As a direct consequence of the digital revolution, academic libraries today face competition as information providers. Using Richard N. Foster's technology S curves as the analytical model, this article shows that academic libraries are in the midst of discontinuous change by questioning a number of assumptions that support the current practice of academic librarianship. The authors challenge these assumptions, and analyze the manner in which digital communications affect academic libraries.

**INTRODUCTION**

It has become cliché to say that the digital revolution has changed the nature of information, but the fact remains that it has. The prevalent format, the speed of information creation, delivery and dissemination, and user needs and expectations have all changed. It has transformed scholarly communication as scholars adapt their teaching and research strategies to the new information environment. It is facilitating an increase in scholarly output in fields that were already expanding faster than libraries' ability to collect. Furthermore, it is enabling researchers to share vast quantities of raw research data. Researchers are turning away from traditional publishing venues and are opting to disseminate their findings and data in community vetted forums. As a consequence, libraries now face competition as information providers. The academic audience is no longer captive. Students and scholars can increasingly bypass the library to satisfy their information needs. These changes are disruptive, as they challenge the traditional role, purpose, and operations of the library, which together amounts to a paradigm shift.

Richard N. Foster, postulates the thesis, known as technology S curves, to explain how technological advances succeed each other in the marketplace (Fig. 1). Foster presents a compelling model with which to interpret the changing information landscape. According to this theory, new technologies perform poorly in their early days when compared with the dominant technology. However, after a period of slow improvement, the performance of the emerging technology improves exponentially and quickly outperforms the old. Substantive yields in improvement are observed for a period until the performance of the new technology tapers off in turn, and diminishing returns set in. It is at the take-off point of the curve that new technologies tend to replace old ones in a discontinuous fashion. This is also the point when incumbents are most vulnerable, because they are penalized for switching too early, but risk falling behind when the new technology takes off in an exponential fashion. Looking at librarianship in this paradigm, the profession has reached a point of diminishing returns as it continues to tinker with its traditional protocols and services, while emerging technologies are improving at an exponential rate.
The Internet has made a significant shift in the environment in which libraries find themselves and is making our professional assumptions seem as foreign as a medieval manuscript in chains.

But the competitive market environment is the most significant change libraries face today. This is altogether unprecedented in the history of librarianship. Until the advent of the Internet, academic libraries had no competition and their patrons were a captive audience. Students and faculty either learned the protocols and organizational principles of the library, no matter how esoteric or complex, or did without. In today's environment simplicity, efficiency and transparency, combined with savvy marketing, have become critical factors in patrons' decisions in selecting information resources. Ease of
access is often considered more important than quality. Thus users eschew authoritative print reference sources for Internet ones of lower quality. The new market also means that competition is not a one-time phenomenon, but rather a present and future reality. Librarians must now confront disruptive innovation as a matter of routine.

As Jerry Campbell points out, the scholarly monograph remains the anchor of the academic library. Looking at current evidence, one may conclude that the print scholarly monograph is secure for the foreseeable future—the number of titles and editions grew substantially from 2002 through 2004 and the trend is expected to continue, while e-books have failed to acquire more than a toehold in the market. Nevertheless, the print scholarly monograph hinges on an unsustainable financial model; a growing number of libraries are purchasing electronic monographs; and many scholarly works are consulted more often than read cover to cover, including reference works, many science books and textbooks. Although current technologies, such as PDF and e-book readers, have failed to supplant the print codex, interest in the future of the e-book remains high on the part of business, funding agencies, technologists, and the public at large. Furthermore, dissertations which are a source of many scholarly monographs are available online in increasing numbers. Considering the wide spectrum of disruptive change that electronic scholarly monographs would force upon the library, it may be wiser to assume that it will change, rather than bet on its immutability.

Thus, the shift to a digital environment brings the very identity of the librarian under question. Librarianship was built upon an ethos of service, but service can no longer be delivered effectively without the application of technology. Libraries must create a more compelling Web presence that attracts users. A combination of computing expertise has to be harnessed in the interests of delivering effective service that will provide a competitive advantage. In fact, a misplaced service ethos tethers librarians to services no longer desired by the majority of library users. The decline in reference questions is a telling sign that librarians to services no longer desired by the majority of library users. The shift to a new information environment will require hard decisions from library administrators. Considerable reallocation of human resources is in order. Like medieval scriptoria after Guttenberg, entire services should disappear in the face of obsolescence. Libraries should also consider opening its professional ranks to nonlibrarians, unless library schools rapidly revamp the curriculum to reflect the new competitive environment. High-level skills in marketing, systems, and a new competitive attitude, so uncharacteristic of the traditional librarian, are now needed. The library profession needs a more compelling raison d'être than overseeing glorified study halls or computer labs as a vision of its future. Library buildings, into which so many universities have invested untold millions, stand vulnerable to repurposing once its last anchor—the print academic monograph—is digitized.

The authors also recognize that there are factors in the analysis of the profession's underlying assumptions that dampen the urgency for change. Universities are known for their institutional inertia, and, at most institutions, administrators are distracted by more urgent needs than changes affecting libraries. The cultural value attributed to libraries gives pause to administrators with a propensity to impose changes, after all who wants to be known as the destroyer of a cultural icon? Moreover, copyright law provides a perverse lever for publishers to slow the adoption of new scholarly paradigms that challenge their preeminence in the marketplace. Publishers of both scholarly monographs and serials have a vested financial interest in making sure that they maximize their investments—which is only natural in a capitalist market—and will resist changes, such as open access, for as long as those are perceived to damage their commercial prospects. Libraries play an important role in the accreditation piece where collection size, staffing, etc. provide concrete measures of performance.
Accrediting bodies have reassured the library community by picking up the theme of information literacy, thus assuring this largely library based enterprise a future for at least the near term. Nevertheless, these factors may not be enough to sustain the status quo in an environment which can change with breathtaking speed.

**ANALYSIS**

Three areas central to the traditional identity of academic libraries are most immediately affected by the transition from an analog to a digital environment: services, the collection, and the library as a place. It is on these fronts that the library’s role and value were maximized in the analog environment, when the print journal and the bound monograph reigned supreme. The transition to a digital environment fundamentally affects all three by virtue of the fact that in a digital environment the locus of value shifts elsewhere. A closer analysis of how this shift affects libraries is warranted for future decisions and has to be driven by a thorough and frank understanding of the significance and implications of this shift.

"Three areas central to the traditional identity of academic libraries are most immediately affected by the transition from an analog to a digital environment: services, the collection and the library as a place."

**SERVICES**

The catalog is perhaps the most heavily used and expensive service any library provides. It is costly both in terms of technology and in terms of human resources. Not surprisingly, libraries have devoted a great deal of time, energy, and money toward reducing the expense of creating and maintaining the catalog. Already in the late nineteenth century, librarians were imagining ways to dilute cataloging costs by sharing cataloging records. These schemes remained impractical until the establishment of the first bibliographic utility in 1971 and the widespread adoption of automated library systems in the 1980s. Although shelf-ready plans permit considerable cost savings by outsourcing and streamlining much of the work, there remains much dissatisfaction with the catalog.

The successful transition from card catalogs to online catalogs obscures the very conservative nature of the cataloging rules and the MARC record that are the foundations of the library catalog. Cataloging practices developed in the nineteenth century were carried over into the OPAC largely unchanged. As libraries automated, records in catalog drawers became MARC records with more emphasis on display than searching or data normalization. Books continued to be treated as revered physical objects and so were identified not only by title but by size, pagination, and publisher. The emphasis on inventory control resulted in precise known item searching, but they worked against users who approached the OPAC as a resource discovery tool. For the first generation of OPAC users, familiar with library card catalogs and no experience searching computer databases, the OPAC seemed a powerful tool.

Yet for a variety of reasons, the OPAC has failed to evolve, and for today’s users, weaned on Yahoo and Google, the OPAC seems oddly out of place. It is difficult to search, its conventions are arcane and its technology dated. They have a Web veneer, but in contrast with current Web search tools, they retain the underlying structures of the original 1970s product. Basic features such as spell checking, context sensitive help and search suggestions, long desired, remain largely absent.

"...for a variety of reasons the OPAC has failed to evolve, and for today's users, weaned on Yahoo and Google, the OPAC seems oddly out of place."

Ultimately, the OPAC works reasonably well as an inventory tool. It is far more precise than Google for many types of known item searches. However, if we expect it to work as a resource discovery tool, then it fails. Its contents are limited in general to the holdings of the institution. For undergraduate students, this may be enough, but graduate students and faculty need access to more resources than most institutions can afford to purchase. Furthermore, all patrons now have access to databases that are far richer. Some, like WorldCat, suffer from many of the problems associated with the OPAC, but others such as Amazon and Google offer a rich discovery environment. As with most Internet search services, they are geared toward discovery because their business depends upon it.

To date, attempts to enrich the catalog have been limited to book covers, tables of contents and occasional attempts to catalog ephemera, articles, and other nontraditional materials. Such information is useful but fails to improve the underlying nature of research where each discovery opens paths to new materials. This is the basic concept behind Google and ISI’s Science Citation Index, which use the relationships between information objects to enhance discovery. Following this model, an enriched OPAC would include bibliographies that would link outward to additional resources, such as scholarly reviews, but also be mined to create more effective rankings. Although social bookmarking is a method being investigated, unless it becomes a standard research method, it risks becoming a volunteer effort that will wither from neglect.

Considering current limitations in the OPAC, it should be a surprise that libraries continue to promote their catalogs as discovery tools. To get a glimpse of a richer future, we should consider Google Scholar. For all its faults and limitations, it does something that no library system can match. It allows us to seamlessly search a wide variety of information from PubMed and Open WorldCat to Science Direct and Blackwell and links to the underlying articles. A user with the right IP address can retrieve commercial and open access scholarly information and yet remain blissfully unaware of the Library’s role in licensing them. Libraries can upload their holdings and OpenURL server addresses to Google to enhance access but increasingly this will be irrelevant as more publishers open their sites to Google’s indexing agents. It also provides book records from WorldCat, which in turn, finds the nearest library that owns it. Google Scholar provides an eye-opening example of the issues raised by the obsolescence of the OPAC and traditional indexing.
services. And in contrast with the OPAC, Google and its competitors provide ample evidence that they understand the dire consequences of not developing their products. Chances are we have only seen the tip of its potential. To a great extent, the OPAC, in its current manifestation, can continue to exist for as long as the scholarly monograph remains its analog format. The eventuality of the scholarly monograph crossing the digital frontier implies a high risk that the library catalog will become irrelevant.

Another critical library service shaken by the transition to a digital environment is reference. In the 1990s when the effects of the Internet were first being experienced, there was a widely held view that reference services would be outsourced or managed through cooperative networks so that users might have 24/7 assistance. Instead something unexpected happened, reference services dropped precipitously. This decrease was caused in part by a demographic dip, yet as the current undergraduate population rebounds, the use of reference services has not recovered to 1990 levels. There appear to be several reasons for these changes. Anecdotal evidence suggests that the term paper is recovered to 1990 levels. There appear to be several reasons for these changes. Anecdotal evidence suggests that the term paper is...
Since digital collections are seldom bought, but rather rented, the concept of building collections becomes anachronistic. A digital library assembles a series of rental contracts that meet current patron needs, renewed or cancelled according to negotiable terms. The majority of these contracts provide access to collections, rather than individual titles. Consequently, collections can be assembled and cancelled with little effort, in no time, and without physical constraints. As a result, today even small libraries can provide access to collections so vast that the number of titles no longer distinguishes the great from the lesser libraries. In a digital environment, the distinguishing characteristic of great libraries is that they will create virtual environments that are compelling and efficient to use, and are sensitive to the patron’s productivity.

These same forces are also being felt in the scholarly publishing world and their resolution will have a profound impact upon academic libraries. Twenty years ago, futurist Harlan Cleveland wrote an article on what he called the information society. In it he argued that as the cost of reproducing information dropped, information producers would find that sharing information was more profitable than selling it. There are many examples of this currently on the Web, but perhaps nowhere does his logic make more sense than in the realm of scholarly information and open access publishing. If the open access model’s current momentum carries, and it succeeds, its impact upon libraries will be profound. It may solve the decades old serial inflation crisis, and it will make scholarly communications significantly more efficient, but it will make library journal collections a thing of the past. The patron then will have unhindered and free access to scholarly content, leaving the library out of the scholarly communications food chain.

**Library as Space**

The importance attributed to the “library as a place” is often recited as an incantation whenever the impact of digital collections on libraries is discussed. Its truth is accepted as self-evident and its power to preserve the status quo left unchallenged. There is little doubt that the library has a cultural significance that resonates in our society. Yet the arguments supporting the importance of the library as place ignore the primary function of any library building to house and provide access to its collections. In traditional library buildings, most of the space is dedicated to storage while public spaces, such as reading rooms, occupy only a small percentage of a library’s square footage. Although for years academic libraries have sprinkled study carrels and computer workstations among their collections, the physical requirements of housing thousands, or millions, of books have often resulted in large drab utilitarian spaces. The question of how to repurpose these spaces as the collections migrate to a predominantly digital format looms large for those institutions unable or unwilling to construct new facilities. The process of repurposing this space will force academic libraries to confront the veracity of the arguments concerning the intrinsic value of the place. Library directors would be well advised to start articulating rigorous arguments as soon as possible.

Libraries have not yet reached the stage at which their space is irrelevant, as they continue to support large circulating collections, and evidence suggests that this will continue for as long as the preferred format of the academic monograph is the codex. But print journals, reference, media, and government documents collections are already shrinking in size and may cease to exist altogether. Some science libraries, with predominately serial based collections, are likely to close entirely. While monographic collections are more stable, many libraries are aggressively weeding their collections or sending them to storage. The effects of this change can be seen in new library construction where the percentage of space devoted to warehousing materials is decreasing while study areas and public spaces increase.

In the absence of compelling arguments for new roles for library buildings, other entities are bound to step into the vacuum. Some shrewd administrators seem to be taking the initiative by proposing that the library become a center of student services. Accordingly the library becomes the “one-stop-shop” from provider of information and study space all the way to being the technology support center, the writing center, and even the advising center. Others have brought in services traditionally found in student centers: cafes, dining facilities, meeting rooms, retail, and information spaces. Study spaces are increasing in size and are becoming less Spartan. While these multipurpose facilities can reverse the drop in user visits, most of the services are not provided by librarians nor are their operations managed by the library’s administration. Libraries may become landlords for providers of more compelling services.

In an environment where library services are replaced by study rooms, computer labs, and eateries, the argument supporting the view of the library as a place rings hollow. When users are drawn to the library primarily for these types of activities, the library will have to compete with the student center as place, the technology center as place, and the food court as place. If the profession fails to maintain a unique identity, then the library will become a legacy asset with depreciating value.

**Conclusions**

In postulating the technology S curves as an explanation for the behavior of commercial enterprises, Richard N. Foster also observes that many if not most companies’ success and peak performance is temporary. Advances in technology yield discontinuous progression and inevitable turmoil among individual companies, as their fate shifts from success in exploiting a new technology to stasis, and then loss as new, and better, technologies are exploited by the competition. His analysis points out that established companies do not retain the advantage in the competitive marketplace, precisely because a sense of comfort and complacency tends to set in once a given technology starts yielding fortunes—which become blinders as emerging companies that exploit newer technologies are underestimated as viable competitors until it is too late. Might the fact that so many of the points made in this article were originally articulated in the literature years ago, without changes in the practice of the profession, not be evidence of complacency? What catalyst will be necessary for the profession to realize that a new paradigm means radical changes?

Telling evidence that libraries are facing a technology S curve can be found in OCLC’s Perceptions of Libraries and Information Resources. When asked which sources of information they used, the study found that 73 percent of college students used the physical library but only 47 percent used the online library compared to 75 percent for Internet search engines. Furthermore, 89 percent begin their search with a search engine while only 2 percent begin their research at a Library Web site. When asked which sources they preferred,
remains unanswered and the authors are unconvinced of many
points out, once established entities recognize the competitive
repurposing of many libraries across the nation. But as Foster
models, such as shelf-ready books, that have yielded efficien-
cities in processing workflows, and the recent construction and
repurposing of many libraries across the nation. But as Foster
points out, once established entities recognize the competitive
threat in which they operate, their reflex is to fine-tune the time-
proven model — obsolete though it may be — rather than
recognizing that the marketplace has made a discontinuous
switch to an altogether new model. The question of whether
these changes are sufficient to reposition the academic library
on the new “S curve” of the digital information paradigm
remains unanswered and the authors are unconvinced of many
of the changes being brandished at this point.

"...once established entities recognize the
competitive threat in which they operate, their
reflex is to fine-tune the time-proven model —
obsolete though it may be — rather than
recognizing that the marketplace has made a
discontinuous switch to an altogether new
model."

The questions and challenges raised in this article are
particularly compelling because libraries lost the first round
in the new competitive environment: libraries offer better
content for the task at hand, yet patrons flock elsewhere.
Monetary costs are obviously not the issue for patrons, after
all Google and Lexis—Nexis are equally free from their
point of view. Academic librarianship needs to fundamentally
revise its practices to become competitive in a digital
environment.

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article evolved into its current form.

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