are also in the field. The trend has become sufficiently pronounced to cause the Federal Communications Commission to undertake a series of new studies, dealing with regulations and rates for service.

Information networks share common characteristics with more familiar forms of communication, such as the American highway system with its ever-increasing size and ability to carry traffic, and the web of railways of an earlier day. The networking phenomenon has been evident in the growth of a complex of pipelines, power lines, airlines, and waterways. It seems part of the genius of Americans to spin networks as the busy spider spins webs, an arachnoid tendency shared by other countries of the world as they achieve modernity. An understanding of ontogenetics may be useful to explain the phenomenon, but this is left to the historians and the scholars to investigate. Information network growth is merely part of a more general communications systems development.

More than twenty years ago the science-fiction writer, Arthur C. Clarke, wrote a paper on the synchronous satellite and predicted that orbiting satellites might be the key to communications in the future. 6 While his prediction has not come to a full flower, there is ample evidence to show that greatly improved world communication is at hand. International telecasting by means of large networks of television stations is commonplace today, drawing less interest on the part of the populace than a new automobile in the neighbor's garage.

If there is any doubt about what this means to us, one might recall the late John Von Neumann's observation that all experience shows that even smaller technological changes than those now in the cards profoundly transform political and social relationships. Von Neumann, whose theoretical work in mathematics had so much to do with the development of the computer, observed that the world finds itself in a rapidly-maturing crisis which can be attributed to the fact that the environment in which technological progress must occur has become both undersized and underorganized.
If Von Neumann was correct—and it is hard to disprove his logic—and we are in a crisis of underorganization and that a transformation of political and social relationships is in the cards, it becomes easier and perhaps more productive to consider the structuring of scientific and technical information and other networks as productive and necessary acts of protective or social engineering.

Communications technology, it has been frequently said, provides man with an unprecedented opportunity to help solve some of the pressing problems resulting from an expanding population in a shrinking world. Anthropologists and historians of science remind us of the contributions and impact made by the Stone Age cave painters, the scribes of the Middle East, the copyists of the Middle Ages, and the printers of the world. In our own era, the man in the street is increasingly familiar with the advance of the electronic media and microphotography, and even copies documents himself by means of xerography at the corner drugstore or local library. These milestones reveal the simple fact that as man develops new communications tools to improve his control of his environment he is in turn influenced by the communications tools he fashions. Norbert Wiener understood this all too clearly when he enunciated his theories of cybernetics, defining the relationship between the control and communications arms, and the need for some kind of balance.

An understanding of what is happening and what may happen in the future is a necessary prelude to the next stage—the development of better communication systems.

Just as we sense conflicts arising in the quest for ownership and control of domestic communications satellites, we should expect to see the same thing happening in the growth of information utility networks. While this is to be expected in a pluralistic society and undoubtedly the process contributes to the vigor and momentum of our science and technology, we should not expend all of our energy in fighting interminable, energy-draining campaigns and battles that might turn out to be Pyrrhic victories for all. The important objective is not primarily the construction of elaborate communications hardware, but formation of information systems that promote better communications among the peoples of the planet, that encourage the channeling of information and data for the common good, and that make the content of the world information bank more readily available to all.

Many forces are driving us towards national information systems,
and there are many problems to be solved: resources to be obtained and applied, agreements to be made about the operation of subsystems, determination of the respective roles of all components of the information systems (including libraries), selection and preparation of those who will man the systems at all levels, integration of the systems elements, preparation of plans, ascertainment of user requirements, determination and establishment of ownership and control of components, ascertainment of relationships and switching of information throughout the systems, and many others.

What does all this mean to librarians? There is no doubt in my mind that librarians can and will have a substantial contribution to make in the development of modern information systems. Just how much will depend on a number of factors, some within and some outside of the control of the library community.

First, I believe that the initial requirement for librarians will be to utilize their excellent centers of learning to focus on the gathering of knowledge about the visible and foreseeable changes in information-handling. Such a charting of intelligence is mandatory.

Second, in order to undertake programs designed to adapt to modern information systems, it is necessary to evaluate critically the capabilities of libraries to undertake necessary changes. The balance sheet should not exclude staff readiness to change, availability of resources, presence of long-term leadership, evolution of goals and objectives, and required educational and training updating.

Third, the library community or specific groups in it should be consulted to determine how they want to participate, or feel qualified to participate in development of and participation in national information systems. Consideration should be given to the presence and probable growth of non-library information activities in the determination of the library role.

Fourth, decisions should be made about specific actions to be taken by various groups in the library world, and necessary agreements with these groups should be made.

Finally, a small, full-time group should be established to keep the program moving, listen to reactions, and provoke new actions and ideas.

The library community, with its dedicated people, its large plant, and its desire to participate in the development of modern information systems based on new technology and human needs, can play an ever more significant part in the common quest to expand and use human knowledge.

JANUARY, 1968
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