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Publishing of Primary Information

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Received January 9, 1985

The American Chemical Society was a prime force in developing computer-aided composition for primary journals. The *Journal of Chemical Documentation* became the first primary journal to be "typeset" by computer-aided photocomposition on a regular production schedule. Out of that work emerged the single coding–multiple use concept that influences much of today's thinking on the application of computers to information processing and retrieval. The growing sophistication and lower costs of hardware, software, and telecommunications plus the proliferation of personal computers may produce significant changes in the traditional author–publisher–user relationship.

In 1958 the publishers of primary journals were facing problems of coping with the steadily increasing volume of manuscripts offered for publication. A problem made even more complex by the impact of inflation on costs of publishing. As concerned as they were at that time, little did publishers realize how serious the problems of inflation were to become in a short few years. Both problems were solved through a steady diet of price increases, particularly to institutional subscribers, and by launching new, more specialized journals carrying fewer pages. In those years it was apparent there was considerable elasticity in journal prices as increases were accepted by institutional subscribers with little loss in circulation. Publishers have continued to rely on these two devices, but there is now increasing evidence that the upper limits of price elasticity are being tested. Current price increases are being resisted by cuts in subscriptions and greater reliance on alternatives: secondary services, interlibrary loans, photocopying, etc.

About 1958 several technological developments created new thinking on how the problems of publishing and processing primary publications might be solved by means other than by increasing prices and by starting new journals. First, a new technology, represented by a new concept in typesetting named the Photon, made its commercial debut. The Photon was described by its makers as a "high speed, typecomposing machine which produces in positive form, on film, printed matter which can immediately and easily be used for graphic arts reproduction."

Second, publishers began to get curious about the possible use of the computer in solving their problems. A curiosity that turned into intense interest when Mike Barnett and his coworkers at MIT announced that they had successfully programmed a computer to control typesetting through the Photon.[1] Potential for significant cost reductions in the composition of journals through a merger of the computer and photocomposition were recognized immediately. About the same time a concept began to form of a system of processing and disseminating scientific literature where a single coding in machine-readable form of the content of a manuscript at the start of the primary processing stage would provide access at all further levels of information use—abstracts, subject indexes, and author indexes; in fact, any and all levels of information need from keywords to full text.

But it would be the potential for reducing costs that would get immediate attention. For most average journals (3000–10 000 circulation) in 1958, approximately half of the total cost for composition, printing, binding, paper, and distribution was for composition. Thus, a 10% saving in the cost of composition for the *Journal of Organic Chemistry*, as we pointed out in 1958, would mean that 110 additional pages could be published per year with no increase in total cost.[2]

Then, still largely true today, the printing industry was not distinguished by its support of the development of new technology. New printing technology was more likely to be the product of publisher initiative. Consistent with this pattern, the Board of Directors of the ACS, aided in no small part by the coincidence that the Photon production plant was located about 10 min from the campus of MIT, the office of the then chairman of the ACS Board, authorized the purchase of a Photon for "investigative purposes". Cost reduction was the

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immediate goal.

The Photon excited us primarily because it was the first application of electronics to typesetting. It produced a film output in place of hot metal. The photo output was produced by timing the flashing of a strobe light through a rotating matrix disk containing 1440 different characters, a significant capability in the setting of scientific material. This "high-speed" device had a rated output of 30 characters/s. Actual output for manual operation turned out to be about eight characters/s. But this was more than twice the speed of any existing hot metal process. A feature of the new device, and a sign of things to come, was the ability of the Photon to relieve the operator of all justification decisions. In hot metal typesetting, about half of the operator's time was spent in making justification and hyphenation decisions at the end of each line.

But getting a new piece of equipment that had not yet had much field testing and making it productive, even in an investigative environment, were two quite different problems. The flavor of our early problems can be gleaned from these paragraphs in our first progress report to the ACS Board of Directors. The report was prepared in April of 1959 and probably is typical of most startup projects involving a new piece of equipment that has had little or no field testing, or what we nowadays refer to as beta testing.

> "The first six months of operation have been beset with more than the usual share of difficulties which seem to accompany the initial phaseses of any research project. For the most part, our troubles have been mechanical ones, although it took several months of frustration and anxiety to establish this fact."
>
> "We started off on the assumption that our problems stemmed from a lack of background and the inexperience of our operator. However, we began to find some basic bugs in the machine which had to be corrected. It is our feeling that these were either design or manufacturing faults, but there is no reason to believe that they are characteristic problems. We are now inclined to speculate that perhaps these are part of the normal problem of putting into production a piece of equipment of this unusual complexity, and it is indeed complex."

Some 16 months later, in a report dated August 1960, things looked more promising.

> "One hundred per cent of the material in the *Journal of Chemical and Engineering Data* is now being set on the Photon. During 1960 we will produce on the Photon over 560 pages of *JCED* and a target of 688 pages has been set for 1961. In view of the dismal outlook of a year ago, we feel this is a real achievement."

In addition, we had devised a method for setting multilevel mathematical material and chemical structures on the Photon. Equally important, our cost figures began to show that costs were approaching those of competitive hot metal typesetting. These cost findings were significant and rewarding, but they only served to whet our appetites for promise of even greater savings through the application of computer-aided photocomposition. The potential was strong enough to attract other publishers of scientific material and several commercial organizations, particularly newspapers, to undertake programs for developing computer-aided composition techniques. But it was equally clear that the potential of the computer in the typesetting of scientific journals and the relationship of this development to the larger problem of information handling required special attention.

"DO IT, FIX IT, TRY IT!"

The problem of finding a place to start was complicated then, as it is so often today, by the almost daily announcements of new devices that would make then existing equipment obsolete. Character-recognition devices to replace tape-punching typewriters, cathode ray tubes to eliminate editing problems, and photocomposing machines capable of speeds of 500 characters/s caused us to wonder about the usefulness of proceeding with an output device with an effective operating rate of about eight characters/s.

But these were announcements of new and untested technologies. In hand, the ACS had an electronically based photocomposing machine, the Photon, that seemed capable of handling most of the complexities of scientific composition, a tape-punching typewriter, and an IBM 1460 computer. Based on what we had leared from our own limited experience and what we had observed of the experience of others seeking to apply the computer in a variety of uses, there appeared to be much more to be gained by starting somewhere as opposed to waiting for theoretically ideal conditions. We were confident that whatever was learned would prove useful to the development of an overall system involving the role of the computer in the publishing of scientific journals. Thus, the decision was to conduct our studies of computer-aided composition with the resources we had on hand, as primitive as those resources may seem by today's standards. Without fully appreciating it, we followed the philosophy later to be stated by Peters and Waterman as "Do it, fix it, try it."[3]

Following are the assumptions and goals set as a starting point for the ACS investigation of computer-aided composition for scientific journals: (1) Pattern the computer-based system on existing procedures for processing manuscripts for publication. That is, we did not want to complicate our problems by fighting human interaction problems. Not yet, anyway. (2) Develop computer programs able to handle the variety of formats required in the composition of complex scientific material. (3) Build a system independent of input and output hardware. (4) Use available resources for initial efforts. (5) Test the system by actual production of one or more ACS journals.

The last of these preliminary goals was achieved when the first issue of the 1966 volume of the *Journal of Chemical Documentation* marked the start of the regular production of that journal by computer-aided photocomposition methods. Thus, JCD (now the *Journal of Chemical Information and Computer Sciences*), as befits a journal dedicated to the solution of the problems of handling information, has the distinction of being the first periodical primary journal to be produced on a regular production schedule by computer-aided methods.

An important factor in reaching this achievement was the cooperation of the editor at that time, Herman Skolnik. His willingness to take some risks with the production schedules and the typographic appearance of his journal was a significant contribution to whatever success resulted. Such willingness to take risks was as essential then as it is now to the successful implementation of new, untested procedures.

To the contributors and readers of JCD, the change in typesetting procedures was completely transparent. The publication looked like any other journal set in hot metal type. Authors received galley proofs and ordered their reprints just as they always had. Any impact on authors and readers was to come much later.

In the opening paper of the first issue of the 1966 volume of JCD, we described the computer-aided typesetting procedures used and presented the achievement as "an important first step in evaluating the encoding of scientific manuscripts into machine-readable form at the time of primary publication."[4] Getting to that point in computer-aided composition was largely a matter of writing programs to handle justification, hyphenation, and multilevel mathematical material. It is worth noting that all aspects of hyphenation have not been solved to the satisfaction of all. Sometimes we solve a problem by changing our values as to what is acceptable. Thus, it appears that today's reader is willing to accept hyphenation decisions made by the computer that would have marked the editor as illiterate just a few years ago.

MAKING IT WORK

Some specifics of the early efforts of ACS may be worth recall since they are as applicable to the solution of today's problems as they were some 25 years ago. First, ACS had the good fortune to be able to put together a team of people with just about the right mix of deep understanding of the requirements of scientific publishing and of outstanding programming skills. The absence of such a mix can make the taks of achieving results difficult if not impossible. In an early joint venture with IBM to develop computer-aided composition, we found ourselves in almost constant disagreement as we tried to convince them why we needed the capabilities we said we needed, and they in turn sought to convince us to accept what they felt their computer could provide. Before too long they gave up on us and abandoned their efforts with the 7090 and later the 1620. We then attacked the problem with our 1460.

The 1460 was a more powerful version of the 1401. It had a 16K memory, and fortunately, it was exceptionally well equipped with peripherals as those things were measured in the early 1960s—two disc storage drives, four magnetic tape drives, a paper tape reader/punch (one the very few available), a printer, and a console typewriter. Still, the 1460 was too small to handle the coding required for a typesetting program. Our programmers solved the problem by developing a modular system of five independent programs controlled by an operating system using available hardware equipment for various input–output operations. Thus, our system contained the basic

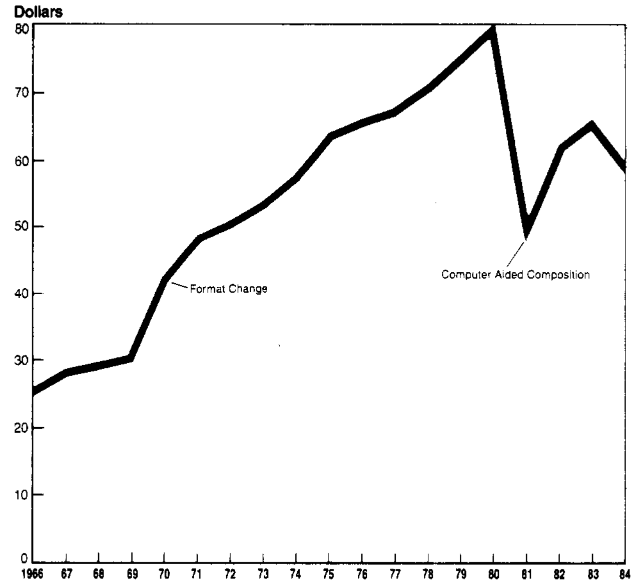

Figure 1. JACS composition costs per page 1965–1984.

operating features of the larger 7090 and the logic that was later built into the operating system of the 360 series of computers. When the 360 became available, our typesetting programs were adapted to the 360 with little effort.

By 1966 the achievements of the ACS and parallel advances made in the commerical field made it clear that computer-aided photocomposition was a reality. Less than 15 years later, computer-aided photocomposition has almost completely replaced hot metal typesetting for all but a very few specialized applications, even though we still use the terminology of hot metal composition and still refer to our efforts as typesetting.

The conversion to computer-aided composition provided not only cost savings (see Figure 1 for the impact of the conversion of the composition costs of the *Journal of the American Chemical Society*) but also new promise for the processing and use of primary information. When computers are used in the typesetting process, typesetting becomes a byproduct of the process. Instead of the keystroke, or its equivalent, leading to the selection of a matrix for casting in hot metal or exposure on a film, the keystroke now results in a digital record on a magnetic tape or disc, which the computer can read and manipulate at high speeds. This very basic change in the product of the keystroking process opened up new approaches for the role of the computer in scientific publishing.

The thinking of many was expressed somewhat eloquently by the chairman of a session on Computer Applications in Scientific Publications, sponsored by the National Science Foundation:[5]

> "The basic concept of a single keyboarding of machine-recording of text material at the manuscripts stage is fraught with exciting implications. Consider, if you will, the machine-recording of text material at the manuscript stage of all necessary elements of data and information that will permit, in addition to the composition of the article itself, the subsequent derivation of secondary information—such as indexes, abstracts, bibliographic listings, and the availability in machine-usable form of such information for storage and search in mechanized retrieval systems."

As to be expected, there was not universal acceptance of this thinking. Particularly, there was skepticism as to the eventual solution of such technological problems as sufficient storage. In addition to concerns over technological problems, there were, not unexpectedly, the internal and external political problems that accompany acceptance of any change. But the trends that were developing confirmed the thinking that the encoded primary manuscript would take on a new role in the future: (1) Computers were becoming faster and cheaper. (2) Storage capacity was increasing and becoming more efficient and cheaper. (3) High-speed composition devices were being developed and being implemented commercially. (4) The continuing rise in prices for journals and information services would open up new opportunities for the development and implementation of alternative methods of processing and disseminating information.

WHERE ARE THE RESULTS?

What has happened to our expectations that a digital record, developed at the start of primary publication, would provide access to a whole spectrum of information services? While CAS began application of the single coding–multiple use concept in-house as early as 1967, it was not until 1980 that all of the primary journals of the ACS were being produced by computer-aided photocomposition. Thus, it is only recently that the availability of the full text of primary journals in digital form, those of ACS as well as of other publishers, could be exploited for use beyond the printing of journals.

A review of the availability of full-text data bases has been prepared by Carol Tenopir.[6] She reviews discussions of the pros and cons of full-text searching and concludes "research efforts have been hampered by the lack of suitable full-text databases." But there is need to look at full-text data bases as much more than as a tool for retrieval of information. The role in developing new approaches in serving needs for current awareness may be of equal or greater importance.

A most welcome step was the availability of an on-line file of the full text of the 18 ACS primary journals in June 1983 through the facilities of Bibliographic Retrieval Services, Inc.[7] Only by exposing users to an actual full-text service and the ability to search every word in full-text files can a positive evaluation be obtained of the role of encoded primary articles in meeting needs for secondary information functions. Only the users can tell us what they want, how they will use the system, and how much they will pay for it.

In the fields of business and general-purpose publications, users are accessing full-text data base services in sufficient volume as to make such activity profitable for at least one of the principal vendors in the field, Mead Data General. In addition to their long-established full-text data base for the legal profession, LEXIS, they have added a general/business full-text service called NEXIS. It contains the full text of newspapers, magazines, wire serive output, and newsletters totaling over 110 publications. Also included in NEXIS is an abstract service published by the *New York Times* covering 120 publications. Government documents are also available as well as political information, the *Encyclopedia Britiannica*, financial information on over 1600 corporations, and LEX-PAT, a service containing information on all patents issued since 1975. Increasingly, full-text data bases are being made available by a number of vendors.

Many newspapers are making effective use of the single coding–multiple use concept. Today's newspaper is encoded at the console of the reporter, either in-house or directly from a field location. The reporter's initial keyboarding of a story goes directly into a central data base and requires no further keystroking except for corrections or additions. All editing, typesetting (computer aided, of course), and platemaking for the printing of the paper are the product of the digital record created by the reporter. The final digital record is now finding use after publication of the paper. For example, the *Washington Post* now makes its final tapes available to several secondary vendors. Other vendors purchase synopses of the day's major stories as prepared by a separate *Post* staff. The *Post* sees a significant source of revenue in the sale of these postpublication tapes.

The whole concept of office automation is undergoing change as the realization grows that the objective is not more effective word processing but the entry of data into organizational data base systems to serve an increasing variety of organizational information needs. As part of this change, we see the typesetting function being moved into the office as word processing equipment become more widely available and hardware for producing graphic arts quality output becomes cheaper and easier to use. Today an increasing number of printers offer no typesetting services but depend entirely on the prepress images provided by their customers.

As part of this movement an increasing number of manuscripts intended for primary publication are being prepared on word processing devices in the research laboratories of the nation. In 1978, King and his colleagues estimated that by the year 2000 nearly all article manuscripts would be handled by word processing and text editing systems and therefore could be sent to publishers in digital form.[8] A more recent paper by Case reports a study by the American Association of Publishers estimating that by 1985 80% of scientific and technical manuscripts would be prepared on word processing devices.[9]

The direct use of author-encoded manuscripts for primary publication is feasible. But as Case points out, "a major problem lies in the incompatability of various systems." We can anticipate that these problems will be solved if there is sufficient incentive in cost savings. Any potential saving is greatly reduced if the necessary typesetting codes must be added by the publisher. Case reports on several groups working on the problems of standards as well as internal representations that will standardize the addition of typesetting instructions. Once progress is made in these two areas, we can expect to see rapid movement toward the direct use of author-encoded manuscripts in primary publishing.

Whether or not the on-line availability of the full text of scientific manuscripts is the answer to the problems that have troubled the publishers and users of journals these past 25 years—growing volumes of papers and inflationary pressures on costs—is too early to say. But we can note some trends that favor the successful utilization of on-line full-text services. For example, increasing prices have tended to eliminate personal subscriptions to journals and are now beginning to impact institutional subscribers. This creates information gaps that may be filled by full-text services.

Possibly no influence will prove any greater than the increasing power and availability of personal computers. Current estimates put the number of PC's at 70 million by the end of 1987. Each such computer provides an access point, a customer if you will, for on-line full-text services. Where once we felt searching would be conducted largely by intermediaries because of the complexities of command languages, it is now apparent that use of on-line full-text services can and will be done by individual users. Command languages are becoming simpler, and what problems there remain about differences in command languages will be resolved.

In the final analysis, on-line full-text services will succeed because they will provide through one access point all of the information services scientists require from the published literature. Further, they will be able to do this in a manner consistent with traditional use of the literature. For example, a user picking up a new issue of a journal subconsciously asks the question "What's new?" The "new" is not obtained by a reading of the full content of the journal but rather by a variety of means for browsing. Some look only at the contents page; others look at abstracts; others leaf through. On-line full-text provides exactly this same capability, with the exception that the user now asks literally "What's new of interest to me?" The "new" could be presented as the user wishes—table of contents, abstracts, authors, conclusions, or an almost unlimited number of combinations. Access is at the user's convenience, and as the user wishes, as much as they want of the "new" can be stored away in his or her computer files.

Throughout this paper it should have been apparent that I have assumed author–publisher relationships remain unchanged from the present pattern. We must consider that the test of the marketplace, that is, actual usage of on-line full-text services, may change that relationship. With a network of millions of personal computers it is not unthinkable that methods different from the traditional procedures of publishing the scientific literature may evolve. As a guess, I would look to some form of networking arrangement involving author, user, and publisher nodes. It is also conceivable that the publisher node would be quite different from that we know today. However, it is another indication that on-line full-text capability holds the prospect for some innovative developments.

As Lerner and her co-workers stated recently:[10]

> "It seems certain that within the next five years more authors will be able to produce machine-readable manuscripts and will have access to computer networks to distribute these manuscripts. Traditionally, the role of the publisher is to safeguard the quality of the archival literature as well as ensuring the widest possible distribution. If control over distribution, service, and pricing is lost to others, such groups may no longer be entitled to call themselves publishers."

To those who say it will never happen, as many told us 25 years ago; consider these thoughts of one who has spent a considerable part of those 25 years in studying the development of information handling, Vincent E. Giuliano:[11]

> "By the year 2000 [only 15 years away] memory and processing power should be so cheap that they will no longer be limiting factors in the cost of information handling: they will be available as needed anywhere in the organization. The next 20 years will also see the continuing extension of high-capacity communications, of networks for the exchange of information between work stations and other computers and of centralized data banks. Together these developments will provide access to information, to processing capacity, and to communications facilities no matter where the worker is or what time it is."

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Copyright: Past, Present, and Future

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Received March 13, 1985

Papers and comments on copyright issues have appeared in the *Journal of Chemical Information and Computer Sciences* as early as 1962, when the journal was known as the *Journal of Chemical Documentation*. Through the years, the American Chemical Society's Joint Board-Council Committee on Copyrights has cosponsored, with various ACS divisions, symposiums on copyright. Papers presented in these forums and later published in the journal have focused on the developments and controversial issues of copyright, as well as their impacts on the chemical community. In this paper, copyright basics are presented, followed by summarizations of copyright concerns that have appeared in the journal. A brief discussion of the future of copyright concludes the paper; copyright will prevail.

In his editorial in the January 1961 issue of the *Journal of Chemical Documentation*, Herman Skolnik, then editor of the journal, described the history of this publication, which later became the *Journal of Chemical Information and Computer Sciences*. He said that even more important than having the journal play a role in the recognition of chemical documentation as a discipline of chemistry was the "objective for the journal to be the forum for a continuing body of literature which contributes to the art and sciences of chemical documentation and to its understanding and advancement." Fortunately for all of us in the information field, copyright has been and continues to be included in this important body of literature.

Papers on copyright that have been published in the *Journal of Chemical Information and Computer Sciences* (hereafter referred to as JCICS) during the last 25 years have provided a focused overview of the important impacts of copyright developments on chemical-information transmission and use.

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