Changing Patterns in the International Communication of Chemical Research and Technology*

D. B. BAKER†, F. A. TATE, and R. J. ROWLETT, JR.
Chemical Abstracts Service, The Ohio State University, Columbus, Ohio 43210

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The multidimensional growth of science is reflected by its published record. Despite the limitations which any single discipline must have in providing an over-all view of science, chemistry, because of its fundamental position in the science hierarchy, probably offers the broadest available index to the growth of science and to the trends in the communication of science information. The patterns of a number of these trends are reviewed.

In some respects, our means of communicating information in chemical science and technology have changed very little over the past 100 years. The informal combination of primary publishers, abstracting and indexing services, libraries, and information centers that constitutes our international communications system has grown in size and complexity; primary literature has proliferated, and the over-all cost of establishing and maintaining a published archive in accessible form has increased correspondingly; but, for the most part, our basic methods of communicating have remained much the same as they were 100 years ago.

Price[1] and others have documented the rise in informal channels of communication in science that complement the formal system of communication. The informal system, however, is a topic in itself and we will limit our consideration in this paper to the publication-oriented system of communication.

While the most frequently discussed aspect of the scientific and technical literature is its exponential growth, there have been some other obvious changes in the literature of channeled science and technology over the years. Its sources and languages have changed substantially. The interests of chemists have broadened, and those working in other scientific disciplines have increased their interest in chemistry and their contribution to the supply of chemical information. The environment in which chemists work has changed, and, with this change, much of the responsibility for obtaining available, published information has shifted from the individual to his employer. This has had a significant economic impact on the publishers and the users of the chemical literature and has affected the means of obtaining access to the primary record. Recently, the application of computer technology to information processing has begun to affect the basic methods by which we transfer information within the scientific and technical community.

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† To whom correspondence should be addressed.

SOURCES AND LANGUAGES

Over the 63 years that Chemical Abstracts Service (CAS) has been monitoring the world's published chemical literature, the national origins of this literature have changed quite significantly. As shown in Table I, Germany, the United States, the British Commonwealth nations, and France accounted for more than 90% of the journal articles abstracted in *Chemical Abstracts* in 1909. Forty-five percent of the total originated in Germany alone. While *CA*'s coverage of the world's chemical literature in its early years was probably something less than complete, still these figures give a good indication of the centers of activity in chemical science and technology during that era.

By 1929, two other nations, Japan and Russia, had begun to emerge as important contributors to the world's chemical literature, the share of the total number of original reports originating in the U. S. had grown, and the shares originating in Germany and France had declined relative to the others.

The figures for 1947 illustrate some of the perturbations produced by World War II. Publication in Germany had pretty much ceased during the latter stages of the war and was just beginning to resume. Publication in Russia was also down from the prewar level.

Over the 1951–70 period, *CA* coverage grew at a compounded rate of 8.2% per year. In the early 1950's the U. S. contribution to this total declined from its World War II high, and by the mid-1950's it ranged between 27 and 30%. At the same time, activity in Russia increased, and in the 1961–70 period Russia contributed 19 to 24% of *CA*'s nonpatent coverage. The published chemical literature of Germany recovered rapidly in the late 1940's, and Germany has been producing about 7 to 10% of the chemical journal literature for the past 20 years. The Japanese contribution has also climbed, reaching 7 to 9% during this period. The share contributed by the group of countries that in the past made up the British Commonwealth of Nations has been a remarkably consistent 12 to 14% over the past 60 years, and the share contributed by the United Kingdom alone has held at about 8%.

Since these figures are percentages of a total that has been growing exponentially, a decline in the percentage for any given nation does not indicate a decline in chemical science in that nation. Germany's 45% of the literature in 1909, for example, represented publication of about 5200 papers; its 6.5% in 1970 represented more than 15,000 papers.

The nations identified here have always accounted for more than 80% of the total published nonpatent chemical literature. At present, Poland, Italy, and Czechoslovakia each contribute from 2 to 3%, and Switzerland, Sweden, The Netherlands, and Hungary about 1% each. The principal change in the pattern of national contribution to *CA* coverage over the past 63 years has been the great increase in the number of nations contributing. Today, papers abstracted for *CA* originate in 106 different nations.

Since 1961, CAS has been keeping detailed statistics on the language of publication of the articles it abstracts. As the figures in Table II indicate, there has been a strong trend toward the use of English in the chemical and chemical engineering literature during this period. In 1961, about 43% of all nonpatent publications abstracted in *CA* were published originally in English; as Table II indicates, most of these originated in English-speaking nations. At the same time, the combined percentage of publications appearing in Russian, German, and French was about equal to the share originating in the nations that speak those languages. The portion published in Japanese was somewhat less than the total originating in Japan, and 14.5% of the abstracted papers were published in some 50 other languages.

In 1970, more than 56% of the nonpatent publications abstracted in *CA* were published in English, although only about 40% originated in English-speaking nations. The 1970 percentages published in Russian, German, and French correspond fairly closely with the percentages originating in the nations that speak those languages. However, less than half the papers originating in Japan are now published in Japanese and these are mainly publications in the area of technology. Furthermore, although nations speaking languages other than English, French, German, Japanese, and Russian produced more than 15% of the total nonpatent publications abstracted in 1970, only about 7% of the total were published in languages other than these five.

Table I. Country of Origin of Nonpatent Material Abstracted in CA

	1907, %	1909, %	1929, %	1947, %	1961, %	1970, %
United States	21.6	20.1	25.8	41.8	27.0	27.4
U.S.S.R.	1.5	1.2	3.4	8.2	18.9	23.6
British Commonwealth	12.3	13.4	13.5	15.6	11.7	12.8
Germany (East and West)	43.0	45.0	26.9	3.1	10.9	6.5
Japan	0.7	0.3	3.7	4.4	8.8	7.2
France	14.1	13.2	7.0	8.4	4.7	4.1
All Others	6.8	6.8	19.7	18.5	18.0	18.4

Table II. Languages of Nonpatent Literature

	1961[a], %	1970[b], %
English	43.3	56.4
French	5.2	4.0
German	12.3	6.6
Japanese	6.3	3.4
Russian	18.4	22.6
Other	14.5	7.0

[a] 39% of all nonpatent material covered in *CA* originated in English-speaking countries.
[b] 40% of all nonpatent material covered in *CA* originated in English-speaking countries.

CHANGES IN THE DISCIPLINE OF CHEMISTRY

Over the past 20 years or so, the distribution of emphasis across the subject range of chemistry has undergone some marked changes as chemical principles have been recognized in the development of understanding of other sciences and technologies. This extension of basic science is illustrated by the growth in the number of subject categories or sections into which the abstracts published in *Chemical Abstracts* are organized. Fifteen years ago, there were only 33 subject sections in *CA* in contrast to the 80 sections at present.

The growth in one area of chemistry is rather dramatically illustrated by a so-called tree of the growth of *CA* sections shown in Figure 1. In 1948, only one section of *CA* was devoted to abstracts of papers on subatomic phenomena, and some 2700 abstracts on the subject were published during that year. By 1970, this topic had been divided into five more specific subject sections that contained a total of 37,834 abstracts for the year.

The over-all growth of chemical and chemical engineering information is subject to many closely interrelated influences, among which are:

The advancement of the natural and physical sciences by rationalizing observations in terms of chemical, physical, and mathematical principles, which is causing the sciences to integrate at a very rapid rate.

The strenuous effort to provide a scientific basis for the empiricism of technology across the full range of applied arts.

The constantly growing, worldwide investment in science and technology.

The greatly enhanced productivity of the individual scientist in recording and interpreting meaningful data through the use of increasingly more powerful research, development, and production-monitoring tools.

The increasing emphasis of the scientific and technical community on immediate access to newly available information which, in combination with the effects of economic constraints placed on primary scientific publications, has led to rapid growth in the popularity of so-called "communications"—shortened papers published on a priority basis—and the establishment of depositories for the detailed information associated with such abbreviated publications.

The emphasis on multinational patent protection, which leads an organization to extend its proprietary rights by obtaining patents on its inventions in an ever-increasing number of countries.

The growing demands by government regulatory agencies and legislative branches for highly-visible, comprehensive, fully-evaluated data on socially-significant scientific developments.

The growing emphasis on the publication of competent literature reviews.

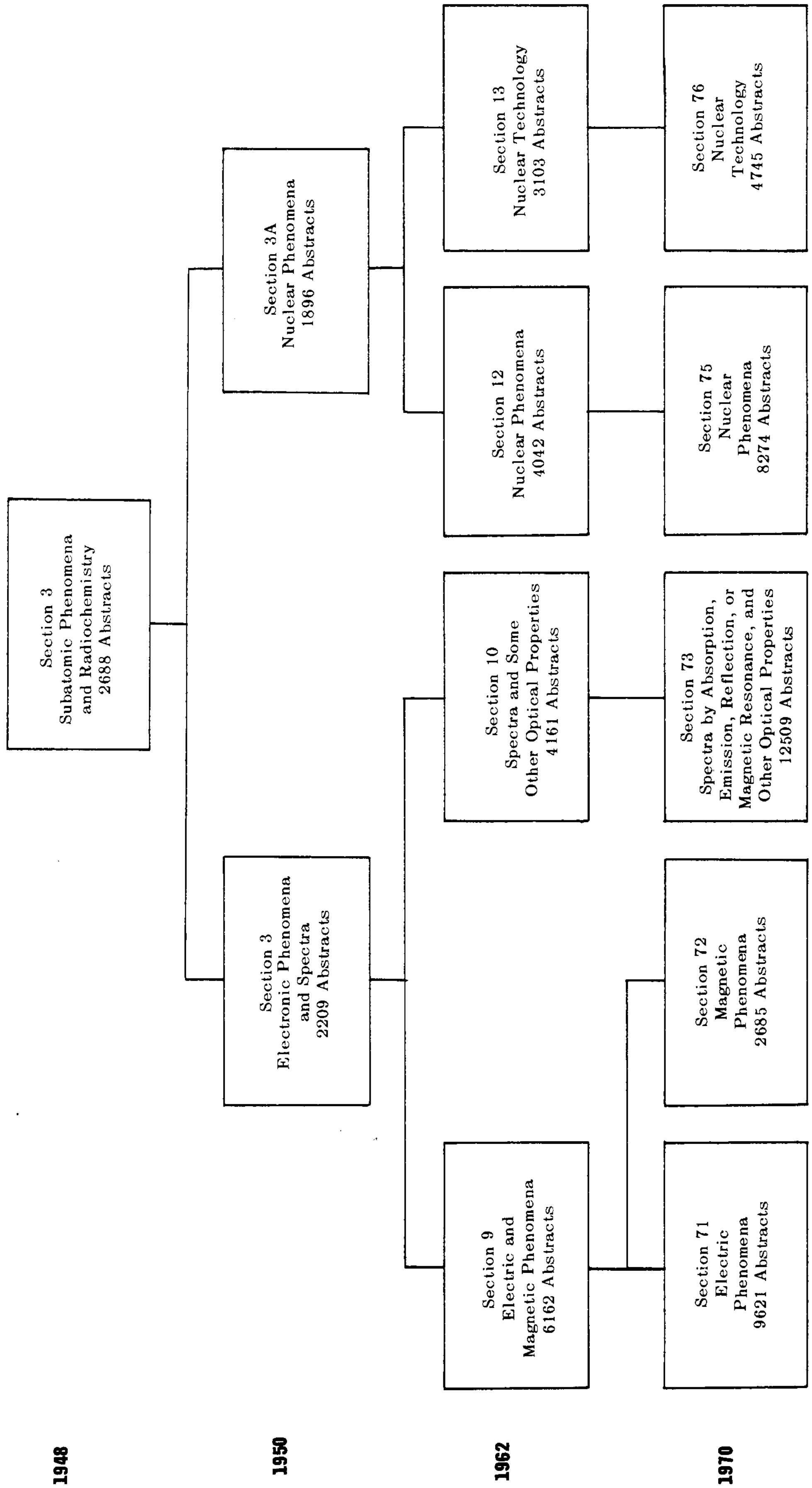

Figure 1. Growth of CA section—1948 through 1970

New information-handling technology that catalyzes the flow of publicly available information.

Although the over-all growth of the scientific and technical literature appears to be about 5% per year as determined by review of the "core literature" in a number of disciplines, *CA* coverage has grown at an average rate of 8.2% per year compounded for the past 19 years (see Table III). Clearly, this variance in growth rates is mainly based on the above-stated influences. However, except for the growth in brief communications, it is not yet possible to quantify the individual influences.

Despite current trends in support of science, the effect of the above influences on the growth of the literature is not likely to be reduced in the foreseeable future. Thus, continuingly closer coordination between primary and secondary publication processes and the elimination by the various discipline-oriented secondary services of "unuseful" overlap to obtain an economical basic accessing system for the primary published literature covering the full range of science and technology will be necessary. While such coordination was not feasible in the information system based solely on printed primary and secondary information, computer technology now offers a processing tool that makes the required interlinkages workable.

THE IMPACT OF COMPUTER TECHNOLOGY

Computer-driven composition is already in use in CAS operations. Here, a composition system directly linked to the information-processing operation eliminates the need for duplicative keyboarding of information appearing in two or more indexes and for human copying of the textual material in proceeding from manuscript to composed galleys and pages. For instance, it is necessary to keyboard an index name of a substance only once for that name to appear in both the *CA* Subject and the *CA* Formula Indexes.

To *CA* users, the direct importance of automating processing lies both in the much quicker availability of *CA* indexes and in the added distribution in machine-readable form of the fully integrated information content of these indexes. With these computer-readable files (which can either be used alone or selectively combined with other computer-readable files that have been produced privately or acquired from processors serving other disciplines) an organization can automatically derive special information services for the scientific and technical community or automatically search for answers to specific questions. In the years ahead, the range of such possibilities will grow rapidly as CAS continues toward automation of all of its operations and as similar files become increasingly available from other processors. Other aspects of this topic are discussed in the following section.

In addition to its impact on information-handling systems, computer technology has also greatly improved the tools used by the individual worker in pure and applied science. The ability of the computer, in combination with greatly improved laboratory instrumentation, to record, manipulate, and correlate large quantities of numerical data has greatly increased the productivity of the individual worker in many areas of research, development, and manufacturing and has contributed to a significant increase in the data content of primary publications.

Table III. Primary vs. Secondary Literature Growth

Year	Papers published in primary publications of the ACS	Abstracts published CA
1957	4,300	101,027
1960	4,500	132,159
1963	5,600	167,256
1966	6,400	216,746
1969	7,644	249,777
Average Annual Increase[a]	5%	8.2%

[a] Compounded for a 20-year period.

A NEW WORLDWIDE INFORMATION SYSTEM FOR SCIENCE AND TECHNOLOGY

The growing availability of computer-readable information is creating a new kind of problem for producers and users of information services. Whereas the general public knows and understands what to do with a printed book or journal, no such wide acquaintance or competence exists for computer-readable information packages. Not only must a subscriber implement a system for using computer-readable services—and this often is a complex and expensive process—he must also learn to utilize the service effectively. In addition, many potential users who might benefit from the use of computer-readable services do not have suitable computing equipment available.

One answer to such problems is the development of information centers to provide implementation services, educational support, and "retail" access to the computer-readable files. For such centers to be successful, there must be close working relationships between the information processors and the centers using the processor's computer-readable services. Thus, from a relatively simple publishing operation, an information network is starting to build. Indeed, such a network exists in chemistry today. Twelve information centers in the U.S., two in Canada, and six in Europe are now providing services to a variety of organizational users from computer-readable data provided by Chemical Abstracts Service.

The advent of computer technology and the pressures generated by the ever-growing volume of publication in all areas of science and technology also show promise of bringing about more effective coordination among the various elements in the rather disorganized communications complexes for chemistry and for science and technology as a whole. Traditionally, each primary journal publisher and each secondary information service has operated almost independently of the rest of the information-processing complex. Now, the application of computerized information-handling and -composition procedures in both the primary and secondary publishing systems opens up the possibility of efficient and reliable transfer of data between the primary and secondary processors. The techniques also provide the basis for sharing the responsibility located in different nations and serving different disciplines by eliminating much redundant intellectual processing effort. Such joint programs will unquestionably lead to the elimination of most of the overlapping coverage of such services without reducing the access of the worldwide community to the primary literature. The growing volume of new information and the rapidly rising processing costs make such coordination an economic necessity.

Among the secondary services in chemistry, for example, organizations in France, Germany, Japan, the Soviet Union, and the United States, among others, have for many years been abstracting and indexing in their own languages all or part of the same body of literature. In recent years, all have been faced with the same economic and manpower problems, and all have been considering the same alternatives. There is an obvious need to find ways to share this burden internationally for the mutual benefit of all.

Some progress is now being made in this direction. In 1969, the United Kingdom Consortium on Chemical Information and the West German Chemical Society (Gesellschaft Deutscher Chemiker) agreed to join with the American Chemical Society in the development and operation of a common, computerized secondary information system for chemistry and chemical engineering. The British and German organizations will assume responsibility for selecting, recording, and organizing information from an agreed-upon portion of the primary literature for input to a central computer processing system at CAS's Columbus headquarters and all will share in the output from this system.

The agreement with the German group in effect brings together the operations of CAS and Chemie-Information und Dokumentation, Berlin (CID), a division of Gesellschaft Deutscher Chemiker (GDCh). Prior to 1970, this GDCh division produced *Chemisches Zentralblatt*, the world's oldest comprehensive scientific abstracting and indexing service. *Chemisches Zentralblatt* ceased publication at the end of 1969, and at the beginning of 1970, CID started to produce two new services, *ChemInform Organic* and *ChemInform Inorganic*, through a computer-based system. In the last half of 1969, GDCh and CAS started the cooperative development of a computer-based system. Currently GDCh is providing, from patents and papers published in Germany, English-language abstracts that are being used directly in *CA* without CAS editorial review. As experience develops, GDCh will provide index entries as well as abstracts, all in computer-readable form.

The U. K. Consortium is developing input capability as a part of the routine editorial processing of their primary publications. The initial U. K. input comes from the *Journal of the Chemical Society, Section C: Organic*. Whereas GDCh is initially concentrating on preparation of abstracts, the British are first attacking the problems associated with the selection of subject index entries. This work follows a project in which a full-time member of the editorial staff of The Chemical Society (London) spent a year at CAS to develop working procedures for identifying—but not converting to a standard form—*CA* Subject Index entries. As this program proceeds, the capacity to generate fully standardized index entries will be developed, and the U. K. group will provide both index entries and abstracts in computer-readable form.

Obviously, the British and the German joint programs with the ACS will complement one another, and a generalized input system will be established. At that point it will be feasible to extend the number of input centers to a projected total of five or six, including input operations at CAS.

Further, as noted earlier, the increasing integration of the scientific disciplines in recent years has caused the secondary services of each of the disciplines to abstract and index more and more publications outside of their own disciplines. With the current volume and continuing growth of publication in each discipline and the increasing integration of the disciplines, no one secondary information processor can reasonably expect much longer to satisfy the full range of information needs of the workers in a given discipline, nor can the scientific community afford to support highly redundant information systems for each of the scientific disciplines.

There is an obvious need for coordination of coverage among the discipline-oriented and mission-oriented information processors. This cooperation must necessarily be accompanied by a coordination of indexing and data-recording practices among the processors so that a scientist can shift readily from one information store to another. Computer technology provides an effective means of interlinking the information stores of the various disciplines by creating bridges between the index nomenclature used by the different disciplines.

With this objective in mind, the three largest private secondary information services in the United States—CAS, Engineering Index, and the Bio-Sciences Information Service of *Biological Abstracts*—have recently launched a detailed review of the relationships between their publications and computer-readable information services. This joint study, which will take several years to complete, will encompass coverage, editorial and indexing policies, and data recording practices. The study is designed primarily to develop information needed by the three organizations for planning cooperative programs, reconciling differences in policies and practices, and eliminating unnecessary duplication. It is expected to provide a formation for more effective coordination of the efforts of these three services.

CHANGES IN THE CHEMIST'S INFORMATION ENVIRONMENT

Along with these changes in the literature of science and technology and in chemistry and chemical engineering over the years has come a change in the environment in which chemists work. Where once the scientist was predominantly an individual investigator, today he is far more likely to be a part of a team employed by a corporation, a university, a research institute, or a government agency. One effect of this institutionalization of science has been a basic change in the means by which the scientist acquires the information he needs in his work. Where once he purchased journals and secondary information services for his personal use, now the responsibility for supplying these tools generally rests with his employer. As a result, while the number of scientists contributing to and using the over-all scientific literature has increased greatly in recent years, the number of subscriptions to primary journals has remained fairly constant and the number of subscriptions to secondary journals has declined substantially.

This trend has been accelerated by several other factors. First of all, scientists have developed a much greater dependence upon public and private secondary services for identification of pertinent primary literature. Second, the proliferation in the number of journals that must be consulted to obtain information on a given topic has lead to greater dependence of a local library on the network of libraries. Resource libraries which provide such back-up are often central academic libraries and, at least in the United States, such libraries are often loath to extend their responsibilities from support of the individual academic communities to the over-all scientific and technical community. Third, the advent of widely available, easily used photocopying equipment that provides relatively inexpensive copies has reduced the individual's dependence upon centralized libraries in favor of personally-oriented collections of copies of selected individual papers, patents, and reports.

Employer-prepared literature accessing bulletins and search services, which extend routine library service in support of the information requirements of individual employees, have long been available in industrial organizations and government agencies, but such "captive services" have not become common in academic institutions. However, the distribution of secondary services in computer-readable form during the past five years has started to shift this pattern for all users of scientific and technical information. This shift of practice results partly from the growing integration of science and technology, as discussed earlier, and partly from the nature of computer-based information-accessing systems. Actually, very few practicing scientists call upon a single secondary service to provide access to the full range of information that they use routinely in their work. Conversely, a given discipline-oriented secondary service is widely useful outside of the accepted bounds of that discipline. For instance, more than half of the subscribers to *Chemical Abstracts* are not specifically centered in chemistry—subscribers include medical schools, metal-processing companies, agricultural libraries, and the like.

In the traditional printed-publication-oriented library system of academia, the educational, research, and development efforts of staff are served, particularly in the larger academic centers, by a library network operating through departmental libraries. This traditional system is mainly based upon action by the individual information user, which in turn is based solely upon locally held publications and interlibrary loan support. The introduction of computer-readable information services, however, often brings about a coalescence of the information-support mechanism for the full range of the staff of an academic institution because of the multitude of available services, the size of the computing system required to provide effective, efficient access to information based on computer-readable services, the multidisciplinary interest in any given computer-readable service, and the significant investment in specially trained staff required to interface between the data base(s) and the individual users of the system. Such a coalescence is starting to produce the same form of internally operated information support for individual academic workers that has long been prevalent in industry and government.

At the same time and for the same reasons, smaller industrial and government installations that have individually operated their own information services in support of internal staffs suddenly are faced by the same need for coalescence that is occurring in the academic sphere. The result is the growing trend toward establishment of information centers, each of which provides service to a number of otherwise independent organizations. Of course, smaller educational institutions are also starting to gain access to computer-readable information by tying into neighboring, larger academic information centers. And as newer processing methods with increased packaging flexibility provide more timely, individual-oriented, printed information tools with suitable spectrums of coverage to satisfy in varying combinations the information needs of many employers, the trend toward centralization of information-accessing is likely to continue, with organizations using such "community services" in place of their own internally prepared services.

At the same time, the trend toward dependence upon a reduced number of copies of individual primary publications is bringing about a financial crisis for many such publications. Whereas the numbers of users and generators of information and the number of published papers continue to rise, the cost of publication production is spread over ever-dwindling numbers of direct journal purchasers. These problems compound in the rapidly increasing subscription prices and disproportionate growth of page charges, with the net result that the smaller organizations that use the primary literature face budgeting crises each year. It is clear that the employer will play an increasing role in supplying primary journals to individuals just as he already supplies secondary services. However, despite the likely dominance of organizational support for all information services in the years ahead, it is essential that such services—primary and secondary—be designed for individual use. Scientific and technical societies must continue to work to coalesce the stated needs of individual information users and exert strong influence upon the development of the required information tools.

CHANGES IN THE PRIMARY JOURNALS

Figure 2 underscores the role of communications in the primary literature. The number of "complete" papers published in the *Journal of the American Chemical Society* has decreased by 20% over the last nine years while the

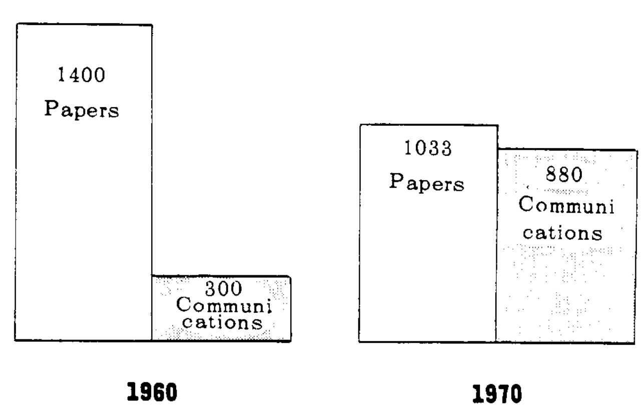

Figure 2. Papers vs. short communications published in the *Journal of the American Chemical Society*

Table IV. U.S.S.R. Publications Depositories

Journal	Where Deposited
Armyanskii Khimicheskii Zhurnal	
Avtomaticheskaya Svarka	
Biofizika	
Biologicheskii Zhurnal Armenii	
Fizika i Tekhnika Poluprovodnikov	
Geomagnetizm i Aeronomiya	
Inzhenerno-Fizicheskii Zhurnal	
Izvestiya Akademii Nauk Armyanskoi SSR, Nauki o Zemle	
Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Fizika-Matematika	
Izvestiya Akademii Nauk SSSR, Fizika Atmosfery i Okeana	
Izvestiya Akademii Nauk SSSR, Metally	The All-Union Institute of Scientific and Technical Information, Moscow
Izvestiya Akademii Nauk SSSR, Neorganicheskie Materialy	
Khimiya Geterotsiklicheskikh Soedinenii	
Khimiya Vysokikh Energii	
Mekhanika Polimerov	
Pribory i Tekhnika Eksperimenta	
Radiobiologiya	
Radiotekhnika i Elektronika	
Tsitologiya i Genetika	
Vestnik Akademii Nauk Kazakhskoi SSR	
Zhurnal Eksperimental'noi i Klinicheskoi Meditsiny	
Zhurnal Fizicheskoi Khimii	
Zhurnal Nauchnoi i Prikladnoi Fotografii i Kinematografii	
Atomnaya Energiya	Editorial Board of Atomnaya Energiya, Moscow
Gazovaya Promyshlennost	All-Union Scientific Research Institute of Gas Industry Economics, Moscow
Neftepererabotka i Neftekhimiya (Moscow)	Central Scientific Research Institute for Economic Technology of the Petroleum Industry, Moscow
Obogashchenie Rud	Bureau of Technical Information, Mekhanobr. Institute, Leningrad
Tekstil'naya Promyshlennost (Moscow)	Central Scientific and Technical Library of the Light Industry, Moscow
Fiziologiya i Biokhimiya Kul'turnykh Rastenii	The All Union Institute of Scientific and Technical Information, Lyubertsy
Gigiena i Sanitariya	(Information not available)

number of communications simultaneously increased by nearly threefold. This shift has been intensified over the last 20 years by the appearance of widely accepted journals devoted exclusively to communications.

As initially conceived, communications were intended to provide quick exposure to work in highly active areas of scientific inquiry. Such announcements of results were then to be followed by publication of full details through the more leisurely, traditional primary publication process. Current experience shows, however, that the communication is often the only published version of a given report. This is illustrated by a recent study which showed that only 50% of the communications published in *Physical Review Letters* are later published as full reports.[2]

Another current practice which is gaining favor is the submission of a paper for publication in two segments: The first segment being processed as a communication, the second segment being placed in a depository operated by the primary publisher and supplied upon request and for a fee in microform or full-sized copy. The Canadian Research Council (CRC) is one of the first publishers to routinely use abbreviated publication in combination with its own depository.[3] The U.S.S.R. publications listed in Table IV contain sections that consist essentially of abstracts of papers on deposit at the locations identified in the table. Supposedly these abstracts represent the only form in which the corresponding papers will be formally published, and CAS has not been able to detect any differences in the reviewing processes for these "abstracted publications" as opposed to "full publications."

The scientific and technical community must be concerned with the likelihood of reduced accessibility of the extended detail associated with abbreviated publications. In terms of CAS experience, there is no identifiable reduction in the number of *CA* Subject Index entries for communications in contrast to longer papers. However, *CA* indexes and abstracts are intended to lead the information seeker to the primary documents, with the determination of document relevance and the selection of appropriate items of data then falling to the searcher. In the case of communications that report a given piece of work but are not followed by later, more-detailed accounts of the accomplishments, there are no published reports dealing with the impact of such abbreviation on the usefulness of the reported work within the scientific and technical community. Certainly there has been no cry by active workers for more published detail.

Nor is there any evidence of lack of needed access to the publisher-operated depositories that include extended detail associated with abbreviated primary publications. In working with the Canadian Research Council, CAS has found that consideration of deposited information associated with an abbreviated paper published in CRC publications would not increase the number of *CA* Subject Index entries. Here again, there has been no outcry by users of CRC publications against the practice and no explicit examination of the impact of such practice upon the patterns of use within the scientific and technical community.

The *Journal of Organic Chemistry* (*JOC*) is also experimenting with publication of abbreviated papers supported by an ACS-maintained depository of expanded detail. The *JOC* experiment has an added feature in that the microfilm version of *JOC* includes both the content of the printed journal and the associated deposited material recorded on the same film. Thus, the deposited material as well as the journal can be easily correlated and widely distributed. The usefulness of this form of distribution will have to be determined as experience accumulates.

The shift to abbreviated publication with or without associated depository has the net effect of crowding more papers into a given number of pages of primary publication and of reducing the average time required to publish a primary paper. This telescoping of the primary publication process thus contributes to the rate of growth of the primary literature. Although the growth of the literature is not greatly influenced by the shift of a single established journal toward abbreviated publication, the over-all influence of many such shifts, plus the appearance of new communications-only publications, is and will continue to be important.

Despite the increase in short primary communications, the average length of articles published in the ACS primary journals has increased over the past 10 years, indicating that the full-length papers currently published in journals are considerably longer than their counterparts of 10 years ago. Various indicators such as the number of *CA* index entries per journal paper indicate that this in not just increasing verbosity on the part of the authors; the amount of data recorded per paper has also increased. As indicated earlier, new laboratory instrumentation has provided the research scientist with an ever-expanding ability to produce reliable data.

CHANGES IN THE PATENT LITERATURE

The increased emphasis on obtaining multinational patent coverage, which started in the early 1950's, has led to changes in the practices of national patent offices regarding issuance of patents and to greatly increased problems in identifying patents and/or patent applications that cover the same invention but are issued in two or more different countries. The results of this increased emphasis is illustrated in Table V. This table shows that patents, which made up 11.7% of the total bibliographic items covered in *CA* in 1955, had grown to 24.6% of the total *CA* coverage by the end of 1970. The figures in Table V to some extent reflect improved *CA* coverage, but these changes mainly result from the increase in the number of countries in which a given invention is patented. In 1963, *CA* began identifying equivalent patents that cover a given invention in two or more countries through publication of a patent concordance index. Other patent services issue similar indexes.

As there is yet little effective cooperation among the patent offices of the various nations, the increased emphasis on obtaining multinational patent protection has forced several of the larger nations to shift to issuance of unexamined patent applications, leaving the initial burden of identifying conflicting applications to the interested parties. Usually, a shift from issuing fully examined patents to issuing unexamined patent applications leads to the publication of current applications simultaneously with the publication of the backlog of unprocessed patent applications accumulated under the previous practice. Thus, over the period that such a backlog is being processed, there is an artificially large increase in the rate of growth of the patent literature for the corresponding country.

In recent years, France and The Netherlands began to issue unexamined patent applications, and West Germany, which very recently adopted this practice, now is in the process of publishing the accumulation of unexamined applications that existed prior to the change in

Table V. Growth of the Patent Literature in CA

Year	Total documents covered in *CA*	Papers, books, and reports	Patents covered by abstract	Patents covered by patent concordance or equivalent	Total patents
1955	84,590	74,664 (88.3%)	8,726 (10.3%)	1,200 (1.4%)	9,926 (11.7%)
1960	132,159	104,484 (79.1%)	24,412 (18.5%)	3,263 (2.4%)	27,675 (20.9%)
1965	214,307	165,770 (77.4%)	29,225 (13.6%)	19,312 (9.0%)	48,537 (22.6%)
1970	309,742	233,630 (75.4%)	43,044 (13.9%)	33,068 (10.7%)	76,112 (24.6%)

Table VI. Effects of New Patent Legislation

	France	Japan	Netherlands	West Germany	Total
Total patents processed per week, 1968	850	450	500	600	2,400
Year to shift to unexamined patent applications	1969	1971	1964	1968	
Total number of backlog applications on file at time of shift	. . .	700,000	. . .	250,000	950,000
Number of years to eliminate backlog	. . .	2 yrs.[a]	. . .	4½ yrs.	
Total patents processed per week, 1971 (est.)	1,000	3,000 (72')	650	2,300	6,950

[a] Backlog will be covered by old method—i.e., examined—and, hopefully, eliminated by mid-1972. We are told that probably less than ⅓ (200,000) will ever be published.

practice. Japan is to start a similar system at the beginning of 1972. The effects of these changes on the volume of patent literature are quantified in Table VI. Short term fluxes in the flow of published literature such as these make it difficult to quantify the long-term rate of growth of the primary literature.

Another type of change was instituted by the United States in 1968 when the Patent Office started to issue defensive publications,[4] whereby an applicant elects to publish an abstract of a patent application in the *Official Gazette* in lieu of completing a formal examination by the Patent Office. Upon publication of this abstract, the applicant agrees to open the complete file record to public inspection. So far, this has resulted in few such publications.

CONCLUSION

There are many signs today of change in our patterns, forms, and methods of communication of chemical research and technology. More far-reaching changes are likely over the next decade as more and more publishers and information processors turn to computer technology as an answer to their growing economic problems.

Coordinated application of computer technology throughout the scientific information-handling community can make it possible to interlink the various primary and secondary information processors and the library community into an effective, international, interdisciplinary information network. It can substantially reduce the overall cost of operating the scientific and technical communication complex by eliminating much of the duplication of effort that now exists and result in far more useful information services for scientists and engineers in all disciplines. However, this is not something that will be accomplished in a few years. Although the necessary technology exists, we need to learn to apply it effectively to information handling. Also, information production and utilization is a worldwide, multidisciplinary problem in which many organizations have vested interests; this tends to slow progress.

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Modern Techniques in Chemical Information

A New Graduate-Undergraduate Course at Illinois Institute of Technology*

PAUL E. FANTA† and SIDNEY I. MILLER
Illinois Institute of Technology, Chicago, Ill. 60616

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In 1968, the chemical literature course at IIT was expanded and modernized; it is now offered for graduate credit and is accepted as a substitute for the second foreign language requirement for PhD candidates. The course presents a survey, with library exercises, of the traditional techniques of chemical information, followed by a discussion and illustration of modern methods for handling chemical information.

The presentation of a course in the use of the chemical literature has a strong tradition at Illinois Institute of Technology. If memory serves us correctly, the course was started by Peter Bernays, now at Chemical Abstracts Services, about 1946 and was offered each year to undergraduates at the junior level as a two hour, one semester course. We have for these many years regarded training in the use of the chemical literature as a subject deserving a separate, formal course, and not something to be picked up casually, inadvertently, or accidentally.

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†To whom correspondence should be addressed.

Illinois Institute of Technology is particularly well endowed with the physical prerequisites for such training, since the John Crerar Library is on our campus and the Chicago Public Library, three miles distant, is a depository library of the United States Patent Office. Furthermore, in recent years IIT Research Institute (formerly Armour Research Foundation) has developed a strong and active group in science and technical information under the leadership of Martha Williams. We also have strength in computer technology in the IIT Computer Center, which is in the process of getting new housing and hardware under the directorship of Peter G. Lykos, who is also, fortunately, a professor of chemistry.

Two years ago, with support of a major grant from