CORE SCHOLARLY INFORMATION TASKS AND E-JOURNAL FEATURES: EXPANDED DISCUSSION

January 2002

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The purpose of this report is to deepen the analysis of six core information practices described in Institute for the Future's (IFTF's) report *E-Journal Usage and Practice: An Ethnographic Perspective on the Role and Impact of E-Journal Usage among Users of Biomedical Literature*. Continuing our analysis of ethnographic interviews with scientific scholars, this report identifies different types, or categories, of e-journal features that may support scientific scholars in their use of biomedical literature for their work. We point out existing e-journal features that support each of six information needs discussed in the qualitative study. Based on emerging technologies, we also suggest potential features that we think would be useful to scholars using e-journals.

I. SCHOLARS MONITOR AND REVIEW CONTENT REGULARLY TO KEEP CURRENT

Regular monitoring and review of the literature is an ongoing, critical activity for scientists. To maintain a high standard of scholarly practice, scientists must stay up-to-date with the knowledge evolving in their field, and interview respondents indicated that the body of literature they are responsible for tracking is rapidly expanding. The goal of this information practice is to cover a broad knowledge domain (or domains) and to get exposure to new and emerging ideas, discoveries, and methods. Rather than using a targeted search, scholars with this goal approach information in a less "results-oriented" manner. Although they are more interested in topics that relate directly to their work, part of the objective is to "see what's out there." The measure of a successful review and monitoring experience is not limited to a list of citations, or even a set of articles retrieved for further study. Rather, users look for a provocative, interesting reading experience and an expanded sense of where their own research links with others. The product or outcome is self-education, professional knowledge, new research ideas, and a better sense of social networks.

Many of the scientists we interviewed have established routines that allow them to accomplish their monitoring and review. On a weekly or monthly basis, they read key journals (both general and field-specific), conduct focused searches on specific topics, participate in journal clubs and lectures, and scan tables of contents received via e-mail. On a less routine basis, they read newsletters and other non-journal literature, attend conferences, and scan published proceedings from conferences. Regular e-mail, phone, or face-to-face meetings with colleagues are also important for keeping current.

Aside from regular focused searches on specific topics, most information monitoring and review takes place within the individual journal environment. Scholars choose specific journals (and sometimes clusters of journals published by aggregators) for regular review because they trust these journals to evaluate and distill what needs to be known to keep current. Indeed, they count on journals as a first-line knowledge filter. Scientists are familiar with the format of the journals they monitor on a regular basis. Familiar journal formats and structures facilitate idiosyncratic scanning and monitoring practices.

Respondents use a mix of methods to scan for different kinds of knowledge. They access content in both paper and electronic journals and review material in hard-copy and electronic formats. Knowledge and content categories include the following:

- *Latest research results—papers*. Content runs the gamut from general to specific, from "cutting edge" to "anything on my topic." Nearly all of the respondents read top-tier journals such as *Science* and *Nature*, as well as a few key journals in their own field. Scientists have different ideas about how far they need to or are willing to roam in terms of relevance to their topic.

- *Latest work by a particular author or lab*. Keeping up with competitors is a powerful motivator for active and regular content monitoring.

- *Advertisements and announcements of jobs and fellowships*. Graduate students and postdoctoral fellows regularly monitor these announcements in printed journal copies and on journal Web sites.

- *Information about new procedures and methods*. New pharmaceutical or medical treatments, protocols, or experimental techniques are popular topics for monitoring, particularly for clinicians.

- *Science "news."* This category includes grant-making and funding announcements, awards, and political and industrial developments in science and medicine. Some scholars include this type of information in their regular information diet. Others do not.

Features That Support Monitoring and Review of Information in Mixed Formats

Features that support this information practice should provide users with a form of ongoing and broad surveillance over categories of information and content. E-journal tools need to include both push and pull forms of communication that work together and act as the tap on the shoulder to the scholar that says, "Look at this; it might interest you," "You can find it here," or "Here it is for you." Monitoring and review features may provide scholars with an easy means of screening and scanning lots of content, but their primary function is to help users scout knowledge or content domains and flag down interesting items. Such features might include the following:

- *Electronic table of contents alerts.* With this feature, users can preview the complete contents of upcoming journal issues, and customize that content with relevant descriptors, including keywords, authors, labs, methods or procedures, funding sources, and other relevant identifiers.

- *Journal preview alerts.* Other kinds of alerts track and flag specific developments by keyword, author, lab, method, or funding source. In a sense, these tools reorganize the journal or reprioritize modules of content using highlights and pointers so that they can first read what is relevant and then decide whether to scan the rest. Researchers could use these tools to mine journals automatically on a regular basis and highlight sections that relate to key criteria. A scholar could use such a scouting tool, for example, to regularly search particular journal Web sites as new material is published. The scholar could then receive notice that relevant content, authors, job announcements, or experimental procedures are discussed in the issue—or could receive the information itself. The push or pull nature of the alert would depend on the scholar's preference.

- *Context-based alerts or guides.* These features within a journal or article could provide users with specific information alerts. A scholar who accesses an article on a specific subfield might receive a pop-up alert or link to an external, related article or development or to another article by the same author, for example. The pop-up alert could offer a choice of direction.

- *Seamless linkages between paper and electronic journals*. Often scholars switch between media formats, reading an article in one format and then finishing their review of the journal contents in another. Pointers that refer journal users to the journal's media counterpart would support this monitoring and review practice by providing more continuity between paper and electronic editions. Such pointers might be, "For in-depth data or a visual model, see article online" or " For a complete discussion on this topic, see our fall printed issue." Knowing what is included or is not included in the paper and electronic versions would help users move across media more easily and with fewer frustrations.

II. SCHOLARS CONDUCT DIRECTED RESEARCH FOR RETRIEVAL

A clear sense of desired outcomes and results guides directed research. In this practice, the knowledge domain tends to narrow. The purpose of reading shifts from absorbing a wide range of ideas to critically evaluating specific content for retrieval. Directed research typically involves focused searching guided by specific objectives and careful evaluation of content for relevance. A successful directed research outcome could be a list of relevant citations or a set of retrieved articles, abstracts, or data sets.

We have identified four core objectives within this information task:

Table 1
Four Core Objectives of Directed Research

Objectives	Why Scholars Use E-Journals
To establish a base or starting point	To get into the literature from a base that provides options
To create paths and stay oriented	To flexibly navigate a growing body of literature
To assess content for use	To triage content and identify relevance using article descriptors and metadata
To retrieve content for application	To have flexibility of format for retrieval based on scholarly goal

Source: Institute for the Future

Objective 1: To Establish a Base or Starting Point

The scope of the search environment and the purpose of a focused search—such as a topical search, an author search, or a search for a particular citation or discrete piece of information—determine the starting point of the search. Respondents indicated that their starting point is of critical importance. Wide-ranging search engines such as MedLine, PubMed, Melvyl, or Google are good places to start when the desired knowledge might be found in any number of information containers. Clusters of journals such as HighWire and Elsevier provide more limits, whereas a single journal narrows the focus even further. Users are not always clear about what is contained within a particular search environment and what is not, however. As one respondent put it, "The information's probably out there. You're just not quite clear. Is this all [of an author's] stuff? Is it only stuff that's available through this publisher?"

Respondents also noted that they choose where to begin a focused search based to some extent on the information systems provided by their institutions. For instance, a University of California postdoctoral fellow often began his searches with the UC search engine, Melvyl, while a Stanford plant biologist acknowledged that it was difficult to keep up-to-date with the university's search capacities and institutional subscriptions.

There are a range of strategies for establishing a base once a particular search environment is selected. Starting points include the following:

- *Keywords.* These words are indicated through titles and evaluated through abstracts, HTMLs, and PDFs.

- *Authors.* Key authors are also indicated through titles and evaluated through abstracts, HTMLs, and PDFs.

- *Web sites.* Important sites for this purpose present summaries of issues and reveal the range of issues related to a particular topic. A first-year environmental health graduate student, for example, reported using Google to identify these kinds of overview sites. Most likely to follow this practice are younger users (who are accustomed to turning to the World Wide Web as an information resource) and beginners in a field (who have not yet developed a strong sense of the structure of knowledge).

- *Colleagues, professors, and known experts.* Such personal referrals often make good starting points, saving scholars time and helping them to zero in on relevant content.

- *Seminal articles.* These articles provide the scholar with a good foundation or base to start a search and with important keywords to continue a focused search, citations to track, and related concepts to explore.

Features That Support Establishing a Base or Starting Point

A list of possible options for starting points for a search may help increase awareness of the range of possibilities and thereby broaden scholars' strategies. Following are some specific features that would help create starting points.

- *Context-based search assistance*. Assistance in developing searches, identifying keywords, and choosing databases for searches would be more useful if it were context dependent. Help prompts that appear depending on context (such as from an article's bibliography, methods section, abstract, or tables or from a topical Web site) might help scholars refine searches and select search databases.

- *Network mining*. Collegial exchanges are critical forms of knowledge sharing. E-mails and articles exchanged among scholars could be a good source of keywords and potential starting points. Agent-based software that mines e-mails with colleagues (in a scholar's lab or department or in a journal club), stored articles, and selected files for keywords could help generate more options for starting points.

- *Better descriptors of knowledge bases*. Features that help scholars identify the scope of searchable knowledge within a given search environment could help scholars make decisions about how to create a starting point and where to depart for a search. Regularly updated information about what is included or not included in a database would help scholars direct searches and determine the best place to start a search.

Objective 2: To Create Paths and Stay Oriented

Paths are created through various search landscapes: journal Web sites, library Web sites, citation indexes, abstract databases, articles, and broader domains of the Internet. Hyperlinks provide mobility. The ability to move both forward and backward allows for more flexible navigation through content. Respondents talked about the difficulties of staying oriented as they moved across search environments, switched from one set of information to another (e.g., from a list of citations to an individual abstract), and skirted information barriers. Staying oriented is critical; it prevents wasted or duplicated efforts and the loss of information.

Features That Support Creating Paths and Staying Oriented

- *Path-building tools*. Once scholars have found a good starting point, they need assistance navigating multiple paths through a knowledge base. Features that allow scholars to *narrow or broaden a search* would help scholars shape the net they cast in their search. Options to constrain a search at any moment—such as to "review articles only" or "more work by this author," for example—would help limit the flow of material and make it easier to evaluate. Features that *enable forward and backward mobility*—jumping forward to where a particular article has been cited or backward to references in a particular article—are helpful as well. *Multiple kinds of hypertext links* also provide flexibility in creating paths. Hypertext links from search engines to journal articles, hypertext links between journals, links to authors, and links to different categories of information (such as methods or procedures) and formats of material (such as books, videos, animation, and so on) are all useful. Such linkages help overcome barriers within a path of knowledge and help break down boundaries between knowledge bases.

- *Orientation tools.* Directed research would benefit from more features that help scholars avoid getting lost along the knowledge paths that they build. Orientation tools help scholars keep their bearing so that they do not waste time during searches. Features that help scholars see their path as it is created—such as *easily accessible search histories or visual display* of a search path—would be useful. Features that provide *consistency of key indicators across search environments* and make search environments more

familiar would help keep scholars oriented, as would "bread crumb" features that allow branching off a path and then returning across search environments without getting lost. Features that enable scholars to *understand the context of their knowledge environment* or database and that answer queries such as, "Where am I?" or "What else is here?" would help scholars keep oriented and make decisions about the direction of searches and likely relevance of different choices.

- *Features that improve presentation of results*. Better organization of results on the screen would help prevent getting lost or disoriented, make path creation easier, and help scholars evaluate material. Features that help organize and present search results in an intuitive way on one screen would help prevent the clutter of results that often occurs after multiple queries.

Objective 3: To Assess Content for Use

Directed research relies on careful screening and assessment of content. When conducting directed research, researchers and clinicians encounter far more information than is relevant to their particular needs, often more than they can possibly assimilate and digest in one session. They thus need tools that facilitate an effective triage process.

Several features and capabilities help scholars to assess articles and content: article titles, dates, abstracts, article ratings, author or lab names and reputation, and technical features such as availability in full text (PDF or HTML format) and searchability within the article itself. One biological chemist talked about how she uses the abstract as an important screening tool for assessing the structure of an article, the value of evidence presented, and the soundness of the argument in the paper. As she said, the abstract establishes the "bottom line" and helps her decide whether to download the article. Other respondents preferred to browse the contents of an article in HTML before downloading a paper. Still others prioritized images and figures to establish the value of an article.

E-journal tools should enable researchers to find what is most useful and relevant to their directed research, to separate the wheat from the chaff, regardless of their idiosyncratic browsing and assessing practices and diverse research needs. Features should help them to make important decisions at a particular moment about whether to download an article, an abstract, or simply a reference and about how to categorize the content for reading, filing, sharing, and citation purposes.

The initial interface with content must be in a "browsable" format for easy and quick assessment. To make this kind of assessment, the user must also be able to customize the interface—that is, to select and combine descriptors and metadata for the initial interface.

Features That Support Assessing Content for Use

- *Rating and ranking options*. Features that give scholars a choice as to how to rate or rank results would be particularly useful. Rating or ranking criteria should be flexible to match the scholar's need in a particular search. To triage results, for example, the scholar might rate articles by number of references or forward citations, rate articles or journals by an impact factor, or rank the priority of journals.

- *Better article descriptors and metadata*. Search results should provide more consistent display of article descriptors and metadata, with article descriptors clear and easily reviewable. Scanning results for retrieval requires an ability to spot cues that the article is relevant and useful. Along with article basics—such as author, journal name, date, title, keywords, abstract, full-text availability—other evaluative information should be included: number of tables or graphics, whether supplemental data are available in hard copy or online only, format (PDF, HTML, and other data formats or standards), impact factor (such as number of times cited), number of references, and type of article (review article, procedure/technique focus, or type of experimental data).

- *Flexible sorting and organization of results.* The ability to organize a set of search results according to a customized set of criteria would facilitate assessment and evaluation. Sorting results in real time or after they have been received would streamline evaluation. Scholars could select important sorting criteria—such as the descriptors and metadata suggested in the previous bullet—and have results organized by those criteria. A scholar may want all top-tier, high-impact journal articles to appear first in a separate folder or box, for example. Articles with many tables, graphs, and data would follow, and so on. These criteria could change as needs of the scholar change.

Objective 4: To Retrieve Content for Application

Retrieval is a critical objective of directed research. Scholars clearly benefit from the ability to access and retrieve online 24/7, particularly when they are engaged in directed research that is outcome oriented. When writing a grant proposal on a deadline, for example, the scholar must be able to search and download articles and citations on weekends or nights even when the library is closed.

Scholars and clinicians need the format of retrieved content to match the specific research goals. Retrieval goals vary with specific scholarly or clinical tasks and include full-text articles for reading or studying, titles and abstracts to build knowledge structure (e.g., in reference manager files), and content for present or future research.

Depending on the research objective, retrieval may simply involve online access—the ability to navigate and read content online. In this case, the process may remain entirely electronic. One respondent, for example, reported downloading full titles and abstracts to put in his reference manager files. This scholar's goal is retrieval for reference, for building his knowledge structure for present and anticipated future research. In other cases, when the researcher's objective is intensive reading or study, retrieval may involve downloading an article in an archivable or printable format, creating the potential for a paper document at will. When retrieval is for intensive reading of dense data or graphic-rich articles, one respondent preferred to retrieve in hard copy—either by printing the material or by going to the actual paper journal copy and seeing the graphics in professionally published form.

Some clinicians may retrieve content on a patient case for quick but critical consultation. In this situation, the clinician may want to search a CD-ROM database or online for "bits of information" rather than full-text articles, or to consult the abstracts in a personal subscription print copy of a journal.

Features That Support Retrieving Content for Application

Scholars need features that enable them to retrieve—in electronic or "potential paper" formats—particular kinds of content (informative titles, abstracts, full-text articles, citations, images) to achieve their various research objectives in the course of conducting directed research. These features would be most effective if they created seamlessness between e-journal environments and word processing, reference management, and data management applications. In addition, scholars who are new to or uncomfortable with the online environment might benefit from a forum in which they could share best practices for search and retrieval of online content.

- *Seamless connections.* Features that create seamless linkages between the e-journal environment and other software applications (such as reference management tools or other file management tools) would facilitate getting e-journal material in the proper form for retrieval. Importing and transferring data across applications should be a simple, one-step process or perhaps even automatic with set preferences.

- *Interactive search and retrieval assistance.* Opportunities to use interactive tools (perhaps real-time interactions with experts) to learn best practices for search and retrieval would benefit scholars. Interactive discussion forums, Frequently Asked Questions (FAQs), help lines, and other support services would help scholars improve their effectiveness in using search and retrieval tools.

- *Tools for portable and flexible retrieval.* As scientists conduct their work in multiple settings and under different conditions, they need flexible retrieval options that work across devices. Features that allow scholars to retrieve material in multiple formats (HTML, PDF, and other data standards) and to download to multiple devices would support these diverse needs. Ease of

downloading to laptops, personal computers, personal digital assistants, and eventually e-books and e-paper will be increasingly valuable to scholars.

- *Features that allow customized printing.* Printing journal content is a time-consuming yet essential activity. Features that facilitate high-quality printing would help scholars generate printed matter that is legible, clear, and well formatted. Features that ensure the printing of articles within margins, that allow users to adjust sizing and tones for complex tables or graphics, and that print out only text or only tables to minimize paper usage would give scholars more flexibility in creating paper content to read. The ability to print multiple articles and to create personal compilations of printed articles would enable scholars to customize portable packages of content. Such improvements in printing would help scholars increase portability, read intensively, and share content in real time with other scholars.

In sum, scholars are most successful at the focused activity of directed research when they can effectively navigate the literature and retrieve particular types of content—full-text articles, citations, author names, data sets, or even abstracts. Scholars value the ability to develop productive starting points from which many paths can be created. Assessment tools—such as informative titles, abstracts, accessible tables or data, article descriptors, article ranking or rating systems, and other metadata—help scholars to evaluate material and decide how they will retrieve content as they navigate paths. Scholars are likely to highly value and to increase adoption of e-journals with features that support these activities.

Some researchers predict that scientific literature will become increasingly modular in form.[1] If this occurs, flow-tracking technologies will become more and more useful as part of directed research. As the channels between discrete modules of information proliferate, scholars will want to understand how and why content is linked along particular channels. They will appreciate help in sorting, evaluating, and making sense of these channels, as well as in learning about recognized online knowledge hubs

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[1] See Kircz, Joost G. and Frédérique Harmsze. "Modular scenarios in the electronic age." Conferentie Informatiewetenschap 2000. http://www.science.uva.nl/projects/commphys/papers/mod2k/mod2k.html

and authorities. "Related articles" and "similar sites" features are examples already in use. Referral systems that let users see the directions in which others have gone from a particular Web location, similar to those found on amazon.com, will help. In addition, link-based searches, or hypersearches, can take advantage of automated link tracking to focus on flow as well as on content.

III. SCHOLARS STUDY AND READ INTENSIVELY TO EXTRACT KNOWLEDGE

Respondents also described a mode of reading that is distinct from browsing or scanning. Study-reading, or intensive reading, helps in the thinking process, in the creation of knowledge, and in the assimilation or integration of new knowledge into existing knowledge bases. Respondents described this reading mode as "really reading" or "trying to think about something." Scholars described how they dissect articles, extract knowledge, and make sense of ideas in this mode. One scientist described intensive reading as a way to fit the insights from her lab experiments into a broader scientific context. Most respondents commented that they prefer to do intensive reading in hard-copy format but that they sometimes resort to intensive reading online when paper copies are not available or when time constraints limit printing or use of a printed edition.

One reason for the apparent preference for hard-copy reading over screen-based reading is that articles can be written on or annotated in hard copy. Some scholars expressed the desire for features that would enable them to take notes electronically on documents they are reading or studying. (This kind of intensive reading and note taking implies that the user has a personal copy of the document in print or electronic format.)

Other important qualities also make printed journal articles preferable for reading. For respondents in this study, readability was clearly linked to document mobility—the extent to which scholars could move around within and across articles. Scholars value *intradocument* mobility, or the ability to move around *within a document* at their leisure. Often they reported that they do not read an article through from start to finish. Instead, they read different parts of an article at different moments and for different reasons—habits formed over years of practice. Flipping pages lets people refer back and forth to the parts they want, making quick comparisons. One senior clinician, for example, described skimming an article first, then reading the concluding discussion about the results, and then looking at other parts of the article more closely. Features that enable users to read an article easily in this fashion—without losing track of where they

are, keeping the sections clearly demarcated—might encourage paper readers to read onscreen (both online and offline).

Scholars also value *interdocument* mobility, or the ability to move *between documents* with ease. People need to compare across data and arguments. Whether the scholar is working from file folders or from stacks on the floor or spread out across the desk, activities that demand wide-scale literature reviews require instant access to several entire documents at one time.

To the extent that publishers want to encourage readers to do more serious reading onscreen, they may want to address these concerns, both by working to provide paper convenience in the electronic format and by encouraging scholars to learn new ways to think about using electronic conveniences not found in paper. Some of the scholars we interviewed were thinking along these lines themselves. One biologist described a scenario wherein paper and electronic journals built on the strengths of each format to take advantage of scientists' reading practices. Concise print versions of the articles could be studied, whereas online versions with supplementary data could be further explored interactively.

Features That Support Intensive Study-Reading

Features that integrate paper convenience in electronic formats may entice more intensive reading onscreen. To encourage intensive study-reading onscreen, electronic publishers need to develop features that meet the specific requirements of this activity. Such features might be divided into two categories: those that improve reading online while in the connected Web environment and those that improve electronic reading offline. In the online environment, publishers can take advantage of hyperlinking and other forms of supplementary data. In the offline electronic environment, publishers (and perhaps related industries) can simulate online and paper features such as hyperlinking between documents and tools for making comments in the margins.

- *Tools that provide paper convenience in an electronic format.* The ability to make comments directly on a document (electronic margin comments) would improve reading in an electronic format. One such possible feature would be a mechanism comparable to the "track changes" editing feature that permits visible "margin" comments and notes. Such a feature would have to be

applicable in the various formats scholars use to archive their materials (e.g., PDF, HTML, Word). Other features that provide paper convenience would be better color for images (better screen quality) and tools to support interdocument mobility—a parallel to flipping pages that is more natural than scrolling.

- *Tools that support offline electronic reading*. The ability to create easy links between different pieces of a single electronic document (intradocument mobility) and with other documents (interdocument mobility) would enhance the onscreen intensive reading experience. New display technologies and devices such as e-books, e-tablets, and e-paper may provide such offline document mobility.

- *Tools that create seamless linkages between paper and electronic formats*. Features to help traverse the gap between paper and electronic versions of journals and articles would enhance scholars' reading experiences. Such features would help scholars make decisions about what to read and in what format. Knowing the similarities and differences between printed and electronic editions of journals would clarify the relationship between the formats. Points of reference between paper and electronic journal editions would also help scholars use each edition to support distinct reading preferences and would provide more continuity between editions.

IV. SCHOLARS CIRCULATE AND EXCHANGE CONTENT TO BUILD PEER NETWORKS

Scholars have many opportunities to increase information exchange among themselves through e-journals. Tools such as e-mail with URL or PDF attachments, lab Web sites, and distributed, flexible printing have given scholars a new basis for interacting around journal content, whether for purely transactional purposes or to meet broader social goals. One respondent stated that the purpose of the journal is to bring authors and readers together. The e-journal, in its enriched Web context, offers a new forum for accomplishing this goal.

Circulation and sharing occur in both hard-copy and electronic formats, facilitated by both print and e-journals. As several respondents indicated, sharing articles within a lab and with other colleagues supports the lab community and the development of peer

networks beyond it. Sharing papers is also an important activity for establishing presence among peers in a particular field. A third-year doctoral student explained his need to establish credibility in several fields addressed in his dissertation research. He accomplished this in part by checking in periodically with his network and collaborators via e-mail and mentioning important articles that they might find useful. The article thus became for him a vehicle for building a professional social network. He used both electronic and postal mail for this task.

Features That Support the Circulation and Exchange of Knowledge

- *Knowledge-sharing tools*. Scholars already leverage Internet connectivity and e-mail each other articles and pointers to material in various databases. Features that facilitate the exchange and circulation of information would support their collaboration. Such features might be simple "Send to" buttons from articles or Web pages that allow users to include personal notes or comments on the material. This activity could be extended to include sharing live search results, other supplementary material, and more interactive content. One useful e-mail feature could collect relevant links from search results, perhaps as the scholar is evaluating them, and send them to a colleague with the message "Look at my search results," similar to the online shopping feature that says "Add to my cart." Hypersearching, or link-based searching, would also allow scholars to monitor and evaluate the knowledge paths of the community.

- *Real-time forums*. Scholars value real-time engagement around content. Features that support the development of forums for real-time discussions and the exchange of information around content would be useful to collegial networks, lab groups, and other *existing* social networks. Features that support conversations with *unknown* colleagues (such as e-mail to the author, unsolicited responses, and reviews) would also be useful in the online journal environment. In one current example, the British Medical Journal site includes response and counter-response around certain articles, taking advantage of real-time rapid response and the ability to include multiple "letters to the author/editor" not possible in print. These discussions could also be conducted in an asynchronous mode.

- *Tools that facilitate networking and meeting new colleagues*. Although technologies cannot create collegial community or social networks, they can support these networks and provide opportunities for scholars to build and nurture them. Features that host or link to relevant listservs, newsgroups, scientific knowledge communities, and bulletin boards would help broaden and build collegial networks. Tools that suggest listservs, scientific knowledge environments, or bulletin boards based on scholars' content preferences would also be useful.

- *Calendar-update tools*. These features would help scholars keep up-to-date on events and publications. An alert feature with links to the most recent conference proceedings is one example.

V. SCHOLARS ORGANIZE CONTENT TO CREATE CONTEXT AND RELEVANCE

Scholarly research does not end with the retrieval of content. Organizing and categorizing content are also significant information practices among the scholars interviewed in this study. These practices typically follow retrieval (and sometimes intensive reading) and consume large amounts of time and thought. Respondents who did not describe the intricate systems they use to organize and make sense of their collected material told stories about how they should be more diligent in this area or about how they plan to organize their content in the future.

Respondents described idiosyncratic systems of cataloging, organizing, and filing collected content to create a broader context and to help create meaning. In essence, scholars described the creation of personal mini-libraries in the form of piles of paper on office floors, e-libraries, paper filing systems, reference manager systems, or a combination of these systems.

Scholars with well-organized information can work more efficiently, accessing information easily and quickly. These scholars share information with less effort and thus build peer networks and contribute knowledge to the scholarly community. Better organization can make information useful in the present and in the future. Noting dates of additions to the organizational structure can also help in tracking the genesis of an idea or in tracking a scholar's intellectual biography, which may be important for colleagues and historians of science.

Features That Support Organizing Content to Create Context and Relevance

- *Tools that help structure information.* Features to standardize information for better, more uniform manipulation and access could improve organization. On the other hand, structural tools could include a highly customizable interface between HighWire and reference and word processing applications. With the ability to customize an interface, scholars could create their own idiosyncratic organizational systems while taking advantage of HighWire's article database and other features. Scholars want to be able to structure information in an intuitive and logical way—and they want help doing that.

- *Tools to create paper documents.* Other potential features include filing, tagging, and storing links. Rather than taking time to download full-text articles or even abstracts, users could store links to content with the potential for later retrieval in paper or electronic form. Links would need to be reliable and permanent so that scholars could be confident of returning to them when needed.

- *Tools to traverse formats.* Users with the ability to move seamlessly between formats (HTML, PDF, and so on) could accomplish their different information practices—of archiving, printing, and reading—in the ways that work best for them.

- *Tools to help scientists place their work in larger contexts.* Organizational tools help scholars create a context that gives meaning to their work. Forward referencing features or features that frame context (such as citation indexes) help scholars understand the development of a concept, debate, or scientific development. Other tools help create a larger knowledge context by showing what has just been, or is about to be, published. Customized or lab-based alerts, for example, provide early warnings of research about to be published by other labs.

VI. Scholars Document Original Content

Respondents identified a final practice of scholarly work as documentation of original content. They described documentation as a two-part process that includes writing and formal publishing. Documentation is an extremely important way for scholars to contribute original ideas and discoveries to the evolving structure of knowledge in a particular field, to share knowledge through teaching and lectures, and to receive credit for that contribution. E-journals facilitate documentation in two ways: by seamlessly linking the searching and writing processes and by speeding up the time between submission and formal publication of an article.

The Writing Process

Scholars share knowledge through formal and informal writing in teaching, research, and clinical practice. Journal articles and e-journal usage come into play at different stages of the writing process. Writing often cycles scholars back to the search process—either to fill a research hole, to retrieve a missing citation, or to locate some specific piece of information to complete a document. In addition, writers are required to reconstruct the trajectory of knowledge that gives context to their work. Archived knowledge thus becomes especially important in the writing process. Used within directed searches, e-journals facilitate these activities and thus speed up the writing process.

When writing an article based on her own research for publication, for example, one postdoctoral fellow needed to "put the information into context." After having designed, implemented, and analyzed her results, she explained, she was well steeped in the literature and had a good sense of the important authors for her article. She then needed to access and download citations to landmark works and to conduct sharply targeted searches within her subfield. In another situation, a graduate student preparing a review paper on his field for his dissertation defense wanted to cover wider sections of knowledge quickly, to search for other review articles, and to gather key articles to cite in his review article. Lectures for students, public presentations, case reviews for a clinical study, and grant proposals are other genres of writing mentioned by respondents in interviews. In each case, the search emphasis included a historical component. Several respondents noted that the lack of online archival depth remained a problem; scholars must turn to print editions when back content is not available online.

E-journals help to streamline the writing process in another way as well—by integrating articles with reference manager software such as EndNote. Scholars reported the management of references as busy work that often takes too much time, especially when different journals require different reference formats. E-journal flexibility and reference manager software together create a value-added set of features that support documentation.

Features That Support the Writing Process

All of the features mentioned as part of directed research practice would assist scholars as they write and find the need to dive back into the literature. Among the most important features and capabilities are full-text online archives, author searches, keyword searches, lab-based searches, historical review searches (i.e., searches that locate scholarly review articles in a particular field over a period of time), visual material searches (for lectures and presentations), and methods searches. In addition, better tools for formatting citations and for importing material into written documents would be useful.

Publishing Practices

E-journals are important within the domain of publishing practices for two important reasons. First, with the transition from hard-copy or disk submissions to online submissions, scholars need to manage more information transfers across more media. Several respondents mentioned the frustrations of formatting, uploading, and downloading complex, data-rich documents. Second, the time period between submission and publication is shortened for e-journals. A postdoctoral fellow in biochemistry noted that the time lag between submission, acceptance, revisions, and publication is much less for online publication than for the typical print edition.

The speed of publishing and dissemination also concerns scholars as readers. Earlier access to article titles and content helps scholars reassess their own work and shape its direction. Respondents suggested the importance of being able to foresee and actually preview content about to be published. Early listings of future articles (in the form of tables of contents, abstracts, and so on) help to provide a sense of new contributions to a particular field. Early versions of entire articles provide even greater insight into the thinking and contributions of other scholars and labs.

Features That Support Publishing Practices

Interviews made obvious the need for two kinds of features: those that support the online submission process and those that enable scholars to see what knowledge is on the horizon.

- *Tools that support the online article submission process.* Scholars could increase their efficiency with the help of tools that standardize data so that they wouldn't have to spend so much time on formatting and information transfers.

- *Tools that allow a preview of the knowledge horizon.* Prepublication options, lab alerts, and any other types of flags or early warnings on papers or discoveries that are about to become public, would allow scholars to reframe ongoing research in light of the most current results.

VII. ACTION ITEMS FOR HIGHWIRE

Following are five action steps for HighWire to consider for evaluating and improving the feature set of its offering to journal users.

1. Encourage and Conduct Firsthand Observations

Some of the specific feature suggestions described here already exist in HighWire–supported journals and/or in other aggregator-sponsored journals. An excellent opportunity exists to evaluate their use and relevance to different user groups and even to conduct detailed observations of usage to understand specific design considerations. HighWire itself could sponsor and implement such a study, or it could partner with journal publishers to accomplish this task. Knowledge obtained from observation sessions of scientists using HighWire and other Web-enabled journals could lead to improvements in the design of offerings and ultimately in the accessibility and flexibility of the journal publishers' content.

2. Determine and then Develop Users' Awareness of Features

The e-journal environment is complex. Because e-journals coexist with other Internet features and other types of nonjournal content, specific journal or aggregator tools may get buried among all the options and different search and retrieval environments. IFTF research indicates that technology users rarely use all the features of a given tool; rather they learn specific features as need and special conditions arise. A "status of feature awareness" could be developed to (1) help clarify whether the problem with unused features is that they are not relevant or that potential users are not aware of them, (2) determine which features are priorities for users, and (3) provide HighWire with a plan for rolling out new features or announcing improvements to features and HighWire capabilities.

HighWire could sponsor forums for users to discuss new or improved features and to share tips for using these features most effectively. Many users learn better from peers than from manuals and formal training sessions. HighWire could also develop push e-mails that announce a "feature of the month" and offer tips for using the feature more effectively. Users may be more likely to learn about and use a feature if reminded about these features one at a time.

3. Involve Journal Publishers in Building Awareness

Journal publishers, as scientific societies and generators of content, have a close relationship to HighWire users. HighWire would benefit from having journal publishers help build awareness of features through their own communications to journal users. Likewise, journal publishers would benefit from better use of HighWire features that make journal content more accessible and customizable for scholars. Involve journal publishers in sponsoring user forums, in communicating tips for better usage of tools to access content, and in developing incentives for using HighWire features. Establish a group of publisher "champions" or "friends of HighWire" who are willing to test features with their subscribers or become more directly involved in providing input for developing offerings.

4. Monitor Developments in Flow-Tracking Technologies

New software and tools in reputation systems, referral systems, and hypersearching will directly affect the kind of environment in which journal content lives on the Internet. At its core, the scientific journal is about documenting and sharing scientific discoveries among peer groups and colleagues—about generating flows of scholarship and evaluation of that work. Careful monitoring of these technology areas for specific tools that would support core information practices should be a priority.

5. Identify Information Practices That Have the Biggest Impact

Whereas all information practices are important for scholars, some may have a broader or more widespread impact than others. Focus feature improvements on information practices that have the biggest impact on scholars' daily experience with e-journal content. Again, journal publishers may be useful partners in helping to determine priorities. Tools that help to measure the use of features will also help to set priorities.