A Framework for Evaluating Science and Technology Electronic Reference Books: A Comparison of Five Platforms in Chemistry

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Abstract

This article examines what is desirable in online reference books in science and technology and outlines a framework for evaluating their interfaces. The framework considers factors unique to these subject areas like chemical structures and numerical data. Criteria in three categories, navigability, searchability, and results, were applied to five key chemistry e-resources. Some e-book publishers are taking e-books farther and changing expectations for the rest. The framework offers a guide for holding publishers accountable for developing e-reference books that meet users' needs.

Introduction

The number of classic reference works now available online is growing rapidly, and libraries are making concerted efforts to add them to their collections largely because users prefer to access information this way (Webster 2003). Reference books are a natural fit for the online environment as they are geared toward consultation on an as-needed basis for smaller pieces of information rather than sustained reading. However, just being online is not sufficient to make an online reference source useful. Trustworthy content is as important as it always has been, but the ease of using a resource to find the desired information is equally crucial. Print reference book "interfaces" do not vary as widely as those of e-books. Evaluating reference books in the electronic environment requires different considerations.

What is desirable in a reference e-book? As e-books in general become more sophisticated, expectations should accordingly be higher. In the process of examining some key chemistry reference books in electronic form, I developed criteria for what features are important, taking into consideration some factors that are unique to science and engineering reference books, chemistry in particular. The major goal is to give librarians a framework with which to make collection decisions and hold publishers accountable. This is especially important now given budgetary limitations and the current economic situation.

Literature Review

Reference books are a better fit for electronic access than other types of books such as fiction or textbooks. They are used for quick consultation, not sustained reading, a type of usage that meshes well with how people often read online -- scanning and searching for useful pieces of information rather than reading content in its entirety (Gunter 2005; Liu 2005; Safley 2006). The ability to offer packages of online reference books, which allow users to search many titles at once, adds to their suitability for the electronic environment; it is both more efficient and increases the user's chances of finding useful information in books they might not otherwise have consulted because of their age or subject matter (Blankenship & Leffler 2006; Miller 2005).

We are not yet at a point when reference e-books are the clear first choice of users although they may go to them for purposes of convenience (Robbins et al. 2006). Finding information in an e-book is not necessarily faster than print, and users will stick with print if they find it easier (Webster 2003). On the basis of student feedback on *ENGnetBASE*, an online collection of engineering handbooks, Barbara Williams, engineering

librarian at the University of Arizona, decided to cancel the library's subscription as the students found it easier to locate information using the print version of a handbook than the electronic. In experiments comparing how quickly groups of students could find the same information in the print versus the electronic versions of handbooks, the students using print were faster. The same thing happened when the student groups switched type of book and when Williams repeated the experiment with a group of librarians. The students found the user interface unintuitive, and searches often retrieved far too many hits (Williams 2007). Another librarian's comparison of how quickly students found information in *Statistical Abstracts* in print versus online had similar findings (Van Epps 2005).

Web site usability has been addressed extensively elsewhere and informs my criteria, particularly with respect to navigation (Holmes 2002; Horton 2006; Johnson 2003; Lazar 2006; Mander & Smith 2002; Menon & Douma 2008). As e-book development has progressed over the last decade, researchers have focused attention on desirable design features (Crestani et al. 2006; Landoni et al. 2000; Sun et al. 2004; Wilson et al. 2002). Considerations for online reference books are not dissimilar from those of other e-books, but there are differences, namely the importance of search. Some work has been done on evaluating resources central for science and technology libraries like e-journals, library databases, and scholarly books in general, but there has been little done to examine the unique needs of science and technology, specifically chemistry, reference books online (Coker 2007; Sabin-Kildiss et al. 2001; Shiao-Feng Su 2005; Vilar & Žumer 2005).

Methods

The focus of this article is reference works with chemistry-related content that do not require any special equipment for access other than a computer with an Internet connection. Article indexes are outside the scope of this article; there is little doubt that users have been thoroughly converted. I also excluded electronic book collections without significant amounts of chemistry content like *NetLibrary*. Resources covered include both single titles and collections.

I compared the interfaces of *CHEMLIBnetBASE*; *CHEMnetBASE* and its contents; *Kirk-Othmer Encyclopedia of Chemical Technology*; *Knovel*; and *Merck Index*. There are differences between these five sources, but all have content devoted to chemical substances, their properties, and other information about them. The five e-books are largely considered well-regarded and essential reference sources for chemistry.

CHEMLIBnetBASE is produced by Chapman and Hall/CRC (see Figure 1). Its focus is chemistry-related reference books although some of the over 500 books in this searchable collection, including some handbooks, might be considered monographs rather than reference (CRC Press 2009).

CHEMnetBASE is another Chapman and Hall/CRC collection of reference books with a very different interface (see Figure 2). It includes the classic *Handbook of Chemistry and Physics,* or *CRC*, as chemists commonly refer to it, which is often the first reference source a chemist uses; the *Combined Chemical Dictionary* (*CCD*), a source of basic information on a variety of chemical substances that is comprised of the *Dictionary of Commonly Cited Compounds*; *Dictionary of Drugs*, *Dictionary of Inorganic and Organometallic Compounds*, *Dictionary of Natural Products*, and *Dictionary of Organic Compounds*; the *Polymer Properties Database*; and *Properties of Organic Compounds* (*POC*), the online equivalent of the *Handbook of Data on Organic Compounds* or *HODOC*. Unlike *CHEMLIBnetBASE*, each resource has a separate interface although the *CCD*, *Polymers*, and individual dictionary interfaces are very similar. Except for the *CCD*, it is not possible to search multiple titles at once. Three additional dictionaries covering carbohydrates, food compounds, and marine natural products have recently been added to *CHEMnetBASE* but are not currently included in the *CCD*.

Kirk-Othmer Encyclopedia of Chemical Technology, published by Wiley, is arguably the most important and best known chemistry encyclopedia (see Figure 3). It covers a wide range of industrially important chemical substances as well as relevant basic science (Maizell 1998).

Knovel is an online collection of about 2000 scientific and engineering reference books (see Figure 4) (Knovel 2003). It includes classic chemistry and chemical engineering reference works such as the *Lange's Handbook of Chemistry*, *Perry's Chemical Engineer's Handbook*, and *Polymer Handbook* (Knovel 2008).

The *Merck Index* is another classic chemistry reference source and, like the *CRC*, often one of the first with which chemists are acquainted (see Figure 5). The content is produced by Merck, the pharmaceutical company; I examined the CambridgeSoft online version. *Merck* provides information on names, properties, uses, and more for a wide range of biologically and pharmaceutically relevant chemical substances. It is also available through Dialog, Knovel, Medicines International, and STN International. Access to *Merck* via *Knovel* is offered separately from the *Knovel* package.

My primary interest is the electronic books' interfaces and ease of use rather than the content. My criteria are listed in Table 1. Distinctions between categories can be fuzzy, and there is a bit of overlap.

Table 1. Criteria for Evaluation		
Navigability • Clean, uncluttered design • Efficient use of space • Minimal clicks to search • Unambiguous navigation • User-friendly language • Help available	Searchability • Browse • Basic search • Advanced search • Chemical thesauri • Structure searching • Metasearch	Results • Clearly presented • Search terms highlighted • Relevancy ranking • Ease of working with results

Results and Discussion

Navigability

Clean, uncluttered design

Simplicity in web design is more highly valued now than in the early days of the web. This is evident in that most resources examined have relatively clean and uncluttered design. The chief exception is *CHEMLIBnetBASE*. There is almost no white space on the home page to give users' eyes relief, and quite a bit of content is below the fold. All titles are in a single long list on the homepage along with boxes for content categories, newly added titles, and promotions for related Taylor and Francis books and journals. The entry point for the web site is unnecessarily overwhelming. On the positive side, the sidebar content on related books is dynamic and only includes cover images and titles of two books at a time.

Efficient use of space

Web sites consist of fairly small spaces, so making key information visible while keeping less crucial content accessible is especially important (Nielsen 2003). On search pages, allowing users to add search fields to a short list of those most commonly used is one way to maximize space; the *CCD*, *Polymers*, and the *CRC* structure/property search page do this (see Figures 6, 7, and 8). Tabs indicating different areas of a web site are another strategy that both *Knovel* and *Merck* use.

The *POC* makes reasonably good use of its space although a "Browse Index" button for all 18 search boxes seems unnecessary (see Figure 9). A single browsing link with a drop-down menu for the indexes would be preferable. *CHEMLIBnetBASE* has very little content in the top horizontal navigation bar. Instead many options are crowded into the left vertical navigation bar, a wasted opportunity since some (*e.g.*, "Download Sales and Information Sheet") would be more appropriate elsewhere on the web site.

Minimal clicks to search

Extra mouse clicks mean more time, frustrating to users. Getting to a search box, so crucial to a web site's functionality, is an obvious place to minimize clicks (Nielsen 2001). *CHEMnetBASE*, *POC*, *Knovel*, and *Merck* all add at least one extra step. The *CHEMnetBASE* homepage has no search functionality; users access its content via the individual title links. *POC* requires another click beyond *CHEMnetBASE* and its own entry page to search. *Knovel's* opening page keeps changing and currently includes company information and other content in addition to a link to the search page. The *Merck* entry point is a menu including two search options and information about the resource (*e.g.*, help); this content could easily be placed, and is mostly duplicated, in navigation bars on the search page.

Unambiguous site navigation

Unambiguous web site navigation is a must for a useful interface. As Donald Norman pointed out in*Design of Everyday Things*, it should be obvious how to operate something (Norman 2002). Navigation through problematic e-books is not uniformly bad; in *CHEMLIBnetBASE*, *Kirk-Othmer*, *Merck*, and *POC*, a single, albeit important, confusing feature stands out.

Navigating *CHEMLIBnetBASE* is relatively straightforward. The location and function of the search box and browsing lists are obvious as is getting to a book's text via search; however, browsing is not. Choosing where to click for access to the book is a guessing game. Clicking on the chapter titles in the Table of Contents tab seems sensible as do the book icon or the book's title or image (see Figure 10). However, none of these are links. Though both plain black and not underlined, the text "Read It Online!" is the active link. This non-obviousness certainly violates Norman's principles for good design. In contrast, for books in *Knovel*, the table

of contents consists of underlined grey links that state "Text" beside the chapter or section name that turn blue when moused over. It is obvious where to click because users are accustomed to looking for underlined links.

Kirk-Othmer has two search boxes. The top box searches *Kirk-Othmer*, and the bottom one searches all of Wiley Interscience which includes journals, databases, reference e-books, and more across all subjects (John Wiley & Sons, Inc. 2008). Depending on the box selected, vastly different results are retrieved. The search box location on the *Kirk-Othmer* site, while not terrible, is also not ideal. There is not yet a standard search box location on web sites, but eye-tracking studies provide evidence that people frequently have a roughly F-shaped browsing pattern (Nielsen 2004; Nielsen 2006). The search box location on the right side, part way down the page, is not where people's eyes are more likely to scan. Also search boxes are not consistent site-wide as only the *Kirk-Othmer* search box is on results pages.

Another example of confusing navigation is the nearly identical gray oval buttons to the left of substance records in a *Merck* list of hits. The top button reads "Mark Record" in order to export or combine sets, and the bottom says "Show Details" to open the record, a more likely user action and thus a better choice for the top button.

The location and appearance of the search button in*POC* are especially non-obvious. No lines or color changes clearly indicate it is a link or button. A "Browse Index" button, which takes the user to the field's index, is located where search buttons commonly are. Users, accustomed to clicking search buttons to the right of search boxes without much thought, can easily end up in an index unexpectedly.

User-friendly language

An easily navigable web site avoids language potentially confusing to novice users. None of the resources are entirely free of jargon; most refer to Boolean operators and other similar terms in their help sections. *Merck* had some of the most glaring examples with an "Explanatory Monograph" link in the help menu and options to "Manage" the "Hit List" by choosing to intersect, subtract, or union saved and current hit lists. The *CHEMLIBnetBASE* advanced search offers "Stemming," "Phonic," and "Natural Language" options, all unlikely to be meaningful to non-expert users.

Help availability

Librarians have long known that users rarely open help, but its availability is still important Capobianco & Carbonell 2003). The searchable sites all offer some form of help. Contextual help or at least a searchable help section is preferable. No resource has a searchable help section; though *Knovel*'s suggested search strategies under the basic search box and "More Search Tips" in *Kirk-Othmer* could be considered forms of contextual help (see Figures).

Help should be easy to locate. For *CCD*, *CRC*, *Kirk-Othmer*, *Knovel*, *Merck*, and *Polymers*, the links are clearly labeled and spatially set apart from other links (*e.g.*, at the end of a row or column), but I repeatedly had difficulty locating what seems to be the *CHEMLIBnetBASE* help section, "How It Works." The wording and the link's placement in the middle of a left navigation bar make it less obvious. Oddly, its help section only describes how to enter search terms and view results whereas the presumably similar *ENGnetBASE* links to its much larger help section under its search box.

The *Merck* help section was the most awkward. Clicking "Help" links on the search page opens a menu with four options: search screen guide, user search guide, explanatory monograph, and therapeutic index category terms. The number of choices and language used seem likely to overwhelm the novice. All the links open PDF files, more sensible for content likely to be printed out rather than scanned for relevant information, more typical for help sections and easier with HTML.

Summary

No resource was without navigability flaws (see Table 2 for an overview).*POC* is the most problematic; the copyright date at the bottom of the opening page, 1998-2005, gives a likely indication as to why. Presumably the site has not been updated as web standards have evolved. Given other recent changes to *CHEMnetBASE* interfaces, improvements may be forthcoming. *Merck* is slightly better but still very clunky and awkward to navigate. Given *Merck's* importance, the Cambridgesoft interface's flaws were especially disappointing; it was much easier to use via *Knovel*. *Knovel* is the simplest to use overall, and *Kirk-Othmer* is the next best.

Table 2: Navigability

Searchability

Browse

Browsing is still relevant and important for users; they may be unsure of what they are seeking, how to describe it, or even how to spell it (Beall 2007). Browsing can lead to serendipitous discoveries of information in unexpected or unfamiliar places, and it can also help locate information described in broader, narrower, different, or otherwise related terms a searcher might miss (Bates 2007; Beall 2007). Bodoff suggests that relevance for browsers and searchers are not necessarily the same, even more reason to include browsing functionality in e-books (Bodoff 2006). All the works except for *Merck* had browsing options (though it is possible to browse the Human Therapeutic Use index terms, one of 26 search fields).

Basic search

A user's entry point ought to include basic search, *i.e.*, a single box for entering keyword searches. This is what users want and will primarily use. All of the resources except *Merck*, *CCD*, *POC*, and *Polymers* include a simple search option. They send users directly to potentially overwhelming pages with numerous search fields though *CCD* and *Polymers* are less problematic with a short list of commonly used properties to search and the option to add or hide properties. However, nearly every searchable field seems to be on the *Merck* and *POC* default search pages including some irrelevant for most users like "Monograph #" (*Merck*) and "Beilstein Reg. No." (*POC*). *Merck's* other search option is the addition of a chemical structure drawing box to their basic search. *POC* has no other search options nor does it have free text search. There are at least 31 fields in substance records, but only 17 are searchable. Some excluded fields like Health and Safety Information may well be of interest to users.

The resources vary in implicit basic search functionalities. With a two or more word search string, *CHEMLIBnetBASE*, *Merck*, and *Polymers* search for phrases; the *CRC* and *Kirk-Othmer* include AND between search terms; and *Knovel* treats it like a proximity operator, looking for words within five to ten words of each other. *Kirk-Othmer* automatically searches for truncated forms of words. *Knovel* will search for singular and plural forms of words, a limited type of truncation.

Advanced search

Not all users are satisfied with basic search alone so advanced search should be available on the web site. Admittedly, advanced search is of more interest to information professionals, but we are also online reference book users. Advanced search need not be and, in fact, ought not be what users encounter first to avoid confusing them (Nielsen 2001).

All the resources had an advanced search option though there is little consistency among them, even those in *CHEMnetBASE*. Commonly available options are Boolean operators, truncation, and proximity searching. *CHEMLIBnetBASE*, *Kirk-Othmer* and *Knovel* allow the use of Boolean operators AND, OR, and NOT in search fields whereas *CCD*, *POC*, and *Polymers* only permit AND or OR as options in drop-down boxes between fields. Only *Merck* does not allow the truncation (*) and wildcard (?) characters. *CRC* and *Polymers* allow additional truncation (%) and wildcard (_) symbols. *CHEMLIBnetBASE* has a formal proximity operator option (w/N where N is the maximum number of words that can occur between two search terms), and proximity searching is implicit with phrases not in quotation marks in *Knovel*.

The ability to search for specific types of information is important for narrowing results and avoiding false or irrelevant hits. Most of the resources are data-centric and thus have many searchable fields, some presented better than others. As mentioned earlier, the default for *Merck* and *POC* is almost all fields. *CCD*, *CRC*, and *Polymers* present options less overwhelmingly by allowing users to add or subtract desired fields; *Knovel* has drop-down boxes for categories of properties. Available fields vary widely. *Knovel* allows great specificity and the ability to get directly to relevant data with the capacity to search for types of properties, specific properties, and ranges of values for the properties. *Kirk-Othmer*, much less data-focused, has fewer searchable fields than the others; they include CAS Registry Numbers, compounds, tables, and figures.

Less common is the ability to search a range of values or just molecular formulas, very useful for e-books with a lot of numerical or chemical data. The *CHEMnetBASE* resources, *Knovel*, and *Merck* let users search ranges of values. Search syntax varies widely between resources; they may require hyphens between numbers, spaces, or spaces on either side of a hyphen. *Knovel* provides a box for each value. Searching molecular formula fields as in *Merck* and the *CHEMnetBASE* titles usually requires Hill order (C, then H, then alphabetical), though it may or may not be case sensitive.

Chemical thesauri

Chemical substance searching has unique challenges with so many possible names for chemical compounds plus CAS Registry Numbers, molecular formulas, and chemical structures. Naïve users may conclude that a substance is not included in a book or database because of their choice of name. Automatically searching thesauri is a distinct advantage possible for e-books that is especially warranted by chemical names'

numerous synonyms. *CCD*, *Merck*, *POC*, and *Polymers* have synonym fields in their substance records, their major emphasis. *Knovel* has synonym tables for many chemistry titles though it did not appear to be comprehensive on the basis of chemical name variations searches.

Chemical structure searching

Chemical structure searching is helpful for compounds with long or many names. It is a nice-to-have feature as it is best for organic compounds since some types of compounds like alloys or polymers cannot be accurately represented as structures (Cooke & Ridley 2004). Chemical structure searching is available for *Merck* and the *CCD*, *CRC*, *POC*, and the Monomers section of *Polymers* in *CHEMnetBASE*, all good candidates for structure drawing with significant organic content. Structure searching is less logical for *Knovel* since chemistry makes up only a small portion of the whole although it would be nice for heavily organic works included like *Merck*. Arguments could be made for and against its importance for *Kirk-Othmer* and *CHEMLIBnetBASE*, both primarily chemistry resources but far less focused on chemical substance data.

Metasearch

Searching across many books simultaneously is a key advantage possible with e-books. Of the three multi-title resources examined, only *CHEMnetBASE* lacked this option; it seems to be merely a portal, without any function other than giving a name to a package of databases and e-books for purposes of marketing. *CHEMLIBnetBASE* is structured differently from *CHEMnetBASE*; it is possible to search across its contents. If *CHEMnetBASE* were searchable as *Knovel* is, users would be more likely to learn about and use content other than the *CRC*, its most visible and well-known resource.

Summary

It is easier to say which resources are my least favorite ones to search than which is best (see Table 3). As with navigability, *POC* ranks near the bottom though it allows structure searching.*Merck* and *CHEMLIBnetBASE* are also far from ideal. However, all have pros and cons. Technical difficulties searching *Polymers* detracted from its positives. The most significant negative overall is a frustrating inconsistency in search options across resources; it may be less problematic for most given user propensity for one or two word searches (Spink & Wolfram 2001).

Table 3: Searchability

Results

Clearly presented

Overall results were easy to read and work with, but small changes would benefit several of the resources. It would be nice if *CCD*, *POC*, and *Polymers* showed search terms on the results page. Links in a *CHEMLIBnetBASE* search results list are black and not underlined, making it unclear that they are clickable without mousing over them, and all 6 fields (*e.g.*, Book or Chapter Title) in a record are links, each going to the same document. Also, there is no color change for visited links, violating a key principle for web site usability (Nielsen 2008). The *POC* results list is in a difficult to see pale purple font. Items in the *CRC* results list can have two links which is potentially confusing; one goes to where search terms occur in the PDF version and another to an "interactive table" limited to relevant data.

Search terms highlighted

Highlighted search terms save user time by preventing the need to scan large amounts of text. For e-books with short entries like *CCD*, *Merck*, or *POC*, none of which highlight search results, it may be less crucial, but it is still helpful, somewhat analogous to daytime running lights on cars, not strictly necessary but a benefit to other drivers. *Kirk-Othmer* and *Polymers* highlight search results in HTML records. Search terms are not highlighted in the PDF versions of *Kirk-Othmer* entries. *CHEMLIBnetBASE*, *CRC*, and *Knovel* highlight results in PDFs and go directly to the words' first occurrence in the text, another time-saving feature. *CRC* and *Knovel* also pull relevant data into tables for data-intensive content, taking advantage of what electronic texts can do and more ought to do.

Relevancy ranking

CCD, *POC*, and *Merck*, comprised chiefly of short entries with basic substance information, arrange results in alphabetical and numerical order. *Kirk-Othmer* and *Knovel* rank results by relevancy to search terms by default. *CHEMLIBnetBASE* and *Polymers* rank results by number of hits, a rough measure that does not take into account the proximity of words or where in a document they are located. However, it is preferable to the

CRC method of chapter/section order which is potentially time-consuming for a frequently occurring search term. It also is more likely that users will miss relevant information given how rarely most look beyond the first few hits. Ranking results by alphabetical or chapter order or number of hits makes it obvious why one result comes before another, likely of little interest to most users. Results ranking methods are not as transparent, but relevancy is usually preferable for getting to information quickly.

Ease of working with results

Sorting by relevancy, subject, or title name is easy in *Knovel* with the click of a radio button. *Kirk-Othmer* and *CCD* also allow sorting; *Kirk-Othmer* can sort by match percent, date, or article title, and *CCD* can sort by chemical name or molecular formula. None of the others do. There are many reasons why the ability to sort results in different ways is useful. For example, scanning an alphabetical list is faster for finding a known article or book not highly ranked by relevancy.

For *CHEMLIBnetBASE*, *Kirk-Othmer*, *Polymers*, and *POC*, downloading data or results amounts to saving or printing HTML or PDF files. *Knovel* and *CRC* allow this as well as the data tables mentioned previously. PDF image quality is occasionally poor in older *Knovel* titles, possibly unavoidable for some originals.

Knovel's interactive graphs, scanned from the text and digitized or generated from equations, set it apart from the other resources. Users can click on points in a graph to determine *x* and *y* values and save them to a table, very useful for tasks like finding density at different temperatures, for example. Graphs only make sense for certain types of information, so it is nice-to-have. It capitalizes on what e-books can do and would makes sense for other resources as well.

Another way *Knovel* takes advantage of the potential of e-books is the ability to pull data into tables and sort or filter it, enabling users to focus on properties of interest or group substances with similar values for a property; the *CRC* has similar capabilities. Both also allow data in tables to be selected and exported to an Excel spreadsheet. *Knovel* has some additional options for manipulating data tables like hiding columns. As with plotting data, the ability to filter, sort, and export data does not make sense for every reference e-book but more could benefit from this treatment. *CCD* allows exporting a list of results to Excel, but it only includes the chemical name and molecular formulas.

Summary

In addition to technical problems searching *Polymers*, I had repeated problems accessing its substance records. *CRC* and *Kirk-Othmer* are doing a lot of things right (see Table 4). *Knovel* has some of the most innovative options for dealing with data and results. Though both text-heavy, content in *CHEMLIBnetBASE* and *Kirk-Othmer* could certainly benefit from similar treatment.

Table 4: Results

Conclusions

What makes a good electronic reference book? The real test of an e-book's value is whether it is used, particularly if there is also print access. It is telling that over half the libraries surveyed by Robbins, *et al.* held the *CRC* in both print and electronic formats (Robbins et al. 2006). Its status as a classic and well-used reference book is a factor, but would users still be so tied to the print if the electronic version were as quick and easy to use? Format duplication is not unique to the *CRC* as most ready reference titles were held in print and electronically by about one-third of the libraries in the Robbins study (Robbins et al. 2006). Some of the reluctance to ditch duplicate print reference sources is motivated by concerns like guaranteed perpetual access to content, but ease of use is crucial, too.

For our users, quickly finding the desired information is their central concern when they consult a reference book, and many factors can affect the speed of this process with e-books. Some stumbling blocks are unpredictable and probably not currently avoidable, namely technical problems unknown in the print world like incompatible browsers or operating systems, requirements for plug-ins, pages that load slowly, or malfunctioning servers. However, problems related to an e-book's design and functionality like cluttered pages, confusing terminology, and non-obvious links also affect user efficiency. Users can evaluate search results more quickly if relevant data has been pulled into tables or search terms have been highlighted. Features unique to *Knovel* like interactive data and the ability to search for property information at a very granular level across many sources can help make users productive in ways not previously imagined. They are shifting the paradigm for what users can and should expect from online science and technology reference books.

The framework described provides guidance for identifying potential ways a users' work might be helped or hindered by an online reference book. Unlike technical glitches, the criteria addressed are not entirely out of

our control. Holding vendors accountable for product quality, evaluating and sharing feedback before we buy or lease, and the willingness to walk away products that do not meet our standards is imperative. E-reference books have improved greatly over the last decade. Although changes can be slow, vendors respond to librarian feedback on their products.

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