

The HighWire Press: A Study in Service to Scholarly Communication

Michael A. Keller and Andrew C. Herkovic, Stanford, CA

HighWire Press, a department of the Stanford University Libraries and Academic Information Resources, is a not-for-profit supplier of a variety of Internet services to over 110 publishers of 340 scholarly journals, principally in the areas of life sciences and medicine, but with some general science and social scientific titles as well. Toll Free Linking and Free Back Issues programs at HighWire provide free access to over 440,000 articles. This article describes the current features and functions provided with HighWire support as well as some of the new features to appear in the immediate future. Knowledge environments, a new sort of comprehensive web-based workspace designed to help scientists do science more effectively are described. LOCKSS, net-caching, peer-to-peer archiving software under development at Stanford is discussed as well as an extensive study of readers of Internet editions of HighWire journals, known as Ejust. References to additional information are provided.

HighWire Press¹ came into being to ensure that its partners - scientific societies and responsible publishers - would remain strong and able to lead the transition toward use of new technologies for scientific communication. Concerned that scientific societies separately would lack the resources and expertise to lead a major technical infrastructure shift in publications, Stanford University, in founding HighWire, accepted the role of partner, agent of change, and advisor within a close collaboration of scientists, librarians and publishers. HighWire began in 1995 as a joint development project of limited duration based in the Stanford University Libraries, with funding from my discretionary fund and from a scholarly society, the American Society for Molecular and Biological Chemistry.² In May 1995, after 90 days of work, we initiated the online production of the weekly Journal of Biological Chemistry (JBC)³, the most highly cited (and second largest) peer-reviewed journal. Scientists and societies rapidly saw the potential for new forms and features of scientific communication, and Science⁴ and Proceedings of the National Academy of Sciences⁵ soon joined JBC online. HighWire remains organizationally a department within the Stanford Libraries, albeit a self-supporting one, and now supports (as of July 2002) 336 sites online, with many more planned. These sites, a large majority of which are scholarly journals, have a strong concentration in science, technology, and medicine (STM).

It is important to realize that HighWire Press is not actually a publisher. Rather, it is a specialized Internet service provider providing its clients, responsible scholarly publishers, Internet editions of their journals and other publications. The publishers then

market and sell access to their on-line editions with business models of their own supported by HighWire's access control systems. Over time, HighWire has also created a vivid, highly interactive environment of scholarly articles, primarily in the life sciences and medical disciplines, and a community of like-minded publishers whose focus is on service to their subscribers and members rather than on profits and stockholders. HighWire's mission statement dated June 1995. It is noteworthy that its five points are as pertinent today as they were seven years ago:

- Foster research and instruction by providing a more direct linkage between the writers and readers of scholarly materials.
- Use innovative network tools for capture, publishing, retrieval, reading and presentation.
- Affect the economics of provision of scholarly information to researchers, especially science, technology and medical (STM) research information.
- Ensure that the nascent marketplace for electronic communication among scholars does not develop along the semi-monopolistic lines of current STM publishing.
- Build new technological, economic and programmatic partnerships with others investigating related problems.

The journals HighWire supports are preponderantly among the highest-impact journals in the literature. Also, as a research institution, Stanford is strongly interested in the economics of provision of scholarly

information to researchers, especially STM research information.

In collaboration with its publishing partners, HighWire's approach to online publishing of scholarly journals was not limited simply to mounting electronic images of printed pages; rather, by adding links among authors, articles and citations, advanced searching capabilities, high-resolution images and multimedia, and interactivity, the electronic versions were realized with dimensions not possible in the printed journals or in mere online facsimiles. Early on, publishers working with HighWire agreed to "toll free linking", making it possible for subscribers to one journal to follow links to full text articles in other journals and meta-information sources like the Web of Science and PubMed without needing to have subscriptions to the journals containing the cited articles.

This approach has expanded in other ways. In cooperation with several publishers, HighWire pioneered the idea of **Knowledge EnvironmentsTM**, a new class of information vehicle which provides a comprehensive web-based workspace designed to help scientists do science more effectively. Building Knowledge Environments starts with careful observation of how scientists actually do their work - what information references and resources they use, how those resources might be delivered better or faster in another form, what needs are not being met with conventional information resources, what information would be shared if sharing were easier or faster, and so forth. Our scientist interlocutors and information professionals ask what new social and organizational, as well as technological, arrangements might be possible.

The first Knowledge Environment™, known as STKE (<http://stke.stanford.edu>), concentrated on the bioscience community of signal transduction. We grew the architecture and technology to be adaptable, with “toolkit” extensions, to the social sciences, the humanities, and policy fields as well. The technological features – seamless navigation across formally distinct data sets, improved search and browsing interfaces, alerting services which notify a user when new information of interest is published, and many more – are designed to be useful to many communities of researchers. Since then, the list of Knowledge Environments has grown to include, so far:

- the IBMS BoneKey-Osteovision®, A Knowledge Environment on Bone, Mineral, Cartilage and Teeth for Clinicians and Researchers from the International Bone and Mineral Society (<http://www.bonekey-ibms.org/>)
- JNCI Cancer Spectrum, a new online version of the Journal of the National Cancer Institute, which integrates the Journal with other sources of cancer information, including abstracts from other journals, cancer statistics, and drug information. (<http://jncicancer-spectrum.oupjournals.org/>),
- ScienceMagazine’s SAGE, the Science of Aging Knowledge Environment (<http://sageke.sciencemag.org/>)

With profound and growing ties to the societies and publishers it serves, and equally profound links to scholars and the research library community, HighWire has pioneered another species of communication as well. Through semi-annual meetings of the journal publishers and innumerable operational discussions, there is a very lively, productive, and path-breaking dialogue among the many participants in the HighWire success to date. Any useful novel feature the reader encounters in the realm of electronic journals probably had its first airing and public debate at a HighWire publishers’ meeting. It has often been stated, not entirely by myself, that HighWire is the gold standard for online journal publishing. If so, this is due to a commitment to the scholar, rather than to corporate profits, shared by Stanford and its partner-publishers. It is also a testimony to the diplomacy and technical focus of the HighWire staff.

HighWire Press continues to grow in several significant ways.⁶ Of course, we are adding new publications continuously, while also increasing the number of publishers we serve. The suite of over 300 journals include 44 of the 100 most-frequently cited journals in the world. A startling metric of use of journals based at HighWire is the more than 350,000,000 hits per month on the array of HighWire servers from over 2,000,000 individual computers around the world. Through the “FreeBackIssues” program that HighWire has championed over the past several years, an ever-increasing number (and proportion) of full-text articles are available to readers around the world without subscription requirements or institutional affiliation. Typically, participating publishers allow their articles to become freely accessible after a fixed period (most often 12 months) of subscription-based access. As of this writing, HighWire supports 431,100 full-text articles at no charge, from 140 journals, making it the largest collection of full-text, life-sciences research articles in the world, as well as one of the largest among all the sciences. At the same time, we are exploring with publishers means for retroactively expanding the backsets and are actively seeking foundation or other means of supporting digitization efforts for older scientific content. Some of the publishers are undertaking similar efforts themselves.

Most significantly, HighWire has brought out a new portal view of the biomedical research literature, embracing not only the 330 or more journals it supports, but also all Medline content. Often referred to as a “one-stop shopping” approach, the **HighWire Library of the Sciences and Medicine** provides searching across a huge section of the literature, including over 11,000,000 research citations or full text articles. The site provides powerful new search features, making it possible to search all of Medline’s abstracts and all of HighWire’s full text with one click. The portal provides discovery tools to make it easier to sort, filter and format search result sets. It also makes clear to the individual reader what articles are freely available (through an optional single log-pin process). It also allows readers to keep profiles of their preferred journals for faster reference to them. And we have incorporated our alerting services in the portal view too. Readers may select keywords, articles, and authors names as search elements used iteratively by software agents who then identify new articles entering the HighWire database and, once so identified, the alerting service sends readers

e-mail messages with hotlinks to the desired articles. Presently there over a million such alerts for over a hundred thousand individual readers. A series of tutorial articles on the features of the portal is available at <http://highwire.stanford.edu/inthepress/asbmb/index.dtl>

One interesting aspect of the new portal is one best experienced directly: concept mapping through a visualization of topical taxonomies through a partnership with Semio Corp. This feature allows the reader to explore concepts in context as a means of identifying pertinent areas of research. To experience the “**Graphic ResearchNet Browser**” go to the HighWire portal (<http://highwire.stanford.edu>) and then click the “Topic Map” near the center of the home page. At present, like the entire portal, this feature is limited to the English language; presumably, it could be replicated in other languages as need and funding emerge. Soon the taxonomy based on the Semio software will make it possible for readers to search for articles containing concepts identified in the taxonomy, but whose exact expression may not appear in the article. And we will make new searching combinations of keywords, authors names, and concepts possible too. Naturally, this concept searching feature will be included in our alerting functions as well.

A current research project of the Stanford Libraries, conducted in cooperation with HighWire and some of its participating publishers, is exploring the behavior, attitudes, and preferences of scientists and medical professionals regarding journal literature and particularly online journals. This **E-Journal User Study**⁷, funded generously by the Andrew W. Mellon Foundation, has informed the development of the HighWire portal. In particular, we now know that researchers are quite concerned about the productivity of their work with the literature and wish for barrier-free access to more full-text content (including older articles), easier, more comprehensive and more precise cross-journal searching, and subject-specific, personalized email alerts. The portal addresses the issue of productivity and effectiveness in numerous ways.

HighWire Press also supports the Oxford University Press in its on-line publication of the constantly growing and changing third edition of the Oxford English Dictionary.⁸ This article is not the forum for an extensive description of this magnificent work, the first historical dictionary of the English language.⁹

HighWire's immediate future much resembles its current activity: bring on new journals continuously; continuously improve the portal and its searching and organizing features; develop new features to make the use of the literature faster and more convenient; make progressive improvements in the article submission, tracking, and editing processes.

One of the reasons that HighWire has concentrated in the sciences, particularly the life sciences, is economic. We at Stanford would like to expand the HighWire model to the humanities and social sciences faster and more broadly than is now the case, the unfortunate reality is that STM research is better funded than other academic domains. One result is that STM publishers, even not-for-profit societies, can afford the sophisticated and relatively expensive services of a high-end e-publishing platform like HighWire, while others cannot. While there are cultural issues as well to consider, we believe many scholarly journals in the humanities and social sciences would benefit from online editions hosted and managed by a sympathetic organization. Thus, we envision a second tier affordable solution for journals that cannot afford the full HighWire treatment. This service, which will undoubtedly take advantage of technologies now in flux, is not yet at the stage where it can be described in detail. We can assure the reader it will exploit many of the lessons HighWire and its partner publishers have learned to date.

In parallel with HighWire's future, the Stanford Libraries are exploring a number of ways to assure archival continuity of online journal content (as well as other genres of research information). In particular, one of these is known as **LOCKSS**, "**Lots of Copies Keeps Stuff Safe**." In brief, LOCKSS is a low-cost, peer-to-peer system and protocol through which libraries that subscribe to a given journal can create and maintain a persistent cache of its content. LOCKSS allows the library permanently to retain the online journal issues for which it has licensed access and assure their integrity through polling among LOCKSS caches at other institutions via the Internet, even if the publisher site goes dark or denies future access to the library. This project is supported by the Andrew W. Mellon Foundation, the National Science Foundation, Sun Microsystems, as well as Stanford. It has worked, like HighWire, in close cooperation with, and respectful of the

business models of, scholarly publishers. The LOCKSS project, which will make its software freely available as open source software, will play an interesting, possibly vital, role in the archiving of online journal content.¹⁰

HighWire has always worked within the individual (and very different) subscription policies of the societies and publishers. HighWire realizes and honors their various business models. This ranges from individual subscriptions to institutional access, and can even scale up to consortial or national access policies. This is critically important; most of the HighWire publishers are not-for-profit, responsible organizations; unlike some other publishers, their business models are both reasonable and justified by the value they provide as selectors, editors, and producers (whether of the print editions or, through HighWire, of the online editions). That is, as postulated in the mission statement above, our object has been, and remains, to assure the survival and enhancement of scholarly communication embodied in the peer-reviewed journal literature, rather than the enrichment of the publisher. The inability or unwillingness of zealots to recognize the difference between responsible publishers and exploitive ones is, in my opinion, tragic and dangerous.¹¹

I have argued, and continue to believe, that this system of journal publication, while stressed and in some sectors abused, is not broken – at least among not-for-profit and other responsible publishers – and is vital to scholarly communication. I very much support exploration and development of additional modes of communication – indeed, we are always trying to enlarge the model – but I reject some of the current notions that would demolish scholarly publishing by economic starvation under the naïve, quixotic, or even nihilistic demand that information be made immediately and indiscriminately "free." As every librarian understands profoundly, information is never free. The brilliant new ways in which information can be disseminated should not blind us to the underlying reality that information remains costly indeed. The challenge for us all in the community of scholarly communication – librarians, scholars, publishers – is to assure that our collective resources are used to the ultimate advantage of the scholarly endeavor. We cannot do so by wishing away the economic realities of the provision of scholarly information.

¹ <http://highwire.stanford.edu>

² A detailed account of the genesis and early stages of HighWire Press can be found in *Against the Grain*; linking publishers, vendors and librarians, vol. 9, no. 5, November 1997, pp.80-85, 93. A freely accessible copy of the article may be found at <http://library.stanford.edu/staff/pubs/atg.html>.

³ <http://www.jbc.org>

⁴ <http://www.sciencemag.org>

⁵ <http://www.pnas.org>

⁶ Some of the most important announcements and articles about developments associated with HighWire Press may be conveniently consulted at <http://highwire.stanford.edu/inthepress/>.

⁷ <http://ejust.stanford.edu>

⁸ <http://dictionary.oed.com/>

⁹ A review covering the features of the OED online by Peter Cliff can be found at <http://www.ariadne.ac.uk/issue23/oed-review/>.

¹⁰ The beta-test version of the LOCKSS software is available at Source Forge: <http://sourceforge.net> and a full description of the LOCKSS project may be found at <http://lockss.stanford.edu>.

¹¹ For further commentary on this, including a contribution by Michael A. Keller, see the Nature forum on "future e-access to primary literature" at <http://www.nature.com/nature/debates/e-access/>.

Further information can be found online at: <http://highwire.stanford.edu>. Readers outside the U.S. may obtain faster connections at: <http://intl.highwire.org>.

Michael A. Keller is the University Librarian, Director of Academic Information Resources, Publisher of HighWire Press, and Publisher of Stanford University Press at Stanford University.

Andrew C. Herkovic is Director of Foundation & Corporate Relations & Strategic Projects Manager in the Stanford University Libraries and Academic Information Resources.