Framework for Assessing the Impact of an Electronic Journal Collection on Library Costs and Staffing Patterns

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I. Introduction

Much has been written about the economic impact of electronic publishing on publishers. There has also been considerable discussion of library costs associated with the various methods of purchasing electronic publications. This paper addresses another important organizational impact triggered by the migration to electronic journals that has heretofore received little attention in the literature: the changes in the library's operational costs associated with shifts in staffing, resources, materials, space and equipment.

In 1998, the W.W. Hagerty Library of Drexel University made rapid migration to an electronic journal collection a key component of its strategic plan. For journals available electronically, **only** the electronic version is purchased whenever possible.[1] The sole exceptions are (1) when the electronic journal lacks an important feature of the print version (e.g., advertisements in business or fashion journals) and (2) when the journal is part of the browsing collection (e.g., *Scientific American* and *Newsweek*). With the year 2000 renewals, Drexel's journal collection consists of 953 print subscriptions and 4,951 electronic journals. A dramatic change in staff workload is the most immediate impact on library operations, but space, equipment, and even supply needs are affected. Some of the aspects of this transformation are obvious and predictable; others are not. This paper describes the changes experienced so far in the Drexel Library.

A common assumption is that converting library journals to digital format will ultimately improve library service and lower cost, but this is yet to be proven. Understanding the costs associated with the library model for delivering digital information has now become a requirement for library survival since in the digital world, as opposed to print, the library has many viable competitors. Our goal is to develop a framework for assessing the shifts in personnel and costs that can be used for planning and budgeting at Drexel and in other academic libraries.

II. Background

The Electronic Libraries Programme (eLib) [1], funded by the Joint Information Systems Committee (JISC) in the United Kingdom, is a series of major library projects investigating issues of digital library implementation and integration. The emphasis is on

[1] Some publishers continue to insist that print must also be purchased, i.e., bundling. This paper discusses our strategies regarding these restrictions in detail.

“working libraries.” The guidelines for evaluation of the eLib projects call for "modelling of functional, cost, organisational and technical variables" as one of the desired components. [2] Pricing models for electronic journal subscriptions, licensing agreements, and infrastructure requirements to provide access are themes that are explored in these projects. Each project tends to be fairly focused in terms of the range of digital content and services offered or the topic addressed. Many deal with organizational and management models that can serve as the basis for scaling up initiatives.

Halliday and Oppenheim [3] looked at economic models of the digital library where the digital library was defined in the broad sense to include all stakeholders - publishers and users as well as libraries. They looked at four different types of models based on distribution methods and content costs and concluded that further research is needed before a model to represent the entire digital library (in the context of a larger operation) can be developed.

Friend [4] makes the case that economic models for evaluating the cost/benefit for electronic journal subscriptions are imperative and offers a tentative cost per use model for electronic journals similar to those traditionally employed to evaluate print journal titles. He notes that many costs such as the cost of shelving are taken for granted and are never included in library economic models. He then goes on to discuss both the direct and indirect assumptions that are implicit in a valid economic model and the difficulties inherent in making comparisons and in calculating the true value to the user.

Almost universally, journal cost analyses use subscription costs exclusively; operational costs associated with a journal collection are not included. For example, White and Crawford [5] undertook a cost-benefit analysis to determine whether acquiring Business Periodicals Online (BPO), a full-text database, was more cost-effective for supplying articles than obtaining articles in the database through interlibrary loan (ILL). They found that the out-of-pocket costs (ILL transaction costs versus the BPO subscription costs) were similar but the level of service was much greater with BPO. This analysis did not allocate all the costs associated with electronic delivery such as the network and increased support.

Hawbaker and Wagner [6] also compute only subscription costs when comparing the costs of journal subscriptions to online access of full-text. They conclude that, for a full-text business database, the University of the Pacific's library can offer more than twice as many journals for a 15-percent increase in expenditures.

Projects like JSTOR [7], which builds journal backfiles, do address building-related costs. One of the JSTOR objectives is "To reduce long-term capital and operating costs of libraries associated with the storage and care of journal collections." By guaranteeing online availability of backfiles, JSTOR not only makes these files more accessible, but also allows libraries to discard old journal runs without decreasing service to their users.

One of eLib's supporting studies focuses on the impact of electronic journals on the computer network and on in-house printing demands, illustrative of resource elements not found in the print model. [8] The authors concluded that printing costs can be high and "while e-journals do not in themselves introduce any significant new technical requirements into the printing environment, by potentially increasing the level of demand

and the scale (including file sizes) they will show up any weaknesses or inadequacies in current services."

In their report on management information systems for the electronic library, Brophy and Wynne [9] posit a scheme in which library functions are divided into five parts: Resource Discovery, Resource Delivery, Resource Utilization, Infrastructure Provision, and Resource Management. They identify performance measures which are largely activity indicators such as hits per service per month or sessions per potential user, along with user satisfaction. Costs could be factored into these indicators in order to measure efficiency.

Odlyzko [10] is unusual in his focus on non-subscription costs. In a 1999 article, he points out additional factors to consider in evaluating the impact of journal growth on libraries:

> Journal subscription costs are only one part of the scholarly information system…. internal operating costs of research libraries are at least twice as high as their acquisition budgets. Thus for every article that brings in $4,000 in revenues to publishers, libraries in aggregate spend at least $8,000 on ordering, cataloging, shelving, and checking out material, as well as on reference help. The scholarly journal crisis is really a library cost crisis. If publishers suddenly started to give away their print material for free, the growth of the literature would in a few years bring us back to a crisis situation.

Odlyzko figures that the library's non-subscription (i.e., operational) costs are on average double the subscription costs. His figures are derived from the Association of Research Libraries (ARL) statistics. [11] This is a macro level measurement that does not take into account, for example, the different processing costs for books and journals or library costs unrelated to the collections which might cause the non-subscription figure to be over-estimated. On the other hand, ARL statistics do not report the considerable costs associated with constructing and maintaining library buildings, a factor which if added to Odlyzko's number would lead to a higher estimate of non-subscription costs. But even if off by a factor of 100 percent, Odlyzko's estimate is astounding to consider, and points out the importance of looking at how these operational costs shift in the transition to an electronic model.

Also with ARL statistics, Shim and Kantor [12] have used a complex analysis tool, Data Envelopment Analysis (DEA), to evaluate the relative efficiency of major research libraries. Inputs are collection, staff and university characteristics like total volumes, number of staff and FTE students. Outputs are activity measures such as number of ILL transactions, items circulated and reference transactions. Shim and Kantor have baseline data that can be used for comparison as libraries transform to the digital model.

The study of library operating costs has always represented a challenge for researchers and administrators, regardless of the format of the materials offered to users. Measuring the costs precisely and allocating the appropriate costs for content, staffing, facilities, hardware and overhead is neither simple nor easy. The tendency has been to underestimate the true costs of providing specific services, and the cost analysis of the transition from print to the electronic delivery model is doubly prone to this kind of difficulty.

Kantor [13] has pioneered the functional cost approach in which all materials and services costs are allocated to a set of library functions. The unit costs then calculated can be used for evaluation and management decision making. Abels, Kantor and Saracevic [14] used this approach in 1996 to study the comparative costs and value of services in five major research libraries. By allocating appropriate costs to reference services, they have identified the difficulties, and particularly wide variability, in analyzing costs in a particular library as well as the problems inherent in comparing results across groups of libraries. Nevertheless, the issues and methods identified can be applied to assessing the costs of competing alternatives as libraries move towards increasing electronic delivery.

Extending this work, Kantor and Saracevic [15] report results of a study that applied both DEA and the functional cost approach to services at the five research libraries. They combined this analysis with a new measure to assess the impact of library services on the user with the ultimate goal of answering the question: "Does the sum total of value flowing from the library justify our cost in maintaining it?"

The landmark ARL/RLG study of interlibrary loan costs is an example of an attempt to include and allocate all aspects of the true costs of library service. [16] Costs accounted for were staff, network and communications, delivery, photocopy, supplies, equipment and software, rental and maintenance, and direct and indirect borrowing costs. The largest cost factor by far was staff, which accounted for 77 percent of the total. Many librarians were surprised by what they perceived to be the high unit costs of both borrowing (mean: $18.62) and lending (mean: $10.93).

III. Development of Drexel's Electronic Journal Collection

In the spring of 1998 only one full-text journal collection was accessible via the Drexel Library's web site and database access was limited to text-based systems. During the summer of 1998 the web site was completely re-designed and by the fall more than 20 databases and several collections of full-text journals were available. The total number of print journals was 1,850 titles at that time. For 1999 and 2000 the number of print journal subscriptions was reduced to 1,475 and about 953 respectively. Some of the reductions were made because we had subscribed to an electronic counterpart; the other journals were not renewed primarily on the basis of low use. During the fall of 1998 through 1999, and into 2000, electronic subscriptions were sought out aggressively and added as they became available, bringing the current total to 4,951 unique electronic titles. Approximately 200 of these titles also continue to be received in print because of publisher bundling requirements.

Library staff began developing and refining selection methods for electronic journals in 1998. The selection/ordering/acquiring process is far more complex than the one in place for print journals. Why have things changed so radically simply because of a new format? The current and evolving pricing models and methods for purchase often include buying packages of titles or services, many with value-added features. Also, print subscriptions rarely include licenses. Reviewing and negotiating proper terms for e-journal licenses contributes significantly to the complexity. Additionally, new variables must be considered in the title by title evaluation of available content (e.g., graphics, linking options, web interface functionality, and other value-added features).

Whenever possible, we are purchasing only the electronic version of a journal and canceling the corresponding print publication. When the publisher's policy is to require purchase of the print journal in order to obtain access to the electronic journal, we attempt to negotiate a discount for the e-journal only. This has met with limited success so far, but does have the advantage of educating publishers about our needs. One of our most interesting problems has to do with creative methods to NOT receive print journal issues. Because of the added cost of receiving, processing, binding and storing the print format, the following strategies are under consideration for eliminating it when the library has purchased equivalent electronic access:

- Throw away the print journal when it arrives.
- Donate the print journals to departmental collections or to circulate among faculty. (Unfortunately, most of the Drexel deans do not want the print journals.)
- Give the print journals to faculty who want them. (We fear this may be more trouble than keeping the print.)
- Sell or give the print journals to a back issue jobber.
- Keep the print journals in the current journal area for browsing, and discard them rather than bind them. Or, send them to a back issue jobber at this point.
- Intercept the receipt of the print format at the distribution level. Our subscription agent, Swets Subscription Service, Inc., is depositing the print copy of some of our bundled titles into their missing issues bank so that we do not receive them.

For FY2000, the decision was made to keep most of the print equivalents in order to measure their use. This will provide data on the value of continuing the investment in storing and maintaining these journals. We are also evaluating the need to continue storing our JSTOR print equivalents. We have discarded nearly all the print indexes back to the date that the corresponding online database begins, and de-accessioning the JSTOR titles is a logical next step in reducing the collection maintenance burden.

Drexel's approach to back files of print journals will seem cavalier, if not totally irresponsible, to those concerned with the archival role of libraries. Our position is that archival storage in most subject areas is not part of the mission of the Drexel Library. On a national, even international basis, archiving of old, little-used materials would be much more cost effective if done centrally or in only a few places for redundancy. This is true of both electronic and print formats. We are willing to make the leap of faith that this will happen, and are ready to pay the cost of access to the archived materials when they are needed. In strategic terms, we believe that our future environment will include central archives that we will be able to use, and are planning now as if that will be the case. There are numerous well-qualified national and international organizations addressing this issue, including the Research Library Group and OCLC which just announced an agreement to cooperate in planning the infrastructure for digital archiving. It does not seem reasonable to deny our current students and faculty a far superior collection in order to acquire and store infrequently-used print journals that will eventually deteriorate. Like most academic libraries, we are now storing hundreds of feet of acidic, crumbling print journals that we will never convert to another medium for storage purposes. They will surely be useless at the turn of the next century, if not earlier.

IV. Impact on Library Staffing and Other Costs

Relevant content at an affordable price is key to offering a quality electronic journal collection, but the resources needed to provide access to the content must also be factored in the cost equation. In this section, the impact on the materials budget and changes in each area of the library's operations will be discussed in detail with particular attention to the changes in staffing patterns and shifts in costs. **Table 1** summarizes these operational effects.

Table 1. The Transition from Print to Electronic Journals: Changes in Staffing and Other Costs

Department	Activity	Electronic Format	Print Format	Net Impact
Infrastructure/ Systems & Space	❑ campus network	= completely upgraded last 2 years	--	↑ increased capital costs
	❑ computer hardware (servers and workstations)	= 100% replacement/upgrade of library computers	--	↑ increased equipment costs
	❑ computer systems maintenance	= installing software, imaging (1.0 FTE)	--	↑ increased staffing
	❑ hardware maintenance	= service contracts	--	↑ increased costs
	❑ setting up access	= new activity, requires troubleshooting	--	↑ increased staffing
	❑ software purchase & development	= new activity to manage more complex process	--	↑ increased staffing
	❑ printing	= increased activity	--	↑ increased costs & revenue
	❑ space utilization	= content stored remotely	= fewer items added/extensive collection weeding	↓ reduced space needs
Administration/ Management	❑ negotiating contracts	= new position added (.5FTE)	--	↑ increased staffing
	❑ managing the change	= closer oversight required	--	↑ increased staffing
	❑ attention to decisions	= increased number of variables	--	↑ increased staffing
	❑ budgeting	= greatly increased tracking and planning time	--	↑ increased staffing
	❑ subscription fees	= $335,000 /for 4,951 titles	= $112,564/for 953 titles	↑ increased costs
	❑ per title cost	=	=	
Technical Services	❑ print journal check-in	--	= fewer items to check-in	↓ reduced staffing
	❑ e-journal acquisitions	= requires higher skill level	--	↑ increased staffing
	❑ claiming	--	= fewer items to claim	↓ reduced staffing
	❑ bindery staffing effort and fees	--	= fewer items; costs down 19%	↓ reduced staffing & costs
	❑ cataloging new items	= significant increase in # of items	= significant decrease in # of items	↑ increased staffing
	❑ OCLC transactions	= increased OCLC charges	= decreased OCLC charges	↑ increased costs
	❑ catalog/e-journal list maintenance	= significant level of new effort	= --	↑ increased staffing
Circulation/ Access	❑ re-shelving bound and current journals	--	= bound down 25%, current issues down 30%	↓ reduced staffing
	❑ collecting use data	= complex, requires higher skill level to organize	= fewer items to count, takes less effort	↓ increased effortreduced staffing
	❑ stack maintenance	--	= fewer items out of place	↓ reduced use & revenue
	❑ user photocopying	--	= fewer copies made; down 20%	
Reserve	❑ article file maintenance	--	= fewer articles on reserve	↓ reduced staffing
	❑ article checkout	--	= fewer items checked out	↓ reduced staffing
	❑ maintaining e-reserves	= requires equipment/ higher skill level	--	↑ increased staffing
Document Delivery	❑ faculty copy service	= copies from e-journals	= copies from print journals	? net impact unclear (started 1999, expect reduction)
	❑ interlibrary loan - borrowing	--	= slight decline in activity and charges	↓ reduced costs
	– ❑ net ILL volume	--	= slight decline in requests	= --all services expected to decline
Information Services	❑ reference at desk	= fewer but some longer transactions	= fewer transactions; down 15%	? net impact unclear
	❑ instruction/promotion	= increased need	--	= expect increase
	❑ preparing documentation	= increased number of items	= greater level of review	↑ increased staffing
	❑ journal selection	= more detailed evaluation process		↑ increased staffing

Subscription Costs

Budget allocations reflect the decision to shift from print to electronic subscriptions. Purchase decisions are based on two processes that occur concurrently throughout the year. First, we have undertaken a major initiative to analyze our current print and electronic holdings on an ongoing basis. Secondly, we are investing significant staff resources to keep current with all e-journal offerings from vendors, publishers and consortia within the scope of our collection and are initiating negotiations for pricing and packages tailored to our needs. In particular, we seek out electronic equivalents of current print holdings and replace the print with the electronic version of the title unless the title meets the exception criteria. Almost all exceptions occur when the content of the electronic version lacks important sections found in the print publication (e.g., advertisements in business and fashion magazines) or when the journal is browsed frequently (e.g., *Scientific American* or *Newsweek*). Eventually, we expect to have a browsing collection of fewer than 100 titles.

As a result of these efforts Drexel's total journal subscription costs are approximately $450,000 for FY2000. Print only journal subscription costs[2] are now about 25 percent of the total budget ($112,564), down from approximately $355,000 only two years ago. Electronic subscription costs are more difficult to calculate since we subscribe to some services and databases such as *RDS Business & Industry* and *ABI Inform* that are part database, part electronic journals. With a "best guess" allocation of the cost of these services, we are spending or expect to spend $335,000 for electronic journals in the 1999/2000 academic year. **See Table 2.** Journals we receive in both formats have been calculated as an e-journal cost because we are subscribing for the electronic format and are "forced" to accept the print as well.

Table 2. Subscription Costs FY2000

Category	# of Titles	Amount	Percent of total
Print only subscriptions	754	$112,564	25%
Electronic journal subscriptions and access to full-text articles	2,545[1]	$224,065	50%
Aggregator/databases with full-text content	2,616[2]	$116,244	25%

[1]Approximately 200 of these titles are "bundled" and require print plus electronic subscriptions.
[2]This figure includes some overlap of titles among aggregators although we are trying to minimize subscribing to duplicate content whenever possible.

On a per title basis the e-journal dollar has superior purchasing power. Our print only journal subscriptions now cost an average of $149 per title while e-journals are $66 per title. This difference is all the more remarkable when one considers that nearly all the electronic journals come, even when a subscription is first entered, with several years of

[2] This number excludes continuations but does include newspapers.

backfiles. The cost of obtaining these back year volumes in print is prohibitive.[3] The increased value of electronic journals is even more evident when coupled with use statistics, as discussed below.

Infrastructure

Systems

The impact of electronic journals on the infrastructure is outlined in **Table 1.** While space is the most important requirement for the print format, networks, computer hardware/software and systems staff are required to provide access to electronic resources. Fortunately for libraries, these items are rapidly becoming key components to a well-functioning operation in all academic institutions, as they are essential for so many other reasons. None of the Library systems are used for electronic journals exclusively since we provide access to the entire web, databases, electronic mail, a library management system with a web-based catalog, office productivity software and several specialized applications.

In response to the overall needs of the University, the entire Drexel campus, including the library and dorms, was upgraded to an ATM switched network during 1998 and 1999. During this time, all of the Library's computer hardware for servers, staff and public workstations was replaced with new state-of-the-art equipment. The Library also installed Lucent Technology's local area IEEE 802.11 wireless network and added 30 laptop computers which can be used to access electronic resources.

Systems Staff

To develop and support this upgraded infrastructure, the internal systems functions were reorganized and centralized in a new library systems department in 1998. Three new staff members in the systems area were added in the past two years. Library computer support and software development is provided through this group. Two are responsible for servers, computer imaging and software installation and upgrades. A percentage of their time is allocated to e-journals since use of these journals is a growing and significant component of infrastructure use. The other new staff member is the Webmaster who has easily spent 30 percent of his time on electronic journal access during this start-up period. He maintains the entire Library web site, which initially included over 200 static HTML pages listing e-journals by title and by subject.

E-Journal-Related Software Development

The systems staff is developing internal tools for automated web site maintenance and decision support. When it became clear that maintaining 200 continually changing static HTML pages was a major burden, the Webmaster developed an e-journal maintenance database using MySQL and PERL scripts to manage the lists and deliver them to the web dynamically. We are also developing our own local journal subscriptions administrative database (the prototype is running on Microsoft Access and will eventually be ported to MySQL). The goals for this database are twofold: (1) to retain the information about the usual selection variables for both print and e-journals, and (2) to track other data collected during the decision-making process. In the past we have not saved most of this data in a systematic way. These additional data elements include:

[3] In a 1998 analysis, the cost of replacing titles (in print format) cancelled in previous years was over $1,500,000, clearly neither cost effective nor affordable.

- requestor information and comments,
- available formats (including ones we have rejected),
- use statistics by format (re-shelving, document delivery and vendor statistics),
- available vendors, and
- decision history by title.

Printing

Users can print from either the public workstations or the laptops to a laser printer located behind the circulation desk. This is an interim solution, in place until we can install public access laser printers connected to a campus-wide system that will allow print costs to be charged directly to user's accounts. Currently under development, this campus system will eliminate the need for the library to handle money for printing. Revenue from printing does compensate for loss of photocopy revenue from journals and automating the collection of fees will streamline the process for both staff and users.

Space Utilization

The chief impact of print journals on infrastructure is managing the physical space for growth of the collection over time. The transition to electronic journals essentially eliminates space concerns; no more trimming the collection, converting to microfilm, or moving it to a remote location to make space for new volumes. Eventually, because of retrospective conversion efforts like JSTOR, we will be able to reclaim journal storage space for other purposes. The cost savings, both on a capital and annual basis, are considerable. Estimating $100 per square foot [17], the minimum cost for library buildings in large urban centers, the 20,000 square foot space currently occupied by the Drexel journal stacks would cost $2 million to construct. Estimating annual maintenance costs at $12 per square foot, the cost of maintaining the space occupied by the library's journal collection is approximately $240,000 per year.

Administration/Management

Journals have always required serious attention from academic library directors. In science and technology libraries, journal costs usually represent most of the materials budget. Faculty often have strong feelings about particular titles which they do not hesitate to make known. Traditionally, the decision to subscribe to a new journal has required careful consideration because of the long-term implications. And, for the last two decades as prices escalated so dramatically, directors became increasingly involved in advocating for additional funding to pay for journals. Often, in recent years as costs skyrocketed, they oversaw time-consuming annual journal evaluation processes and implemented severe cost-cutting measures. Electronic journals raise new issues which require the director's involvement to an even greater extent. Activities that are new or escalated for a director who makes a major commitment to electronic journals include:

- communicating and obtaining institutional funding and support,
- joining consortia and other "buying clubs,"
- contract negotiation and review,
- determining and revising strategies for e-resource acquisition,
- building a library staff with the appropriate skills, and
- managing the change.

Decision Making

The Dean and the Associate Dean oversee the selection/acquisitions process. Decision support is called for at both the broad and finer levels and content cost comparisons (including cost per article use, title or collection group) are needed to make decisions to subscribe to content initially and to renew subscriptions. Finally, in our situation, as we shift funding from the traditional model of ownership to our new model of access, the ability to compare print and electronic titles and to analyze trends is essential.

Staffing

We have created a new position, Electronic Resources Librarian (ERL), to provide a focal point for integrated development of all electronic resources. This position crosses traditional departmental functions including management, systems, technical services and reference. The person in this position shares the responsibility of keeping up-to-date on the availability of new electronic resources with the Information Services (IS) librarians who do collection development. She initiates contacts with vendors to negotiate favorable pricing and packaging and arranges trials for each new service considered for purchase. She also reviews licenses and contracts and spends some effort negotiating appropriate amendments and corrections to these documents. For example, one of our goals is to always provide remote access to content we make available to our users; initially some contracts do not allow this.[5] The ERL also interacts with consortia for purchase of electronic resources and evaluates the cost/benefits of going with a particular group offer. Once the purchase decision is made, IP information is communicated to vendors and content changes are made on our web site. The ERL manages the overall content for our web site and looks at how new content affects the current design and implementation. She also collaborates closely with the Webmaster in designing and populating our e-journal database. Finally, gathering and organizing use statistics for electronic resources is a major aspect of her responsibilities. Use statistics will be discussed in the Circulation/Access section below.

The transition from print to electronic journals has had a large impact on the workload and involvement of the library's administration. It is always more difficult and time-consuming to manage change than maintain the status quo. The amount of time spent managing and overseeing this transition is divided between three professionals (the Dean, Associate Dean and Electronic Resources Librarian) is over 1.0 FTE. This includes major ongoing efforts to restructure workflow and reorganize staff positions to respond to the changes we are implementing.

Technical Services

In the Technical Services Department, the transition to e-journals has had a direct impact on the day-to-day work of each staff member. Changes in workflow and procedures are dramatic, with very large shifts in costs. It is clear that the significant decrease in print titles has directly decreased workload for tasks related to the print format. For example, less time is needed to check in print issues, claim non-arrivals,

[5] While most data providers now understand this need, there are still publishers, particularly some of the societies, who are lagging behind.

replace missing pages, and prepare and receive bindery shipments.[6] Also, as would be expected, direct costs for cataloging new print titles and maintaining existing MARC records (OCLC charges) have decreased. Bindery fees are also reduced by 19 percent over the past two years since we are binding fewer items.

Offsetting the decrease in activity levels and costs related to the print format is a very large increased workload for both the serials acquisitions and cataloging functions related to providing access to electronic journals updating the e-journal maintenance database that now creates our e-journal lists is a major new task. The e-journal collection is much more volatile than a print collection: links break, coverage changes and sometimes the electronic journals themselves are available through a new distributor. An advantage of electronic distribution that creates extra work is that we are not tightly linked to calendar year only subscriptions; so journals are added continuously and sometimes cancelled during the year. Maintaining access points to e-journals both in our e-journal database and soon in the library catalog,[7] requires a different set of skills than the activities associated with maintaining a print journal collection. A technician level position has been substituted for a clerical position in order to have a person with the appropriate skills assigned to these duties.

Another activity that has greatly affected the department head in Technical Services and the Associate Dean is an expanded review process for journal renewals that includes the Information Services (IS) Librarians (each represents the various colleges in the University). During the past two years, we have evaluated every journal title, print or electronic, before it is renewed. The coordination and tracking of the renewal decisions has increased significantly. Additional details about this process are discussed below in the Information Services section.

Not only has the format of materials shifted but, as important for the Technical Services department, is the fact that the volume of materials has increased more than three-fold. We are now managing about 6,000 journal titles as opposed to 1,850 titles two years ago. Our cost per unit for processing journals has substantially decreased. We are processing more items with similar staffing levels and expect this to be the case even as cataloging e-journals becomes routine. Unfortunately, we are not simply able to switch existing staff to e-journal tasks. Currently we are in the process of “re-engineering” the entire department. We have upgraded two positions, added one temporary position, and replaced one position. We have recently hired a cataloger who will focus on managing both the cataloging and the maintenance aspects of electronic journals. It is clear we need detail-oriented support staff who have advanced computer skills and who can adjust to continuous changes in procedures and methods as our environment evolves.

Circulation/Access/Stack Maintenance

[6] To date we are re-deploying existing staff to work on clean-up projects associated with a recent physical re-organization of the journal collection, and a migration to a new automation system.

[7] Our ultimate goal is to catalog all our e-journals. This step was postponed because of the volatile nature of the e-journal situation in the past year and a half, and because we are in the process of moving to a new library management system. While maintaining the e-journal database has been time-consuming, creating and maintaining e-journal catalog records would have been even more labor-intensive and much more expensive. It would also have delayed significantly the process of making the titles available.

Staffing

Obviously, shelving activities are noticeably affected when fewer journals are physically stored in the library. Bound journal re-shelving has been reduced by 25 percent and re-shelving of current journal issues is down 30 percent over the past two years. At Drexel, collection of print journal re-shelving statistics is only partly automated. Shelvers track use by title as they shelve bound volumes and current issues. Fewer journals to shelve also translates to less time collecting statistics.

So far one of four permanent shelving positions has been eliminated by attrition. We expect continuing reductions in re-shelving and are planning to further shift and/or reduce shelving staff. Fortunately, these positions have high turnover rates.

Electronic Use Statistics

In theory, it is easier to collect use statistics and richer, more accurate demographic and search information for electronic journal usage because data collection can be automated and expanded. In reality, at this time, obtaining useful and comparable title-by-title use data for electronic journals is difficult and labor intensive to compile in a way that is helpful for making management decisions. Activity measures, and particularly consistent activity measures across journal vendor services, are frustratingly difficult to come by. Mercer [18] describes the difficulties encountered in trying to collect and analyze the vendor information so as to use it for service evaluation and decision-making. Among the statistics reported are session length, number of searches, journal title hits, page hits, types of pages hit, top XX titles accessed each month, "turnaways," form and type of articles downloaded, and number of unique IP addresses using a service or journal title.

We are using a variety of methods to attempt to collect meaningful statistics in order to compare electronic usage to print journal use and to calculate cost per use values for renewals. We work with vendors to obtain complete, comparable and up-to-date information. We are also archiving our proxy log files and web server statistics and experimenting with how to extract meaningful information from this data. The impact is a significant increase in time for this activity. Our assumption is that most of this time is developmental and as our methods improve and stabilize, the amount of time (and, therefore cost) will level off. Similar to the situation in Technical Services, the set of skills needed by staff who are working on these tasks is very different than those needed previously to collect re-shelving statistics for print journals. The result is that the responsibility for e-journal statistics has been transferred to the Webmaster and the Electronic Resources Librarian.

Table 3 gives a sense of the usage levels for some of our electronic journal collections. This data is by no means comprehensive as it represents only 61 percent of the e-journal titles. Nevertheless, this segment of the e-journal usage for 1999/2000 already exceeds our total print re-shelving counts for the same time period. Since the numbers are not strictly comparable, they must be interpreted carefully. The print statistics represent volumes or issues re-shelved, rather than actual articles copied or read while the e-journal statistics below represent articles accessed which may or may not have been read. The print use data is somewhat under-reported because, even when asked not to, users re-shelve journals after they look at them. Even so, we can say that our users are accessing the electronic journals in numbers far exceeding our print collection, but it is too early to quantify the trend with confidence.

Table 3. Journal Use Data

Print Journals
Use = number of volumes or issues re-shelved

	Use 1997/98	Use 1998/99	Use 6/1999 - 2/2000[1]
Bound Volumes	21,613	17,424	8,789
Current Issues	28,747	22,609	15,194
Total	**50,360**	**40,033**	**23,983**

Electronic Journals
Use = number of full-text articles accessed (either HTML, PDF, or other type of full-text article)

Collection/Vendor	Number of Titles	Percent of Collection	Use 1998/99	Use 6/1999 - 2/2000[1]
ACS Web Editions	32	1%	4,113	3,819[2]
Science Direct	1,017	21%	1,377[3]	25,540
OCLC ECO	57	1%	789[4]	946
Project Muse	100	2%	888	721
ProQuest[5]	1,000	20%	31,816	30,532
WilsonSelect	800	16%	4,079	11,748
Total	**3,006**	**61%**	**43,062**	**73,306**

[1]Use statistics reported for the first eight months of the current fiscal year - July 1999 through Feb. 2000.
[2]ACS Web Editions reports usage on a quarterly basis. This represents through end of December 1999.
[3]Drexel subscribed to Science Direct in mid-May 1999. Use data for 1998/99 is only available for June 1999.
[4]Incomplete data - OCLC cannot provide two months of use data for 1998/99.
[5]Reports full-text use data for ABI/Inform Global and PA Research II components of ProQuest.

Like cost per title, use cost analysis, based on subscription costs only, clearly shows substantially decreased costs per use (i.e., journal title or article accesses) over the print format. For our current print journal collection, the cost per use is approximately $5 on average. The range among titles is a few cents to hundreds of dollars for a few very expensive print titles. For electronic journals, we can analyze cost per use on a publisher by publisher level but not for all of our e-journal content because of the lack of complete usage information. However, we have experimented with the analysis of specific titles that do have complete use data to identify trends. In those individual instances, the electronic use is consistently higher than the print use ever was. The cost per use for e-journal titles based only on the number of articles accessed and the subscription costs for the specific vendor ranges from a low of $.54 to a high of $13.92 calculated on the basis of eight months' use data. The annual cost per use will be much lower. Interestingly, the vendor on the high end of the range is not *ScienceDirect* although our costs for the *ScienceDirect* service, our most expensive vendor, represent a sizable percentage of our total subscription budget. This method demonstrates that on a unit cost basis, electronic access is a very good value with our average cost per use

being approximately $2.22 per article over this eight-month period. Additionally, our proxy transaction logs, the only method we have of tracking title level use for most vendors,[8] show that our users are accessing a wide range of titles. We would have never been able to afford subscriptions to this same range of titles in print.

Photocopying

Since our statistics have decreased so dramatically for print journal usage, it is only logical that photocopier use would also decrease since this is one of the primary uses of our library photocopiers. Very poor photocopy machines, managed by an under-performing vendor, were replaced in the summer of 1998 at about the same time the electronic journals were introduced, by new machines managed by an excellent vendor who has service staff on-site. This improvement more than compensated for any immediate reduction in photocopying of print journals. We now have photocopy use statistics for a year and a half. They show that for the period from October 1999 through February 2000 photocopying on machines used by students dropped 20 percent below use in the same period the previous year. During this time period the Drexel student body and library use increased. Thus, the decrease in photocopying is evidence that our shift to the electronic format is having an impact on both costs and revenues from the copy machines.

Reserve

Circulation of reserve materials, which had been steady at about 30,000 items per year, dropped by 50 percent during the current academic year (1999/2000). Since we will not be implementing an electronic reserve system until this coming summer, this change is likely due to the availability of electronic resources. What portion of the e-resources used are electronic journals, and what are other e-resources is an open question. We do expect this trend to continue for the print reserve format, particularly when our full electronic reserve module is implemented later this year. It appears that not only are students using fewer reserve materials but our faculty are also placing 30 percent fewer items on reserve. With respect to staffing impact, we have reorganized part of the work assignments in this department due to the reduced workload. We expect that the skills of staffing this area will also need to be upgraded as we add a full-service electronic reserves service, particularly since faculty will require help scanning materials and preparing them for e-reserves.

Document Delivery/Interlibrary Loan (DD/ILL)

Our expectation with the implementation of electronic journals was that we would see a significant decrease in user requests for journal articles via our DD/ILL services. There is no evidence so far that this decrease in "borrowing" photocopies of journal articles is occurring. The library's document delivery service, which provides copies of articles from the Drexel Library collections free of charge to faculty and distant learners, will deliver about 1,000 articles from the electronic journal collection this year. The majority of these articles are for faculty who presumably are not aware of the ready accessibility of e-journals, or who either cannot or choose not to retrieve the articles themselves. At the moment, the net impact of the electronic journals seems to be negligible on both the

[8] These logs represent remote off-campus use only; we are exploring methods of analyzing our on-campus use as well.

staffing and the costs for the DD/ILL department. Some changes in procedures have been implemented over the past two years to support the process of providing copies of the electronic articles to faculty. Our prediction is that ultimately we will see a decrease in net requests for this service as our users become increasingly self-sufficient and as electronic content continues to expand.

Information Services (IS)

Reference services are nearly always affected by any significant change in content. At Drexel the Information Services/Reference staff are responsible for materials selection in addition to the usual functions of answering questions, teaching classes, and performing public relations functions such as promoting the availability of services. So they are involved in several stages of the “life cycle” of electronic journals at Drexel. They share responsibility for identifying candidates for purchase, evaluate potential purchases, help students and faculty use the e-journals effectively, incorporate information about them in their classes, and help publicize them to their constituencies.

Journal Selection

As mentioned earlier, the journal selection and renewal processes are now more time-consuming because so many more factors must be taken into consideration. Before annual renewals, we double-check all print titles for an electronic version, and check the quality and inclusiveness (e.g., for advertisements) of the e-journal. The IS librarians are responsible for collection development in specific subject areas for books, journals and reference materials in all formats. This includes microform and audiovisuals, although they are a minor part of the Drexel collection. The IS librarians serve as the "scouts" for new prospects along with the Electronic Resources Librarian who also provides assistance with interface, access and pricing issues and arranges trials if needed. Electronic journal content is sometimes available via a service, sometimes as an individual title and sometimes as a bundled title. The packaging has much to do with how this step of the evaluation occurs. The IS librarians then recommend whether or not to add the new material based on agreed-upon criteria previously discussed. The last step of the evaluation is review by an ad hoc committee consisting of the library's administration, the Head of IS, Electronic Resources Librarian and the IS librarians. Recommendations are prioritized and funding approved. For e-journal titles purchased on an individual basis, the process is somewhat different. The Associate Dean prioritizes outstanding requests based on feedback from the IS librarians and prioritizes the titles based upon all the criteria mentioned previously. Subscribing to everything that is relevant and available is as elusive a goal in the electronic world as the print; we have a "hold" queue for some very expensive titles.

Reference Service

Some interesting trends are occurring at the reference desk. Questions are decreasing by about 15 percent although it seems that some of the transactions that do occur turn into "teaching" opportunities for those users who are less self-sufficient. On the whole, statistics confirm staff observation that students, in particular, using the web-enabled computers in the "hub" near the reference desk, are relatively self-sufficient. Patrons dependent on a combination of text-based online resources and print, which was in place prior to the fall of 1998, required considerably more help even though there were fewer workstations available. In fact, when classes are in session, the 27 workstations located close to the reference desk are nearly always fully occupied. At some point in the next two years, we will most likely double the capacity of this area.

Instructional Program

Offsetting the decrease in reference questions is that the IS staff are spending more time on instruction and outreach activities to make faculty and students aware of the library's resources and services. Workshops and teaching sessions have increased. Vendor presentations are more frequent. IS librarians are engaging in greatly expanded public relations by personal visits and presentations, email updates to departments, exhibits and other activities. In March 2000, the library inaugurated a monthly online newsletter that routinely features articles about specific electronic services. Another effort that has also expanded is the preparation of both online and printed documentation to help users understand how to use electronic journals.

Staffing

The electronic journal option and new processes have most certainly increased the workload for selecting journals. We do expect that over time this increase will level off as the collections and offerings stabilize in the electronic environment. No new staff positions have been added in the IS department but there has been significant turnover and, again, we are carefully screening new hires for expanded computer skills and experience with using, selecting and promoting electronic resources. A lot of the increased journal evaluation work comes in the summer, a time when most of the other activities of the department are reduced. So, the department has been able to handle the additional work so far at current staff levels. If necessary, adjustments will be considered in the future.

Overall Cost of Staff Changes

In summary, the impact on our overall costs and staffing patterns has been significant. **Table 4** illustrates the shifts in staffing costs for each activity area where there has been an increase or decrease. The types of work performed and the tasks performed when electronic resources are added to academic collections, are consistent with a recent ARL analysis. [19]

Table 4. Total Annual Salary[1] Costs (1997/98 - 1999/2000)

Function	Capital and Development Costs	Net Difference in Operating Costs	Impact
Systems activities: infrastructure setup, software development, initiating access, and computer maintenance	$55,000	$35,000	significant increase
Management oversight, negotiation and license review	$40,000	$40,000	significant increase
Technical services check-in, binding, cataloging and maintaining e-journal database	None	-$13,000	decrease
Re-shelving, stack maintenance and collecting print use data	None	-$20,000	significant decrease
Content selection and evaluation	$10,000	$40,000	significant increase
TOTAL DIFFERENCE FROM PRINT to E-JOURNALS	**$105,000**	**$82,000**	**significant increase**

[1]Includes fringe benefits.

These costs were derived from allocating percentages of individual staff members' time to the various tasks and projects described in this paper. The amount of time was determined by interviewing staff and supervisors to analyze the impact for each area and by reviewing library statistics and other records. It is difficult to precisely establish the percentage for development costs so these estimates are our "best guess" for staff time contributed partly based on our overall collection ratios (the percentage of our collection comprised of e-journals) and on the other uses for our network, hardware and software.[9] The development time for software is more exact and easier to calculate since several of our projects, presenting the electronic journals to users and managing the selection process more effectively, were entirely e-journal related; thus 100 percent of the time spent on those efforts have been designated as startup costs.

V. Discussion

Drexel is probably farther along in the transition to an all electronic journal collection than most academic libraries in the United States. A late 1997/1998 survey of ARL and non-ARL academic libraries found that just 29 and 33.5 percent, respectively, had cancelled print journals in favor of electronic access in the previous 12 months. [20] Fifty-one percent of the ARL libraries and 40 percent of the non-ARL libraries had not cancelled print subscriptions in favor of electronic **and** declared that they will not in the future. Their reluctance was attributed to the enormous change required in academia to relinquish print.

[9] By observation of students' use of the workstations and laptop computers in the library, we know that a high percentage of their computer use is non-library related.

This description of the Drexel experience should be useful to others because our transition is indicative of what most academic libraries will eventually experience. There are accredited academic institutions that are functioning with completely digital libraries, i.e., they never had a print library. Examples are Jones International University [21] and the University of Phoenix. [22] Other libraries have created large electronic journal collections - e.g., the University of California system [23] and most, if not all, large research libraries - but they are **maintaining large print collections** concurrently. The approach Drexel is implementing - **substituting** electronic for print – will be the typical scenario in most academic libraries because it will be necessary to make electronic collections affordable.

Electronic journal migration at Drexel is in a transition phase that is likely to continue at the current level of activity for at least two more years. We are, to use a phrase common in the United Kingdom, a “hybrid” library, managing a combination of print and electronic resources concurrently. This compounds the usual difficulties encountered in teasing out the total cost of any library service. In this analysis we have tried to distinguish between start-up costs, as well as between fixed capital costs and ongoing operational costs. The additional expense of running the two systems simultaneously is particularly difficult to determine. Nevertheless, we have shown that there are substantial costs in maintaining an electronic journal collection that more than offset the savings from eliminating the clerical chores associated with maintaining a print journal collection. Our start-up costs are substantial, but that, in part, is because we decided to embark on the transition rapidly at such an early stage. Likely, as the electronic journal publishing industry and related service industries mature, the change process will become easier, and thereby less costly, for libraries.

In spite of similar missions and many common goals, every academic institution is unique and every academic library reflects the characteristics of its parent institution. At Drexel, the rapid electronic journal migration is occurring against a background of unusually rapid development in the university and within the library. In the past five years overall student enrollment has grown by 25 percent and the number of faculty has increased nearly 20 percent. After a period of budget cutbacks, a new library director was hired two years ago with a mandate to build a service-oriented, technologically advanced library. The overall library budget was increased by 50 percent. As a consequence the electronic journal migration is only one part of the library's transformation. In addition to the technology upgrades and web site development mentioned above, there have been many changes in the facility; the physical collections have been re-organized; and new staff have been recruited into all but one key professional position. All of these institutional factors, combined with the profound and growing influence of the Internet on information seeking habits of students and faculty, confound interpretation of changes in library statistics and use patterns. Thus, interpretation of observed changes in these numbers must be approached cautiously.

Factors, in addition to format that might influence journal use are the growth in the student body and faculty, higher use of the library overall, expanded public relations and teaching programs, and the introduction of many quality web-based abstracting and indexing databases. However, the article level use of electronic journals so far outstrips title level use of print journals that it is difficult **not** to conclude that the electronic format is making most of the difference. Moreover, it is not just electronic for print substitution that is increasing; the overall volume of use is much greater. Electronic use in the first eight months of this academic year for just the six collections listed above (61 percent of

the e-journals) is a third more than the use of the print collection in all of 1997/98, the year before e-journals were introduced.

Drexel's per title subscription costs are lower for electronic journals. While this is a function of our selection process and the particular "deals" we have been able to obtain, we suspect that the majority of academic libraries will have the same experience, particularly if they are able to purchase a large number of titles through aggregator collections. Even when the e-journals figure is "loaded" with the increased staff costs, it is much lower ($82/title) than the per title print journal cost ($149). Since use is much higher for e-journals the cost benefit is even greater. And, unless e-journal prices increase significantly, we can anticipate that as the number of titles available in this format grows, and use grows, so will the value in terms of cost.

E-journals have many added value features that justify their purchase even if they were about the same price as print. Probably the most important is that they are accessible anytime and anywhere a valid user has an Internet connection. But they also have the potential for taking advantage of the linking capabilities of the web: linking from A&I databases to the e-article and from an article's references to the full text of the associated article. E-articles can incorporate multi-media, link to background material, and point to related information automatically.

Clearly there are continuing challenges facing the Drexel Library's administration and staff as we proceed with this migration. Foremost, we must continue to re-organize and to re-train staff for some time. Staff represent the largest cost. Job skill and staff level needs are changing most rapidly now at the clerical and technician levels. One of the strategies we are employing to address this issue is to hire students, specifically masters students from Drexel's College of Information Science and Technology (IST), into these positions whenever possible. These students already come with most of the computer skills we need and have for the most part, a keen interest in the electronic content and the environment of our evolving library. These students benefit from free tuition and from the "real world" experience. The library benefits from the skills and maturity they bring to their jobs **and** from the fact that they graduate and leave for professional positions after two years. The planned turnover provides flexibility in our planning for possible staff reductions and frequent work re-assignments without the necessity of layoffs. We are certain to make continued adjustments in organizational structure as we progress toward a mostly electronic library.

Another major challenge is that the process of selecting and acquiring e-journals is extremely cumbersome. Since e-journal use appears to be much higher than print use, the cost per use of a print title may not predict an e-journal's value. But it is the still the best number we have. The additional evaluation factors peculiar to e-journals that must be considered, contract review, and weighing the "deals" from multiple sources for an e-journal further complicate this process. Serials vendors are not providing data for e-journals in the same fashion that they provide data about print journals (e.g., lists by country, subject, publisher for print journals). We are currently working with a subscription agent to simplify the acquisition process but this has been, and will continue to be, a long learning process for both of us.

Obtaining good use data is an additional problem area. Unfortunately, at this stage in the e-journal life cycle, comprehensive title-by-title use data is not available from many of our vendors. Some data comes in print, some via computer files, and some of it is

posted on vendor web sites. It is not reported in a standardized format. What are site accesses, title browses, article hits, page hits? Definitions are lacking. We prefer use data at the journal article level, in part because we think this is the most meaningful figure. It is also the best number for comparing to re-shelving statistics, the traditional measure of print use. Other problems have to do with comprehensiveness of the data, reliability and reporting periods. Some vendors will only provide the "top 10" or "top 20" journal titles which is clearly not useful for evaluating the entire collection or assessing use trends. Others seem to have routine "server crashes" and loss of data. Finally, some statistics are reported on the calendar year or quarterly basis or only at a gross level. All of these issues affect the customer's ability to determine whether or not the product is a good value and worth continuing. There is room for meaningful collaboration between librarians and vendors on these issues.

Improved methods for making the e-journals available via the web also has the potential for saving staff time costs. The availability of records in OCLC, persistent URLs for all titles, and more stable URLs, along with better ways of fixing them when they break, will all help. In the near term, we are planning to build a seamless interface between our journal database and new online catalog. This is another opportunity for library/vendor collaboration.

In summary, while the cost of providing access to electronic journals has increased our expenditures overall, unit costs have significantly decreased since we now provide a collection that is almost four times larger and far more heavily used. We know we are obtaining a better return on investment by migrating to e-journals, although at this early stage the magnitude of the gain cannot be calculated precisely. We plan to stay the course - to aggressively continue with our transition to electronic journals.

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