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## Special Report: Scientific Communication

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*The latter half of this century has witnessed a proliferation of scientific information as well as remarkable advances in ways of communicating that information. Both researchers and policymakers throughout the Americas need knowledge about the new technologies that are available in order for their countries to fully participate in this information revolution and reap its benefits. To address that need, the "International Seminar on the Challenges of the Information Era: Agents and Users" was held in São Paulo on 18–20 October 1994, under the sponsorship of the Pan American Health Organization and PAHO's Latin American and Caribbean Center on Health Sciences Information (BIREME).*

*One of the round tables at the seminar focused on scientific production and quality recognition. This special report features the text of presentations given by two members of the international panel of experts who participated in the round table. The first, by Dr. Edward Huth, deals with the implications of new electronic publishing technologies for the producers and consumers of scientific information. The second, by Dr. Eugene Garfield, explains how quantitative analysis of scientific publishing in different countries can elucidate national research policies and be useful in guiding them.*

### Electronic Publishing in the Health Sciences

EDWARD J. HUTH<sup>1</sup>

In electronic publishing, we are where the automobile industry was around 1910. Automobiles were beginning to be built in steadily increasing numbers. Many different makes could be bought; some were good and some were not. They had different designs. They were bought and used by only small numbers of persons. Many buyers were automobile fanatics;

some, persons wishing to be ahead of their fellows in style of living; a few, persons needing them for real jobs. Skeptics were everywhere. "Who wants to ride in a smelly and noisy machine?" "Nobody needs to go so fast!" "What is wrong with trains and trolleys?" "Automobiles are too expensive!" In time, some kinds of automobiles disappeared while others came to dominate the market, their manufacturers becoming the main producers. More and more persons became owners and users of automobiles, and they were used for more and more purposes—short trips, long trips, to carry persons, to carry goods.

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Today, more and more electronic devices and methods are being applied in many ways to distribute information of many kinds. Hardly two or three months go by without some new system or new possibilities within existing systems being introduced. We probably would all agree that the transmittal of information by electronic methods will surely increase. Our only uncertainties are as to what systems will dominate, how quickly, what they will be used for, and how many persons in our populations will use them.

## VARIETIES OF ELECTRONIC PUBLISHING

Too many kinds of what has been called "electronic publishing" are now operating to describe them all in detail. But the following survey of what is going on will help to sharpen the focus on what true electronic publishing is and might become.

### The CD-ROM

First, there are CD-ROMs (compact disks—read-only memory). Everyone knows the compact disk as the medium for music. This medium is also growing as a major method of publishing. A typical compact disk serving as the digital equivalent of a book can carry all of the text and illustrations of a large encyclopedia. CD-ROMs can be read, of course, only through a computer. The format has the advantage of permitting rapid jumps around in the text and carrying action pictures, not just static illustrations. Some CD-ROMs can now be regarded as true electronic publications: they are not paper publications simply transferred to CD-ROMs, but rather are text, illustrations (still, moving, or both), and their linkages prepared specifically for the medium.

The present use of CD-ROMs likely to have the greatest interest for health-science

librarians is the issuing of CD-ROMs carrying journals previously or simultaneously published in the conventional formats of issues and volumes. The disks, however, carry all the issues for, perhaps, three or four years. The disks are not issued with the same frequency as individual journal issues but at some interval, for example, quarterly or yearly. The leading publisher in the health sciences with this kind of system is the American Society for Microbiology. Subscriptions to its journals—for example, the *Journal of Bacteriology*—are available for both a paper version and a CD-ROM version. The CD-ROMs are produced from the same basic electronic text used to compose pages for the paper version.

Having journals available in this format may be a great value for libraries. A single disk can reduce the space needed for storage of a group of back issues of a journal from a meter to a centimeter. Another advantage is the probable longer survival of such disks in libraries with climates damaging to books and journals published on paper. It should be noted, however, that thefts of CD-ROM disks might be relatively easy and could represent substantial losses. A variation from the single-journal CD-ROM is the CD carrying a group of closely related journals, a format more likely to be useful to researchers than to librarians.

### Electronic Document Delivery

As with the CD-ROM medium, systems for the electronic transmission of documents (for example, journal articles) have so far been applied mainly to making available, on request, texts that have already been published by the conventional system of ink on paper. The texts of the documents to be delivered are stored as computer files that reproduce the documents as they appeared in the paper journal or book.

Several systems (1) of this kind are operating, some of them still experimental. One system is TULIP (which stands for *The University Licensing Program*). It makes available papers already published in 43 Elsevier and Pergamon journals. A trial of this system is under way in nine major U.S. universities.

A second system is that called Red Sage—a curious name, one borrowed from the Washington restaurant in which the system was conceived. Red Sage makes available papers from 24 Springer-Verlag and 16 John Wiley journals. Several major clinical journals will probably be added soon to the initial list. Red Sage is being tried at the medical school of the University of California, San Francisco.

Other major systems of this kind include that being run by the Institute of Electrical and Electronics Engineers, the system called Faxon Xpress of Faxon Research Services, and Primis of the publisher McGraw-Hill.

These delivery systems cannot truly be called “electronic publishing.” What they deliver are documents already published in paper journals. In general, the user must know the document he or she wants through having found a reference in an independent bibliographic indexing system or searching the system’s own index. One system (Red Sage) does transmit images of journal covers and tables of contents, a capability that permits the kind of scanning that goes on in libraries now. These systems could, however, represent a transition to journals published only electronically and no longer on paper.

The development of these systems does raise important questions about the economics of journal publishing and, probably, about the shifting functions of libraries.

If most users of journals in libraries go there only because they need to get particular documents and such systems can rapidly deliver those documents, libraries will not have to subscribe to and

shelve some paper journals. Then, as subscription orders from libraries fall, the income generated from individual subscriptions may not be enough to sustain publication on paper. To compensate, a delivery system will have to raise the rate it charges per document and pass more profit to the publisher, or the publisher will have to raise the charge for the paper version, perhaps to the point where the market for the journal vanishes.

The changes for libraries could be great. A library serving mainly as a place to receive and house journals could become mainly the academic equivalent of a retail store. The scholar goes there not to look at paper journals (new issues or bound volumes), but to “buy” a particular item, the paper he or she needs. Librarians then become experts in knowing who can supply what, in what form, how fast, and for what price. One can imagine that libraries would not even be visited; a telephone call to a librarian to request a document or documents on a subject would suffice. The librarian executes the order and delivers the document.

## Electronic Journals

The systems I have described so far do not represent true electronic publication in the most specific sense. They are derivatives from the publication on paper that is now the originating step in making scholarly documents available. How soon will scholarly publication move to a system of solely electronic publication? This would be a system in which the author prepares the document, makes it available in a digital electronic format, and has it published—which is to say made publicly available—in an electronic medium and only an electronic medium. Because a major fraction of scholarly documents are, and for the foreseeable future will be, articles in scholarly journals, the question narrows down to that of the future for electronic journals.

## ELECTRONIC JOURNALS, TODAY AND TOMORROW

Electronic journals are being published. Some follow the convention of "issues"; they provide groups of newly published papers at some time interval. Others make each paper available as it is ready for publication, abandoning the "issue" format. But the number of electronic journals is small. It is much smaller than one might guess from the huge numbers of persons in the United States using electronic network systems, either an open system, notably the Internet, or a commercial subscription system, for example, America OnLine and CompuServe in the United States.

The best source at present for a survey of electronic journals currently operating is the directory (2) that has been published annually since 1991 by the Association of Research Libraries, which has its office in Washington, D.C. The edition issued in May 1994 lists 181 electronic journals. Only a few of them pertain to science or applied science (such as clinical medicine or nursing). Among the scientific disciplines, mathematics leads the list: seven journals. As of May 1994 medicine had three electronic journals; astronomy, one; biology, one (a journal of botany); and psychology, one. Most of the listed journals are in the humanities or are what I call "organs of special subcultures": journals that deal with various blends of social rhetoric, politics, and similar kinds of content that can be called "scholarly" in a loose sense.

Why is science—now such a huge scholarly enterprise—represented by so few electronic journals?

### The Conditions Favorable for Starting and Building a Journal, Electronic or Paper

Journals are born and thrive under certain conditions. An analysis of those con-

ditions may tell us when electronic journals are likely to be started and to have a good chance of continuing to exist. My analysis begins by pointing out that scholarly journals represent human activities, are human institutions, and are influenced by human desires.

In my view, the conditions determining the use of journals are basically economic conditions that shape human choices and behavior. I mean "economic" in a broad sense that covers "needs," "utilities," and "costs." These elements need not be directly represented by cruzeiros or yen or dollars. A convenient way to proceed is to state a basic equation that can be used to represent these conditions and how they interact.

$$\text{The Value Equation: } \text{Value} = \frac{\text{Utility}}{\text{Cost}}$$

The user, or potential user, of a journal, whether an author or a reader, has one or more needs. The "value" of a journal is the user's estimate of the desirability of using that journal to fill the need or needs. "Utility" is the estimate of how closely what the journal provides matches the need. "Cost" is what the user has to put out to get the estimated utility.

The components of the "utility" and "cost" terms in this value equation may differ greatly for authors and subscribers.

For authors the main utility is probably getting one's name and the evidence of one's work seen by the largest possible number of persons whose recognition has value for the author. Visibility is what is wanted for a paper, not obscurity. And it must be visibility in the right kind of place. In most communities it is more useful to be seen coming out of church on Sunday morning than coming out of a brothel. Likewise, in medical publishing it is far more valuable to place an article in *The New England Journal of Medicine* than in a journal that has to be given away, even if both have the same number of readers. The giveaway journal is

probably ignored by the academic brethren whose recognition is sought; those brethren read, or at least scan, *The New England Journal of Medicine*. If the author knows that a paper is unlikely to be accepted by a highly visible journal with a large circulation, then he or she will go for publication in a journal known to be seen by other colleagues in the same field. This can be a small-circulation journal with high visibility among the persons whose recognition is valuable.

For readers, utility differs widely among investigators, academic physicians, and nonacademic physicians, and I shall not try to analyze those different utilities here. The cost factors may be more critical. The term "cost" represents much more than the subscription price. It can include, for example, whether a journal is delivered right to your desk or you must go to the library to request a copy of one article and wait for it to arrive to pick it up—a time "cost."

A thorough analysis of whether to start a new journal will lead to estimates of how effectively it is likely to meet the needs of a defined group of authors and a defined group of readers. The fact that the health sciences so far have only a tiny handful of electronic journals suggests that publishers have estimated that they are not likely to be seen right now as highly useful by enough authors and readers.

### *The Values of Electronic Journals for Authors*

Electronic journals can offer authors some values that paper journals cannot. They make a paper available to subscribers as soon as the paper is accepted in final form. That difference can save two, three, or more months, the typical time needed to get a paper journal composed by the typesetter, its proof checked and corrected, and the journal printed and mailed. But how important is that savings of time for authors when the edi-

torial and peer-review processes take just as much time as they do in paper journals?

Electronic journals do not have the cost constraints on lengths of papers that are imposed by the cost of the entire printing and distribution process; hence authors can publish papers that carry all that they wish to say and that the editor agrees is relevant to a full report by the author.

Electronic journals can serve as a continually growing archive of papers published, so authors might like the idea that readers will have ready access to their papers in the future.

The lesser visibility of electronic journals is their present weakness in the view of authors. No one sees an author's paper until a computer is turned on, the journal selected, and the paper called up. Unless the reader is willing to read the paper on the monitor screen, the paper has to be printed out or a printed copy ordered. In contrast, paper journals go through the mail and arrive at the subscriber's desk, or at the library where someone puts the journal on the display shelf. The subscriber to the paper journal can be relatively passive; the reader's cost in effort to see the paper is substantially less. This difference in "cost" for readers of electronic journals probably works against the visibility sought by authors.

### *The Values of Electronic Journals for Readers*

Electronic journals can offer readers some values not available from paper journals. Probably the greatest value comes with the so-called hypertext function. It is easy in an electronic journal to link parts of papers to each other so that rapid jumps can be made within the paper. If the reader wants to know what cited document is used to support a point made in the text, an immediate jump can be made to the cited reference. The hypertext link is even more valuable for linkages among separate documents. If a

letter to the editor comes to the journal with a substantial criticism of a paper it has published, that letter can be published with linkages to and from the paper in question. A reader of the letter can go directly to the paper criticized; a reader of the paper gets a signal that a subsequent comment on it is available and can call up that comment.

Another value for subscribers is the accumulation of published papers. There is no need to save piles of journals or spend money on having them bound.

### **The Present Paucity of Electronic Journals in the Health Sciences**

From the present tiny number of electronic journals in the health sciences and related fields one must conclude that both professional societies and commercial publishers so far see too little value in electronic journals for authors or readers. Part of the problem is that some publishers may be waiting to see how successful electronic journals become and do not wish to risk making the wrong judgment on how to proceed. I have no way of knowing whether reluctance to start electronic journals is due to careful analyses of author and reader needs along the lines I have suggested above or merely fear of the unknown. Mistakes can be costly. In the case of the electronic journal for which I served as the originating editor, *The Online Journal of Current Clinical Trials*, published by the American Association for the Advancement of Science (AAAS), I believe that some misjudgments were responsible in part for its failure to build up an adequate following among authors and readers. First, characteristically (and historically) new journals get started when a new scientific field becomes large enough to support a new professional society to represent it. Then the members of the society, frustrated with trying to get their papers readily published in existing journals, launch their own journal, which will

guarantee visibility for their papers, at least among their peers. The AAAS did not have such a constituency; most of its "members" are simply subscribers to its weekly journal, *Science*.

### **What Is the Future for Electronic Journals?**

Electronic journals are going to develop and continue to grow in number when the right conditions exist to enhance their value. These conditions will be in place when publishers and professional societies become aware of the excessive costs of paper publication for small audiences, when transmission systems are faster and can transmit more complex images, when a critical number of potential readers have receiving facilities, and when the discomfort of authors about the "invisibility" of their papers gives way to the appeal of faster publication and larger audiences for electronic journals.

I see two main lines of development.

Small professional societies wishing to start a new journal that will almost certainly have only a small audience may be persuaded by publishers of the cost advantages of electronic publishing. So we will probably see more electronic journals launched as scientific and clinical disciplines continue to divide into new small disciplines.

Second, existing paper journals will begin to use the electronic format for secondary, though advantageous, purposes. These uses could include publishing accepted papers through an electronic channel before the paper journal carries them. That way, readers eager to see particular papers could pay a small premium to get them, while readers using journals mainly for "scanning" and "awareness" needs would be content to wait for a few more weeks for the paper journal. Such shifts will probably begin if the "document distribution" systems discussed above become more economically self-

supporting and demands for the paper journals they represent go down.

## CONCLUSION

As electronic publishing grows, it will have effects on authors, readers, and librarians. Some of these are already occurring. Authors are increasingly expected to supply manuscripts in digital form for paper journals, and journals' needs of this kind will grow. Readers who require the latest information will have to learn how to get it through electronic channels. Librarians will have to keep informed on what electronic journals are

launched and how they should be handled for their clients; new kinds of problems may arise in management of costs.

This is my sketch of what is going on now and my guess as to what is ahead. I should like to be alive 50 years from now to see how it all turns out!

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# Quantitative Analysis of the Scientific Literature and its Implications for Science Policymaking in Latin America and the Caribbean<sup>2</sup>

EUGENE GARFIELD<sup>3</sup>

I have been asked to address the methodologies that I and others have developed over the years—mainly using the *Science Citation Index* database of the Institute for Scientific Information (ISI)—to

examine the productivity and impact of scientific research in individual nations and regions of the world. I will also discuss how these techniques could be used to formulate and reinforce successful

<sup>2</sup>Based on a lecture titled "Publication and National Research Policies: Quantitative Analysis of the Scientific Literature and its Implications for Science Policymaking," delivered on 19 October 1994 in São Paulo. A number of the charts used to illustrate the lecture, copies of which are available from the author, are not reproduced here because of space limitations. These include productivity, impact, and citation data for Argen-

tina, Brazil, Chile, Mexico, and Venezuela, with graphical comparisons for specialties such as molecular biology, neuroscience, pharmacology, etc.; lists of most cited Latin American authors and papers in clinical medicine; and citation analyses of tropical medicine.

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