Applying Hypertext and Hypermedia to Scholarly Journals Enables Both Product and Process Innovation

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Abstract: Early uses of hypertext technologies were associated with scholarly communication. New electronic-only journals have been quick to adopt hypertext/hypermedia technologies. Existing print journals have also started to adopt such technologies as they make the transition to parallel delivery. The widespread uptake of the World Wide Web has enabled journals to improve, enhance and transform what they do. This paper surveys these developments and places them in context.

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Additional Key Words and Phrases: Scholarly communication, Electronic journals, Parallel publishing

Some history

Hypertext can be broadly defined as the combination of hypertext linking mechanisms and multimedia content [Bolter 1991, pp. 25-7]. We think of hypermedia as exemplifying the sort of rich information that the computer has made possible. And yet, hypertext and hypermedia predate the computer, in some cases to a significant extent. Hebrew citation indexes in mediaeval editions of the Talmud are an example of rich pre-computer hypertext [Weinberg 1997] and Paul Otlet's work at the International Offices of Documentation [Rayward 1997] can be seen as an early manual hypermedia system. Even the citations to print sources used in this article can be regarded as a slow and clumsy form of hypertext.

These early applications of hypertext were associated with scholarly communication. Vannevar Bush, in his seminal paper, specifically cited the need to improve scholarly communication as one of the reasons behind the design of the memex:

> "Professionally our methods of transmitting and reviewing the results of research are generations old and by now are totally inadequate for their purpose... The summation of human experience is being expanded at a prodigious rate, and the means we use for threading through the consequent maze to the momentarily important item is the same as was used in the days of square-rigged ships." [Bush 1945].

The hypertext system that has had the greatest influence on scholarly communication to date is undoubtedly the World Wide Web, which has made hypertext concepts and implementations widely available. The Web too arose out of the needs of scholars, being developed by Tim Berners-Lee and Robert Cailliau at CERN to facilitate information sharing and communication within a small group of research physicists.

Since the invention of printing, journals have been the traditional means for scholars to communicate. Electronic journals (e-journals) predate the Web and were being mooted as possibilities as far back as the early 1970s [Bamford 1972]. Early experiments with e-journals were undertaken in 1976, but were widely regarded as having failed ("I have seen the future and it doesn't work" - [Senders 1980]), in large part due to the limitations of the available technologies. The first successful e-journals appeared in 1989 or 1990, based on ASCII text distributed via email. Early hypertext journals were trialled using a variety of proprietary technologies. The best known of these is the Online Journal of Current Clinical Trials which used the Guidon browser based on SGML technology [Keyhani 1993]. This ran into a number of difficulties including persuading the user base to get and use a proprietary browser. Consult [Peek 1996] for an excellent summary of the issues surrounding electronic scholarly publishing.

The Web changes everything

The advent of the Web provided for the first time a medium that was both 'good enough' and 'big enough' to be used by scholars. Good enough, even though the Web was (and is) a deficient hypertext system. Big enough, because it had millions of users rather than thousands and was on every desktop. The Web and the associated growth in use of the Internet catalysed the development of e-journals. Most existing e-journals moved rapidly to the Web and all new ones that were developed assumed a Web delivery platform. Some Web-based e-journals offer articles in Adobe's Portable Document Format (PDF) technology, but just as a way to deliver formatted printable versions (or paper reprint equivalents). They are not using the hyperlink features in PDF to any great extent.

The advent of the Web enabled e-journals to innovate by engaging in both product innovation and process innovation [Utterback 1994]. Adding a range of hypertext and hypermedia features transformed the e-journal in three different ways. Product innovations included the use of hypertext/media to improve on print by adding navigation mechanisms appropriate to a non-print environment. They also included its use to provide enhancements to the journal text that would be very difficult in print. Finally, process innovation used hypertext/media to transform the journal and the process of scholarly communication altogether.

Improving - Doing better

Hypertext was initially used to provide relatively simple navigational mechanisms within a particular journal article or issue. Articles might include internal links for endnotes or to provide an article table of contents. Links between documents on the same server could support journal tables of contents. As the site design for e-journals settled down, the directory structure (and hence the URLs that assumed that directory structure) became more predictable and stable. This made it easier to make citation links to documents in other e-journals on different servers. As more print journals moved online and began to digitise or convert their back issues this became increasingly feasible. At present, the web of hypertext cross-links and citations (both within families of journals from a given publisher and between journals from different publishers) is growing steadily richer. All of these features should be viewed only as

'doing better' or improving on what print journals already do. Following an online link is faster than going to the library to look up a print citation, but it is still in some sense the same activity.

Enhancing - Doing more

Because the Web allows links to point to any machine-readable data, journals were also able to add a range of enhancements to e-journals. A simple example (which barely justifies the use of the term hypermedia) is the use of colour to enhance an article. This is prohibitively expensive for most print scholarly journals but is essentially 'free' online.

Some e-journals are also adding links from articles to citation databases such as Medline, enabling tracking of other articles by the same authors, articles that refer to the article under consideration, or articles on related topics. E-journal articles are increasingly adding links to relevant websites as an enhancement of the normal source citation convention. Another link enhancement is forward citations. These link to articles that cite the article currently being read. In this way, the reader can gain a sense of how the scholarly community has reacted to a given work.

More sophisticated hypermedia uses include links to sound files (for example to play rock music clips when discussing that music [McNeilly 1995]) or links to movies (for example to show performances [Magrini 1995]). These could have been added to print journals but would have required including audio or video tapes (in different formats for different countries) as part of the journal. Few print journals were prepared to deal with the problems this would have caused. The limitations of unassisted print communication in the past required the use of elaborate notation systems when discussing non-text information. Examples include traditional scores for music, the International Phonetic Alphabet for language, and Labanotation for dance. The direct use of hypermedia in journals removes or reduces the need for these and enables e-journals to 'do more' than print.

Transforming - Doing differently

Particularly innovative applications of hypertext/media (together in some cases with Java applets) are enabling e-journals to transform the process of scholarly communication altogether and begin the process of transforming the journal. Particularly good examples are the Journal of Biological Chemistry and the Journal of Interactive Media in Education.

The Journal of Biological Chemistry (available online at http://www.jbc.org/) is published by Highwire Press, an initiative of Stanford University Libraries. It is a parallel delivery (print and electronic) journal that began life as print-only and has been gradually adding features to its online version. This provides a range of unique features that are only possible in an online hypertext environment. These include automatic creation of hyperlinks to MEDLINE citations provided by the National Library of Medicines PubMed service (available online at http://www.nlm.nih.gov/databases/freemedl.html) for the article itself, for cited articles, and for related articles, bidirectional links between citing articles and cited references (where available) and 'forward' citations (links to other articles that cite the current article).

The Journal of Interactive Media in Education (available online at http://www-jime.open.ac.uk/jime/) is published by the Knowledge Media Institute, part of the Open University in the U. K. It is an electronic-only journal, although printable versions of articles (as PDF) are available. One of the things that distinguishes JIME is its integration of the review and publishing process. JIME has a publishing model that provides for both closed and open peer review as part of the review cycle as well as initial and ongoing peer commentary, integrated with the article, once published. The article therefore becomes the focus for discussion, rather than a standalone artifact, and the process of quality control is much more open and transparent. Another of JIME's distinguishing features is its use of Shockwave and Java to support demonstrations or interactive examples embedded within articles. This allows readers to interact with the systems being described and enables the journal to model its own field of application.

Conclusions

These innovations mean that one should properly talk about the *h-journal* (hypermedia journal) rather than the e-journal (electronic journal) [Coleman 1996]. The h-journal is truely an improvement (in most areas) on its print predecessors [Treloar 1996]. In some respects h-journals are still inferior to print. Navigation mechanisms are still sometimes slower (particularly within an issue), e-journals cannot be annotated onscreen, and the resolution of current displays is still deficient. But these are clearly soluble problems and technologies exist or are being trialled to overcome them. Hypermedia is now an integral part of the most innovative online journals.

The potentials in the new hypertext/media technologies are becoming actual in the domain of scholarly communication. These innovative features are transforming the scholarly journal in an evolutionary way and at the same time compensating for areas in which online is still inferior to print. The result should be gradual uptake of h-journals among users and an accelerating shift away from print starting very early in this new millennium.

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