

THE IMPACT OF ELECTRONIC PUBLISHING ON THE COMMUNICATION OF SCIENCE

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ABSTRACT

Scientists have always been major users of computers and networks as part of their research involvement. Hardly surprisingly, they have therefore also pioneered the use of information technology as a communication channel. A shift from print to electronic communication in science is currently under way. The question examined here is how this will affect scientists (as both authors and readers) along with publishers and librarians. Electronic journals are used as a case study, since their numbers are beginning to grow rapidly. It is concluded that an extended transition period from printed to electronic sources can be expected, which will make information handling more complex for all participants (though perhaps especially for librarians).

Keywords: Electronic publishing; Scientific research; Electronic communication; Electronic journals; Libraries; Communication in science

INTRODUCTION

Information technology is currently making an impact on scientific research in two senses. Computers and networks are affecting both the way the actual research is carried out and also the way in which it is communicated. Though the interest here is in the second activity, it is worth noting at the start that there is not a clear-cut division between the two. A good example is work by chemists on molecular structures, where computer-based modelling is the norm. The programs used for such investigations also provide a basis for retrieving specific molecular structures and related information about them. Another totally different example of

such interaction is access to electronic communication. Most scientists acquire access to computers because it is necessary for their research. Having gained such access, they soon realise the flexibility it offers for communication with each other.

The overall interaction is well illustrated by developments in high energy physics. Experiments in this area have long involved a large amount of computer use, and are now highly automated. At the same time, the conditions encourage innovative approaches to communication. The community is relatively small in number; it expends large sums of money per researcher; and it

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is often necessary to communicate research results rapidly. Hardly surprisingly, high energy physicists have become enthusiastic users of electronic communication. One example is the World Wide Web, now the standard way of accessing the Internet. This was created originally at CERN, the European high energy physics laboratory, as a way of handling distributed databases. Another example is the provision of electronic preprints of articles. This started in pre-Web days using electronic mail distribution. Now it is run from the Web site at the Los Alamos laboratory in the USA. Such preprints are clearly seen by the community as more valuable than the old system of distributing hard copy preprints, and it is also quicker. Hard copy distribution could only go to named individuals, whereas the electronic database of preprints can be accessed by anyone who has a networked computer. Indeed, the value of electronic preprint distribution has been recognised by other groups besides the high energy physicists - for example, most areas of physics are now using it.

It is still true, even in developed countries, that not all scientists have access to networked computers on their desk. The last three words here are important as there is considerable evidence that computers are used much less for communication if they are not immediately to hand. Even those scientists who do have access to electronic networks may not use them: though most who have electronic mail facilities now value them. There are considerable variations from subject to subject. Basically, the more conditions in a subject are like

those in high energy physics, the more likely electronic communication is to be used. For example, a survey of British biologists carried out in the mid-1990s found major differences between members of a university agricultural faculty and staff of a commercial pharmaceutical laboratory (Rolinson et al., 1995). About half of the former group did not use electronic mail, whereas there were no non-users in the latter group. Similarly, two-thirds of the former did not use online databases, as compared with only a third of the latter.

The extent to which scientists use electronic facilities obviously depends, in part, on the relevance of the services and information sources that they provide. One problem with the rapid expansion of electronic services is that many scientists are not aware of what they now offer. But level of use can also depend on the range of services available. For example, biologists have tended to use CD-ROMs as information sources more than other scientists. The main reason seems to be that the extensive range of biological information sources now available in this form are helping to overcome the traditionally fragmented nature of the biological literature. Again, level of access can depend on the user-friendliness of the electronic facility involved - something that will be discussed below in the context of the electronic journal.

Apart from research-related reasons for using electronic communication, external pressures, too, are playing a part. Many scientists, especially in universities, are subject to financial restrictions that affect

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their communication activities. For example, in the survey of an agriculture faculty mentioned above, nearly a third of the respondents reported a high level of restriction on attendance at conferences and over a quarter reported a similar level of restriction on the use of telephones for long-distance calls. Under these circumstances, electronic facilities offer an attractive alternative route for communicating with colleagues. Scientists in Eastern Europe provide a good example of this. Economic problems there have curtailed not only such activities as attendance at conferences, but even access to Western publications. For them, communication via electronic networks has proved a vital alternative source of information.

Where scientists are well equipped with information technology, and experienced in its use, it is now becoming a preferred channel for communication. For them, such use may be seen as improving the effectiveness of the way they work. A survey of university staff in the UK, USA and Australia found widespread support for this belief, as indicated in Table 1 (Schauder, 1994).

ELECTRONIC JOURNALS

Sorting through large quantities of text can be time-consuming, even for a computer. As computers have become more powerful, so the amount of the text they can handle rapidly has increased. Until the 1980s, efficient handling concentrated mainly on abstracts; now full-text handling is commonplace. Pictures represent a stage further in terms of difficulty. Even modern computers can be hard-pushed to move backwards and forwards rapidly between high-resolution computer images. Equally, networks have a limited bandwidth, and this restricts the speed with which text and, especially, graphics can be distributed.

Scientific publications typically consist of a mix of text, tables and graphics (ranging from diagrams to high-resolution photographs). As the foregoing discussion suggests, such a mix is better handled in smaller, rather than larger portions. In other words, article-length portions are easier to access and manipulate than book-length

Table 1: Extent to Which Work Effectiveness has been Improved by the Use of Information Technology (% of Responses)

Activity	To a great extent	To some extent	Not at all	No answer
Obtaining research information	31	48	17	4
Filing information	33	39	23	5
Obtaining peer input regarding publications	27	42	24	7

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Preparing drafts of publications	85	10	3	2
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portions. Other factors work in the same direction. For example, many people find it tiring to read from a computer screen for any length of time, so shorter pieces are more acceptable. Fortunately, journals are a more important source of information than books for many areas of science. It follows that the obvious reporting of scientific research to put online is that which is currently communicated by printed journals. In terms of journal editing, this development also seems sensible. Many authors are using word processing to produce journal articles. Indeed, since multi-author articles are common in the sciences, many authors have already been sending their articles backwards and forwards online to each other prior to submission to a journal. Similarly, much editorial handling, including transactions with printers, is already automated. Hence, it is not a great step to move from print to electronic output in journal publishing.

However, there are deeper questions at issue here. It is necessary first to explore why scientific authors choose particular channels when they wish to communicate information. Table 2 indicates the three most important factors in a researcher's mind when deciding where to submit an

article (Schauder, 1994). Clearly, the prestige attached to the outlet by the relevant research community, and the extent to which it attracts readers from that community, are requirements that outweigh others.

A printed journal typically gains high prestige when it publishes articles of considerable importance over an extended period of time. The latter requirement means that new journals rarely have high prestige in their early years: they must gradually earn it. For electronic journals, the situation is even harder, for they must also persuade authors that electronic channels have the same prestige as print channels. At present, when there is still some doubt whether contributions to electronic journals will be accepted for promotion purposes, this is not easy (Butler, 1995). The point at issue is partly one of quality. Not only will authors be prepared to send their important articles to electronic journals, but also will the editing and refereeing be carried out as rigorously as for printed journals? High-energy physics preprints have been mentioned previously. These evidently provide an example where speed of publication is important. Consequently, the virtues of electronic publication are for them more significant than its drawbacks. The pre-

Table 2: Important Factors in Authors' Decisions Where to Send Research Articles (% Response)

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Factor	Important	Some importance	Not important	No response
Prestige	70	25	1	4
Readership	67	25	3	4
Speed of publication	25	55	14	6

prints are not formally refereed, yet they are widely accepted and quoted within the community. This illustrates the point that acceptance of electronic publication depends on the importance of the special properties it can offer. If such publication is not seen as having an added value beyond that of print-based publishing, it is unlikely to be pursued.

The same point can be made about readership. Can the outreach be improved by electronic publication? In the first place, this depends on whether potential readers have networked terminals on their desks. In universities in the UK or USA, most science staff probably does satisfy this requirement. By no means all staff worldwide have such access, nor, indeed, do all students in British and American universities (and it must be remembered that the terminal has also to be equipped with the appropriate software for viewing electronic journals). But there is a problem beyond this. Academics often only do a small part of their journal reading in their office. More is done at home, or whilst travelling. These are places where access to a net-worked computer may be non-existent.

Having access to a networked computer is not the same as actually reading electronic journal articles (Woodward et al., 1997). Network delays are common (e.g. between North America and Europe in the latter's

afternoon). Browsing through a journal - a favourite activity of many scientists - is therefore far from easy, if each change from one screen to another is subject to delay. Where a journal article is wanted for more detailed reading (at home or elsewhere), the reader may decide to produce a print-out. This, too, can involve long lag times. The problems do not stop with delays. Publishers each have their own approach to the provision of electronic journals. So, in order to obtain coverage of their own fields of interest, readers currently have to access the Web sites of a range of publishers, in each case remembering to use the relevant password. Even when access has been gained, reading an electronic journal may be less easy than for a printed journal, and navigating through it may be considerably more difficult.

Altogether the inconvenience of reading current electronic journals is so evident, that it might be wondered why anyone would bother to do so. The answer is that the potential advantages of such reading also need to be considered. The most important for many readers is the ability to access from their desk. There is no longer a need to walk to a distant library building only to find that some of the material wanted is not actually available. In assessing future reading of electronic journals, the question is how such advantages will weigh against the disadvantages.

CONCLUSION

Electronic journals are only one example of electronic publishing, but they serve to indicate some of the factors that affect both potential authors and potential readers of electronic publications. It can reasonably be argued that technical problems, such as navigation through an electronic journal, will improve rapidly as hardware and software become more sophisticated. This is true; but it is equally true that rapidly changing ways of handling electronic journals will certainly continue to confuse readers. A survey of scientists and engineers in the UK found that a majority expected they would need help to cope with reading electronic journals (Royal Society, 1993). Most expected this help to come from their libraries.

There is an interesting reflection here on expectations regarding the role of libraries in an electronic environment. Past discussions of electronic publishing have tended to assume that electronic publications would typically bypass libraries. In fact, the pressures are actually likely to require the continued participation of libraries. Consider first the question of cost. Many of the early electronic journals were free (in the sense that there were no subscription costs). Readers were therefore happy to access them directly. Now, as learned societies and commercial publishers move into the field, explicit and often large subscriptions are being demanded. Under these circumstances, readers expect their libraries to bear the cost, and then make

the electronic journals available to them. In addition, readers increasingly expect libraries to improve the interface with electronic journals, so that they can get rapidly to the material that interests them. This extends to the expectations that libraries will assist them in using electronic journals by providing both advice and training. Finally, it is assumed that libraries will be involved in storing the material, so that past issues of electronic journals will be retrievable in the same way as current issues.

These expectations regarding the library's role are not limited to electronic journals. They apply, for example, equally to information on CD-ROMs. The overall implication for libraries of a move to electronic publication is that though basic activities (making information available, helping customers, etc.) will continue in the future, their nature and relative importance will change. The same can be said for the other participants in scientific publishing – authors, publishers and so on. Clearly, the changeover is not being made in one step. Some groups, or subjects, or types of publication will favour a rapid shift to electronic publishing. Others will move more slowly. During the transition period, hybrid publications (i.e. ones which are available in both electronic and printed form) are likely to dominate. The advantages of this are obvious. Consider, for example, the needs of authors. If a high prestige printed journal is also published in a parallel electronic form, this will not affect its prestige. However, it may help to extend the readership, and can certainly speed up the publication time.

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Hence, authors are generally happy with such parallel publication. This approach is also more acceptable to the other participants in the information chain. The drawback is that production and handling of information in two forms is obviously a more complex operation. It can be expected that this will make the life of librarians, in particular, more complex over the next few years.

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