

The Costs of Providing Electronic Journal Access and Printed Copies of Journals to
University Users

Michael D. Cooper

School of Information Management and Systems
University of California
Berkeley, California 94720-4600

July 2003

Abstract

Six models are developed to analyze the cost options the University of California faces in providing access to academic journals. The driving force in this analysis is a movement by publishers to deliver the content of their journals via the Internet. Researchers like this capability because it provides speed and convenience, but they also recognize the importance of printed copies of journals. In the cost models, a number of alternatives are presented for how the University should manage the printed versions. These alternatives include the status quo, where libraries continue to receive, process, bind, and store the journals on their shelves. One variation is to store the bound volumes at a storage facility incurring a storage cost of \$0.33 per volume per year, about one-fourth that of a regular library facility (\$1.43). Another variation is to forgo the normal binding process, at a cost of \$12.87 per volume, and store the journals in pamphlet boxes (\$3.20), again, the cost is reduced by about one-fourth. Another variation is for the library to keep unbound copies of journals on their shelves for browsing and at some point discard them. This saves binding costs, processing costs, and the cost of the space to store the material. When materials are sent to a storage facility, libraries incur a cost of \$3.57 per volume to send them, and an additional cost of \$2.88 per volume to receive the volumes at the storage facility. If the University has journals sent directly from the publisher to a storage facility, the material never appears on the shelves of the local library, but likewise never incurs any processing costs at the local library. Each time a volume circulates from a library, the cost incurred is \$3.26. If the volume is circulated from a storage facility, the cost is \$4.70. Storage of materials at a storage facility is less expensive than at a local library but circulation costs are higher at the storage facility.

A major factor in these models is the cost of the journal subscription or the cost of providing electronic access to journal articles. The average cost of a printed subscription to an academic journal in 2002 was about \$745. The University of California's average cost is about \$200 more per title because of the specialized research nature of the institution. The total amount paid for journal subscriptions is shifting from payments for printed material to payments for electronic access. Right now the balance for a large sample of journal at the University is about 64%/36%, but this ratio is shifting daily in favor of higher costs for electronic access. Electronic access is a cost-effective alternative. If an electronic access fee is \$600 per journal title per year and if the title is used 75 times that year, the cost is \$8 per use. If the journal were used 200 times the cost would drop to \$3 per use. No matter which of the models is chosen, it seems very likely that electronic access will be provided, and that printed material will also be stored in the library or storage facility for the scholars who need that form of the material. This strategy coincides with the obligations of the university both to provide the most efficient form of access and also to provide and maintain copies of printed materials for future generations of scholars.

Journal Access and Storage Cost Models

Several cost models are explored in this paper. The first is a model that could be termed an *electronic library*. In the electronic library model, the library negotiates contracts with journal publishers to allow its users to have electronic access to journals. It catalogs the electronic resource, sets up a communications infrastructure to support access to the resource, and allows users access to the journals. No printed copies of journals are acquired, checked in, displayed, cataloged, bound, circulated, or stored.

The other models are variations on the electronic library concept. They all provide electronic access to journals, but in addition, they fulfill an important function of a major university library system—acquiring paper copies of journals to meet the long-term needs of scholars. These paper copies are checked in, displayed, circulated, and bound. After binding they are kept on local library shelves. In one variation of these models, the bound copies are not shelved in the local library but in a regional or campus storage facility.¹ In another variation the printed copies are kept for a while to facilitate browsing, then discarded.

All these models require that certain costs be determined in order for the models to be tested. Once the costs are known, they can be combined to form a picture of the overall cost structure of each alternative. The cost elements fall into several major categories. One is construction cost. Libraries and storage facilities do not materialize out of thin air. They cost money to build and to be outfitted with shelving and other furnishings. A second is acquisitions costs. Library materials such as books, journals, and electronic journal subscriptions must be purchased, and this cost is a significant component of the models. A third is processing costs. In addition to the cost of the “raw materials” of books and journals, libraries expend considerable labor in the process of purchasing the materials, receiving them once purchased, checking in each serial issue, cataloging journal (or serial) titles and books, and moving the materials to the library shelves. Finally, the library makes the materials available to the user by circulating them. There are significant library labor costs in this operation.

In a planning document leading to this cost study, Cooper (2000) enumerated a number of cost categories and cost elements that should be considered in comparing the cost of providing paper copies or providing electronic access to journals (see Table 1). Selection and acquisition costs include the costs of deciding whether to acquire the item, and negotiating and signing a contract for digital materials. Once the material arrives on a continuing basis, subscriptions need to be renewed. If the item is in the form of print material, and if the print material does not arrive when expected, it must be claimed. Digital materials that are not available when expected must also be claimed.

¹ In a library storage facility, materials may be stored by size so as to optimize the number of volumes that can fit in a given area.

Library processing costs include the cost of cataloging the item, receiving it, storing it, and binding it, if appropriate. Library circulation costs for print copies of material include retrieving the item from the stacks (if necessary), checking the item in and out to the user, and reshelving it. Library circulation costs for electronic copies of material may include the cost of authenticating the user as someone who is allowed access to the material and recording the electronic use of the item for verification of vendor billing charges.

Users also incur costs in circulating material, be they print or electronic items. These costs include finding the item in the catalog, retrieving the item from the shelves of the library or from an electronic database, checking the item in and out of the library, and making a copy of the retrieved item.

If the library stores print material at an off-campus or campus storage facility, it incurs costs of moving the material to that facility and circulating the material to the user from that facility. When materials are moved to the facility, they must be selected from the originating library for the move, physically transported to the facility, checked in at the storage facility, have their locator information changed in the local and/or union catalog, and shelved in the facility. When they are circulated to the user, the request for circulation must be processed at the facility, the item retrieved from the stacks, a photocopy made of the requested item or the volume transferred to the requesting library, and the item checked out, then in, at both the storage facility and the requesting library.

Table 1
Cost elements for comparing electronic and print journals

Cost element	Cost element is present for print journals	Cost element is present for electronic journals
Library selection/acquisition costs:		
Decide whether to acquire item	Y	Y
Negotiate contract	Y	Y
Write order/sign contract	Y	Y
Renew subscription	Y	Y
Claim issue	Y	Y
Library processing costs:		
Catalog title or revise existing cataloging	Y	Y
Receive issue	Y	N
Verify that electronic issue is accessible	N	Y
Update holdings information	Y	Y
Mark physical item with property stamp and call number	Y	N
Store issue on shelves	Y	N
Bind a series of issues	Y	N
User circulation costs:		
Search catalog for title	Y	Y
Retrieve volume from open stacks	Y	N
Check out item	Y	N
Make photocopy or print of item if needed	Y	Y
Return item to library	Y	N
Library circulation costs:		
Retrieve volume from closed stacks	Y	N
Issue authentication to allow user electronic access	N	Y
Check out item to user	Y	N
Record electronic journal item usage	N	Y
Check in item	Y	N
Reshelve item	Y	N

Table 1 – Part 2

Cost elements for comparing electronic and print journals

Cost element	Cost element is present for print journals	Cost element is present for electronic journals
User remote storage facility circulation costs:		
Request item be retrieved from storage facility	Y	N
Pick up item from library	Y	N
Check out item	Y	N
Make photocopy or print of item if needed	Y	Y
Return item to library	Y	N
Remote storage facility circulation costs:		
Transmit request for item to storage facility (library)	Y	N
Receive request and retrieve item from storage (storage facility)	Y	N
Photocopy or fax item (storage facility)	Y	N
Deliver item to requesting library (storage facility)	Y	N
Receive requested item (library)	Y	N
Check out item to user (library)	Y	N
Deliver item to storage facility (library)	Y	N
Check in item (storage facility)	Y	N
Reshelve item (storage facility)	Y	N
Remote storage facility transfer costs:		
Select item to be transferred to storage (library)	Y	N
Pick physical items to be transferred (library)	Y	N
Update holdings information in catalog (library)	Y	N
Transport items to storage facility (library)	Y	N
Check in items at storage facility (storage facility)	Y	N
Shelve items at storage facility (storage facility)	Y	N
Library storage costs:		
Cost per volume per year for storage of material	Y	N
Storage facility storage costs:		
Cost per volume per year for storage of material	Y	N

Source: Cooper (2000).

Limitations of the Models

The models that are presented here are approximations and are intended to provide guidelines for setting policy on how the University of California should provide access to both electronic versions of scholarly journals and printed copies of those journals (both current and past).

A number of cost elements have been omitted from this modeling because the data was extremely difficult to obtain, did not substantially improve the quality of the results, or was so subjective in nature that it would have required significant analysis to make it useful.

One type of cost that falls into the latter category is user time. In the broadest sense, the time that a user spends performing some library function should be considered when the library makes a decision about providing services. For example, Cooper (1989) analyzed the time the user spent in obtaining materials from each type of library facility. Cooper (1999) also assessed the amount of time a user would have to wait for the delivery of materials from a regional or campus storage facility. In the present study, user time is not considered.

Computer equipment and communications infrastructure costs fall into the category of those costs that are deemed extremely difficult to partition. For example, communications lines are used for many purposes besides accessing a database of bibliographic records or the text of journal articles. Since it would be almost impossible to divide costs between one activity and another, these costs are also omitted. Another reason that these costs are omitted is that they are *sunk*. That is, expenditures for them have already been made and cannot be revoked.

One factor that would have been extremely valuable to include in this analysis is the frequency of use of individual journal articles in an electronic format. However, the current state of computer transaction logs that record this information is poor. There is little consistency in the type of information about usage supplied by electronic journal publishers to libraries. There is some hope that this situation will improve, brought about by Project Counter (<http://www.projectcounter.org>), which is lobbying for better logging by publishers.

When a library arranges for access by its users to the electronic version of an academic journal, complex negotiations must take place. Currently there are very few set patterns for the contracts that result. Each contract that a large institution negotiates is individually handcrafted and labor intensive. While there may come a time when the negotiation process becomes routine, it is not yet so, and although its costs are significant, they are omitted from this study. They are also a sunk cost. Similarly, the costs associated with selecting which electronic journals to acquire are omitted because of the complexity of obtaining the data from an extremely decentralized university system.

Long Term Storage Issues

The collection of library materials in major academic libraries exists for the scholars of both today and tomorrow. The library provides access to current materials and stores the materials for future generations to use. Current materials can be viewed in printed form and, in many cases, in electronic form. If the materials are available electronically, what should the role of the university library be in obtaining, making available, retaining, and storing the printed version of the electronic resource? If the answer to this question is that the university library should store print versions of materials even though a digital representation exists, any economic analysis must consider this factor. Further, if a print version is to be stored, it can be made freely available like a normal item in a library, stored in such a way as to optimize the space it occupies and thus reduce its ability to be browsed by users, or stored in an archive under controlled environmental conditions. There is also the possibility that the item be considered a *copy of record*—the one printed copy of the journal that the library or library system retains as a backup for scholars even though there exists electronic versions of the journal.

Universities have reached a point where providing electronic journals to users is useful, available, and convenient. Nevertheless, although users find the electronic journals convenient, they recognize that they need print copies as well. In the case of a major university with a strong commitment to research, this need cannot be ignored. There is a continuing responsibility to make available print copies of materials.

Previous Research on Cost Models

The goal of this analysis is to examine the costs of providing users with access to both electronic and printed copies of journals. This goal is consistent with the objective of a major university library system, namely, to provide continuous access to both current and past issues of journals in the collection.

A number of models have been used to characterize one or both parts of this scenario. In a series of papers, Montgomery (2000), Montgomery and King (2002), and Montgomery and Sparks (2000) have proposed a methodology for comparing the cost to a library of maintaining electronic and print subscriptions to journals.² In their context, maintaining a storehouse of past printed publications is not necessary: “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”. (Montgomery and Sparks (2000), p. 5).

They defined a series of cost categories related to the selection, acquisition, technical processing, and circulation of electronic journals, and unbound and bound print copies of journals. These categories include the space required to house printed copies of journals and the space used by computer workstations for access to electronic journals, and the computer system infrastructure to supply access to electronic journals and to perform technical processing on print journals. The staff costs for journal management and processing were also considered. These costs were accumulated in terms of administrative activities; communications among staff; collection development; acquisitions; physical handling, including binding, labeling, and reshelving; record creation and maintenance; public relations; reference; teaching; and other.

For 22 weeks, library staff kept track of the time they spent on each of these tasks. Average salary costs for each job classification were applied to the time data to arrive at total costs for each activity, broken down by electronic journals, current journals (print copies of unbound issues), and bound journals. In addition, from the subscription costs and the number of uses of each title, the cost per use computed. Table 3 reproduces the cost per use information from Montgomery and King (2002).

²There appears to be some inconsistency in the numbers and costs reported in these three articles. It will be assumed that the Montgomery and King (2002) article contains the best information.

Table 3
Cost per use for journals

Journal type	Total cost for all subscriptions	Recorded uses	Subscription cost per use	Operational cost per use	Total cost per use
Electronic journals					
Individual subscriptions	\$73,000	23,000	\$3.20	\$0.45	\$4.00
Publisher's packages	304,000	134,000	2.25	0.45	3.00
Aggregator journals	27,000	20,000	1.35	0.45	2.00
Full text database journals	59,000	159,000	0.40	0.45	1.00
Total	462,000	335,000	1.40	0.45	2.00
Print journals					
Current journals	38,000	15,000	2.50	6.00	8.50
Bound journals	NA	8,800	NA	30.00	30.00
Total	38,000	24,000	2.50	15.00	17.50

Source: Montgomery and King (2002), Table 4. See original text for complete description of methodology and notes to table. The authors indicate that the values in the last three columns in the table have been rounded.

The table shows that the total cost per use for all types of electronic journals is \$2.00, while the cost per use for print journals is \$17.50. Obviously there are numerous qualifications to the methodology and to the data that must be made, but this is still a significant difference. Providing electronic rather than print copies of journal articles can result in considerable cost savings for libraries.

Using a different methodological approach, Cooper (1989, 1991) has examined a related problem—determining the most economic approach to storing library materials in a large university system, specifically the University of California’s San Diego (UCSD) campus. Cooper examined the costs of storing materials in on campus library facilities versus regional library facilities. The methodology used in that study has relevance here: The unit costs of the tasks involved in selecting, acquiring, processing, circulating, and storing library materials were computed by measuring the time required to perform the tasks and then using average salary costs to compute the unit costs of the tasks. The alternatives examined in that study are also relevant here because the proposed solutions to the current problem involve different locations for storing materials.

Table 4 summarizes the results of the cost analysis in terms of unit costs per volume. The goal was to compare the costs when materials were stored in an open-stack library, when materials were stored on compact shelving in an open-stack library, when they were stored on compact shelving in a storage facility on a university campus, and when they were stored in a regional storage facility. The costs were broken down into three major categories: the cost to build a library facility; the cost to select, process, and transport material to the designated library facility; and the cost of circulating materials from the facility. The table shows that construction cost per volume for a new open-stack library facility was about \$26, while the same cost for a regional library facility was \$4.55. To circulate an item from a local open-stack library costs \$0.87 and from a regional storage facility \$15.32. About half of the cost of circulating an item from a regional facility at the time of the study was attributable to the cost of moving the item from the regional facility to the local library. Since then, as we shall see, this cost has been reduced substantially. Nevertheless, circulating an item from a regional facility incurs additional costs because the facility is designed to store items in the most compact manner, not provide access to them in the most efficient way.

The user circulation costs represent the cost of the user's time to complete the necessary formalities to obtain the item. This includes locating the item in a catalog, retrieving it from the open or compact stacks, or requesting it from a storage facility.

Table 4
 Cost comparison of alternative book storage strategies for the
 University of California, San Diego

Cost category	Store materials in open-stack shelving on campus	Store materials in compact open-stack shelving on campus	Store materials at a storage facility located on campus	Store materials at a regional storage facility
Construction cost	\$25.93	\$4.55	\$7.09	\$4.55
Selection, processing, and transportation costs:				
Select material to be transferred to storage		\$0.28	\$0.28	\$0.93
Process material at local library before transfer to storage facility		\$1.06	\$1.06	\$2.14
Transportation costs to storage:				
Movement of item within local library		\$0.31	\$0.31	\$0.31
Transportation to storage facility		\$0.005	\$0.005	\$0.18
Process material at storage facility		\$0.15	\$0.15	\$1.64
Subtotal		\$1.80	\$1.80	\$5.21
Circulation costs				
User cost	\$2.65	\$2.65	\$1.64	\$1.64
Staff cost	\$0.87	\$0.87	\$5.21	\$15.32

Source: Cooper (1989), Table 7. Values in the table are in dollars per volume and have been adjusted for inflation to the year 2001 using the inflation index in Appendix A.

In another study, Cooper (1999) analyzed six options available to the U.S. National Library of Medicine (NLM) for additional storage space to meet the growth in their collection, compared with the costs of operating the existing library facility. Table 5 summarizes the results.

Construction costs to store a volume have a low of \$1.48 for aboveground storage adjacent to the library where construction costs are minimal. When the library moves a storage facility off the National Institutes of Health campus, the construction costs rise to \$2.86, and when an underground storage facility is built adjacent to the existing NLM building, the cost rises to \$3.63. The cost of processing materials to be moved to a new facility and moving the materials to the new facility are constant across alternatives (\$2.23 per volume), except when the facility is off campus (\$2.96 per volume).

Circulation costs vary with the type of facility constructed because of differences in retrieval times, because of differences in the type of shelving used, and because of the differences in distances traveled to retrieve the item. In the existing library, the circulation cost is \$3.26 per volume. For the on campus alternatives, the costs range from \$3.65 to \$4.24 per volume. When a volume is retrieved from an off campus site, the cost is \$10.54 to \$10.68 per volume.

In some cases a viable alternative to physical delivery of the material is to scan an article and deliver the scanned item rather than a bound volume. This has the advantage of reducing wear on the physical volume and expediting the request. The scanned item can be transmitted electronically to the requesting library or the requestor if desired. The scanning cost per article was estimated at \$3.10 when done within an NLM facility, and \$5.00 at a contractor site.

Table 5

Construction, processing, and circulation cost summary of library book storage options at the U.S. National Library of Medicine

	Existing library facility with standard shelving	Remodel adjacent building for compact electrical shelving	Build underground storage facility adjacent to existing library with high density shelving	Build multi-use building with compact electrical shelving in basement stack space	Build above-ground library storage facility on adjacent land with high-density shelving	Build a storage facility on land away from the library and use high-density shelving	Contract with a region-wide government agency to build and operate a storage facility on their land with high-density shelving
Construction cost or remodel cost per volume	NA	\$5.96	\$3.63	\$7.55	\$1.48	\$2.86	\$8.89
Processing cost per volume		\$2.23	\$2.23	\$2.23	\$2.23	\$2.96	\$3.51
Total construction and processing cost per volume		\$8.19	\$5.87	\$9.78	\$3.71	\$5.81	\$12.41
Alternative circulation costs per volume							
Deliver physical volume	\$3.26	\$3.65	\$4.24	\$3.75	\$4.24	\$10.54	\$10.68
Deliver scanned copy						\$3.10	\$5.00

Source: Cooper (1999), Table 12, p. 31. Numbers in original table have been adjusted for inflation to 2001-2002 using the inflation index in Appendix A.

Construction Costs

The analysis that will be presented later in this paper relies on many individual costs for its conclusions as is evident from the listing in Table 1. The major categories of costs that will be examined include construction costs for new library facilities, the cost of journal subscriptions, costs for processing materials at a local library, costs for processing materials at storage facilities, and the costs of circulating materials from local and storage facilities.

Libraries have two major alternatives for storing materials: in a library on the university campus or in a storage facility off campus. There are variations on these alternatives, for example, by the type of shelving that is used: regular shelving that holds about 12.5 bound volumes of material per assignable square foot (ASF) of space and compact shelving that holds about 38.6 volumes per ASF.³

Cooper's (1989) construction cost figures (adjusted for inflation) show that the cost per volume for the construction of a new open-stack facility is \$25.93, and of a new regional storage facility \$4.55. Four construction cost alternatives examined by Cooper (1999) for the U.S. National Library of Medicine (NLM) are relevant here (see Table 5). Construction of a new underground storage facility with high-density shelving was calculated at \$3.63 per volume. Construction of an aboveground storage facility on campus with high-density shelving was \$1.48, and construction of an off-site storage facility with high-density shelving was \$2.86.

As of the middle of 2002, The University of California had eight library construction projects on multiple University campuses in various stages of development. Some had just gotten underway, and some were far enough along to have firm construction costs established. For the on campus library projects, the average project cost per assignable square foot was \$447 for a complete library facility, or \$35.76 per volume. For the one regional storage facility under construction, the cost was \$318 per ASF or \$8.24 per volume.⁴ Unlike previous regional storage facilities where there was one concrete floor and upon that were built a series of stack levels, this facility consists of a series of concrete floors that will house shelving. This difference in construction form could account for the difference in construction cost between this figure and the other estimates.

Although the construction costs for the library facilities given in Cooper (1989) and Cooper

³ These values are standards that are used by the University of California in its library planning activities.

⁴ The costs per ASF in this paragraph were supplied by the University of California Office of the President, Office of Facilities Planning and Office of the Director of Design and Construction Services. These costs do not include the cost of land on which to build the facility, the costs to utility companies to make their utilities available at the site (if necessary), nor equipment costs. They do include shelving costs. Although some of the costs used in these calculations are taken from planning cost documents, final construction costs for these projects are generally very close to the planned costs.

(1999) are relevant to this analysis, the current construction costs from the University of California will be used for future calculations. There has been a rapid escalation in construction costs in the last few years, and it may not be accurate simply to extrapolate costs using inflation adjustment or construction price adjustments from values in previous years or from other locations.

The costs of \$35.76 per volume for on campus library construction and \$8.24 for regional library construction must be adjusted to arrive at a cost per volume per year for storage. Generally accepted accounting principles recommend that the life of a building be in the range of 25-30 years. For these calculations, the buildings will be assumed to have a useful life of 25 years. Thus the cost of storing a volume in a library facility per year is $\$35.76/25$ or \$1.43, while the cost of storing a volume in a storage facility is $\$8.24/25$ or \$0.33 per year.

Journal Prices

One of the most difficult aspects of this analysis is to determine the subscription costs that the University will pay for printed copies of journals and computer access to the electronic form of academic journals. For almost as long as libraries have existed, subscriptions were straightforward. If a library wanted to subscribe to a journal, they paid an annual fee and received the issues of the journal for that year. In the last few years, the paradigm has changed. Libraries now pay for printed copies of the journals and for the rights of their users to have access to the electronic form of the journal through the Internet. But this payment paradigm is likely to shift even further. As mentioned earlier, many publishers recognize that the future pattern of use of their journals will be dominated by electronic access rather than print access, and as a consequence, they are changing their pricing policies. The price the library will pay in the future is likely to be for electronic access and the printed version of the journal will be available only at an additional cost.

This situation is significant because it has a major impact on the present cost analysis. One factor in modeling the trade-off between the uses of electronic journals versus printed copies of journals, and the subsequent storing of printed copies, is the cost to the university of the electronic access or the print subscription itself. There is no stability in electronic access fees or subscription changes at the moment (2002). Without price stability, it is difficult to arrive at a trade-off analysis that will have any lasting applicability.

To give an idea of this instability, it is useful to review today's pricing strategies by some of the major publishers. One model that can be used to analyze publishers prices divides them into three categories: a price for creating the original content of the journal, a price for providing electronic access to the journal's content, and a price for providing a printed copy of the journal. The first category will be termed a *content fee*, the second an *electronic access fee*, and the third a *journal subscription fee*.⁵

Libraries have been subscribing to printed copies of journals forever. But they are currently migrating from only providing printed copies of their journals to their users to providing printed and electronic copies, to possibly providing only electronic access. Publishers recognize this situation and some have placed restrictions on the number of print copies that can be cancelled without having to renegotiate the contract. Since a publisher needs to recover the cost of a lost print subscription to a journal when it is forfeited in favor of electronic access, the contract rules take into account the extent to which the library will pay for this action.

Another aspect to the pricing situation is a corollary of the cancellation-pricing problem. A major university, such as the University of California, may wish to provide electronic access

⁵ These terms are the author's own and do not reflect any common usage by libraries or publishers.

to journals and continue to provide printed copies of the journals, but it may wish to reduce the number of subscriptions to certain journal titles. This decision may come about as a cost-saving measure, or in recognition of the dominance of the use of electronic access to journal articles over paper copies, or to implement the *last copy* strategy discussed earlier. No matter what the reason, publishers have complex pricing arrangements that adjust both the electronic access fee and the journal subscription fee under this situation.

With these factors in mind, let's examine the present situation. As of mid-2002, the University of California's campuses paid an average of about \$952 for a subscription to one printed journal title per year and paid an average of \$530 for electronic access to one journal title per year. Roughly 64% of the total expenditure was for printed copies of journals and 36% for electronic access to those same journals.⁶ The average subscription price computed from Van Orsdel and Born (2002) in Table 2 was \$745. Given the University's strong research emphasis, it is not surprising to find its average above that of Van Orsdel and Born. The University purchases almost all of the most specialized journals that are published, and these publications are priced accordingly.

⁶ These numbers should be considered very rough approximations of publisher prices that were in flux at the time of the study, for publishers in the CMI study, and were arrived at by considerable subjective judgment.

Processing Costs

Most of the models in this cost analysis assume that library journals will be received at the local library and then shipped and stored at a regional or campus storage facility. The major tasks performed by the local library include selecting material that will be transferred to the storage facility, processing materials at a local library facility before they are transferred to storage, and then transporting them to the storage facility. Once materials reach the storage facility, additional processing takes place—for example, receiving the materials from the local library, updating bibliographic information, and shelving the items in compact storage at the facility.

As part of the current study, an extensive investigation took place to accurately assess local library processing costs and other costs. Data was collected from nine University of California campus libraries and two storage facilities, the Northern Regional Library Facility (NRLF) located in Richmond, California, and the Southern Regional Library Facility (SRLF) located in Los Angeles. Library and storage facility staff was supplied with a list of tasks for which the time spent and the number of units processed was recorded. These tasks include both library and storage facility processing and bibliographic control activities. Average salary costs by job title were used to compute total costs and then unit costs. The costs from the nine campuses were summarized, as were the costs from the two storage facilities.

The unit costs that were derived from the study were expressed in two different units, number of volumes of books or periodicals processed or number of titles processed. For this study and for related research into library stack space utilization, it was necessary to have a common set of units. A study was undertaken to measure the amount of shelf space used by a random sample of periodical titles. This study found that the average number of bound volumes in a serial title run for all the serial titles sampled on the University of California campuses was 32.4. This number is relatively high because of the extensive research holdings the University maintains. Appendix B gives some of the major measures that were derived from the study.

Table 6 summarizes the processing costs incurred by local libraries in preparing material to be sent to a storage facility. These costs were determined by the CMI study that only surveyed printed journals for which an electronic version of the journal was available. This is not a random sample, but one that focuses on a specific category of materials.

The table shows that the cost to select material to be transferred to a storage facility is \$8.89 per title, or \$2.26 per volume.⁷ Processing costs include preparing titles for transfer, removing volumes from the shelves in anticipation of their movement to the facility and labeling them, modifying the bibliographic records that represent the physical item, and

⁷ The conversion from titles to volumes uses the data in Appendix B.

packing the material for shipment to the facility. These costs total \$0.71 per volume. The University currently contracts with a vendor to move materials from local libraries to storage facilities at a current average cost of \$0.60 per volume irrespective of the originating or receiving library. The total selection, processing, and transportation cost is \$3.57 per volume.

The costs per volume for selection, local processing, and transportation from Cooper's (1989) University of California San Diego study are \$0.93, \$2.14, and \$0.31 respectively.⁸ This totals \$3.38, which is quite similar to the \$3.57 derived in the current CMI study. In Cooper's study for the National Library of Medicine (1999) he found selection costs of 0.59, processing costs of \$1.37, and transportation costs of \$0.56, for a total of \$2.52.⁹

A second category of costs occurs the first time material is sent to a storage facility. Based on a cost analysis prepared in 1991 and adjusted for inflation using the index in Appendix A, it is estimated that the cost of receiving and processing a volume for storage in a University of California storage facility collection is \$2.45.¹⁰ And the labor cost for shelving a volume at the same facility is estimated at \$0.43. Cooper (1989) estimated the processing and shelving cost at \$1.64. Cooper's NLM study (1999) found regional library processing costs to be \$0.56 (2001 dollars) when NLM ran the facility and \$1.11 when a contractor ran the facility.¹¹ A comparison of these processing costs is given in Table 7.

Journal issues that are held at a local library or sent to a library facility may be left as individual items or may instead be bound. Two types of binding are possible, full Buckram binding of the issues, estimated to cost \$12.87 per volume, or placing the items in pamphlet file boxes (at a cost of \$3.20 per volume).¹²

⁸ These numbers have been adjusted for inflation.

⁹ See Cooper (1999), Table 4, p. 15. The original 1999 figures were \$0.53, \$1.13, and \$0.50, respectively. The numbers in the text have been adjusted to 2001 values.

¹⁰ See University of California Office of the President. Office of Library Affairs (1991). *Uniform Fee Schedule and Model for UC Regional Library Facilities*.

¹¹ The original values before adjusting for inflation were \$0.50 and \$1.00, respectively.

¹² The University of California Bindery in Richmond, California, supplied the costs of binding. Pamphlet files are purchased in bulk in various sizes. The cost of pamphlet binding is the average of the cost of the two most-used file sizes.

Table 6

Cost to select and process materials for shipment to a storage facility

Cost category	Cost per title	Cost per volume
Select materials		
Select materials for transfer to a storage facility	\$8.89	\$2.26
Process materials		
Staff preparation of titles	\$0.52	\$0.13
Pull volumes and affix labeling		\$0.21
Size volumes		\$0.02
Prepare for record updates; print records	\$0.18	\$0.05
Revise pulled material; place searches and holds		\$0.16
Pack and secure trucks		\$0.02
Refile forms or documentation	\$0.05	\$0.01
Update records	\$0.43	\$0.11
Total processing		\$0.71
Total transportation		\$0.60
Total selection, processing, and transportation		\$3.57

Source: University of California Office of the President, Office of Library Planning and Policy Development. Collection Management Initiative cost study, 2001-2002.

Notes: Some values were originally computed in terms of cost per title and some in cost per volume. Where there is a parallel entry in a row with two figures, the original value was computed as a cost per title and was converted using the values in Appendix B to give the cost per volume. Where there are no entries in the “cost per title” column, the value was originally computed as a cost per volume.

Table 7

Summary of processing costs for moving materials to a storage facility

Cost category	CMI cost study	Cooper UCSD study (1989)	Cooper NLM study (2000)
Select materials for transfer to a storage facility	\$2.26	\$0.93	\$0.59
Process materials for transfer to a storage facility	\$0.71	\$2.14	\$1.37
Transport materials to the storage facility	\$0.6	\$0.31	\$0.56
Subtotal	\$3.57	\$3.38	\$2.52
Process materials at the storage facility	\$2.88	\$1.64	\$0.83
Total	\$6.45	\$5.02	\$3.35

Note: The values from 1989 and 2000 have been adjusted for inflation.

Storage Facility Circulation Costs

The final category of costs encompasses those related to supplying materials to the user from a storage facility—circulation costs. There are two methods of delivery. The first is delivery of the physical material, usually a bound volume. The bound volume is usually delivered by transporting it to the library closest to the requestor, and having the user come to the library and pick the item up.¹³ The second is delivery of a reproduction of the requested material, such as a photocopy. The reproduction can be delivered the same way the bound volume is, by shipping it to the closest library. But it can also be faxed to the user or transmitted via email.

The Collection Management Initiative cost study analyzed the costs of providing a physical volume from a storage facility to a user at a requesting library. Table 8 summarizes the results of the analysis. The cost per volume to process a user's request for material stored at a storage facility was \$1.28, while the cost to receive the item shipped from the storage facility to the local library was \$1.75. Once the user was finished with the item and returned it to the local library, the cost to receive it and return it to the storage facility was \$0.47. Those costs total \$3.50. Two trips of \$0.60 per volume add \$1.20 in transportation costs, making the total cost of circulating the volume from the storage facility \$4.70 per volume. Table 8 also summarizes the results from Cooper (1989). Although the cost categories are different, the process being described is the same. The total from this study came to \$3.93.

In Cooper's (1999) NLM study, he found a circulation cost of \$10.54 from an off campus storage facility.¹⁴ This cost included the cost of selecting the item from the shelves of the facility, transporting it to the library, circulating it to the user, discharging it from the user, transporting it back to the storage facility, and reshelving it at the facility. Transportation costs are a large proportion of the total (\$7.23 in 2001 dollars). If this is subtracted from the total, then circulation costs are \$3.31—not dissimilar from the other amounts in Table 8.

The costs of the second form of circulation, delivering a reproduction of the item to the user from the storage facility, were computed using the Uniform Fee Schedule estimates prepared by the University of California Office of the President Office of Library Affairs (1991). These estimates were adjusted for inflation to the year 2001. A cost of \$3.94 for each reproduction circulated to a user was established. In Cooper (1999) the cost of this type of circulation at the National Library of Medicine was found to be \$3.10 (adjusted to 2001), while a contractor was willing to offer the service at \$5.00 per request.¹⁵

¹³ There is a small amount of use of a regional library facility collection by users who come to the facility itself. There is not an appreciable difference in cost of this activity versus the normal delivery service to warrant segregating its costs from the others.

¹⁴ See Cooper (1999), Table 8, p. 22. The total cost in 1999 was \$9.48.

¹⁵ See Cooper (1999), Table 8, p. 22.

Table 8

Two estimates of the cost of circulating materials from a University of California Regional Storage Facility

CMI Cost Study cost estimates for circulating materials from a storage facility	
Cost category	Cost per volume
Process user request for materials stored at Regional Library Facility	\$1.28
Receive item from Regional Library Facility and circulate item to user	\$1.75
Receive item from user and return item to Regional Library Facility	\$0.47
Total	\$3.50

Cooper (1989) cost estimates for circulating materials from a regional storage facility	
Cost category	Cost per volume
Verify that item is in regional storage and place request for it	\$1.96
Retrieve item from hold shelf and charge item out to user	\$0.98
Clear item from circulation file at library and return it to regional storage facility	\$0.98
Total	\$3.93

Notes: The estimates in the lower table have been adjusted for inflation to the year 2001 using the index in Appendix A. Although the categories in the two tables are slightly different, each table fully encompasses the circulation activity.

Summary of the Cost Models and Unit Costs

The previous sections have summarized the literature and the cost data available for analysis. This section restates the cost models and synthesizes the cost data. The following section will present a comparative analysis of the costs of each approach.

Six different cost models for the provision of journal content to users are analyzed. The first is to provide users with electronic access to journals but not to subscribe to printed copies of those journals. The second through sixth models all assume that the library will subscribe to the printed version of the journal. The costs presented in the first model will always be incurred. That is, the library will provide electronic access to journals. The library needs to choose which of the second through sixth models are appropriate. To obtain the total cost of providing electronic and printed access to a collection of journals, one adds the cost from Model 1 to one of the costs from Models 2 through 6.

Because prices of electronic and print subscriptions are difficult to predict, the simulations of the models try to compensate for the major fluctuations expected in average serial prices. In the cost models, a number of assumptions are made about the prices of subscriptions paid by the university.

Model Summary:

Model 1: Users have access to the electronic copies of journals through their browser software and the Internet. When printed copies are needed, they can be obtained from the local library or from the storage facility. The cost of acquiring, processing, or storing the printed copy of the journal is not included in this model. The only cost included in this model is the electronic access fee for the journal.

Model 2: The local library continues to maintain its subscription to the printed copy of the journal and displays the current issues on its shelves for browsing. But after a normal period of time the library removes the individual issues from the browse shelves, binds them in Buckram for storage, and sends them to its stacks.

Model 3: A variation on Model 2 is the third model, where instead of the local library sending the Buckram-bound volume to its stacks, it sends the volume to a storage facility.

Model 4: The local library keeps the printed copy of the journal available for browsing for a certain amount of time and then discards it. This is done on the theory that the value of the printed copies is for browsing, and once a sufficient amount of time has elapsed, electronic form can substitute for a print copy from a storage facility. In this model there are no construction costs for either a local library or a storage facility. There are costs to the library of updating its records when it discards the materials.

Model 5: The fifth model assumes that the local library will make current copies of the journals available for some period of time, and then they will send unbound issues to the storage facility, where the issues will be stored in pamphlet boxes.

Model 6: If it is assumed that most user requirements for current journal articles can be met by electronic access, printed copies of the journals can be sent directly from the publisher to the storage facility, bypassing the local library. Model 6 presents that scenario. In the model there are construction costs for a storage facility and there are processing costs incurred when the storage facility receives the materials. But there are no costs to local libraries of handling the materials.

In Models 2 through 5 one factor is constant. No construction costs are included for the library space occupied by journals when they are displayed for browsing. If printed copies of journals are removed, the space they currently occupied will be filled with other journals.

These models are summarized in Table 9. The first four rows of the table describe the characteristics of each model. Thus in the column labeled Model 1, the method of access to the journal content is only electronic. In Model 2 the printed copies are retained at the local library initially and remain there. Finally the issues are bound in Buckram. In Model 4 the library retains printed copies of the journals for a while, then discards them.

Following the description of each model in the table are a series of rows with the unit costs associated with that model. For example, for Model 1, the only cost element is the access fee the library pays to the publisher so that its users may view the content of the journals with their browser software. In Model 5, the library must house bound copies of the journals in a storage facility at \$0.33 per volume per year. It must pay subscription costs of \$952 per title per year, it must select material to be sent from the local library to the storage facility at \$2.26 per volume, it must process the materials at the storage facility at \$0.71, per volume and it must transport the material from the local library to the storage facility at \$0.60 per volume. At the storage facility, each volume must be processed at a cost of \$2.88 per volume. When a user at the local library requests a volume or an issue from the storage facility, the cost to the library is \$4.70, if a reproduction is supplied, the cost is \$3.94 per article. In Model 6 material is shipped directly from the publisher to the storage facility so there is only construction costs for the storage facility (\$0.33 per volume) and processing costs at that facility (\$2.87).

The costs in Table 9 are a synthesis of the data presented earlier in this paper. They are derived from estimates taken from the Collection Management Initiative study with two exceptions. Construction costs come from the University of California Office of the President's unit responsible for construction activities, and the circulation costs from a local library come from Cooper (1999).

The table shows the significant cost savings that can be achieved by storing a single volume at a storage facility—\$0.33 versus \$1.43 per volume per year. It also shows the cost savings of storing materials in pamphlet boxes rather than binding volumes. The difference here is \$9.67 per volume. Depending on the way the materials are handled, local library or storage facility processing costs are incurred or avoided. The full cost of moving materials from a local library to a storage facility is \$3.57 per volume, while the cost of processing material at a storage facility is \$2.88 per volume.

When all these factors are cumulated, the variation in the fixed costs gives one good measure to evaluate the alternatives. When electronic resources are used, there are no fixed costs for the University. Aside from that, the least fixed costs are incurred in Model 4 (\$2.97) because the material is discarded after some period of time and there are neither construction nor binding costs. The third least expensive fixed-cost option is Model 6 (\$16.75). Here materials are kept in the storage facility but are shipped directly from the publisher to the facility, thus bypassing some processing and transportation costs. In this model the materials are stored in pamphlet boxes that reduce costs substantially. Model 4 has the lowest fixed cost, but there is no copy of record maintained. If the University wishes to maintain a copy of record, the lowest fixed cost alternative comes in Model 6.

Model 5 has a fixed cost of \$20.32. The fixed-cost difference comes from the fact that the material spends some time in a local library before being sent to the storage facility. The \$3.57 difference is processing costs. Model 2 has a fixed cost of \$56.20 and Model 3 has \$58.33. In each of these cases it is either the binding costs, or the processing costs, or both costs that make the models especially expensive compared to the alternatives.

Table 9

Summary of unit costs for electronic access and print access to journal articles

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Method of access to journal content	Electronic access only	Print access only	Print access only	Print access only	Print access only	Print access only
Initial status of printed copies of journals	NA	Retain at local library	Retain at local library	Retain at local library	Retain at local library	(See box below)
Final status of printed copies of journals	NA	Retain at local library	Move to storage facility	Discard after defined period	Move to storage facility	Sent directly from publisher to storage facility
Binding status of printed copies of journals	NA	Bind issues in Buckram	Bind issues in Buckram	NA	Store issues in pamphlet boxes	Store issues in pamphlet boxes
Construction cost per volume per year						
On campus library facility with regular shelving		\$1.43				
Storage facility with compact shelving			\$0.33		\$0.33	\$0.33
Cost of selecting materials for acquisition	NC	NC	NC	NC	NC	NC
Journal subscription costs per title per year						
Electronic access fee	\$530					
Printed copy of journal		\$952	\$952	\$952	\$952	\$952
Processing costs to move a volume to a storage facility or to discard it						
Select material to be sent to storage			\$2.26	\$2.26	\$2.26	
Process materials for transfer to storage			\$0.71	\$0.71	\$0.71	
Transport materials to storage			\$0.60		\$0.60	
Binding costs per volume		\$12.87	\$12.87		\$3.20	\$3.20

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Processing costs per volume at the storage facility			\$2.88		\$2.88	\$2.88
Total fixed costs (excluding electronic access fee/journal subscription cost)	\$0.00	\$56.20	\$58.33	\$2.97	\$20.32	\$16.75
Circulation costs per issue or volume						
Circulation from a local library		\$3.26	\$3.26	\$3.26	\$3.26	
Circulation from a storage facility			\$4.70		\$4.70	\$4.70
Supply a reproduction of the journal article to the user from a storage facility			\$3.94		\$3.94	\$3.94

Notes: The numbers in this table are derived from many sources and are described in the text. The fixed cost total is not simply a sum of the fixed costs, since certain conversion factors apply. NC=Not Collected. NA=Not Applicable.

Simulation Analysis

In this cost analysis of alternative delivery approaches for journal content, there are two important variables whose values are difficult to be able to state with any certainty:

- (1) The electronic access fee and subscription cost to a journal, and
- (2) The number of times an electronic or print copy of a journal will be used in a year.

In order to complete the comparative analysis of the alternatives described in Table 9, a simulation approach was taken. In this approach, the electronic access fee and subscription cost were systematically varied, as was the number of uses per year, to see the effect on the average cost per circulation of an item.

The overall strategy in the analysis is to compute an average cost per circulation or average cost per electronic access. The first step is to compute the total cost for each circulation. This is the fixed costs plus the variable costs. The variable costs change as the number of times the item is circulated changes. Variable costs are unit costs, so for each unit of circulation, the variable costs are multiplied by the number of times the item is circulated. The average cost is the total cost divided by the number of units of circulation. In computing the average cost, the number of units of circulation enters the equation twice, once as a multiplier of the variable costs and once as a divisor for the total cost.

The fixed costs do not vary as the number of uses of a volume changes. Examples of fixed costs are construction costs, where for a given year it costs a fixed amount of money to provide space to store the volume, irrespective of the number of times it is used. Another fixed cost that occurs in some models is the cost of selecting materials to be sent to a storage facility. This cost occurs once when the item is sent for the first time and does not recur. Still another fixed cost is the cost of binding the material.

The second category of costs is variable. They vary depending on the number of times the volume is circulated, or the number of electronic accesses that are made to the database. For printed volumes, the variable costs are simply the unit costs of circulating the item. For electronic journals, there are no variable costs because the cost of providing electronic access (the communications infrastructure) is not considered in this analysis. This infrastructure is so multipurpose that it would be nearly impossible to distinguish its use for one activity versus another.

For the simulation analysis, it was assumed that both the electronic access fees and print subscription fees vary. For the electronic access fee, values of \$500, \$600, and \$700 per year were chosen for analysis. For print subscription fees values of from \$900 to \$1000 per year were selected. These values correspond to the average fee (\$530) and subscription costs (\$952) in the CMI sample. In addition, it was assumed that the number of electronic accesses varies from 20 to 75 per year, and the number of circulations of the printed copies varies from

1 to 20 per year. The reason for the disparity in the assumptions about usage is that it is much more likely that the electronic version will receive high usage because of the manner of its availability. Materials that are selected and sent to a storage facility are low use items.

Figure 2 shows how the average cost of electronic access varies for three different access fees of \$500, \$600, and \$700 per year. When there are 20 accesses, the average cost of an access is \$25, \$30, and \$35 per access respectively. Since there are no other fixed or variable costs accounted for in the model aside from the access fee, these figures are derived by dividing the number of accesses by the yearly fee. As the number of uses per year rises into the range of 50-75, the average cost per use begins to flatten. For a \$500 fee, it ranges from \$7 to \$9 per use. For a \$700 fee, the range is \$9 to \$13. It seems highly likely that the number of electronic accesses to a journal title will greatly exceed 20 per year given the size of the University community composed of more than 100,000 students, staff, and faculty. If this is the case, the cost per use will be even lower.

All the proposed solutions that the University of California is considering for providing access to scholarly journals include insuring electronic availability as well as some form of access to the printed version of the material. Thus the costs in Model 1—the model that provides electronic access alone—will always be incurred. The costs of one of the other five options will be additional.

Table 10 shows the average cost per use for two alternative subscription costs for each of Models 2 through 6. The subscription fees modeled are \$900 and \$1000 per journal per year. The calculations of average cost per circulation are given for 1 to 20 uses.

The simulation results do not show a significant difference in the cost of storing materials between any of Models 2 through 6. For example, at 10 uses per volume and a \$900 subscription fee, the average cost ranges from \$94 to \$101. At \$1000, the average cost ranges from \$104 to \$111. Thus whether the material is kept in the local library, shipped to a storage facility, bound in Buckram, or stored in pamphlet boxes causes an average cost difference of about \$7 per circulation. However, there is a significant difference in the final outcome. For Model 4 the printed copy is available for browsing then discarded. Even though Model 4 is the least expensive, there is no printed copy remaining. With Model 5 costing a few dollars more at the 10-uses level, one obtains a copy of record. And if one considers Model 6, which preserves a copy of record and sends it directly to the storage facility, one saves about a dollar over Model 5 at the 10-uses level.

Figure 2

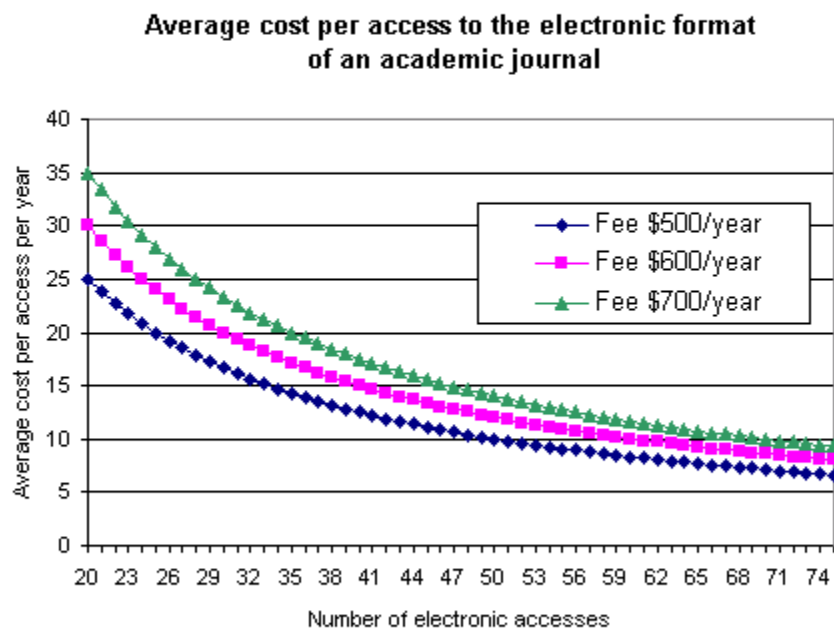


Table 10
Summary of selected journal cost simulation results

	Model 2	Model 3	Model 4	Model 5	Model 6	Model 2	Model 3	Model 4	Model 5	Model 6
Subscription cost/year	\$900	\$900	\$900	\$900	\$900	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000
Number of Uses										
1	\$959	\$963	\$906	\$925	\$921	\$1,059	\$1,063	\$1,006	\$1,025	\$1,021
2	481	484	455	465	463	531	534	505	515	513
3	322	324	304	311	310	355	357	338	345	344
4	242	244	229	235	234	267	269	254	260	259
5	194	196	184	189	188	214	216	204	209	208
6	163	164	154	158	157	179	181	170	175	174
7	140	142	132	136	136	154	156	147	150	150
8	123	124	116	120	119	135	137	129	132	132
9	110	111	104	107	107	121	122	115	118	118
10	99	101	94	97	96	109	111	104	107	106
11	90	92	85	88	88	99	101	94	97	97
12	83	85	79	81	81	91	93	87	90	89
13	77	78	73	75	75	85	86	80	83	83
14	72	73	68	70	70	79	80	75	78	77
15	67	69	63	66	66	74	75	70	73	72
16	63	65	60	62	62	69	71	66	68	68
17	60	61	56	59	59	65	67	62	65	65
18	56	58	53	56	56	62	63	59	61	61
19	54	55	51	53	53	59	60	56	58	58
20	51	53	48	51	51	56	58	53	56	56

Notes: Values in cells are average cost per circulation for a given electronic access fee or journal subscription cost (columns), and for a given number of circulations per year (rows). See text for a description of each model.

A Cost-Savings Model

In previous sections of this paper, the costs of providing electronic access and the costs of various strategies for storing printed copies of journals have been explored. The next issue to address is the costs or savings that could accrue to a group of libraries that provided electronic journal access for the users of that group or consortia. For example, assume that the University of California Systemwide administration was to negotiate contracts with journal publishers to provide access to electronic journals for all libraries in the University system. What kind of costs or savings result from such a plan?

The model used to measure the effect of this strategy compares the cost of the current arrangement of providing printed materials with a proposed strategy in which the number of printed copies would be reduced as electronic access was provided. The cost savings are computed as the difference between the current and proposed strategies.

The results presented here are for one scenario, but they can be easily extended to any number of alternatives. In that scenario, the university system has already committed itself to purchase the electronic version of the journal, and that is a sunk cost. Assume that the printed copy of the same electronic journal costs \$900 per year. Further assume that there are five libraries that currently subscribe to the printed version of the journal. Of these five libraries, one binds its copies, and after usage of the print material has declined, the bound journal is sent to a storage facility to become the copy of record (Model 3). The other four libraries continue to subscribe to the journal, but when usage has declined, they discard the journal on the premise that the printed copy can be retrieved from the storage facility if needed (Model 4).

The scenario under which the costs of the current alternative are defined incorporates a rather aggressive cost saving plan. In the most conservative planning situation, each library in the consortia would maintain its own subscription to the journal and save and bind past issues. As a starting point in the present cost savings calculations, it is assumed that the libraries are already cooperating to the extent that only one of the libraries is saving its printed version of the journals. Thus the model of the current alternative presented here potentially understates the possible savings.

Now consider the situation where the libraries believe that they can satisfy a considerable portion of their users needs for the journal by providing it electronically. In this scenario, all five libraries drop their subscription to the printed form of the journal; all the while the University Systemwide administration maintains its contract for access to the electronic journal. Further, in order to provide a copy of record, the Systemwide administration has printed copies of the journal delivered directly to a storage facility (Model 6).

The current cost of the journal using this scenario can be computed by adding the cost of the journal under Model 4 and multiplying it times the number of libraries, namely four. To this total is added the cost of the journal under Model 3 (for only one library). The cost under the proposed plan is the cost of the journal using Model 6. Since the model assumes that each journal will be used from 1 to 20 times in **each** library, we must use the average cost for 5 to 100 uses and then multiply by 5 (five libraries) to get the total cost for the consortium. The costs savings are for the consortium as a whole, not an individual library. And finally, the cost savings is the difference between the current cost and the cost under the proposed plan.

Figure 3 and Table 11 summarize the results from this analysis for a \$900 print subscription that is used from 1 to 20 times a year in each of the five libraries participating in the hypothetical consortia.¹⁶ The average cost under the current plan varies from \$922 for one use to \$49 for 20 uses. The average cost per use for Model 6 (the proposed plan) can be seen in Table 10 to vary from \$188 for one use to \$14 for 20 uses per library. The total cost savings range from \$3,670 for one use to \$3,561 for 20 uses. Notably, cost savings per use range from \$734 to \$26. The savings are very high when the uses range from 1 to 7. The change in savings diminishes beyond that point but is still reasonably high for every level of use. Thus the savings of such an arrangement are significant.

¹⁶ It is important to note that the model assumes that each journal will be used from 1 to 20 times in **each** library. This means that the total uses will be from 5 to 100 in the simulation because there are five libraries in the consortia. The costs savings are for the consortia as a whole, not an individual library. To compute the savings value for each library, divide the average cost by the number of libraries (5).

Figure 3

Cost savings from cancellation of individual campus print subscriptions and sending 'copy of record' directly from publisher to a storage facility

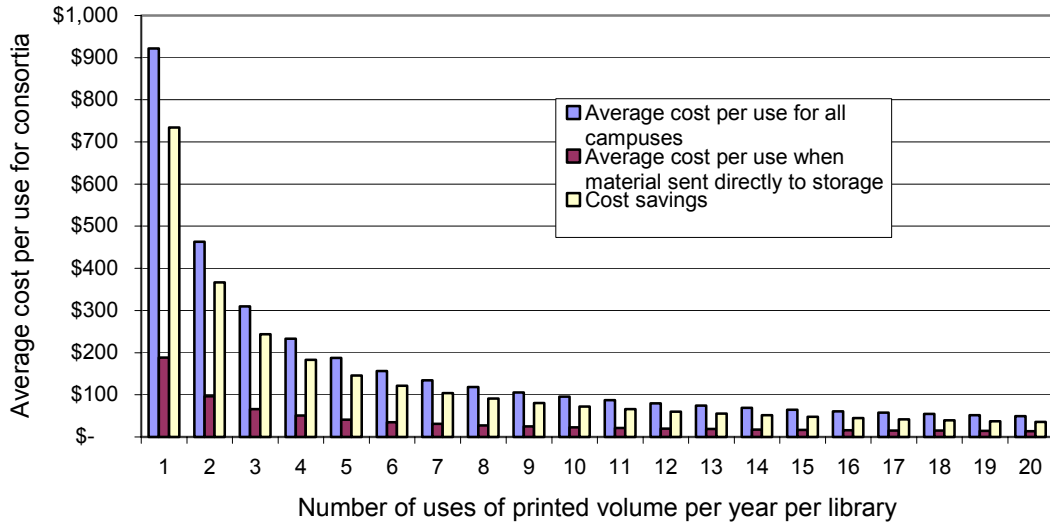


Table 11

Computation of cost savings from cancellation of individual campus print subscriptions and sending 'copy of record' directly from publisher to a storage facility

Uses Per Library	Consortial Uses	Current Scenario							Proposed Scenario			Cost savings	Cost savings per consortial use
		Average cost per use for library binding and storing journal (Model 3)	Total cost per annum (Model 3)	Average cost per use for libraries receiving then discarding journal (Model 4)	Total cost per annum (Model 4)	Number of libraries discarding journal (Model 4)	Total cost for all libraries that discard the journal	Total cost for libraries that discard plus cost for library that sends material to storage	Average cost per use (Total consortial uses)	Average cost per consortial use for having material sent directly from publisher to storage (Model 6)	Total cost per annum		
1	5	\$ 963	\$ 963	\$ 912	\$ 912	4	\$ 3,647	\$ 4,610	\$ 922	\$ 188	\$ 940	\$3,670	\$ 734
2	10	\$ 484	\$ 968	\$ 458	\$ 915	4	\$ 3,660	\$ 4,628	\$ 463	\$ 96	\$ 964	\$3,664	\$ 366
3	15	\$ 324	\$ 972	\$ 306	\$ 918	4	\$ 3,673	\$ 4,646	\$ 310	\$ 66	\$ 987	\$3,659	\$ 244
4	20	\$ 244	\$ 977	\$ 230	\$ 922	4	\$ 3,687	\$ 4,664	\$ 233	\$ 51	\$1,011	\$3,653	\$ 183
5	25	\$ 196	\$ 982	\$ 185	\$ 925	4	\$ 3,700	\$ 4,681	\$ 187	\$ 41	\$1,034	\$3,647	\$ 146
6	30	\$ 164	\$ 987	\$ 155	\$ 928	4	\$ 3,713	\$ 4,699	\$ 157	\$ 35	\$1,058	\$3,641	\$ 121
7	35	\$ 142	\$ 991	\$ 133	\$ 931	4	\$ 3,726	\$ 4,717	\$ 135	\$ 31	\$1,081	\$3,636	\$ 104
8	40	\$ 124	\$ 996	\$ 117	\$ 935	4	\$ 3,739	\$ 4,735	\$ 118	\$ 28	\$1,105	\$3,630	\$ 91
9	45	\$ 111	\$ 1,001	\$ 104	\$ 938	4	\$ 3,752	\$ 4,752	\$ 106	\$ 25	\$1,128	\$3,624	\$ 81
10	50	\$ 101	\$ 1,005	\$ 94	\$ 941	4	\$ 3,765	\$ 4,770	\$ 95	\$ 23	\$1,152	\$3,618	\$ 72
11	55	\$ 92	\$ 1,010	\$ 86	\$ 944	4	\$ 3,778	\$ 4,788	\$ 87	\$ 21	\$1,175	\$3,613	\$ 66
12	60	\$ 85	\$ 1,015	\$ 79	\$ 948	4	\$ 3,791	\$ 4,806	\$ 80	\$ 20	\$1,199	\$3,607	\$ 60
13	65	\$ 78	\$ 1,019	\$ 73	\$ 951	4	\$ 3,804	\$ 4,823	\$ 74	\$ 19	\$1,222	\$3,601	\$ 55
14	70	\$ 73	\$ 1,024	\$ 68	\$ 954	4	\$ 3,817	\$ 4,841	\$ 69	\$ 18	\$1,246	\$3,595	\$ 51
15	75	\$ 69	\$ 1,029	\$ 64	\$ 957	4	\$ 3,830	\$ 4,859	\$ 65	\$ 17	\$1,269	\$3,590	\$ 48
16	80	\$ 65	\$ 1,034	\$ 60	\$ 961	4	\$ 3,843	\$ 4,877	\$ 61	\$ 16	\$1,293	\$3,584	\$ 45
17	85	\$ 61	\$ 1,038	\$ 57	\$ 964	4	\$ 3,856	\$ 4,894	\$ 58	\$ 15	\$1,316	\$3,578	\$ 42
18	90	\$ 58	\$ 1,043	\$ 54	\$ 967	4	\$ 3,869	\$ 4,912	\$ 55	\$ 15	\$1,340	\$3,572	\$ 40
19	95	\$ 55	\$ 1,048	\$ 51	\$ 971	4	\$ 3,882	\$ 4,930	\$ 52	\$ 14	\$1,363	\$3,566	\$ 38
20	100	\$ 53	\$ 1,052	\$ 49	\$ 974	4	\$ 3,895	\$ 4,947	\$ 49	\$ 14	\$1,387	\$3,561	\$ 36

Note: See text for a complete description of the cost savings model and its assumptions. Gray shading denotes columns based on consortial, rather than individual library use

Summary and Conclusions

This paper has provided a comprehensive examination of the cost factors involved in providing electronic access to journal articles and printed copies of journals to users in an academic environment. The examination began with a review of the economic trends that academic libraries are facing. While the U.S. Consumer Price Index has been growing at 3.3% per year, expenditures on journal subscriptions have been rising at 8.0% per year. In addition, journal subscriptions are not inexpensive, ranging from about \$100 to over \$2200 per title for scholarly publications. The mean subscription price found in a current survey was \$745. For the University of California, the average is about \$952. The problem is not just printed journal subscription prices, but also the fees that universities pay for their users to have electronic access to journal articles through the Internet. Libraries are beginning to see a shift in the total they pay for subscriptions versus the total they pay for electronic access. Right now the balance for the University of California is about 64% for printed journal subscriptions and 36% for electronic access fees. Publishers envision a decreased demand for printed journals and consequently are beginning to shift their pricing to raise electronic access fees. This makes it difficult to assess how a university should plan for journal expenditures, let alone decide on a strategy for managing printed journals.

A major university has an important responsibility to maintain copies of printed materials. The CMI study of more than 7,000 University of California students, faculty, and staff found that while 83% of the users strongly agreed or agreed that having electronic access to journals was a good alternative to printed journals, 57% realized that it was very important to have printed copies of the journals available as well. From the users' standpoint, printed copies of journals are essential. Other researchers have pointed out that there are additional reasons for maintaining printed copies, including the likelihood that the longevity of a printed copy is greater than an electronic copy because there is no guarantee the electronic copy will be migrated to each succeeding electronic standard as that standard emerges. Further, as journal publishers go out of business or sell their journal titles to other publishers, there is no guarantee that the publisher's electronic journals will be transferred. For these and other reasons it is essential that the University of California maintain its own copies of printed material for current and future scholars.

Six cost models were examined in this research. The first assumed that the University would provide electronic access to journals and not subscribe to printed copies of journals. No one is proposing this model should be followed. It exists merely to serve as a building block on which the other alternatives are based. The other models call for electronic access and for one form or another of access to printed materials. These other models include providing electronic access and print access, binding the printed copies of the journals, storing them at the local library, and allowing users to check them out from the local library. Variations on this model include moving the bound copies to a storage facility, and changing the form of binding of the journal issues to reduce cost. Another model is for the library to keep unbound issues, but when browsing has declined or a specified period has elapsed, to discard the journals. This model assumes that it is valuable to allow a user physical access to the

journals. Finally, the printed journal issues can be sent directly from the publisher to the storage facility and stored there. In this scenario, the journal completely bypasses the local library. When the user needs the printed version, it can be requested from the storage facility.

One factor in evaluating these models is the cost of constructing a library facility to house the materials. The cost per volume per year to build a library with standard shelving is \$1.43, while the cost to construct a library storage facility where volumes are stored in the most compact manner is only \$0.33. If materials are sent to a storage facility instead of being retained at the local library, it costs about \$3.57 per volume to process the material for shipment. When the materials are received at the storage facility and installed there, there is an additional cost of \$2.88 per volume. When users request materials and check them out of a local library, the cost is about \$3.26 per volume, as opposed to \$4.70 per volume when the item is retrieved from a storage facility. The cost of circulating the volume from the storage facility is higher because volumes in the storage facility usually are stored to optimize the number of volumes on the shelves, not to facilitate the user browsing the collection. If the storage facility supplies a facsimile of the article instead of the physical volume, the cost is \$3.94 per article.

Simulation techniques were used to assess how the average cost per circulation of a volume or of an electronic access varied. The unit costs discussed above were used in each of the six cost models, and the electronic journal access fee or the journal subscription price was varied to see its effect on average cost. One other variable was also changed, the number of times the journal would be accessed or the number of times the volume would be circulated. The results of the simulation show that the average costs are not insignificant for access to printed materials but are relatively small for electronic access.

Assume the electronic access fee is \$600 per journal per year. In this case there are no fixed costs. If there are 75 uses of the title per year, the cost is \$8 per use. Given the size of the user population, 75 uses is probably a very conservative estimate of actual use per title. If the number of uses rose to 200, the cost would be \$3 per use. This figure compares extremely favorably with the cost of any alternative in which a printed copy of the journal is either initially acquired and then discarded, or kept locally or in a remote storage facility. But a major premise of this paper is that the University must maintain its own copies of printed materials. In that situation the simulations provide the costs of the alternatives.

In Model 2, where the local library binds copies of the journals and keeps the bound volumes in its stacks, the average cost per use of a volume is \$51, assuming a subscription price of \$900 and 20 uses. In Model 3, where the library moves the bound volume to a storage facility and the subscription and usage figures remain the same as above, the cost per use is \$53. For Model 5, where the journals are stored in a facility that costs substantially less to build and are stored in pamphlet boxes, the cost per use drops to \$51. Although high, these numbers are not substantially different from one another.

Model 4 simulates the case where the local library acquires the material, keeps it on its shelves, and then discards it after an appropriate period of time. For the same \$900 subscription that is used 20 times, the cost per use is \$48. In Model 6, the material goes directly from the publisher to the storage facility. Using the same set of parameters as Model 4, the cost per use is \$51. The important difference between Model 4, which has the lowest cost per use, and Model 6 which is slightly more expensive, is that in Model 6 the University retains a copy of record of the item in a storage facility at a very minimal additional marginal cost.

Electronic journals minimize the need for physical infrastructure and provide a cost-effective, immediate means of providing access to library users. But scholars still need access to printed copies of journals, and the costs of providing this access are not insignificant. The least expensive alternative that retains printed copies of journals is for the University to have the printed copies of the journals sent directly to the storage facility. If there is a requirement that the materials be housed at a local library for some period of time before being shipped to a storage facility, the least cost alternative is for the material to be received at the local library, and then stored in pamphlet boxes at a storage facility. Storing materials in pamphlet boxes instead of binding the materials in Buckram costs about four times less. Likewise, the construction costs are more than four times lower for a storage facility than an on-campus library facility.

If electronic access to journals is provided, there is a potential cost savings to the University system as a whole. To assess that savings, a cost model was constructed to compare a present acquisition policy to one where the individual libraries relied much more on electronic access to meet user needs. The scenario modeled was one in which electronic access to journals was provided by the University Systemwide administration to all members of the university community. The current policy was that each of five libraries subscribed to the printed version of a journal. One of these libraries displayed unbound copies on its shelves, bound its copies of the journal after an appropriate period of time, and sent the bound copies to a storage facility (Model 3). The other four libraries display the unbound copies and when usage has declined disposes of these unbound issues (Model 4).

The proposed scenario was one where the Systemwide administration continues to provide electronic access, but none of the libraries receives a printed copy of the journal. Instead one printed copy is sent directly from the publisher to a storage facility (Model 6)

The cost savings from this arrangement were substantial, but varied depending on the number of times the journal was requested by a user from a storage facility. If a journal with a print subscription cost of \$900 per year were used five times in each of the participating libraries in a year, the savings to the consortia would be \$729 for that one journal for one year. The savings are substantially higher for a lower number of uses, but even at 20 uses in one library per year, the savings is \$178 for the one journal.

Acknowledgements

This research was supported by a grant from the Mellon Foundation on December 21, 2000, to the University of California Office of the President (UCOP) to support a study of alternative methods of managing library collections composed of both print and digital materials.

The author wishes to thank Laura Fosbender and Claire LeDonne, of the staff of the Collection Management Initiative, for their help in supplying data. I am especially grateful for the assistance of Joanne Miller, of the UCOP Office of Library Planning and Policy Development, in filtering and analyzing a myriad of pieces of information that contributed substantially to this report. Gary Lawrence, Director of Library Planning and Policy Development at UCOP, is responsible for my involvement in this project. He has done a great job of providing me with clear objectives and lucid explanations, and of steering me away from bad mistakes.

References

- Cooper, Michael D. (2000). *A Comparison of the Costs of Providing Electronic vs. Printed Copies of Journal Articles to University of California Users: A Conceptual Design Framework for Data Collection and Analysis*. School of Information Management and Systems, University of California, Berkeley, California. June 2000, 19 pp. Available at <http://www.ucop.edu/cmi/staff/cooper.html> and at <http://beachmat.berkeley.edu/~mike/TechReports/UCOPCostFramework2000.pdf>
- Cooper, Michael D. (1999). *A Cost Analysis of Book Storage Options at the National Library of Medicine*. School of Information Management and Systems, University of California, Berkeley, California, May 1999. 42 pp. Available at <http://beachmat.berkeley.edu/~mike/TechReports/NLMStorageCosts1999.pdf>
- Cooper, Michael D. (1989). A cost comparison of alternative book storage strategies. *Library Quarterly*. 59:3, pp. 239-260. Available at <http://beachmat.berkeley.edu/~mike/Articles/LQVol59No3-1989.pdf>
- Cooper, Michael D. (1991). The sensitivity of book storage strategy decisions to alternative cost assumptions. *Library Quarterly*. 61:4, pp. 414-428.
- Council on Library and Information Resources (2001). *The Evidence in Hand: Report of the Task Force on the Artifact in Library Collections*. Washington, DC: Council on Library and Information Resources. November 2001. Available at <http://www.clir.org/pubs/reports/pub103/contents.html>
- Kisling, Vernon N.; Haas, Stephanie C.; & Cenzer, Pamela S (1999). Last copy depository: Cooperative collection management centers in the electronic age. Presented at the *Creating New Strategies for Cooperative Collection Development Conference*, Aberdeen Woods Conference Center, Atlanta, Georgia. November 12-14, 1999. Available at <http://www.crl.chicago.edu/info/awccconf/Papers PDF/Atlanta PDF Files/Kisling-Haas-Cenzer.pdf>.
- Montgomery, Carol H. (2000). Measuring the impact of an electronic journal collection on library costs. *D-Lib Magazine*. 6:10 (October 2000). Available at <http://www.dlib.org>
- Montgomery, Carol H. & King, Donald W. (2002). Comparing library and user related costs of print and electronic journal collections. *D-Lib Magazine*. 8:10 (October 2002). Available at <http://www.dlib.org>
- Montgomery, Carol H. & Sparks, JoAnne (2000). Framework for assessing the impact of an electronic journal collection on library costs and staffing patterns. Paper presented at the *Economics and Usage of Digital Library Collections Conference*, Ann Arbor, MI, March 24, 2000. Available at <http://www.si.umich.edu/PEAK-2000/montgomery.pdf>

- University of California Office of the President. Office of Library Affairs (1991). *Uniform Fee Schedule and Model for UC Regional Library Facilities*. January 10, 1991. 6 pp.
- University of California Task Force on Collaborative Strategies for Archiving of Print in the Digital Environment (2000). *Developing a 'Copy of Record': Archiving Pilot Project for the University of California*. February 2, 2000.
- Van Orsdel, Lee; & Born, Kathleen (2002). Periodical price survey 2002. *Library Journal*. April 15, 2002, 51-56.
- Young, Mark; Kyrillidou, Martha; & Blixrud, Julia (2002). *ARL Supplementary Statistics 2000-01*. Washington, DC: Association of Research Libraries. Available at <http://www.arl.org/stats/sup/index.html>

Appendix A

Inflation Indexes

Many of the costs and prices used in this analysis were compiled in different years. In a number of cases the values have been inflation-adjusted for comparison purposes. The adjustments were made using an inflation index designed specifically for use by the University of California, Office of the President in Oakland, California, and compiled and maintained by the Director of Library Planning and Policy Development. The values of that index are reproduced in Table A-1.

Table A-1
University of California library inflation index

Year	Index value	Percent change
1960-61	1.0000	8.7%
1961-62	1.0874	3.5%
1962-63	1.1257	6.3%
1963-64	1.1965	5.7%
1964-65	1.2643	6.2%
1965-66	1.3428	7.1%
1966-67	1.4379	6.5%
1967-68	1.5318	7.5%
1968-69	1.6469	7.5%
1969-70	1.7708	7.6%
1970-71	1.9060	4.7%
1971-72	1.9949	2.6%
1972-73	2.0471	10.3%
1973-74	2.2569	11.7%
1974-75	2.5213	11.6%
1975-76	2.8133	10.4%
1976-77	3.1070	9.2%
1977-78	3.3935	9.1%
1978-79	3.7019	5.3%
1979-80	3.8971	21.3%
1980-81	4.7285	19.8%

Year	Index value	Percent change
1981-82	5.6626	10.8%
1982-83	6.2724	2.2%
1983-84	6.4112	5.2%
1984-85	6.7476	13.1%
1985-86	7.6334	7.6%
1986-87	8.2140	5.8%
1987-88	8.6912	4.5%
1988-89	9.0862	3.2%
1989-90	9.3811	4.8%
1990-91	9.8289	4.7%
1991-92	10.2881	1.2%
1992-93	10.4164	2.9%
1993-94	10.7184	1.5%
1994-95	10.8770	3.4%
1995-96	11.2482	2.8%
1996-97	11.5653	2.2%
1997-98	11.8209	2.3%
1998-99	12.0982	2.4%
1999-00	12.3834	3.9%
2000-01	12.8716	4.5%
2001-02	13.4483	5.1%

Source: University of California Office of the President, Director of Library Planning and Policy Development.

Appendix B

Collection Management Initiative Shelf Management Statistical Results

Table B-1 summarizes a few of the more important ratios that were derived from the Collection Management Initiative (CMI) conducted by the University of California Office of the President (UCOP). This study was conducted during 2002. It also presents two other constants that are used in the cost model calculations.

Table B-1

Collection Management Initiative shelf measurement study base values

Description	Value
Average number of feet of shelf space used for a single journal title	3.124
Average number of feet of shelf space used for a single volume of a journal	0.132
Average number of volumes per title	32.40
Average number of volumes per title per year	3.93
Average number of volumes per title per year assuming final year is unbound	4.23
Number of serial titles stored in a library in display format in one assignable square foot (ASF) of shelving per year	1.00
Number of serial titles stored in a library in a pamphlet box in one ASF of shelving per year	3.45

Appendix C

Additional simulation values for Model 6

Table C-1 provides the additional costs that were used in Table 11, which illustrates a cost savings model for a consortium of five libraries. Since the model assumes that each journal will be used from one to 20 times in **each** library, the number of total uses is multiplied by five.

Table C-1

Selected simulation values for Model 6 at \$900 per subscription

Number of uses	Cost
25	\$188
30	96
35	66
40	51
45	41
50	35
55	31
60	28
65	25
70	23
75	21
80	20
85	19
90	18
95	17
100	16