less and less relevant as new knowledge unfolds, the tendency is to retain it because it is common usage. Inasmuch as nomenclature is closely associated with our ability to teach and to communicate, a goal of high priority is to design a nomenclature system based on a more natural scheme of classification and relevant to the most current assumptions on the nature of chemical structures.

Closely related to the nomenclature problem is the conceptual framework and applications of notation and topological systems. Although these systems were conceived as answers to nomenclature problems, especially for the indexing of chemicals, they now constitute an area of interest and of importance in their own right. Indeed, some of the best research in chemical information science over the past 15 years has been on notation and topological systems. It is essential that research activity in this area continue well into the future and that chemical information scientists seek new systems not only for retrieving chemicals but also for correlating chemical structures with their properties, reactions, and uses. One of the dangers I perceive is the high desire among chemical information scientists to select prematurely a notation or topological scheme as the answer to all problems. As chemical information scientists, we should know from the history of chemical nomenclature how easy it is for a poor decision to lead to the sacrosanct common usage.

Despite the great importance of classification schemes in the history of knowledge and education, the lack of research on classification concepts over the past 30 years has been a lacuna in chemical information science. This neglect reflects the absence of stress on organized ways of looking at and working with chemistry as a science. Yet science is concerned primarily with the systematic arrangement and organization of facts. Apparently we prefer to relegate to future chemical information scientists the responsibility for designing classification systems relevant to the accumulating facts of chemistry.

Indexing methods and developments, however, have enjoyed a high activity over the past 30 years. Unfortunately, this high activity cannot be viewed as synonymous with progress. Much of the work has been oriented to keyword indexing and concomitant with the increasing number of computer-based information systems. Keywords today are equated to the significant words used by an author in the title of the paper, and sometimes in the abstract or even the whole paper. Abstraction of keywords from the whole text has been a goal of information processors since the introduction of second generation computers, but without economic success. Information processors and brokers currently are enticed with the possibilities of retrieving documents by on-line, whole-text searching for keywords, primarily because this is something computers can do easily. This objective can be economically feasible only if the information processor is tied in with the producer or publisher of documents which are photocomposed via computer. Let us assume that all scientific journals are computer composed suitably for input for whole-text searching by scientists with interactive on-line terminals. We would need to store in the computer system more than one million articles produced annually by about 35 000 journals. The economics is mind-boggling, even for a governmental agency's budget. Moreover, the economics is mind-boggling for the 270 000 journal articles abstracted and indexed by *Chemical Abstracts* in 1973. Most importantly, we need to consider seriously the intellectual consequences of keyword indexing in contrast to subject indexing.

Computers and telecommunications have been a major factor in the changing trends of chemical information science, especially over the past 15 years. Both, in my view, are magnificent tools for the processing and communication of chemical information. They are in no way, however, a substitute for the chemical information scientists' exploration of the fundamental logical nature of chemical information. With the advent of the information processor's and broker's intellectual and financial monopoly of information services, the chemical information scientist's role is changing from the "user of" to the "used by" the computer in the human-machine interface. We may then inquire of the future of chemical information scientists. Let us assume that the word crunching of titles, abstracts, and even the author's complete text in a computer is not a viable hypothesis for chemists seeking information from the literature, that chemists will insist on having retrieval systems that yield only desired references or data, that chemists will require information systems in which they can browse as they do now in a chemistry library, and that chemists will want to interact with the computer as they do now with other chemists. If these are the requirements of chemists vis-à-vis their literature, and I think they are, then chemical information scientists will be with us far into the future working toward the achievement of these goals.

The Journal and Its Possible Future†

B. J. LUBEROFF

CHEMTECH, 48 Maple Street, Summit, New Jersey 07901

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Is it any wonder that in seeking someone to honor for his ability to manage the literature we've picked Herman Skolnik? The man reads it at over 1000 words a minute! I, on the other hand, like most mortals, plod through the literature as though in galoshes. I'm like Julian Huxley's student of foreign language who can't possibly enjoy the "scenery" because he finds himself as though "plodding up a steep hill on a hot day". I was thus more than startled when Herman asked me to address this learned conclave taking as my subject "The Journal and Its Possible Future". It seemed as though an offer to lecture on taxes had been proffered to Crawford Greenwalt who said, in "The Uncommon Man", "I cannot present myself as an authority on taxes except possibly in the same melancholy sense in which a pedestrian is an authority on taxicabs because one has knocked him down".

Nevertheless, I know Herman well enough to know that there is method in his apparent madness. I thus decided that he invited me to share ideas with you not as a pedestrian plodding up the steep hill of the literature but, instead, as an Editor. Why as an Editor? Because they contribute more to

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Table I. Purposes of Journal Papers

. An ego trip for it's author and/or his institution
. A way for a publisher to make money by selling the paper and/or the advertisements it separates
. A justification for funds spent and/or sought
. A foundation on which to build discovery
. An almost religious duty to clarify Nature for others
. An aesthetic thing comparable to a fine painting
. A stuctural member useful, or potentially useful, in adjusting Nature in ways we call technology

the problem than to the solution? No, that's not Herman's style. No, I think that he wanted to emphasize the strong kinship between Editors and literature scientists. (He, himself, is both, you know.) So, with all that in mind let's now inquire into the health of the Journal. Here I'm reminded of the Henny Youngman classic.

"How's your wife?"

"Compared to what?"

So, how's the Journal? Well, let's see.

We're here celebrating not only the 100th anniversary of the birth of the American Chemical Society and the 200th birthday of the American United States, but also, in a way, the 300th birthday of the scientific journal. (It was in 1665 that the first one appeared.) Now we have, as Herman said, 40 000 of them. How come? To answer, let's first look at the purpose of the journal. We could say that the journal's purpose is congruent with that of science; therefore, let's look at that of the American Chemical Society as exemplary. Its charter says about purpose: "...fostering public welfare and education, aiding the development of our country's industries, and adding to the material prosperity and happiness of our people." Do journals—does science—do that? Not quite. There's a lot of technology in that statement; we'll return to that value judgment later. Here let me say that I see journals trying variously to fulfill several purposes (Table I). What we see here is a kind of spectrum of science as she is done. But note that our spectrum has three dimensions. There's the author and there's the reader but there's also the publisher; and each is working for his own end. Ideally, we'd like to see all three acting in perfect harmony, but that rarely, if ever, happens. As we'll see, to bring into harmony whatever discord there is in the literature is why we need literature scientists and editors.

Now, there's an interesting and often overlooked truism about journals. To create a journal all that one *requires* are authors; they're both necessary and sufficient. In fact, Gene Garfield has estimated that all it takes is 100 scientists to keep a journal filled.[1] The problem is, who'd read it? Readers are neither necessary nor sufficient to the *founding* of a journal. But to keep it alive they sure are nice to have. And that's where the publisher comes in. His job is to get authors and readers together while reaping a profit for himself. Since both authors and readers are notoriously tight-fisted, each thinking the other should pay the freight, publishers had to discover advertisers. Once the publisher has gained the attention of readers, he can sell that attention to advertisers and thereby feed the kiddies. His problem is that many of those who write in journals don't seem to care much about readers; ergo, few advertisers and the definition "a journal is a magazine that loses money".

Withall, however, the numbers and size of journals have grown prodigiously so that there are now over 10 000 of them in chemistry alone. That that truly is a prodigious number can be seen by a simple calculation. If there are 500 000 chemists in the world and each reads 10 journals regularly, that gives the average journal some 500 regular readers. With

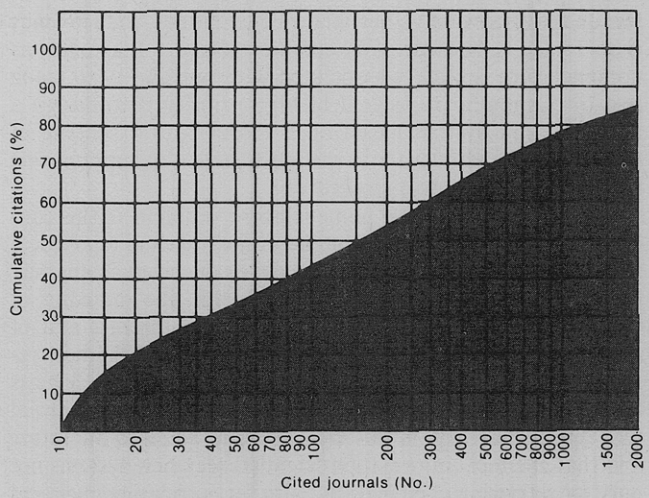

Figure 1. Distribution of references among cited journals [from E. Garfield, *Chem. Technol.*, 168 (March 1976)].

subscriptions as its sole source of income, a journal with that kind of circulation would have considerable difficulty surviving. If it were to try to, it would have to charge $250–500 per subscription per year. (I've noticed that some journals are doing just that.) But now, two interesting things happen. First, the publisher convinces the author that the foregoing analysis is valid, i.e., no readers of the kind of esoterica that he writes and thus justifies exacting a page charge. This the author pays more or less reluctantly because he needs to be published—not read, mind you—*published*.

Now the publisher goes to the libraries and convinces them that their clients can't survive without the esoterica that his authors write. Surprisingly, many librarians succumb and buy subscriptions. And, since there are 5000 to 6000 specialized libraries, a convincing publisher can create quite a market—for something few will ever read. Now, what's a poor librarian to do? He or she knows that only about 150 journals account for 50% of all citations (Figure 1). In 1973 only 39 engineering journals were cited four or more times.[2] But there's always the fear that that gem that the client needs this time is residing in something like the *Journal of the Manchurian Railway Association*. (I really found a key reference there once.)

Well, one thing the librarian can do is to make sure that he or she has access to a comprehensive indexing system *that works*. And one way to assure that is to initiate interlibrary comparisons of search procedures that are much like interlab validations of analytical procedures.

Getting something out of an index is often like looking up the spelling of a word. If you can't spell it, you can't find it. I've got a poor speller's dictionary that lists words in their most often misspelled form. But to my knowledge there's no similar index in science. Thus if you can't define the *real* problem, no index will help. People, therefore, must read. The library manager's job is thus to find out which journals are being read and keep them *accessible*. Now the problem becomes determining what is being read. Have you thought of using shelf counters? Lacking them, one can see how dog-eared a journal looks before it goes to the bindery. Or one can keep everything locked up—only for a while, of course—and analyze request slips. Or just lock up one journal at a time, or drop your subscription to it, and see what happens. Or note what's going back and forth on interlibrary loan or burning out the Xerox machine.

Certainly the last thing literature managers should do is to ask the client. What client is going to admit that he can no longer comprehend the *Journal of the American Chemical Society*? Nobody can admit that what his old prof is writing

really isn't very important. So the "get everything" syndrome is back.

Now, I hate to see librarians being stampeded into taking every journal that comes down the pike. They've just got to be professionally selective. And that's where they become kindred souls with editors. We're both gate keepers. Editors decide what gets published; librarians decide what gets bought. Suffice here to say that Editors who don't get bought don't stay Editors very long. And that's as it should be. (Chemists don't buy personal subscriptions any more, but that's a whole other sermon.)

Now, librarians have another problem; and, believe me, I appreciate it—my wife brings things home from garage sales, things we "might need" some day. Your related problem is what to do with the periodical you bought because somebody might need it—some day. Now, here I'd like to emphasize probably the most important thing I've got to say: *The literature scientists' prime function is to oversee the dissemination and use of the literature.* Husbanding it, caring for it, binding, shelving, and storing it are only means to that end. They are not ends in themselves. That's easy to forget that because overseeing storage and maintenance takes so much time and money. But remember a manuscript unread helps *no one.* Our job, yours and mine, is to take concepts from one head and put them into another. Thus, we really are here concerned with the journal's intellectual content, not its physical form. Nevertheless, I would raise just a few questions about trends in form, because it does influence intellectual accessibility.

Do you really know anyone who enjoys reading microforms or can do it with enthusiasm for any length of time? Have you ever pulled a journal off the shelf to finds its bulb burned out? Have you really calculated the cost to store hard copy figuring $5/yr/sq ft for storage and 10 ft of shelf piled on that square foot? Do you really think that paper and printing costs hurt that much? (Two-thirds of CHEMTECH's budget is for things other than paper and printing and we have a large circulation.) Is CAS helping anybody understand chemistry by calling acetone "XXVIII"? Those kinds of ploys may be fine for archivists but we're in business for *readers.* Remember?

Have you ever calculated the dollor value of your time in chasing a lost issue of something and compared that figure with the cost of having gotten an extra subscription in the first place? Take CHEMTECH, for example (I wish you would "take" CHEMTECH). An extra annual library subscription would cost you $50. If, when the time arrives to send it for binding, you find two monthly issues missing, how many hours and phone calls can you afford before you've blown that whole $50? Why not buy several subscriptions, one for the archives and the rest to disseminate.

The last time I was priviledged to address this Division, I recalled a bit of Molly Goldberg's advice: She said, "Every day give the child a smack. Why? You don't have to know why. He knows why". In your business it sounds like this. Instead of sequestering literature, buy an extra subscription. Tear out things you think are pertinent to your clients and send those pearls off in the mail. What's left send to people at random. Enclose your card saying, "Thought you should see this." Let them figure out why. When they do, and they will with surprising regularity (I'll demonstrate that shortly), you'll appear to be a genius. Rarely will it appear that you erred.

Now, with your continued indulgence, I'd like to explore a bit further into the tapestry of our profession because only by appreciating its texture can we grasp how the journal's function is interwoven. First, bear in mind that there is a dramatic difference between science and technology and that the large majority of chemists are really engaged in technology; the journal, as usually defined, is therefore largely written by and for the minority. Members of this minority ("scientists", usually in universities) are characterized by a strong inclination to work on whatever problem intrigues the individual and to do so more or less alone. Problems that can be handled in this way are, almost by definition, narrow. These misanthropic propensities of scientists lead the individual to identify with colleagues along disciplinary rather than organizational lines. Thus the most valued colleagues are often at institutions remote from one's own so that the written paper is the best way to communicate and gain approbation. Since these discipline-oriented people have selected exquisitely narrow fields of concentration, their journals are equally narrow. There thus tend to be many specialized journals, each with small circulation, relatively low page charge, but attendant high subscription cost.

Interestingly, you see the same motivation to fragmentation and specialization in ad-supported magazines. Here advertisers want to pay only for their message to go to potential customers, again a select, narrow group. But whatever the reason, fragmentation causes people, like Alvin Toeffler,[4] for instance, to worry about what's going to happen when each individual is reasoning from his unique data base. Then there are chaps like George Hammond who remark that even when two discipline-oriented people collaborate the view is so narrow that it's as though one scientist did the work and the other wrote the paper. Hammond says the result is little more than you'd get from one scientist working alone.

Now technology is different from science. It's englutenating rather than fragmenting. Its problems are created by society not by seminarians. Technologists thus identify with organizations each made up of many disciplines all of which come to focus on whatever complex, real world problem comes to hand. Because these problem-oriented folks are in daily contact with each other they communicate by means other than the printed page. In fact, in profit-oriented organizations there's great real or imagined economic pressure *not* to publish. I've thus heard an eminent engineer say, "If it were any good it wouldn't be in a journal." Although that statement has limited truth, the technologist's information base does give the journal only a minor role. Thus, only 15% of "idea generating messages" came from journals in the 19 R&D projects that T. J. Allen studied at the Sloan School.[3] Al Shapero, at The University of Texas, Austin, has similar more recent data that leads him to conclude that only those who write in journals are the journal's true customers.[4]

There's been a relatively new, major force in all this, and that is government—ours and the Russians'. Americans back at the time of Sputnik became panicked that our *engineering* was "behind the Russians". Logically, our government began to prime the pump by providing funds for graduate study—*in science* and for developing data it perceived it needed for its perceived missions, many of which have come under serious question. Well, we now no longer seem to be behind the Russians, but we've grown habituated to feeding at the government trough. And so we have as one symptom the move to Technology Transfer. That is a way of saying, "For gracious sake, will somebody please find a way to use these data that cost us a fortune to generate". Personally, I see government style Technology Transfer as a kind of waste management program. On the other hand, practicing chemists have been practicing pragmatic technology transfer for hundreds of years. If you need data to do what you want to do, you first ask everyone you know. If that fails, you go to the literature. If that fails, you go into the lab and get the data. In some circles that's called "market pull". You recognize a need and set about to fill it. The government's version of Technology Transfer is like a chemical venture based on "raw materials

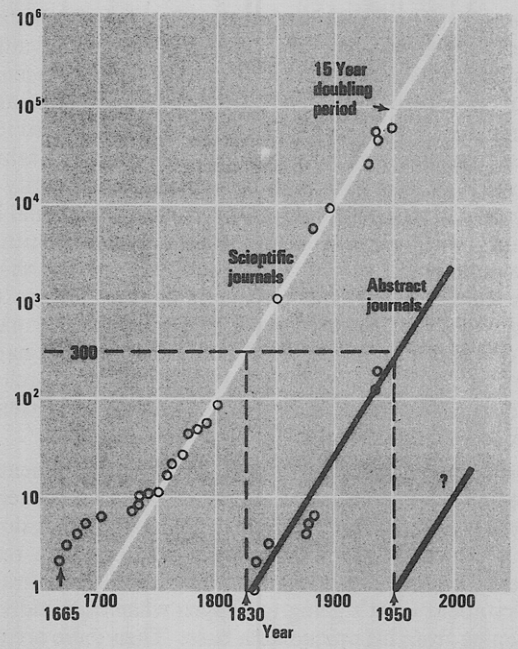

Figure 2. Growth of number of journals and abstract journals. Data are for total number of journals founded containing any science; the number of current journals is about half the cumulative total [from J. Butler, *Chem. Technol.*, 140 (March 1972)].

push", and I predict that it's doomed to fail. When the public realizes what's been going on, it will be very reluctant to pay for more "useless"—and that's in quotes—data. We are shortly—very shortly—going to awaken to the time-value of taxpayers' money invested in research that might be useful...someday. Just think of the dollar interest that's lost on each $100,000 program whose results lie unused year after year, or perhaps worse, whose results are perceived as useless. Senator Proxmire seems to be making a hobby of publicizing such programs.

All this gets around to the question of peer review. Who exactly is a peer? If a piece of work can be understood, much less appreciated, by only two people in the whole world, who, really, should pay to see that it's done? Take as an example of the problem of peer review the peers selected to judge Patty Hearst, a young, college-educated, millionaire heiress. The jurors may not have been her peers, but they sure were a cross section of American taxpayers. Can't such good people comprehend what *we* do? If they can't, who's at fault? Remember that bit about taxation without representation.

Well, it's now time to try to put this all together. People seem to have three driving needs: to survive, to reproduce, and to explore the unknown. If the first two go unfettered, if government continues to assure the economic survival of those who do whatever research they feel like doing, then journals will proliferate like crazy, particularly if governments subsidize the journals themselves. But I see a stronger and stronger damping mechanism coming into play. People are going to let it be known through the free market system and ballot box exactly what it is they do and don't want. If providing for their wants requires generation and dissemination of information, people will pay for it. But sooner or later they're going to decide to pay no more for pure science than they do for art or poetry or drama. When that happens some people will decide that they want to do research, or read about it, badly enough to pay their own way. Great! But I don't think those people will buy all the journals we've got as we know them. They'll want something else. I thus agree with Jim Butler's prognostication (Figure 2). He says that as primary journals spawned abstract journals, so too will they

Table II. Communication Systems after Thayer[a]

Features	Blocks
Effectiveness	Organizational
Economy	Interpersonal
Comprehensibility	Individual
Validity	Geographic
Usefulness	Temporal
	Legal political
	Channel or media

[a] I. S. Servi, *Res. Manage.*, 10 (1975).

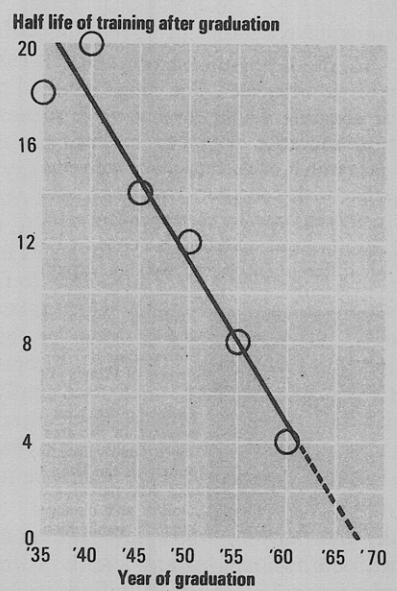

Figure 3. The half-life of a chemical engineer's training [from S. S. Dubin, *Chem. Technol.*, 394 (July 1972)].

spawn (are spawning) a kind of periodical whose content is selected in new ways. It will have the features and lack the "blocks" outlined in Thayer's 1968 book on Communication Systems (Table II). It will be conceived along *problem*, as opposed to disciplinary, lines: it will be *concept* as opposed to fact oriented; in short, it will be *reader* as opposed to archivist directed. Thus, as Dr. Skolnik has said what will be published will be worth publishing and worth reading. "In large measure it will comprise conclusions and paradigms that computer-stored data support." Key words for retrieval will be readily found in these papers rather than in the already over-long titles. And as Britain's Lionel Cross has pointed out,[4] topology will replace vain efforts to name things because people can read structures at least five times faster than they can digest the corresponding names.

I think that the growth rate of traditional journals will be attenuated by these pressures and that we'll see increasing utilization of other means of communication. I particularly see an increase in word-of-mouth communication not only because, as Diehl and Howell point out,[5] factural content thus relayed is reinforced by feedback and by conveyed emotional content, but also because so many citable scientists are alive. If you don't understand what they've written, you can phone up and ask for an explanation.

While this is happening, literature scientists will be called upon more and more to be the real peers. They will thus have to insist on their clients treating them not as "service personnel" but as professionals. They will have to probe more deeply, more sensitively, more knowledgably—in short, more professionally—into the real need of their clients. They will have to learn to recognize before anyone else does what is or may be relevant to those needs and then to supply that information relatively undiluted and in digestible form. In short, they'll have to do what Editors are really supposed to do.

Editors and their journals will change but slowly, and like phlogiston they will stay with us until something obviously better is proven.

Let me close with a figure which ties the whole thing together (Figure 3). Here Sam Dubin of Penn State correlates year of graduation on the horizontal axis, with, on the vertical axis, the time it takes for half the undergraduate engineering courses in that year's college catalogs to be replaced by other courses. He calls this period the half-life of a college education. As you can see, the undergraduate education of an engineer class of '45 was 14 years. The class of '65 became obsolescent faster, half-life 2 years. And in the '70's we see an apparent negative half-life. That means that this year's frosh have courses that last year's couldn't take. If you had any doubt about what people will be doing with their leisure when the 30-hour work week arrives, your answer is here. And where are they going to do it? In your libraries? With what? I think with something different from the traditional journal. Dubin estimates that today's engineer must spend 20% of his time reading just to stay even. How much time will future technologists need if the journal doesn't change or at least get supplemented by Butler-style periodicals?

Now, I promised you a demonstration of the value of an apparently irrelevant article torn from CHEMTECH and sent to a colleague. What we'll be doing is looking at the familiar in an unfamiliar way as recommended by de Bono's "Zig-Zag Thinking",[6] Gordon's "Synectics"[7] and Prince's "Mindspring".[8] My purpose is to demonstrate the value of *reading* and doing so over a wide subject range.

Please conjure up a picture of your most vexing problem. Got it? Now, open your dictionary *at random* and read the fourth word in the leftmost column. I don't know what the word will be anymore than you do, but I'll bet that you'll find that it has relevance to the solution of your problem, *if you think about it.*

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Status of Indexing and Classification Systems and Potential Future Trends†

CARLETON C. CONRAD

Information Systems Department, Central Report Index, E. I. du Pont de Nemours & Company, Inc., Wilmington, Delaware 19898

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Expansion of industry and government research programs beginning in 1920 constitutes the basis for the growth of proprietary research activities. Practical economies dictate that technical information from such research be readily accessible to its owners. Many new indexing methods have been developed during the past 30 years to attain effective storage and retrieval of these research results. This review cites five significant developments that appear to have had the greatest impact on the handling of technical information during this period. Contributions are assessed for both indexing and classification together with speculations on possible future trends.

The author of our keynote paper has set the stage by calling the period from 1943 to the present the Golden Age of chemical information science.[7] I cannot disagree that this recent 30 years or so has been a remarkable period, and one of high activity and much significance. For the purpose of my topic, which deals with the status of indexing and classification systems as applied to chemical information science, I will be turning back a little further—back to the end of World War I. I turn to this period because it was the time when a large-scale chemical industry began to emerge and grow. Concurrent with this industrial growth more and more money, energy, and scientific guidance began to be employed in keeping this industry moving steadily forward. Also, new commercial products had to be created, developed, manufactured, and marketed. This entire program demanded more research and development. Thus, for the first time great quantities of industrial chemical information began to be created: more information, more subjects, more chemicals, more people, more people changing assignments, a growing public literature in journals and books, and a growing internal proprietary literature. During this period of growth, the 20–30 years following World War I, a new information item began to unfold across the entire chemical industry. This new item was the industrial research report.

† Presented at the Award Symposium on "Contributions of the Division of Chemical Literature (Information) to the Chemical Society" at the ACS Centennial Meeting, New York, N.Y., April 6, 1976.

THE CHALLENGE OF NEW DOCUMENTS

The early industrial research reports presented no particular retrieval problems. They were normally treated as a conventional book, pamphlet, thesis, memorandum, or letter would be handled. The organization that produced them kept them, stored them, and hopefully indexed them and could retrieve them. This latter capability was important because each one of these reports had cost a great deal of time and money to produce. For these reasons, they were valuable documents. To recreate them would cost much money. To repeat the research that they summarized would be a large unnecessary expense, and consequently, most organizations were sooner or later faced with the need to develop efficient proprietary methods for handling access to this growing body of information.

In addition to the proprietary nature of this body of industrial research information, which meant there were no public or published indexes to its contents, this literature was