

## SCHOLARS DEBATE THE IMPLICATIONS OF INFORMATION TECHNOLOGY FOR SCIENTIFIC JOURNAL PUBLISHING

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Scholarly journal publishing is characterized by periodic release of journal issues containing original scholarship. The material included in these publications is generally established through peer review, and the path to publication can be lengthy as research is verified, validated, revised, printed, and disseminated. In contrast to this slow and methodical approach is the rapid exchange of information facilitated by today's information technologies. Not surprisingly, these technologies have, over the last 20 years, affected many aspects of traditional print publishing from manuscript preparation through submission, peer review, production, and distribution. These technologies can be used to ease many limitations in the traditional scholarly journal publication process by overcoming, eradicating, or rendering moot issues related to timeliness, the advent of more subdisciplines and their attendant specialty publications, rising publication costs, and stressed library budgets. Other potential effects on the quality and dissemination of scientific results is not yet clear.

A forthcoming report, "The Implications of Information Technology for Scientific Journal Publishing: A Literature Review," prepared for the Division of Science Resources Statistics of the National Science

Foundation (NSF), examines the literature in English on the implications of information technologies for scientific journal publishing. The focus of the review is on how new communication technologies would affect the quality and dissemination of scientific results and in particular on the "e-journal"—the electronic scholarly journal, whose contents are accessed via the Internet/World Wide Web.

The report identifies about 380 journal articles, reports, conference papers, and technical papers including interviews, surveys, case studies, professional analyses, opinion pieces, and qualitative studies. The 58 quantitative studies are of various kinds (behavioral, bibliometric, attitudinal) and highly heterogeneous in method, scope, and design.

### A System in Flux

This highly heterogeneous literature does not support easy generalizations across the various domains involved in science. Indeed, studies of scientific communication more generally have identified variations across fields of science that reflect differences in work practices, internationalization, market penetration, technological penetration, traditions of prepublication collaboration, and intellectual structure.

The new information technologies, particularly those associated with and subsumed by the Internet and the World Wide Web, challenge the very notion and definition of "publishing." This definitional challenge is

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itself an area of research. Scholars of communication have begun to delineate key distinctions among print, parallel, and purely electronic publication. Legal analysts have begun to reconsider the assumptions of the U.S. copyright system, which was predicated literally on the notion of a print “copy” and, of course, could not fully capture the nature of an electronic copy in today’s advanced information technology.

Current estimates place the number of electronic journals in science, technology, and medicine at between 3,200 and 4,000. Note, however, that there is little agreement in this emerging field as to what precisely constitutes an “e-journal.”

### **Changing Roles**

The literature about electronic journal publishing is dominated by discussions of the relationship between the formal peer-reviewed journal article and the larger hierarchy of scholarly and scientific communication forms and the extent to which the new information and communication technologies have altered and disrupted traditional roles. Some observers believe the new technologies will enable reform of the publishing system. Depending on how they are applied, the new technologies could be used to eliminate or reduce the role of publishers and/or libraries; change or eliminate peer review (which has historically been a function coordinated by journal publishers but which has a strong element of being a “public good”); and change how intellectual property rights are managed.

### **Pricing Electronic Journals**

Associated with the debate about shifting roles is the question of pricing electronic journals. Pricing e-journals is part of a more general discussion among economists about methods for pricing information goods, and it is of interest to librarians concerned about escalating serial prices. Pricing represents an area of emerging research, and early experimental results are only just beginning to be released.

Construction of pricing models requires assumptions about how e-journals will be defined, used, and valued—a topic for which results are still preliminary, diffused, and evolving as e-journals come to be more widely accepted.

### **Acceptance of Electronic Journals**

The pace of e-journal acceptance appears to vary across fields and with conditions of employment. For example, the natural sciences, where terminology, metrics, and research designs tend to be more closely coupled, appear to place a different value on archiving than do the social sciences, where research designs, variables, and measurements are more individualistic. Acceptance of e-journals among both seems to be associated with the availability of archiving of journal issues, but natural scientists place greater value on ready access to comparatively recent results whereas social scientists place greater value on maintaining a longer historical record.

### **Functions and Attributes of the Electronic Journal Article**

Also under study by researchers are the functions and attributes of the electronic journal article as a brand-new “artifact” (as opposed to merely a Web version of the print article). These studies examine the relationships among the electronic and print artifacts, archiving, and security, among other topics. Given the heterogeneity of the literature, the clear differences in communication practices among the sciences, and the associated variation in diffusion of the information technologies within the sciences—which is affected by the nature of the research as well as by traditions of formal and informal communication—it is not surprising that there is no obvious consensus on what has transpired and still less on what is likely to transpire. In general, however, researcher scientists have been consistently found to seek convenience. This is manifested in their browsing and searching behaviors; a desire for the ability to print material; a preference for hyperlinks to related literature and to archived material, which includes databases of scientific information as well as previously published material; and functionalities at the desktop. The most fully developed attribute of the e-journal article is the hyperlink, which is becoming essential to the definition of an online publication.

### **Impacts of Individual Works**

Hyperlinks also figure in another area of research about electronic publishing. Information technologies in general are supporting expanded study of the “impacts” of individual works. Impacts of individual articles or

journals have historically been measured through bibliometric techniques, which are well understood among information scientists and which were themselves enabled by advances in computing. There are efforts to extend this methodology using hyperlinks and also to extend the notion of "citations" to include broader acknowledgments of other ways that the impact of one work on another might be expressed. This appears to be particularly interesting in the Web environment, which offers both multiple forms of providing information (Web pages, white papers, electronic versions of peer-reviewed journals articles, listserv discussions, and so on) as well as the means to establish explicit connections through hyperlinks.

### **Gaps and Areas for Future Research**

Many kinds of research are needed to provide information for use in private and public decisions about scientific journal publishing: pricing of electronic serials and their relationship to business and publishing models; the potential for antitrust abuse among commercial entities and the relationship between the increasing specialization of scientific communication and the rise of these commercial entities; the relative roles of learned societies, universities, libraries, and commercial interests given the special dynamics of scholarly journal publishing; the potential conflict created by state involvement in copyright enforcement; and the meaning of fair use in the digital environment.

As noted, formal peer-reviewed e-journal publication is one of several forms of scientific communication, and it is not yet clear how the continuum (or hierarchy) of communication forms will evolve or what the roles of various stakeholders (authors, readers, publishers, libraries, and intermediary services such as abstracting and indexing services and infrastructure service providers) will become. Nevertheless, it seems likely that there will continue to be diversity among the various scientific fields and that the sources of the variation will include work practices (large versus small group, group work versus individual); use of shared data sets (e.g., protein sequence data, oceanographic measurements, climate data, social science data); multidisciplinary and computational intensity; employment patterns (whether in a university or corporate research

laboratory); career expectations and requirements for promotion and tenure; and extent of international collaboration. All merit systematic study.

Barriers to acceptance of e-journals across the various fields include relative unfamiliarity, which might be expected to become reduced with time; skepticism about the quality of material, which also might be expected to dissipate with time; and concerns over permanence, which is linked to issues in archiving, quality control, and information security. Related to acceptance is access. No body of literature was identified related to electronic journals and democratization of scientific research on a national or international scale, although there appears to be widespread interest as well as faith in the potential of technology to support this. Moreover, isolated examples exist of publishers who seek to accommodate different clienteles. This issue of universal access appears to be an area ripe for investigation.

Studies in the scholarly communication of science, as they are enabled and potentially transformed by the new information technologies, offer a rich future. The first generation of studies provides a base on which more broadly based investigations may be established. Among the topics for future research are reading and authoring behaviors across disciplines and over career trajectories, the relationship between copyright and issues in higher education that arise from remote learning and the intellectual property rights associated with course curricula, the evolution of new services such as archiving, and the relationship between the societal interest in peer review and the means by which peer review may be institutionalized.

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