Convergent publication, or the hybrid journal: paper plus telecommunications

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SUMMARY

The majority of research studies of 'the electronic journal' have concentrated on producing a computer-based near-replica of the printed paper journal. This article argues that such an approach is inappropriate and suggests that a complementary, computer plus paper, approach might have advantages. The article discusses the advantages and disadvantages of the paper product, then briefly reviews the research on electronic journals before discussing their advantages and disadvantages. The strengths and weaknesses of both paper and electronic formats are then compared, and from this comparison a proposal is made for the creation of a hybrid journal system combining the strengths of both media.

INTRODUCTION

The production and publication of learned journals occupies an important place within human culture, and the journal is both a marketable item in itself and also a means for the communication of information that may lead to the advancement of understanding and, amongst other things, additional marketable products. It is therefore extremely important that such journals continue to be economically viable products, and be priced at a level consistent with the widespread dissemination of knowledge. Unfortunately recent trends have cast some doubts on the viability of the traditional product [1,2] and new means, including frequent doses of information technology, have been sought to redress the balance. One such dose has been the concept of the electronic journal, and a number of experimental studies have been conducted to investigate the efficacy of this cure [3–6]. However, as yet no conclusive prognosis has been established.

The paradigm employed so far for the introduction of the electronic journal has been that of using the new technology to replace the old product, and therefore most, if not all, experimental and commercial ventures have concentrated on producing an electronic replica of the printed journal page. This approach has resulted in some reduction of the production time and cost though the screen-based product, even when printed out, is usually inferior to the original paper product. This inferiority results from the present state

of technology, which though adequate for simple text messages, is unable to deal with the subtleties of fonts, layout and, above all, graphics at an economic cost.

The primary purpose of this article is review the experimental results, and to compare the advantages and disadvantages of the electronic journal with those of the traditional paper product. From this comparison a proposal is made that an alternative paradigm be employed, in which the new technology is employed initially to provide facilities additional and complementary to those provided by the earlier technology. Future developments both in the production of the paper product and in telecommunications and display technology might then see the convergence of the two sets of facilities perhaps into a single product based on a deeper understanding of the technologies and the social needs. Within this alternative approach, the best features of both media are selected as the starting point and this hybrid product can be developed as technology and usage permit.

ADVANTAGES OF THE PAPER JOURNAL

The advantages of the conventional paper product are very clear to see. Paper journals (and other products) have been around for a long time, and very obviously work, except for a few minor disadvantages mentioned earlier and elaborated on in the next section. Processes have long been established for both the production and dissemination of conveniently packaged paper products, in bulk and as individual items, and these products are available on a global basis. No additional equipment is required to access the material, and the basic access mechanisms, those of reading and writing, form one cornerstone of educational systems. The printed learned journal both provides a definitive version, and has proved to be a reasonably good archival medium. The inclusion of a variety of graphics is relatively straightforward, though more time-consuming, and there are certainly no difficulties in accessing graphical information; in fact fewer than in accessing verbal information.

DISADVANTAGES OF THE PAPER JOURNAL

It is difficult to conceive of the disadvantages of the paper journal in an age when 'paper' has become synonymous with 'scholarly publication', nevertheless there are a number of disadvantages associated with the paper version, and the effect of these disadvantages is likely to increase. One such disadvantage is caused by the size of the printed paper journal; not only is there a strain on the natural resources required for paper production, but also the requirement to distribute the journal via bulk transport facilities places limitations on the packaged size of the journal. This latter requirement suggests that individual issues of a journal should be small enough for an individual to access/handle easily, and large enough to be economical for bulk transport. On the one extreme we cannot afford the distribution of individual articles (except perhaps on a relatively small scale within so-called invisible colleges), nor are we able to readily handle bound volumes of one thousand or more pages. A balance must be struck between these two extremes, which will also be affected by the requirement not to overly delay publication of an accepted article. These requirements have led to the batching up of a group of articles into issues of the journal, which are usually dispatched at regular intervals and are of roughly similar size. This process can lead to individual articles being held up until a batch is complete, but this time delay

is usually small compared to the other delays caused by the refereeing process and by printing. However, there are journals that specialize in rapid publication of, usually, short articles of high importance and topicality.

Learned journals differ from their more popular cousins in that their content is usually of greater durability, and that the need for the information is not always foreseen. For this reason learned journals tend to be purchased on a subscription basis, either by libraries or by individuals, and there is no scholarly journal equivalent to the casual purchase at airport, or railway station, newsstands. Because of this upfront purchasing, the subscriber has no accurate prior knowledge of the content of each issue, but will in the long term demand a reasonably high hit-ratio of interesting information. As learning and scholarship has expanded, so has the absolute number of published articles, and in order to maintain this high hit-ratio of individually interesting information in a journal purchased unseen there has been an increase in the number of specialist journals. This journal specialization may be consistent with the packaging requirements; however, it does provide positive feedback to the subscriber's increasingly narrow range of interests and may be very detrimental to the development of interdisciplinary studies. At the least it can lead to situations where scholars and research workers reinvent another specialism's wheel, or more seriously are unaware of results from other fields that may be relevant to their own work. This latter could be a serious handicap as increasing recognition is being made of the need for interdisciplinary research.

Related to this increasing specialism of journals, is the problem of locating useful already published material, and although the bibliographic journals, and more recently on-line databases, provide an admirable service this is an expensive and potentially unstable approach. This problem may be particularly acute for those journals that include 'Letters to the Editor' sections and general discussions. Many of these contributions relate to previously published material and provide an admirable forum for the development of the subject matter. They may even provide corrections to the original material, provided either by the original contributors or observant readers. However, these contributions may spread over several issues, which can be excessively drawn out if the journal issues appear infrequently, e.g. quarterly or less. If some future reader made use of a published article, without being aware of the ensuing discussion (either because of understandably incomplete bibliographic referencing, or because of having located the original article by some other means) that reader could be deprived of substantial later developments. The inherent problem of the paper journal is that it is only capable of providing backwards pointers, but not the forward pointers that are also required.

A BRIEF HISTORY OF THE ELECTRONIC JOURNAL

The problem that the original electronic journal studies set out to address was an issue separate from the disadvantages of the paper journal listed above. During the 1970s the term 'electronic publishing' was not synonymous with desk-top publishing, and computer-assisted typesetting had not got far past its 'nroff' days. The concern in those days, at least within the academic, library and journal publishing circles, was with the rapid increase in the quantity of scholarly information being published, which was putting a strain on the editorial and refereeing stages of journal production at the front end, and

on the abstracting and bibliographic secondary processing at the other end. All this had economic implications, not least of all because university libraries, who in the UK are a major purchaser of scholarly journals, were having their funding cut at a time when the subscription cost of such journals was increasing rapidly.

In a report produced by the Royal Society[1], and published by the British Library, considerable concern was expressed for the continuing stability of the scientific information service. In summary this concern was triggered by the following factors: and increases in the quantity of published information, leading to delays in the editorial and publishing services; increases in the number of specialized journals, usually of low circulation; and increasing subscription rates, decreasing the circulation even more. This of course has a knock-on effect to textbook availability, because an increasing proportion of university library budgets is being spent on journal subscriptions, almost entirely at the expense of the book budget.

As it was very unlikely that the volume of information to be published would diminish, and would probably increase even faster, the only alternative was to decrease the cost of the publication process, and at the same time hope to decrease the delays inherent in the publication system. Some of these delays, and a considerable proportion of the costs of publication, result from the multiple retyping of the article, e.g. by the author originally, perhaps again after refereeing, then by the typesetters and printers, with modifications after proof-reading by the author. Remember that in the late 1970s, word-processors were few and far between, and very primitive in their abilities, with the output quality not suitable for photographic reproduction. The delays in the editorial processing were caused by pressures of alternative commitments by both the journal editors and their regiment of referees. These editorial delays and typing delays were compounded by publishing delays caused by the necessity to batch articles up into journal issues.

Possible solutions that were suggested for reducing the costs and delays in the system included the introduction of 'editorial processing centres' [7] and the use of hefty amounts of telecommunications and computer technology. An editorial processing centre was essentially a support service provided by publishers for a group of journal editors and provided both clerical services and a mechanism for distributing articles to referees and chasing up the more tardy of the referees; such duties being frequently left to the individual editor.

The other potential life-saver for the journal system was the injection of technology, and for the most part this was again aimed at decreasing the time spent in the refereeing cycle. The basic idea was that the author of an article would send the article to a journal editor via electronic mail; the editor would then forward the article again by email to the selected referees; the referees would append their comments to the article and return these electronically to the editor, who would collate the comments and act accordingly—sending them to the author so that the article could be suitably amended and then resubmitted for publication. The original conception was that the article should then enter the conventional paper-based publication system, but it is also fairly obvious that paper could be abandoned altogether and that, once the article was accepted, it could be emailed to all journal subscribers.

This gave birth to the idea of the electronic journal, and the first experiment to study this suggestion was initiated in the USA and Canada in October 1978 and lasted until

March 1980 [3]. Unfortunately at that time there was no available email service, as we now know it, and also surprisingly there could be no UK participation because the, then, Post Office placed an embargo on any substantial transatlantic message traffic that was not under their control.

Instead of email, this early experiment made use of the EIES computer teleconferencing system hosted on a single machine at the New Jersey Institute of Technology [8] and the electronic journal and a number of other message exchange facilities were mapped onto the EIES data structures. The user community, consisting of authors, referees and the journal editor, were then able to access the host machine via whatever telecommunications facilities were available to them, i.e. primarily via the dial-up telephone network. This EIES based experiment had some partial successes in studying how people might communicate within a scientific community, but the electronic journal aspect of the study was less successful, with very few papers being submitted for refereeing etc. Amongst the principal reasons for this were difficulties in accessing the journal system, and concern in handing over copyright to a new and not very visible journal.

Following on in part from this study, the British Library Research and Development Department funded the HUSAT Research Centre at Loughborough University of Technology and the Computer Science Department at the University of Birmingham to carry out a further study of the electronic journal concept and additionally to look at other computer-mediated means of communication. This became known as the BLEND project and was in operation from 1980 until 1984. This period also saw the mass advent of microcomputers and the increasing availability of wide-area computer networks.

However, at the start of BLEND none of this had happened, and yet again the email-like facilities were provided by a computer teleconferencing package, this time the NOTEPAD [9] system written by Infomedia Corp., and hosted on a DEC2060 at Birmingham. For BLEND, a community of about 50 research workers in the Computer Human Factors field had agreed to participate in the experiment and had further agreed to submit one article and one shorter contribution each year for three years to an electronic journal on 'computer human factors'. In addition to this formal refereed journal, BLEND provided teleconference facilities for less formal message exchange, including pre-publication drafts of articles, a newsletter, and a general-purpose email service [4].

NOTEPAD was chosen as the support software primarily because it had a simple and clear user interface which was particularly appropriate for occasional users of the system; this being the category of most of the community — typically accessing the system once or twice per week. Also it had a data structure for the various conferences which mapped very straightforwardly onto the normal format for a learned journal, with additional conferences being set up to provide a discussion area for each accepted article. In addition other conferences were set up to provide an opportunity for less formal message exchange [10]. Within the body of each journal article the 'instructions for authors' stipulated that a Contents list be provided corresponding to section headings etc., with an indication where each section was stored within the article data structure. This was a very useful addition because it became very obvious that many readers chose to access each article in a sequence other than the one provided by the author.

One of the major aims of BLEND had been to study the subjective impact of the software system, and on the basis of user feedback the software steadily evolved during the

lifetime of the project. The first evolutionary stage involved modifications to NOTEPAD itself, which were made by Infomedia, but later modifications were made locally by running subprocesses from within NOTEPAD, and by embedding NOTEPAD within a shell which permitted improved access between conferences. The subprocess facility proved to be a very useful one in that it provided a simple mechanism whereby it was possible to extend the software capabilities while working within the overall NOTEPAD framework. Capabilities developed in this way included improved software for accessing the journal and presenting it to the reader, and facilities for aiding on-line refereeing of articles. This latter consisted primarily of a mechanism for attaching individual comments to any paragraph of the article, with these comments being accessible only by the writer (i.e. referee) or by nominated others (i.e. the journal editor and, perhaps, the originating author) [11].

This concept was extended further into a References and Annotated Abstracts Journal with standard keyword searching facilities, plus the capability of adding comments and tags to abstracts for latter collection by the searcher or, in addition and after obtaining the journal editor's permission, leaving these comments in the database so that they were available to other readers. Such comments might be personal recommendations (or the opposite), and other users could then search the database for articles recommended by a particular known expert in the field.

Amongst the important lessons learned from the BLEND study is included the necessity of providing good navigational clues both within each article and within the journal and conference database as a whole, since readers tended to move around the database, and even the article, in a non-linear manner and could frequently get lost.

Most of the findings and the methodology of the BLEND project have been reported in a series of reports published by the British Library [11–15] and further details are inappropriate here, except to add that despite other, originally unforeseen, pressures of work arising from involvements in the Alvey and ESPRIT programmes, the BLEND community produced a total of 88 articles, some formal and others short informal reports, and that the formal refereed papers appeared in four 'issues' of the electronic journal [14].

Since the termination of the BLEND study, there has been no similar comprehensive research into a potential electronic journal system. However, some separate, related studies have been carried out within the CEC DOCDEL research programme [16], and from 1982 until 1986 Elsevier published the 'Computer Compacts' journal which provided a database of news items and product announcements in a parallel paper and online database format. Similarly some existing learned journals, e.g. the *Journal of Bone & Joint Surgery* [17], make issues of their paper journal available online, though so far in text-only format.

Another relevant development has been the ADONIS trial document delivery service [18] which has been set up to aid major document supply centres in Europe, USA, Mexico, Australia and Japan to fulfil requests for individual articles in the field of biomedicine. The contents of 219 journals are indexed and scanned in facsimile format for transfer to CD-ROM disks. These disks, with an effective page capacity of more than 7000 per disk, are then dispatched at the rate of about one disk each week to the participating document supply centres. Currently the disks are accessed from a single drive attached to a specifically designed workstation; however, a jukebox with a capacity of 240 disks

has recently been developed. The present trial covers journals issued during the period 1987 to 1988 and the disks will be used at least until the end of 1989. Although the ADONIS study is not an electronic journal in the sense considered in this article, it does indicate that it is possible to create very large document databases that could be used in any electronic journal system, and to that extent ADONIS demonstrates the viability of one of the underlying technologies for an electronic journal system.

ADVANTAGES OF THE ELECTRONIC JOURNAL

The initial motivation for research into the feasibility of electronic journals was founded on a need to decrease the time spent on the editorial and production phases of the paper journal. In this context the decade since the start of experimentation on on-line electronic journals has seen a number of substantial changes within the technological environment. The widespread use of microcomputers as word-processors, and the increasing use of floppy disks as an exchange medium, has already eliminated much of the earlier total retyping of articles. The diversity of formats for floppy disks has been narrowed down and increasingly disk drives are becoming available which can be read a number of different disk formats. Similarly a small range of word-processing and text-formatting software is becoming dominant in the market with new packages being required to accept a variety of input formats as a matter of course. Electronic mail facilities are now in fairly widespread use, at least within the scientific and technical research communities, and high quality laser printers and facsimile transmission services are also available. These facilities are now being used to speed communication within the editorial and refereeing processes, and between the editor and publisher, and this time saving can be substantial when international communication is involved.

These advances in both technology and standardization have already been incorporated with great effect into the production process for some learned journals[19], and to a large extent this might be interpreted as the accomplishment of the early ambitions of electronic journal research, without any need for electronic journals. However, the research work did point out a number of other advantages of electronic journals, in addition to faster availability arising from the elimination of the printing queue, that are relevant to the post-publication period. These advantages are all concerned with extending the functionality of the journal, whereas the improvements noted already are more concerned with streamlining existing arrangements. These functional extensions mainly fall into two categories: extensions relevant to a particular journal article; and extensions relevant to the journal information system as an entirety.

For an individual article, the electronic journal offers the readership two extra features. The first of these is the ability to access easily other contributions that may be relevant to the primary article. In particular any corrections, comments or extended discussion, can be clearly signposted from the original article and, in effect, included with that article. In the paper journal system this material can only refer back to the original article, and cannot provide the forward reference that is probably more important. Similarly in this context it is possible to make minor corrections to the original article, though this is perhaps a dangerous concept and should be considered very carefully.

The other functional extension for the individual article is the possibility of providing

software to support navigation around the article, as the research work carried out in, for example, the BLEND project suggested that readers do not necessarily access an article in a linear manner. This software might simply provide word searching mechanisms as, for example, provided by a text editor, or permit the article to be written in hypertext format with various levels of detail, or provide alternative routes through the article depending on the reader's background knowledge and particular interests.

More important, perhaps, are the additional functions that the electronic journal format provides when a large body of such journals is considered. As mentioned earlier, major factors influencing the size and subject matter of a particular journal are the packaging requirements, and the journal subscriber's preference for each journal to supply a high hit-ratio for relevant material. In the electronic journal system, it becomes possible to supply individual articles to the readership from a large database, which could cover a much wider range of subject and topic areas than would be reasonably practicable with a paper journal. This implies that packaging is no longer a consideration as far as the reader is concerned, and that a very high hit-ratio of relevant material can be achieved on an individual reader basis rather than for a journal readership considered as a whole. This high hit-ratio can be maintained by a combination of at least two mechanisms; either by the reader performing some form of bibliographic search on the journal database; or by the reader defining an 'interest profile' within the journal system so that any new material matching that profile can be selectively distributed to that reader. This selective distribution could be in full-text mode or simply a brief message listing the titles and, perhaps, abstracts of recently available material. This latter mechanism would allow the reader to perform a further level of selection, by on-line browsing through the article, before perhaps down-loading it into a personal electronic library stored on an optical medium.

This combination of 'electronic repackaging' into a small number of wide-ranging journals and the selective distribution of individual articles to subscribers would remove the necessity for small circulation specialized journals, except at the stage of editorial acceptance, and could play an important role in promoting inter-disciplinary studies. Similarly 'selected reprints' publications could be readily produced, and kept up-to-date, by the simple expedient of providing a reference list to articles already in the database.

DISADVANTAGES OF THE ELECTRONIC JOURNAL

It was possible to anticipate many of the disadvantages of the electronic journal before any of the research work started, and much of the research work has aimed at assessing the subjective impact of these disadvantages rather than simply identifying them. Similarly it was known that the electronic journal would introduce a potential for change, for example in the costing policy, though whether this was a disadvantage or an advantage probably depended on your role within the learned information system.

A primary disadvantage of the electronic journal is the need for additional equipment with which to access the information, and at almost the first meeting of the BLEND trial community it became apparent that many people were concerned about an imposed change on their reading habits—they could no longer read journals in the bath, and on the train or plane. Similarly there was concern about the potential disenfranchisement of people,

especially in the developing countries, without access to this additional telecommunications and computer equipment.

Other disadvantages became more apparent as the studies progressed, and these can be divided approximately into the categories of function and of economics. Within the function category, a particular disadvantage that the electronic journal shares with electronic mail is the lack of a definite prompt when new material or messages are waiting. With paper products this prompt is the physical presence of the object, either on the door-mat or deposited in some form of 'in-tray'. With the electronic product this prompt is absent, unless you happen to be a frequent user of the computer system on which such messages are received, and this might not be the case if you only use the system to receive a few electronic journals. Obviously if the 'reward value' is high for accessing the journal's host system, then the would-be reader is likely to make the necessary effort. Within the BLEND-LINC study, the likely reward was maximized by having known fixed 'publishing dates' for issues of the journal, and by combining electronic mail and conferencing facilities within the same host system. However, the use of fixed publishing dates has a degree of artificiality in an on-line environment, and even within BLEND the publishing date concept was abandoned during the later stages, to be replaced by a 'release when accepted by the referees' philosophy. Unfortunately not enough data was collected to make any meaningful comparisons between the two approaches, and in any case the general information environment was changing as more and more of the participants acquired electronic mail facilities additional and superior to those provided by BLEND. As it is unlikely that users of an electronic journals system would wish for all articles to be sent to them via an email-like facility, this requirement to collect information from an electronic journal system will continue to be a disadvantage while potential subscribers continue to use some other, perhaps local, host for their other computing activities. However, the movement towards personal workstations and a looser connection to electronic mail and other host facilities may additionally promote the acceptance of the electronic journal concept by introducing an automatic 'check to see if anything is there' facility within the workstation environment. Certainly if the electronic journal concept is to succeed, some means must be provided for integrating the system into the users' normal working environment, either via a simple and effortless means of access, or by the information obtained from the system being of high value.

Improvements within the facilities offered by workstations may eventually address one of the other disadvantages of the electronic journal work, namely the inability of such systems to provide any graphics capability. It is now almost a matter of course that learned journals contain some form of graphical information illustrating and complementing the text, though the form of this graphical information may vary according to the needs of the subject matter of the journal and, perhaps, be limited by the financial resources of the publisher or the subscribing readership. Within the two experimental journal systems mentioned earlier, there was no possibility of providing any graphics capability other than very crude attempts at 'typewriter graphics' formed by mapping the diagram onto the standard character set. At the very least this was unsatisfactory from the visual point of view, and in most cases it was impossible to so characterize the diagrams. This could lead to at least a thousand words being written to replace each picture, and to a loss of immediacy and understanding. Even now with the replacement of dumb terminals

with fairly powerful workstations, the situation is not much improved as the software to implement the various representation standards for graphical information is not always in place. However, developments in these areas may lead to improvements over the next few years.

A further functional disadvantage of the electronic journal stems from one of the strengths of the medium. As mentioned earlier it is relatively simple to change the text of an article in order to remove errors in the original, but this can lead to multiple versions of that article existing in the personal 'electronic libraries' of the readers and no clear record of which one is the definitive version. Some mechanism will need to be found for providing an archive of agreed definitive versions, and these perhaps be stored on an optical medium.

The second group of disadvantages of the electronic journal have been classified as 'economic' as opposed to 'functional' though, as mentioned earlier in this section, whether these economic disadvantages are true disadvantages depends on your viewpoint, e.g. as publisher, reader, or provider of telecommunications and database facilities. As mentioned earlier, the use of search facilities provides readers with the opportunity to focus on the material of direct interest, giving a very high hit-ratio, and they may not wish to pay for other material included in the journal that is of no immediate interest. This raises the possibility of changing from an 'up-front' subscription to payment for 'only what you read', which in the transition period would put a strain on the finance of the journal production process. Even in any new steady state of the publication system, there would be added economic complexities as the current distribution services would be replaced by network providers, the printing industry replaced by online databases services which might or might not be provided by the publishers themselves. There is even the possibility of the journal editor communicating directly with a database service, and eliminating the current publishing role.

Even without these divisions, there are many possibilities for the charging mechanism though one which might further interdisciplinary research and scholarship would be to charge a relatively low up-front fee for access to the journal index and a per article charge, maybe including the copyright fee, for every article accessed in a substantial manner, with perhaps reduced rates for access to the abstract only or to a small fraction of the article. The statistics generated by this charging mechanism could be used to produce a 'readership index', which could be more useful than the present-day citations index, and even to provide a 'best sellers' list of scholarly articles, though this might be of dubious quality.

CONCLUSIONS — A POSSIBLE SYNTHESIS

The above-mentioned advantages and disadvantages of the both paper and electronic journal systems are summarized in Table 1. Although this list is certainly not complete, it does show that, far from indicating a superiority of one over the other, the two systems have almost complementary strengths and weaknesses. This would suggest that instead of using an electronic journal system to replace the existing paper system, most advantage could be obtained by parallel publication in the two formats, although this would increase the overall cost.

However, this suggestion does not take account of the likely changes in the technological

Table 1. Summary of the advantages and disadvantages of the two media

Paper journal advantages	Electronic journal disadvantages
Easy access;	Access requires secondary equipment;
Established worldwide distribution;	Possible lack of integration into normal environment, e.g. lack of prompts;
Definitive version;	Multiplicity of versions — archival of
Good archive format;	definitive version;
Graphics straightforward.	Graphics capability restricted as yet;
	Change in costing policy.
Paper journal disadvantages	**Electronic journal advantages**
Printing delays;	Elimination of printing queues;
Packaging constraints;	Navigation aids and hypertext formats;
Hit-ratio unknown;	High hit-ratio via bibliographic search or selective dissemination;
Increasing no. of specialist journals;	Fewer separate journals;
Specialism isolation;	Aid to interdisciplinary research;
Locating supplementary material,	Inclusion of discussion with original article;
especially discussions etc.;	Easy cross-referencing;
Transient material retained;	Ease of removing transient material.
Copyright problem;	Ease of producing selected reprint
Strain on natural resources.	publications;
	Change in costing policy.

climate and the continuing expansion of scholarship and research. The advantages of the paper journal are primarily associated with the individual journal issue, whereas the electronic journal format addresses a much larger body of knowledge. As it is certain that the accumulation of knowledge will continue to increase and it is unlikely that earlier publications will cease to be relevant, the advantages of the electronic format will increase in relevance. Also, in the short period since the start of research into the feasibility of electronic journal systems, the necessary communications infrastructure has been extended in area and increased in bandwidth to accommodate an increasing amount of remote access to databases, and storage capacity has increased by orders of magnitude. Similarly communicating microcomputers have, or are likely to, become an integral tool of most of the people who currently make use of learned journals. These developments point to a steady weakening of the disadvantages of the electronic journal listed above, while the effect of the disadvantages of the paper journal may increase in severity. This would point to an electronic journal system becoming a distinct possibility from about the mid-1990s onwards.

An electronic journal system offering the facilities outlined above would consist of a large read-only database of publications relevant to the, extended, field of interest (i.e. covering many present-day journals) with access provided via special-purpose software running on the user's workstation. This software would provide aids for rapidly browsing the article online, or downloading it to the workstation for more extended study and,

possibly, printing. In all cases the user would be given some indication of the appropriate cost. Attached to each article in the database would be an area in which readers could add discussion and comments, including pointers to other relevant articles; these discussions could be under editorial or managerial control. In addition discussion areas, based on computer teleconferencing techniques, could be set up as requested for more general subject-related communication, and for other more transient information, e.g. conference announcements, job opportunities, and recent publications.

However, such a system will still take some time to be put into effect and it is worthwhile considering a transitional period during which advantages are gained by exploiting the complementary nature of the separate paper and electronic publishing systems. In particular the present, paper-based, publication system could be amplified so that it can take on some of the characteristics of the electronic journal system. Such a hybrid system, containing both paper and electronic aspects, could then be developed so that the two components converge to produce a fully functional electronic journal system.

Within this hybrid system the paper product would still be regarded as the definitive version; however, until the paper product is available, each refereed article could be stored online in some standard format (e.g. ODA), and made available to subscribers. Initially these subscribers could transfer the entire document to their workstation, but facilities would be developed for previewing, and for selective transfer. The specifically 'electronic journal' aspects of the system would be provided by setting up a computer teleconference associated with each article, in which discussion can take place arising from that article; though there is no definite requirement that this teleconference be hosted on the same machine as the article database. The journal editor can publish this discussion, in summary or in full, in a subsequent issue of the paper version of the journal. This will ensure that all subscribers have access to the full information even if they are unable to access the online version or participate in the computer teleconference. The journal editor would close down each conference when thought appropriate. In addition other computer teleconferences, not directly connected with any particular article, may be set up as suggested by the journal editor or requested by the subscribers.

Although the full advantages of an electronic journal system can only be obtained when the database covers a large number of journals, it would be more appropriate for the hybrid system to commence with a small number of related journals. The use of the system should then be monitored to assess the relative economic advantages of the electronic and paper variants. In particular the system could be used by journals of different circulations in order to ascertain ranges of applicability. This experience would then form the basis for the design of a fully functional electronic journal system to be constructed when the necessary technological infrastructure is in place.

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