# Electronic Journals
# scholarly invariants in a changing medium

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## 1 Introduction

For several centuries, the printed journal has played a central and essential role in scholarly communication. In most scholarly disciplines, the accumulated contents of some set of respected journals provides a canonical corpus defining the effective state of knowledge in the field. Until recently, the only medium capable of communicating a precisely standardized text economically to a sizable community of scholars, over a period of decades or centuries, has been printing. In spite of many technical improvements in printing, the function of the medium for writers and readers has changed very little over the centuries since Gutenberg.

Electronic media now compete with printing for the communication of texts. In the few decades since the introduction of electronic transmission of text, a variety of electronic textual media have been developed, with different and rapidly changing functionality. It is impossible to predict the form and the speed with which electronic textual media will take over various roles

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from printing. But, extrapolating from the success of journals that are currently published electronically, it is clear that electronic media will capture a large share of scholarly publication in the next five years, and that printed media will not be competitive in journal publication beyond a very few more decades. It is very difficult to compare the costs of printed publication with various electronic forms, but it is highly likely that the marginal costs of electronic distribution will soon be much lower than those of printed distribution. Conversion and startup costs will delay the dominance of electronic media, but the improvement in marginal cost makes it inevitable.

In the face of inevitable conversion of scholarly journals from printing to electronic communication, we need to analyze the act of scholarly publication, and to separate its intellectual essence from the accidents imposed by printing. Then, we may consider how that intellectual essence may best be supported by new electronic media. Characteristics of journal publication with definite scholarly value must be preserved, while those imposed by the nature of printing may be redesigned for even greater value.

## 2 The Essence of Scholarly Publication

Scholarly publication inherently requires five roles, which may be performed by individuals, informal groups, or formal corporations:

1. the *author* writes the text of an article;
2. the *editor* judges the quality and relevance of the article, and either rejects it or accepts it for publication;
3. the *publisher* announces the acceptance of the article, and makes it available to the public;
4. the *archivist* preserves the article in an archive;
5. each of a community of *readers* reads the accepted text of the article.

The act of publication in a journal adds intellectual value to a text in a number of ways:

1. the article is *certified* as a significant contribution to a particular scholarly discipline, saving individual readers the work of filtering out insignificant texts;

2. the text of the article is *standardized,* so that different readers are confident that they read the same text, and can refer to it precisely in their own work;

3. the article is *distributed* to current readers in various locations;

4. the article is *archived* for readers of the future.

In many cases, the interaction between the editor and the author improves the inherent quality of the text of an article. The editor may also organize groups of articles, so as to aid systematic reading on a given topic, and the standardization of the text supports other organizational tools, such as abstracts, reviews, citation indexes. Scholarly publication may also serve its discipline indirectly, by providing incentive to authors to share their work, and a means for assigning credit, but the design of journals should be determined by the direct intellectual needs of scholarly inquiry, rather than the managerial needs of the community of scholars. So, we must discover how to preserve the value of *certification, standardization, distribution,* and *archiving* in the act of publication in a scholarly journal, while the form of the medium of communication changes far more each few years than it had previously in many centuries.

# 3 Critical Resources in Scholarly Communication

The behavior of a complex system at a given time is often dominated by a small number of critical resources. Even small changes in the structure of the system may change the critical resources, with huge and surprising effects on the behavior of the system. The physical capability to print and distribute paper journals has certainly been a critical resource for some significant aspects of the behavior of the current system of scholarly communication. The costs and delays inherent in printing may have provided economic incentives for some of the valuable qualities of journals. For example, the economics of printing provides some incentive to find relatively small numbers of texts each of which is interesting to relatively large numbers of readers, and this may lead to higher standards of *certification* in order to accept an article, and to greater efforts toward wide *distribution.* We may need other, perhaps social, incentives if the economic ones change. On the other hand, the costs of printing as a critical resource have certainly masked the costs of other resources, which may become critical with electronic media.

It is useful to ask what might happen if all aspects of scholarly communication other than reading and writing were free—if instantaneous transmission of arbitrarily large texts from any point to any point, and permanent archiving and retrieval of texts, were free to all scholars. In such an impossible case, the critical resource determining the behavior of the community of scholars would be the attention of the readers. The role of the editor of a journal would be understood as one of allocating the attention of the readers to significant texts. The editor can only allocate attention, of course, when the readers grant it in the first place, and the success of a journal editor would be measured by the continuing attention of readers.

I suspect that the readers' attention is already a critical resource in much of the current system of printed scholarly communication, but the more easily quantified physical costs of printing, and the very slow and noisy way in which attention determines circulation and revenues, distract us from attention as a resource. In my experience, scholars are more likely to think of the editor's job as allocating paper than as allocating attention. The lowering of incremental costs with electronic publication should increase the importance of attention as a resource, and make that importance more obvious. Unedited electronic forums already seem to exhaust many readers' attention, without approaching the limits of the physical resources of the communication medium.

# 4 The Structure of Electronic Scholarly Journals

In the past, *standardization, distribution,* and *archiving* have all been accomplished by printing, and the formal structure of these activities has been largely determined by the structure of the medium. The formal structure of *certification,* which is usually based on the advice of expert referees who remain anonymous to the author, is certainly due largely to the structure of the scholarly community, but the medium of printing may have ruled out some methods that the community would otherwise have chosen.

The basic protocol of publication in a scholarly journal—the author freely chooses to submit an article, the editor (perhaps with the advice of referees) evaluates the article, insists on revisions if appropriate, then accepts or rejects the article—is independent of the medium. There is no reason to change that highly successful protocol in converting from print to electronic network publication. The detailed structure of *certification,* and more so *standardization, distribution,* and *archiving* need to be reconsidered, and in the latter three cases thoroughly redesigned, to take advantage of the nature of a new electronic medium.

## 4.1 Certification of quality in a submitted article

I see no compelling reason to change the structure of the refereeing process to adapt to an electronic medium. But, there are some more highly interactive, and more open, forms of *certification* that might be tried. Ann Okerson[1] has one interesting proposal for interactive certification. Unrefereed articles might be published in a preliminary forum, and promoted to a more exclusive forum when and if an accumulation of evidence merits it. Unsolicited comments from readers might be used, instead of or in addition to reports requested by the editor. Electronic media are at least likely to promote experiments with alternate forms of *certification,* whether or not any of these new forms is adopted permanently.

## 4.2 Standardization of an accepted text

The change from print to an electronic medium will lead to radical changes in the way that the text of an article is standardized. In print journals, articles are normally submitted and certified as fully formatted paper copies produced by the author, and the final agreement for publication is based on a typeset proof produced by the editor and publisher. The standard text of the article as distributed to the readers looks geometrically the same as the proof, with standardized page numbers added, which are often used in references to the article. It is feasible to impose geometrical standardization on a text in an electronic medium as well, simply by storing a complete

[1] "The Twilight of the Journal?" presented at the *Conference on Academic and Professional Journals in the Twentieth Century,* University of Chicago, April 1992.

digital graphic image of each page of the article. Electronic media allow a number of other formats as well, and the graphic image will certainly *not* be the basis for standards once readers experience the advantages of other formats.

There is a whole continuum of possible data formats in which to define standard texts in electronic media. These data formats vary not in the way that printed texts look, but in what information they require to be given in a standard internal copy of a text, and what information is added each time the text is printed, displayed, or otherwise rendered into a form perceptible to humans. It is hard to appreciate the differences between data formats based on a short description in an article such as this one. The problem is that the crucial differences are not visible in a single rendering of the text on paper. In principle, any one of the data formats can be used to produce any printed layout of the text that we like. But, there are profound differences in the ease with which the different data formats can be

- rendered into a single pleasing printed layout;
- rendered in a variety of ways to suit the different needs of readers and the different capabilities of printers and other output devices;
- adapted to new printers and output devices not yet invented;
- used for automated information retrieval and text processing;
- excerpted, abstracted, indexed, cited;
- revised to preserve access to the text when technological advances make the format obsolete.

There are five general types of textual data format that are natural to consider, each based on a different notion of what a text is.

1. **Geometric.** A text is a series of pictures, each of them giving a page of text.
2. **Typographic.** A text is a nested set of boxes of characters, assigned to various fonts and point sizes.

Table 1: Five levels of abstraction in textual data formats.

| Formats | Typical Names | Concepts and Relations |
|---|---|---|
| Geometric | Bitmap, Pixel Image | dots, coordinates |
| Typographic | PostScript, DVI, MacWrite TeX, *troff* | characters, fonts, point sizes, lines, pages |
| Sequential | ASCII, Character Set | characters, cases, control characters |
| somewhere in between | LaTeX, AMS-TeX, SGML | |
| Structural | | sections, paragraphs, titles, sentences |
| Semantic | Knowledge Base, Semantic Net | conceptual objects, predicates, assertions |

3. **Sequential.** A text is a sequence of characters, including letters of the alphabet, numerals, punctuation, spaces (perhaps also formatting symbols such as line and page breaks, but these are in effect a crude form of typographic information).

4. **Structural.** A text is a syntactic structure consisting of characters organized into words, sentences, paragraphs, sections, titles, etc.

5. **Semantic.** A text is a collection of assertions about some topic.

Table 1 lists the five types of format, some technical names, phrases, and products that are typically associated with them, and some of the concepts and relations that are given explicitly in the representation of a text in such a format.

- The *geometric* format is very attractive because it allows a direct encoding of the actual contents of a print journal. The advantages of geometric format are expressed in the slogan, "what you see is what you get." The disadvantages are given by the counterslogan, "what you see is all you've got" (due to Brian Reid and/or Brian Kernighan). The only thing easily done with a geometric representation of a text is to display it in one predetermined layout on one predetermined page size. The bitmapped representations of displays on current graphics terminals and printers use geometric format.

- The *typographic* format compresses the information in the geometric format by describing the characters in a text, and their placement on a page. Display in a predetermined layout is still very easy, but small changes in font and layout details become easy as well, and simple text-processing operations, such as searching for a particular phrase, are not too difficult. PostScript, DVI, MacWrite, TEX, and *troff* are current examples of typographic formats.

- The *sequential* format is the easiest to use with a wide variety of current computer systems. It makes phrase searching quite easy. An ugly display is very easy to produce, but typeset quality display requires tedious human intervention. Excerpting and indexing is very easy. The overwhelmingly dominant standard for sequential text is the ASCII character set.

- The *structural* format allows automated layout for a variety of page sizes, font collections, user preferences, etc. Phrase searching is just as easy as in the sequential format, but text processing may also take advantage of structural characteristics, such as section titles, captions, structure of mathematical formulae, etc. It is relatively easy to take an excerpt from an old text, and incorporate it in a new text, using the stylistic conventions of the new text. Structural typesetting languages, such as LATEX and AMS-TEX, and the markup language SGML, are very near to providing structural formatting standards—they are all largely structural, but they carry varying amounts of sequential and typographic information along with structure.

- The *semantic* format is a wonderful idea, but perhaps decades of research in artificial intelligence are required before it can be used routinely. In principle, such a format allows automated reasoning on the basis of the content of a text, but that requires a lot more research, too. It would probably be necessary to keep a structural version of the text along with a semantic version, since it is unlikely that the author's style, which is a crucial part of text along with the content, can be generated in any better way. Collections of semantically formatted

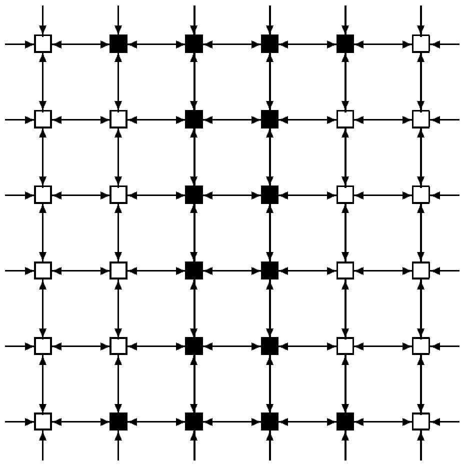

Figure 1: Sample logical structure in geometric format.

information are often called knowledge bases, and use structures such as semantic nets.

Figures 1–5 suggest the essential qualities of these data formats through diagrams that show the logical structure of a portion of the textual data. All of the formats, except the sequential one, can produce the layout shown in Figure 6 automatically.

Electronic journals will eventually choose structural formats almost exclusively. Geometric and typographic formats will be used for some time because of their closer connection to the printed page, and sequential formats will be used for some time because they require little or no new software. But eventually, as better standard structural formats develop, along with software to display them and process them in other ways, they will be found to be the most natural.

Even when texts are archived and distributed in print, there is a lot of psychological evidence that they are understood structurally, rather than geometrically or typographically. Notice how a successful novel goes through many printings, with many different layouts, all of which must preserve the structural elements of chapters, titles, paragraphs, sentences, etc., while varying widely the styles in which these elements are displayed. The fact that

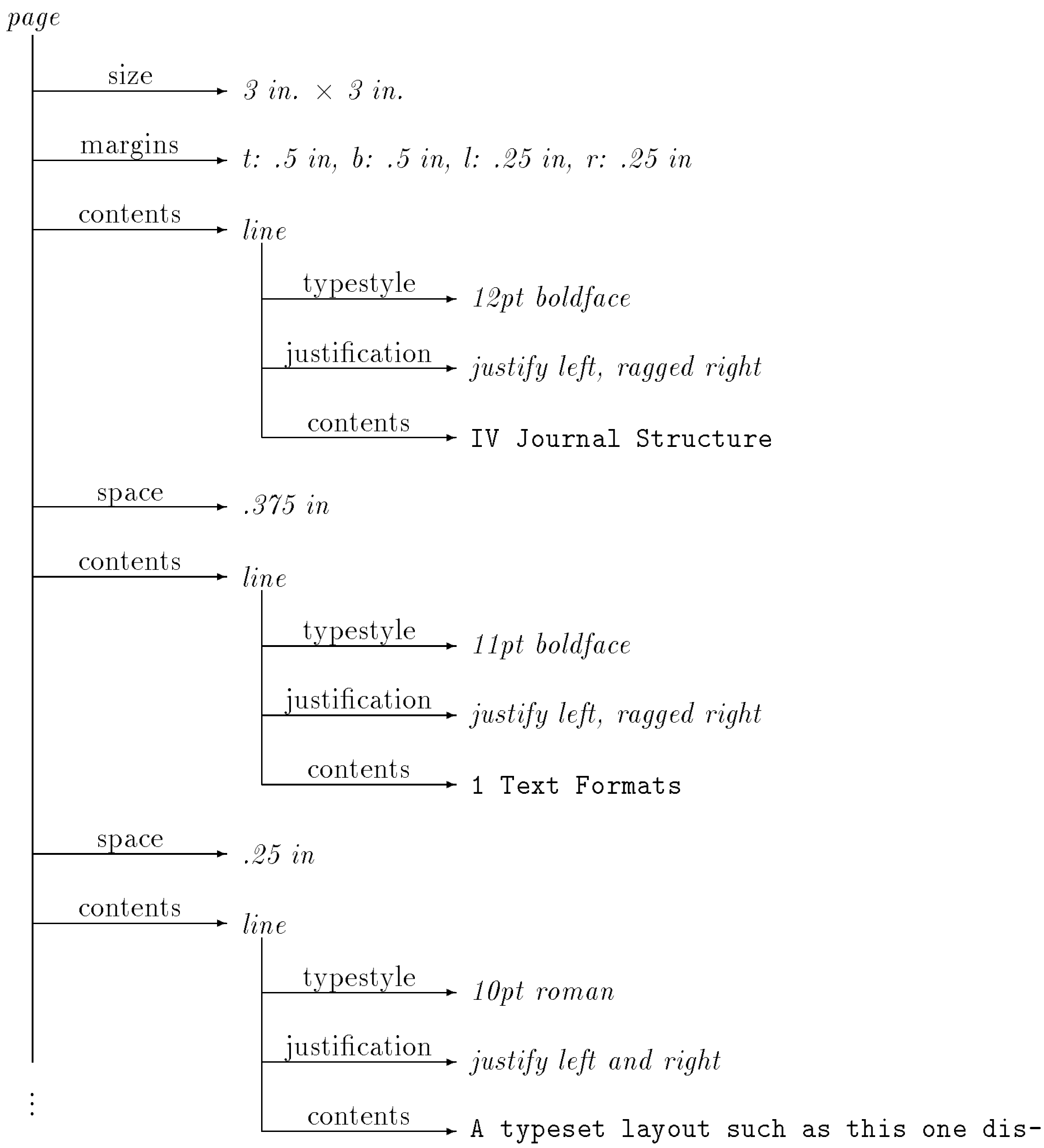


Figure 2: Sample logical structure in typographic format.

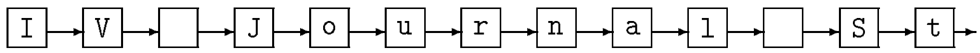


Figure 3: Sample logical structure in sequential format.

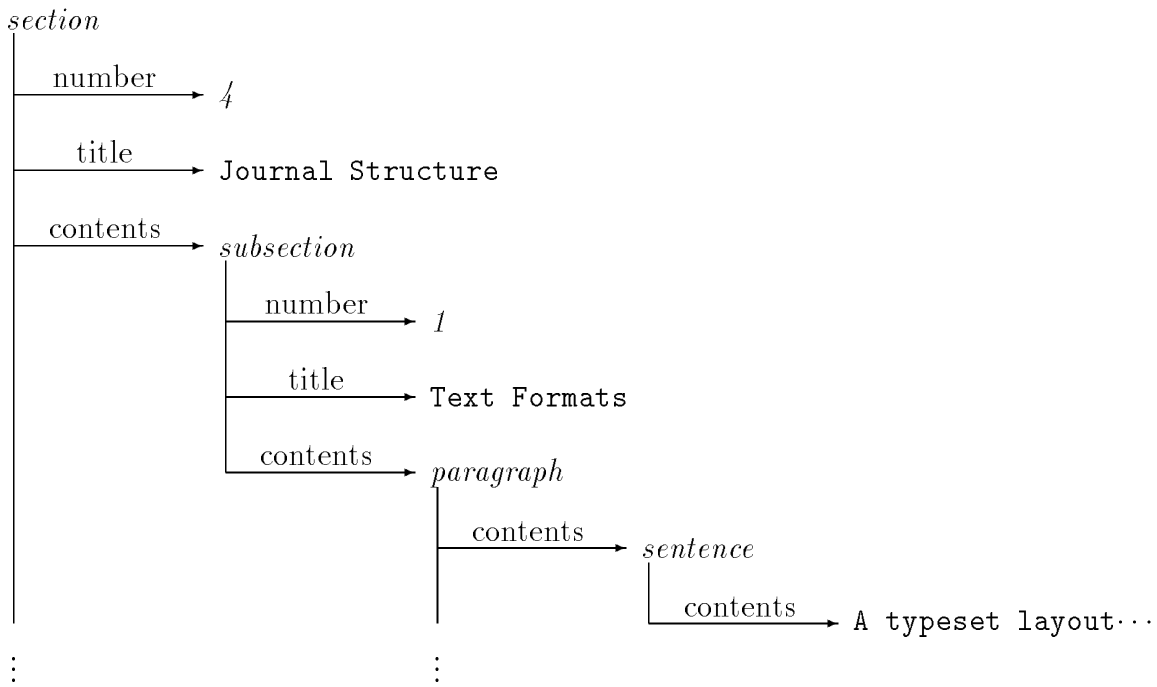


Figure 4: Sample logical structure in structural format.

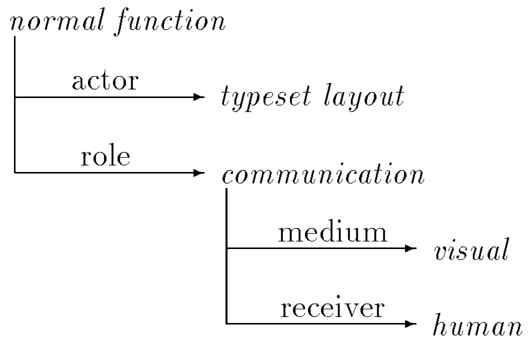


Figure 5: Sample logical structure in semantic format.

**IV Journal Structure**

**1 Text Formats**

A typeset layout such as this one displays the structure of a text directly to a human reader. Many different electronic data formats can produce the same layout.

Figure 6: Typical layout displaying the text in Figures 1–5.

we immediately recognize different layouts of the same structure as interchangeable presentations of the same text is strong evidence that the natural mental format for text is a structural one. The extreme case of a text read out loud and recorded on tape is particularly enlightening to consider. Two people, one who has read a printed text, and another who has listened to a recording of it, generally have no problem discussing the text as a single conceptual object, independent of the presentation.

For text consisting purely of some natural language, and for mathematical formulae, current formats such as $\mathcal{AMS}$-TEX, LATEX, *troff,* and SGML have already demonstrated most of the ideas required for structural representation. As more sophisticated hypertextual structures become widely used, they will incorporate naturally into structural formats. For diagrams and figures consisting of line drawings, structural formats are not yet very satisfactory, but a few more years of development should produce some good ones. Photographs and pictures included in text will have to be presented by fragments of geometric data appearing as components of a structural presentation—radical new ideas will be required for uniform structural presentation of pictures.

## 4.3 Distribution of journal articles in electronic media

The structure of the interaction of between publishers and readers will change radically in electronic journals. The economics of printing and mailing led to the distribution of print journals in bound issues, which combine the functions of announcing the acceptance of certain articles in the table of contents and providing access to the texts of those articles by replicating them on numerous individual and library bookshelves. Electronic distribution allows the functions of announcement and access to be separated and specialized for greater utility and efficiency.

In principle, an electronic journal might mail some sort of magnetic or optical record to subscribers, much as a print journal mails printed issues. In the long run, as the sort of interactive remote connection between computers supported by InterNet and BITNet becomes universally available, the dominant form of electronic distribution will certainly be electronic transfer of articles from one or more shared archival copies of the database of journal articles. The number, location, and performance of the archives will be determined flexibly and dynamically by the current economics of the network, and the functionality of the archives will grow gradually from mere transmission of articles and predefined subtexts, such as abstracts, by remote file transfers, to arbitrarily sophisticated information-retrieval services. The natural unit of distribution for most transfers will be the single article. There will be no particular need to group articles into monthly numbers, and each article may be published as soon as its text is accepted in a standard form. Perhaps the concept of annual volumes will be retained, with changes in format or organizational structure occurring only at the beginning of a new volume, to limit the confusion inherent in such changes. Actual delivery of texts of articles will be done in direct response to demand by readers, avoiding the inefficiencies of broadcasting all articles to all subscribers.

Announcement of availability of electronically published articles can be designed independently of the form in which readers get access to the articles themselves. Readers may ask to be notified of each new article appearing in certain journals, or to be presented periodically with collected tables of contents. Abstracts may be used as well as titles for notification, to reduce the number of complete articles transmitted unnecessarily. More sophisticated services based on information retrieval research will be developed to notify readers of the articles most likely to interest them. Announcement of articles will be essentially an automatic reminding service to readers who wish to stay current.

Electronic publication over a network, then, is the act of placing a certain text, approved by the editor and an author, in the official publicly accessible journal database, and of announcing that fact to interested readers. All printing or other display of an article, and even its transmission to the reader, is associated with the act of reading, rather than of publishing.

The natural size of published articles may change under electronic publication. The fixed overhead of publication discourages very short articles, while the physical problems of printing and binding discourage very long ones. It is very hard to predict the effects of electronic publication on article size—the form of certification certainly has a big impact, and a number of cultural and intellectual characteristics of individual fields lead to a lot of variation in article size for reasons other than the economics of printing. At least one journal, *Psycoloquy,* is already taking advantage of electronic distribution on the InterNet to publish unusually short refereed contributions.

## 4.4 Archiving articles electronically

If the act of publication involves placing a text in a database, then an archive of some sort is created without special effort. Some care must be taken, however, to ensure the permanence of that archive.

- There are some obvious problems with the longevity of electronic media. The optical compact disk is widely thought of as immortal, but the medium has not been around long enough to measure its durability. A reasonable rough guess for the lifetime of a top-quality compact disk is 50 years, which is a lot less than the age of some crucial printed journals.

- Even before the failure of the physical media on which journal articles are stored, technological improvements may make them obsolete, and the devices that read them may cease to be made.

- The worst problem of all for electronic preservation may be changes in the data formats used to represent texts. These changes can lead to failures in the software used to search, retrieve, and display the texts. While changes in physical media intrude on our attention, vigilance may be required lest a crucial format change is not noticed.

It is crucial for electronic journal organizations to start planning in their first years for the preservation of the information that they publish. A schedule of copying needs to be considered in advance to make sure that aging media can be replaced before they fail, and old data formats can be converted before their software is lost. If a number of journals agree on standards in physical media and data formats, they will create economic pressure on the suppliers to offer facilities for conversion.

## 4.5 Realignment of roles in electronic journal publication

Independently of changes in the medium of publication, the five roles of *author, editor, publisher, archivist,* and *reader* will remain associated with their respective tasks of *writing, accepting, distributing, archiving,* and *reading* scholarly articles. The assignment of specific activities in support of those roles, and the assignment of individuals and organizations to perform those roles, is likely to change.

- The role of the *author* should not change much. Because the author will usually submit an article in the same sort of data format in which it is to be published, he will probably be more involved in formatting questions that are currently dealt with rather independently by a copy editor. The role of author will continue to be performed by individual scholars and small groups. Electronic communication *before* submission of an article may make it possible for larger groups to act as authors.

- The *editor*'s role will also change rather little. Because the final act of publishing by storing in a database can easily be done by the push of a button, the editor might perform that action herself, instead of authorizing the publisher to do so. It may be necessary, however, to degrade the ease of publishing an article deliberately, in order to avoid errors and maintain readers' confidence in the correctness of the journal database. Editors will continue to be experts chosen from the community of scholars.

- The *publisher* will have less to do in order to cause the publication of each article, but more to do with the computing and network facilities that support the journal. The role of publisher might be performed by the staff of a computer center, or by a library organization, along with a small business and administrative staff.

- The *archivist*'s role will involve many tasks very similar to the publisher's, so these two roles may well be performed by the same organization. In effect, the archivist is responsible for the longevity of the same database that the publisher maintains from day to day.

- The *reader*'s role will take over from the publisher the tasks of initiating individual transfers of articles, and of laying out and printing or otherwise displaying the texts of the articles. The role of reader will still be performed by individual scholars, but if publishers and archivists offer sufficiently good information retrieval services, individual scholars may become sporadic readers of a larger number of journals, instead of regular readers of a small number.

# 5 Financing Electronic Scholarly Journals

While electronic communication is expected to improve the cost-effectiveness of scholarly publication, it will not make publication free. Some mechanism must be be derived for financing electronic journals. It is reasonable for readers and perhaps authors to bear the cost of publication, but it is crucial to the health of scholarly research that any charges be designed so as not to inhibit flexible and spontaneous reading. Financing mechanisms are too often designed around the physical and legal means of enforcement, instead of the influence that they will have on the behavior of people in the market. In particular, it is important not to burden the reader with an important financial decision every time she considers reading an article. If electronic publication mimics the financial structure of current printed journals, which is quite conceivable, nearly all of the potential utility of the new medium may be masked. Imagine a national highway system with roads and cars engineered for safe travel at 65 miles per hour, but with a toll booth every mile collecting a penny toll. The total cost of a long trip would be quite reasonable, but the time and energy spent in paying would destroy most of the utility of the highways. I believe that this analogy does not exaggerate the danger to network utility of inappropriate financial mechanisms at all—it may even understate the potential problem.

It is not at all clear how electronic scholarly journals will be, or should be, financed. In the short run, a number of them are being given free to readers, and subsidized completely by volunteer editorial effort from scholars, donation of computing and data storage service from research organizations, and the free use of InterNet communication. It is unlikely that all of these subsidies will continue for many years. And, it is nearly impossible for a shoestring volunteer organization to make a credible commitment to the longevity of published texts, especially when format conversion is required. Here are a few possible replacement financial structures to think about.

1. The InterNet may develop a system of accounting and charges comparable to that of the current telephone system. Access to journal databases could be charged to the reader in a form similar to the use of services at a 900 telephone number. In this case, it will be crucial to the health of the scholarly community that the charge per access be reasonably uniform and small, comparable to a modest long-distance

call, and that charges be accumulated and presented monthly much as a telephone bill. Otherwise, scholars will spend far too much time pondering whether or not they can afford to read a particular article.

2. Individual readers may subscribe to general scholarly journal services, at an annual rate determined by broad categories of volume of use. With this mechanism, it is crucial that the number of different services required to cover a given topic be very small. Ideally, a single service would allow access to all scholarly journals.

3. Larger institutions may subscribe, probably through their libraries, to the services above, in behalf of all their scholarly staff. Rates could be determined by broad categories of institutional size, type and volume of use, perhaps negotiated annually.

4. National and international organizations, such as the Association for Research Libraries, might fund journals with block contracts in return for unlimited access by all of their members.

5. Scholarly societies might fund journals from dues and conference revenues. Unfortunately, many societies currently depend on profits from their journals.

Each of these mechanisms has potential drawbacks, and some require new developments that may or may not occur in the InterNet. The best hope for a financial mechanism agreeable to scholars lies in the early development of electronic journals taking advantage of currently available free services. If such subsidized journals demonstrate their value, there will be pressure for future technical and business developments in the network to accommodate the needs of the journals. If the network facilities and business practices on which journal financing will depend develop prior to the widespread acceptance of electronic journals, it may be very difficult to finance journals in a healthy way for scholarly research.

# 6 Strategic Issues

It is hard enough to describe in useful detail the ideal structure for scholarly publication on the network. It is even harder to predict how close to that ideal structure we can come. And the hardest problem of all is to take effective action to develop the best possible means of publication quickly and efficiently. There are two particularly easy ways to fail to make progress. First, we can be drawn into the Charybdis of long-range thinking about ideal structures, and never develop a truly feasible plan. Or, at the other extreme, we can strike on the Scylla of short-sighted reaction to explicit demands with naive use of whatever resources are available immediately.

To achieve useful progress toward better publication methods, we must *think ideally,* but *act opportunistically.* That is, we must keep in mind our best approximation to the long-range ideal form for scholarly publication, and then look for short-range opportunities to make incremental progress toward it, accepting wholeheartedly that much of what we do will be redone several times. We must also be willing to make experiments, accepting that not all of them will succeed. Finally, we must understand that no person or institution can control the development of the network with any precision, but every participant can have some influence. We must yield to massive social movements in the network, but continually take opportunities to influence the form of the network by good example.

I do not have an organized recipe for progress in electronic scholarly publication, but I can suggest some isolated principles with a fair confidence that they are more helpful than harmful.

- A key, and often overlooked resource, is other people's work. Publishers of electronic journals cannot afford to develop more than a token portion of the software required to support use of the journal by readers. We must look for opportunities to base electronic journals on suites of software that are already well distributed because of their other uses.

- Not only must we exploit other people's past work, we must influence their future work, by creating markets for the services that we want. For example, one way to preserve archival texts when their format becomes obsolete is to hire a lot of staff to do the conversion. A better way is to be part of a large enough community using the same format, that vendors will offer conversion software and services to satisfy the market that we have helped to create.

- Another crucial resource is the training of authors and readers in the use of software. Early electronic journal projects must find scholarly communities that are already adept in the use of some relatively homogeneous computer systems.

- The need to match the training of existing scholarly communities will lead inevitably to an annoyingly large number of different formats for text. Opportunities to coalesce different formats will be rare, and we must seize them whenever they arise.

- In many cases, new journals should lead the way in experiments with unusual formats for electronic texts, since they can be designed more freely. Established printed journals, with historical commitments to their communities, should pick up techniques that have been proven to work elsewhere.

- The future financial structure of the network is completely unknown. It is quite possible that it will develop in ways that are very unfriendly to scholarly publication—for example, network tariffs based on connect time would discourage flexible, interactive, interleaved use of a variety of publications and other network services. In order to influence network financing, we need to establish journal services and demonstrate their value as early as possible. Then, there is some chance that the institutions that make decisions about financial structure of the network will seek tariffs that allow scholarly journals to succeed.

- Journal customers, particularly libraries, should try to influence the financial structure of publication by favoring journals and information services that are marketed under enlightened licenses. We should be reluctant to pay for licenses that restrict the utility of information by prohibiting local network distribution or limiting strictly the number of simultaneous users. We should *particularly* avoid licenses that fragment the scholarly community by restricting access to particular schools divisions or departments. Much of the unifying power of the library is lost if, for example, a historian is denied access to information that is provided for the law school.