A COST COMPARISON OF ALTERNATIVE BOOK STORAGE STRATEGIES

Michael D. Cooper

Most academic libraries have a limited amount of space to house their collection. This paper develops a cost methodology to use in deciding the location (on-campus or off-campus), type of access (open or closed stacks), and type of shelving (regular or compact) to augment existing stacks of the library. A number of factors are considered in the model including the cost of constructing storage facilities, the cost of selecting materials that are to be moved to storage, the cost of processing materials at the local library in anticipation of their move to storage, the cost of transporting materials from the library to the storage facility, processing costs at the storage facility, and circulation costs from the storage facility. Both library and user costs are included in the models, and cost comparisons between alternative storage strategies are made. Data from a specific case study at the University of California, San Diego, are used to illustrate the model.

Introduction

One of the most pressing and complex problems facing academic libraries today is housing collections that increase in size every year. The obvious solution is to construct new library buildings. However, in periods of severe budget constraints, high construction costs, and limited space to build new facilities on campuses, other solutions may be neces-

1. The author acknowledges a number of individuals who offered advice and information during this project. Gloria Stockton, director of the University of California Northern Regional Library Facility, provided extensive help. At the University of California, San Diego, Alvina Robertson and Phyllis Mirsky supplied construction cost information; Suzanne Metzger, a detailed analysis of circulation tasks; and George Soete, an analysis of storage selection costs. This study was suggested by Dorothy Gregor, university librarian of UCSD. I am particularly grateful to her for her advice and encouragement.

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sary. Among the alternatives is the construction of storage facilities located in areas where land is less expensive and where library materials can be stored compactly in ways that increase the number of volumes per assignable ('usable') square foot of floor space.

This paper examines the costs to the user and the library of four approaches to storing library materials: (1) the cost of on-campus open shelf (i.e., browsable) storage of materials in normal shelving; (2) the cost of on-campus compact shelving; (3) the cost of local off-campus storage of materials in compact shelving; and (4) the cost of regional storage of materials in compact shelving. The methods used by the user to access and retrieve materials and the procedures used by the library staff to fill requests differ for each of the four approaches. The cost of construction is often the major criterion in the decision to use one type of library storage facility rather than another. This paper identifies several other significant cost factors in storing library materials and argues that all of them must be considered in planning the housing of library collections.

The issue of whether to build remote storage facilities for library materials is highly charged. A well-reasoned analysis of many of the problems related to remote storage can be found in Piterk's report [1]. A number of researchers and authors have argued persuasively that it is unacceptable to remove materials from a campus library facility to remote storage because browsing is essential to the scholar [2, 3]. Others have accepted that materials may have to be located away from a central campus and have discussed the process of planning for remote storage [4]. This paper will not attempt to deal with the impact of compact or remote storage on intellectual access. Instead, it will focus on the monetary costs of the alternatives both from the user's and from the library's point of view.

The analysis includes the cost of constructing various types of library facilities, the cost of processing library materials that are sent to a local or to a remote storage facility, and finally, the alternative costs of circulating an item from a library's regular open stack collection, from local storage, and from remote storage. In order to make the analyses as accurate as possible, all data are drawn from a case study of the University of California, San Diego (UCSD), library system. A single system is chosen in order to base cost comparisons on actual construction costs, on actual procedures followed to process materials, and on actual circulation costs for alternative storage methods.

Previous Research

The problem of how libraries should manage the physical storage of a growing collection of materials has been addressed by numerous au-
thors. Three papers provide an excellent framework for the economic analysis of storage problems. One is by Stayner [5] and the others are by Lawrence [6] and by Lawrence and Oja [7]. Stayner [5] develops a model that allows cost comparisons between storing materials in normal shelving, storing them in compact shelving, borrowing them through interlibrary loan, or converting them to microform. The criteria used to decide between one form of storage and another are the cost of the storage mechanism and the number of times the item will be used.

While Stayner's article develops a conceptual framework for the economic analysis of the problem, Stayner and Richardson's monograph [8] provides the most complete review of the physical storage options available to libraries and supplements the presentation with an excellent and comprehensive cost analysis.

The type of model developed by Stayner [5] is not new to libraries. In 1977, Pamlour [9] proposed a model to analyze whether serial publications should be kept in a library or discarded. The model considered the cost of storage, binding, and borrowing, as well as usage frequency in developing weeding criteria. Pamlour's model served as a basis for one part of Lawrence's [6] and of Lawrence and Oja's [7] economic analysis of storage problems. Lawrence and Oja present models to characterize the cost-effectiveness of various storage strategies and then develop data to test the models, using the University of California system as a basis.

A number of other authors have provided useful survey data, background information, cost summaries, or literature reviews. Schorrig [10], for example, conducted a survey of eighty-nine libraries in order to estimate the growth in library collection sizes and the new construction that was underway to increase collection storage space. Her analysis included information on existing shelf load factors and weeding algorithms used.

Muller's work [11] provides a good review of the pre-1965 literature on storage costs and presents a comparison of alternative book storage systems. A similar examination of alternatives was developed for the Regents of the University of California [12] and the Ohio Board of Regents [13] and both provide more current cost figures on storage facility costs. The criteria used in the selection of a physical site for a remote storage facility are enumerated in Location Analysis [14].

Interlibrary lending is an important alternative to storing materials in one's own library, and Waldhart's [15] review of the literature on interlibrary lending is a useful access point to that literature.

Construction Costs

Library materials are most commonly housed in on-campus facilities using "normal," as opposed to compact, shelving. In this paper, it is
assumed that normal shelving holds approximately 12.5 volumes per assignable square foot (ASF)\(^3\) of floor space and that compact shelving holds from two to three times as many volumes per square foot.\(^4\) Compact shelving can take many forms, from simple warehouse shelves of fixed height on which books could be stacked two rows per shelf, to sophisticated shelving units mounted on movable tracks that allow aisle space between ranges to be eliminated.

Construction costs of library facilities vary by type. This paper examines the cost of four alternative types: (1) the cost of constructing new on-campus (or close to campus) library facilities with normal (as opposed to compact) shelving, (2) the cost of constructing new on-campus library facilities with compact shelving, (3) the cost of converting existing on-campus facilities to accommodate compact shelving, and (4) the cost of constructing new off-campus library facilities with compact shelving.

Cost of New On-Campus Facilities
During 1987 the University of California (UC) system had a number of library construction projects either planned or under way. At the Davis campus, new construction cost per assignable square foot of library space was estimated at $160. Using that amount, the construction cost to store a single volume of material at Davis is $12.80. Comparable construction costs at other campuses include $188 ($15.04 per volume) at UC, Santa Cruz; $159 ($12.72 per volume) at UC, San Diego; and $239 ($19.12 per volume) at UC, San Francisco.\(^5\)

Thus, depending on the location of the project, construction costs vary between $159 and $239 per assignable square foot. If all the space were used to store library materials at 12.5 volumes per assignable square foot, the average construction cost per volume would vary between $12.72 and $19.12.

Cost of New On-Campus Compact Storage Facilities
There are two reasonably good sources of information about the cost of building on-campus compact storage facilities. The first is the University

4. The value of 12.5 is derived from a standard for regular shelving established by the California State Legislature for planning university library facilities.
5. These figures were provided by the University of California Office of the Director of Capital Improvements and are considered highly tentative. In the case of the value for UC, San Francisco, for example, the assignable square feet include a tunnel and a garage. Also, construction on the San Francisco campus is costly due to poor soil and a difficult site. The University of California, Davis, campus supplied a higher construction cost figure ($173) for library facilities than the one reported here, but for consistency the figures from the same source were used.
## Table 1

<table>
<thead>
<tr>
<th>Description</th>
<th>Construction Cost at Champaign-Urbana 1984 ($)</th>
<th>Construction Cost at UC San Diego 1986 ($)</th>
<th>Cost Increase for UC San Diego Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building construction cost</td>
<td>3,537,597</td>
<td>4,245,116</td>
<td>707,519</td>
</tr>
<tr>
<td>Compact shelving cost</td>
<td>3,300,000</td>
<td>3,960,000</td>
<td>660,000</td>
</tr>
<tr>
<td>Total construction cost</td>
<td>6,837,597</td>
<td>8,205,116</td>
<td>1,367,519</td>
</tr>
</tbody>
</table>

### Cost per volume:

<table>
<thead>
<tr>
<th>Description</th>
<th>Building construction cost</th>
<th>Compact shelving cost</th>
<th>Total construction cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.74</td>
<td>1.63</td>
<td>3.37</td>
</tr>
<tr>
<td></td>
<td>2.09</td>
<td>1.95</td>
<td>4.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.67</td>
</tr>
</tbody>
</table>

### Source

Data in col. 2 from Collier [17]. Other data computed by the author.

### Note

Unit costs may not add to total due to rounding. Construction cost differences are computed using Dodge Building Cost estimates [18]. Two adjustments are made in the 1984 University of Illinois values: one for the difference in construction cost between Champaign-Urbana and San Diego, and the other for the difference between construction costs in 1984 and 1986.

The geographic reference point for the analysis presented in this paper is the University of California, San Diego. Almost all construction costs are adjusted for the difference in cost of construction between the original locale of the project and San Diego, as well as the difference between the year the construction took place and 1986.

The second is the Southern Regional Library Facility at the University of California, Los Angeles (UCLA). These costs will be used to project costs for UCSD.

In 1984 the University of Illinois Library completed a compact book storage facility on the Champaign-Urbana campus. This facility, occupying about 8,529 square feet of site area, was designed to store 2.03 million volumes of materials using the Spacesaver Corporation’s compact shelving system. Collier [17] reports some useful construction cost figures for the project, which are summarized in Table 1. The total construction cost for the facility was about $6.8 million with roughly 48 percent of that amount spent for the compact shelving. The total construction cost per volume stored was $3.37.

Table 1 adjusts these 1984 Illinois construction costs to construction costs in San Diego in 1986 using the Dodge Building Cost Index [18]. When these adjustments are made, the total construction cost per volume at UCSD rises to $4.04 per volume.

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6. The geographic reference point for the analysis presented in this paper is the University of California, San Diego, campus in 1986. Almost all construction costs are adjusted for the difference in cost of construction between the original locale of the project and San Diego, as well as the difference between the year the construction took place and 1986.
The University of California is just completing its second regional compact storage facility. Since the new facility is located at a corner of the UCLA campus, it is considered "on-campus compact storage" for cost comparison purposes here. The cost of the facility, which will hold 3.5 million volumes, is currently estimated to be $15.2 million. After adjustments for construction cost differences, the cost to build a comparable facility in San Diego is estimated to be $14.7 million. The cost per assignable square foot for the 132,323 square foot facility is $111.17, and the cost per volume is $4.33.

Cost of Converting Existing On-Campus Facilities to Hold Compact Shelving
One option available to libraries is the conversion of existing on-campus space to compact shelving. Because storing two to three times as many books in the same square foot of floor area requires heavier floor loading, the construction costs for such a facility are greater. Regular floor loading in libraries is estimated at 125 pounds per square foot, while compact shelving requires a floor load of 275–300 pounds per square foot. It is estimated that the increased loading requires an additional $2 to $3 per square foot in framing and construction costs, provided that the building is no higher than three stories. Ideally, the library will remodel an existing building by finding available space on ground level and replacing existing stacks with compact shelving. If this strategy were used, the estimated cost of purchasing and installing compact shelving would be $1.90 to $1.93 per volume.

Cost of Constructing New Off-Campus Library Facilities Employing Compact Shelving
The first regional storage facility constructed for the University of California system and other participating institutions in the state was completed in Richmond, California, in 1982. This facility is located about ten miles northwest of the University of California, Berkeley, campus on university land known as the "Richmond Field Station." The Field Station is in an industrial area of the city of Richmond and houses several engineering research institutes, as well as the Northern Regional Library Facility. The facility cost $8,568,000 to construct in 1982, and it was designed to hold 3.08 million volumes stored two deep on fixed-height industrial-strength shelving. The building, which has 116,000 assignable square feet of space, cost $73.86 per ASF to construct. The cost per volume for construction was $2.78.

Construction costs are lower in San Diego than in Oakland, California (the closest city to Richmond for which there is a published construction cost index). However, construction costs have increased between 1982

7. Information provided by the UCSD library staff.
and 1986, the reference year for these calculations. When both these factors are considered, there is less than a 1 percent change in the figures; thus, for simplification, both changes are ignored in the analysis.

Construction Cost Summary
The data presented above show major cost differences among the three major construction alternatives: on-campus normal housing of materials, on-campus compact shelving, and off-campus compact shelving. The data suggest that new construction costs for University of California libraries range from $12.72 to $19.12 per volume. The cost savings for converting on-campus, on-grade stacks to compact shelving are substantial. At the University of Illinois, materials are stored at a cost of $4.04 per volume, while at the Southern Regional Library Facility of the University of California the equivalent storage cost is $4.33. When a compact storage facility is moved off-campus, the cost per volume stored drops to $2.78, as indicated by the figures from construction at the Northern Regional Library Facility. In summary, the estimated construction cost per volume for the three categories of facilities is $15.84 for on-campus normal shelving, $4.33 for on-campus compact shelving, and $2.78 for off-campus compact shelving. As the figures show, it is over one and one-half times more expensive to construct compact shelving on-campus than off-campus. Further, if $15.84 per volume is used as the average or midpoint for construction of new libraries with normal shelving, it is more than five times more expensive to construct normal shelving on-campus than compact shelving off-campus.

The most financially attractive construction alternative is off-campus compact storage at $2.78 per volume. If land is available, this type of facility could be constructed on-campus as well, and the same cost savings could be realized.

Processing Costs
The library's collections undergo some technical processing in order to make them available for use. Once materials are part of the collection, additional processing is required before they can be physically moved to other facilities, such as on- or off-campus compact storage facilities. This section discusses the processing that must occur before materials can be moved to a storage facility. Among the tasks to be performed are the

8. Table 1 shows that the construction cost at Illinois was $3.37 per volume. When this number is adjusted for the difference in construction cost at San Diego, the value becomes $4.04.

9. This conclusion is based on historical information and could change if new designs and technology were available.
selection of materials to be sent, the modification of location information on the bibliographic records of the materials to be moved, the cost of physically moving the materials, and the cost of processing the materials when they arrive at the storage facility.

Selection Costs
Materials can be selected for transfer to a local or remote library storage facility in a variety of ways. Often a selection rule based on the age and/or previous usage of the material is developed. For example, candidates for storage may be chosen from material that is more than ten years old or material that has not circulated more than five times in the past ten years. Combinations of age and usage rules are, of course, possible. Raffel and Shishko [19], Lister [20], Gupta [21], and Urquhart and Urquhart [22] summarize a number of these rules.

In order to minimize the cost of selecting materials for storage, some libraries employ a series of steps in the selection process, each requiring a different level of skill. One method is to employ student library assistants to scan the shelves of the library and, on the basis of use data, mark those items that are candidates for storage. After this preliminary scan, bibliographers and faculty members review the selected items. If any member of the latter two groups disagrees with the selection of an item, he or she removes the marking the student assistant has placed on the volume. After all evaluations have been completed, the volumes that remain marked are transferred to the storage facility.

This analysis presumes two alternative compact storage facilities: one located on-campus and another located more than a hundred miles away. Selectors indicate that there is a difference in their attitudes when evaluating materials for remote rather than local storage. In addition, selectors consider it easier to reverse a decision placing material in a local storage facility than a decision placing it in a regional facility. Finally, once material is moved to either local or remote storage facilities, it is likely that further selection will be more difficult because the material will not be as accessible to selectors, and there are more important selection activities to perform than to reselect materials that have already been reviewed. These differences in attitude result in a longer selection review for materials designated for regional storage.

Table 2 summarizes the cost of selecting materials for local and regional storage. The table shows a cost of approximately $0.17 per volume to select materials for a local storage facility, and a cost of $0.57 to select an item for a regional facility.

Processing Costs
Once an item has been selected for movement from the library’s open stacks to a local or regional storage facility, additional processing is
TABLE 2
COST OF SELECTING MATERIAL TO BE SENT TO A LOCAL AND TO A REGIONAL COMPACT STORAGE FACILITY ON THE UCSD CAMPUS 1986

<table>
<thead>
<tr>
<th>TASK</th>
<th>LOCAL COMPACT STORAGE SELECTION COST</th>
<th>REGIONAL COMPACT STORAGE SELECTION COST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HOURLY RATE ($)</td>
<td>NUMBER OF HOURS</td>
</tr>
<tr>
<td>Student assistant time to scan shelves</td>
<td>5.00</td>
<td>55</td>
</tr>
<tr>
<td>Bibliographer time to review candidate material</td>
<td>18.97</td>
<td>120</td>
</tr>
<tr>
<td>Faculty time to review candidate material</td>
<td>28.83</td>
<td>20</td>
</tr>
<tr>
<td>Supervisory time</td>
<td>29.25</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Total</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Note.—The estimates in this table are based on the cost of selecting 25,000 items for storage. The value of faculty time is based on the average rank and salary of faculty members on the UCSD campus. The average rank is currently Professor Step II (nine-month appointment).

required to effect the move. Under University of California policy, a machine readable record must be created for any item moved to a regional storage facility so that alternative forms of access can be provided. It is also necessary to change either the existing card or the online catalog records to reflect the material’s current location.

Table 3 summarizes the processing costs for serials and monographs that are being moved to storage. It presents three major cost categories: converting serial records to machine form, converting monograph records to machine form, and revising catalog records to reflect the new storage location. The table assumes that approximately 60 percent of all materials transferred to storage will be serials and that approximately 84 percent of the items to be stored will be represented in a bibliographic database such as OCLC. Given these assumptions, the average processing cost of volumes being shipped to storage is $1.31.

The University of California, San Diego, expects that 100 percent of the materials sent to regional storage will be fully processed, but that only 50 percent of the material sent to local compact storage will be fully processed. A significant proportion of the material sent to local storage can be moved in blocks from the stacks. For example, the UCSD Library decided to move all materials with the Library of Congress “Z” classification to storage. In this case, no processing need be performed.
<table>
<thead>
<tr>
<th>Task</th>
<th>Proportion of Materials Requiring This Process</th>
<th>Cost per Volume ($)</th>
<th>Weighted Cost per Volume ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convert serial records to machine-readable form*</td>
<td>.60</td>
<td>.25</td>
<td>.15</td>
</tr>
<tr>
<td>Convert monograph records to machine-readable form:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convert existing machine-readable records to standard by matching</td>
<td>.84</td>
<td>1.99</td>
<td>1.67</td>
</tr>
<tr>
<td>against bibliographic utility†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contract with bibliographic utility to convert remaining records</td>
<td>.16</td>
<td>3.50</td>
<td>56</td>
</tr>
<tr>
<td>Subtotal for conversion of monograph records to machine-readable form†</td>
<td>.40</td>
<td>2.23</td>
<td>.89</td>
</tr>
<tr>
<td>Revise cataloging to change location information:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change card catalog records§</td>
<td>.40</td>
<td>.43</td>
<td>.17</td>
</tr>
<tr>
<td>Change machine-readable records‖</td>
<td>.60</td>
<td>.17</td>
<td>.10</td>
</tr>
<tr>
<td>Total*</td>
<td></td>
<td></td>
<td>1.31</td>
</tr>
</tbody>
</table>

*The cost of converting a serial title to machine-readable form is estimated at $3.20. It is assumed that there will be an average of thirteen volumes per title transferred to storage; thus $3.20/13 = $0.25 per volume. On average, 60 percent of the material sent to storage will be serials; thus the weighted cost per serial volume is $0.25 × 0.60 = $0.15.
†It is assumed that 84 percent of the library's monograph records can be converted by matching them against a database like OCLC's, while the remaining 16 percent will have to be converted by original input.
‡The subtotal ($2.23) is the sum of $1.67 for conversion via matching and $0.56 for original conversion. This is then weighted by the proportion of records that are monographs (0.40) as opposed to the proportion that are serials (0.60).
§Changing card catalog location information is assumed to take 2.5 minutes per title, and the wage rate to perform this task is assumed to be $10 per hour.
‖Changing machine-readable location information is assumed to take one minute per record with wages paid at $10 per hour.
*The total processing cost is the sum of the serials processing cost ($0.15), the monograph processing cost ($0.89), and the cost to change the location information of the materials ($0.17 + $0.10 = $0.27).

The cost to process material moved to local storage is thus assumed to be 50 percent of $1.31, or about $0.65 per volume. Moving materials to open compact shelves in an on-campus facility would also take advantage of these significantly lower processing costs.

**Regional Library Processing Costs**

When materials are sent from the regular stacks of a library to a regional storage facility, their new location is noted in the catalog of the sending library and their arrival is recorded by the receiving facility. The analysis presented in the previous section enumerated the technical processing...
costs of moving the materials out of the library’s stacks. This section
discusses the costs of processing the materials once they arrive at a
regional facility. No analysis is presented of the cost of processing the
materials when they arrive at a compact storage facility on-campus since
such a facility would be considered part of the library and no additional
processing would be necessary. If a compact storage facility were con-
structed on-campus, location information for transferred material
would be changed in the catalog, but there would not be any formal
processing of the transferred material. The user would know that the
materials would take longer to retrieve, the staff would consider the
material part of a “branch” library, and there would be no need for more
complex processing. If, however, materials are moved to a regional
compact storage facility responsible for storing materials for several
libraries, better control and access must be provided than for materials
moved to an unshared local storage.

In order to determine the costs of processing materials once they
arrive at a regional storage facility, a study was made of the cost of
operating the University of California’s Northern Regional Library Fa-
cility. As mentioned earlier, the facility was opened in 1982 and has a
storage capacity of 3.08 million volumes. Operating costs for the facility
were examined from 1982/83 to 1985/86, and it was found that they
varied widely depending on the volume of materials received.

The facility classifies its operations into receiving, processing, and
circulating materials. Move operations are tasks related to the physical
receipt of materials from depositing libraries. Technical operations in-
volve processing the material when it arrives at the facility. User services
consist of providing access to the materials for depositing libraries, that
is, of circulating the stored materials. When the facility’s collection was
small, circulation was also relatively low. In the last fiscal year examined
(1985/86), circulation was close to 53,000 items.

The facility provides two key services: adding materials to the collec-
tion (technical operations), and circulating materials already in the col-
lection (user services). Over a four-year period (1982/83 to 1985/86) it
added roughly 3.9 million volumes to its stacks and circulated 133,401
volumes. The unit costs of technical operations was $1.00, and each
circulation from the collection cost $3.66.

Transportation Costs

Materials selected for storage must be physically moved on book carts to
a staging area where they are loaded onto a truck to be taken to the
storage facility. The cost of transportation of the materials in the library
is calculated as follows. It is assumed that it takes one and a half minutes
to find a specific book that is randomly located in the library stacks. It
then requires four minutes to place ninety books on a book truck (about three seconds per book) and fifteen minutes to load twenty-two book trucks filled with two thousand books onto a delivery truck (about .45 seconds per book). This totals $0.19 per volume when wages are computed at $7.00 per hour, or $0.12 per minute (rounded).

Transportation of materials to the Southern Regional Library Facility involves a 262-mile round trip from the University of California, San Diego. The total transportation cost is based on eight hours of driver time per trip at $0.12 per minute ($57.60). If the vehicle used to transport the materials is assumed to cost $22,000 and is expected to run for 75,000 miles, then the approximate depreciation cost per mile is $0.30. Assuming an additional $0.30 per mile for gas and maintenance, the total for the trip is $214.80. The cost of transporting two thousand volumes at a time to the facility is ($214.80/2000) $0.11 per volume.

Movement of materials to local storage involves a twenty minute round-trip drive of five miles. Based on the vehicle operating costs developed above, the cost of transporting two thousand volumes to local storage is $0.003 per volume.¹⁰

Circulation Costs

The cost of circulating materials is an important consideration in the analysis of the cost of storing books in normal, on-campus, or off-campus storage. This section develops circulation costs.

User Costs

When users discover that materials are not available from local open stacks, one of their concerns is the delay they will experience in getting the material. In order to include the delay in this analysis, an average cost of user time has been computed and will be employed when circulation costs are analyzed. Two types of user time expenditures are considered. The first is the time taken by the user to check out an item, including the time spent filling out forms or searching open stacks for the material. The second is the delay the user experiences while waiting for material to arrive from either local or regional storage facilities. These delay times are large and are tabulated separately in order to distinguish them clearly from the other costs.

The average value of user time was estimated at $10.38 per hour by considering the average potential salary for each category of user. An

¹⁰. This includes labor cost of $2.40 ($0.12 times twenty minutes) and equipment cost of $3.00 (five miles times $0.60 per mile).
alternative strategy for computing user delay costs could have been to ask the user for a dollar-per-hour figure that she or he associates with the delay. According to the circulation data for the UCSD Central University Library, 18 percent of the circulations were by faculty members, 22 percent by graduate students, and 60 percent by undergraduates and others. The average hourly wage for a faculty member on the UCSD campus is $28.83. The value of an hour of graduate student’s time was estimated at $9.97, the same as a research assistant’s. Similarly, the value of an hour of an undergraduate’s time was estimated at the rate paid to a student library assistant, $5.00. When the hourly salaries are weighted by the circulation proportions, the value of $10.38 is obtained.

*Circulation Costs from Open Stacks*

The process of circulating an item from the open stack collection of the UCSD Central University Library is similar to procedures in most libraries that are not yet automated: the user finds the call number of the desired item in a card catalog or an online public access catalog and then enters the stacks to locate the item. If the item is found, the user takes it to the circulation desk and checks it out. If it is not found, the user may (or may not) inquire about it at the circulation desk and may (or may not) place a hold on it. When the item is returned, the staff clears the circulation record from the file and reshelves the book.

Table 4 lists these tasks along with the average number of minutes each takes. Some tasks are performed by users and others by library staff. User costs are computed using the $10.38 rate. All staff costs in the circulation department are computed using $7.00 per hour (rounded to $0.12 per minute) as the average rate paid to circulation staff members.

Not all tasks are performed for all circulations. Table 4 presents the proportion of circulations for which each task is expected to be performed. This proportion is included to normalize the unit costs so they can be added together to obtain an average unit cost for one circulation. For example, it is expected that all circulations will involve the user consulting the card or online catalog, while only 50 percent of the transactions will result in the user filling in the charge card.

The result of the analysis indicates that the average cost to the library

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11. Lacking other evidence, it is assumed these rates hold for circulation from storage as well. If it were assumed that no undergraduates circulated books from storage, the patron time and cost would be higher and the estimate not as conservative as it is.

12. The value of faculty time is based on the average rank and salary of faculty members on the UCSD campus. The average rank is currently Professor Step II (nine-month appointment).

13. That is, ($28.83 \times 0.18) + ($9.97 \times 0.22) + ($5.00 \times 0.60) = $10.38.$
### TABLE 4
**Estimated Unit Cost of Circulating an Item from Open Stacks and Compact Open Stacks at UCSD**

<table>
<thead>
<tr>
<th>Description of Task</th>
<th>Proportion of Circulations in Which Task Occurs</th>
<th>Average Number of Minutes for Task</th>
<th>User Cost ($)</th>
<th>Staff Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine call number and stack location using card catalog or MELVYL online catalog*</td>
<td>1.00</td>
<td>3</td>
<td>.51</td>
<td>...</td>
</tr>
<tr>
<td>Enter stack and search for item</td>
<td>1.00</td>
<td>6</td>
<td>1.02</td>
<td>...</td>
</tr>
<tr>
<td>Find item in stack and complete charge card</td>
<td>.50</td>
<td>1</td>
<td>.09</td>
<td>...</td>
</tr>
<tr>
<td>Charge item out to user</td>
<td>.50</td>
<td>1</td>
<td>...</td>
<td>.06</td>
</tr>
<tr>
<td>Recall item for user</td>
<td>.05</td>
<td>10</td>
<td>...</td>
<td>.06</td>
</tr>
<tr>
<td>Search for item that was not found</td>
<td>.05</td>
<td>13.5</td>
<td>...</td>
<td>.08</td>
</tr>
<tr>
<td>Clear item from circulation file on return</td>
<td>.50</td>
<td>5</td>
<td>...</td>
<td>.30</td>
</tr>
<tr>
<td>Reshelve item</td>
<td>.50</td>
<td>.5</td>
<td>...</td>
<td>.03</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>...</strong></td>
<td><strong>1.62</strong></td>
<td><strong>.53</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note.—Circulation staff labor cost is computed in this table at $7.00 per hour or $0.12 per minute. User time is computed at $10.38 per hour or $0.17 per minute. See the text for the derivation of the user's cost per hour.

*MELVYL is the University of California online catalog for all nine campuses. This analysis assumes that all searches will begin with the user consulting the card catalog.

of circulating an item from open stacks is $0.53, while the average cost of the user's time in obtaining the material is $1.62. When the books are circulated from open stacks it is assumed there is no delay experienced in obtaining the material.

*Circulation Costs from Compact Open Stack Shelving*
The advantages of open stack shelving are that users can page their own materials and browse the collection. The advantage to the library of such an arrangement is that user paging of materials has the lowest possible staff cost per circulation of all alternatives examined. Thus the data in table 4 are also applicable to determining circulation costs from compact open stacks.

*Circulation Costs from Local Compact Storage*
When an item is circulated from a compact storage facility located on the UCSD campus, the user first determines from the catalog that the item is
in the local storage facility, then fills out a request to have the item paged. After the library staff verifies that the item is, in fact, in the local storage facility, it is paged from the facility. If the item is found, the user is notified and the item is checked out to the user when he or she returns to the circulation desk. If the item is not found, the staff searches for it. When a checked-out item is returned, it is cleared from the circulation files, then sent back to be reshelved in the storage facility.

These steps are summarized in table 5, along with the proportion of cases in which each step is likely to occur and the estimated time needed for each step. The user cost for the transaction is estimated at $1.00, which is less than the cost to the user of retrieving the item from open stacks. However, the delays are substantial; the user experiences delays of more than ten hours per request. The library cost of the transaction ($3.18) is close to three times the cost of an open-stack circulation.

*Circulation Costs from Regional Compact Storage*

The procedures for circulating an item from a regional compact storage facility are quite similar to those followed for a local compact storage facility. Requests are placed in the same way, though there is some reduction in staff time when clearing the request from the requesting library’s files, because some of the tasks are shifted to the regional facility. The main difference between regional and local compact storage is the cost of transporting volumes to the regional facility and the cost of processing them once they have arrived. As table 6 shows, the transportation cost for the 262-mile round trip between San Diego and Los Angeles is $4.30 per volume, based on fifty volumes transported per trip. The value of fifty volumes per trip is an extremely generous estimate, since the actual number of books carried will probably be far less. If the number is reduced, the unit cost of transportation ($4.30) rises significantly. Either way, transportation cost is a significant factor in operating the facility.

In the section on regional library processing costs, it was reported that the cost of circulating a volume out of the Northern Regional Library Facility was $3.66. Table 6 gives the total cost of circulation of an item from the Southern Regional Library Facility to UCSD as $9.36. This number is relatively high because there are few regional circulation transactions, and there are small economies of scale in the operation. When a volume is circulated from the regional facility, circulation functions are duplicated at the local library and the regional facility. As a result, it is an expensive proposition to circulate an item from the regional facility when both the local and regional processing costs and the transportation costs are computed.
<table>
<thead>
<tr>
<th>Description of Task</th>
<th>Proportion of Circulations in Which Task Occurs</th>
<th>Time Needed for Task</th>
<th>User Delay Cost ($)</th>
<th>User Cost ($)</th>
<th>Staff Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine call number and stack location using card catalog or online catalog</td>
<td>1.00</td>
<td>3 min.</td>
<td>...</td>
<td>.51</td>
<td>...</td>
</tr>
<tr>
<td>Request that item be paged from local storage</td>
<td>1.00</td>
<td>2 min.</td>
<td>...</td>
<td>.34</td>
<td>...</td>
</tr>
<tr>
<td>Verify that item is in local storage*</td>
<td>...</td>
<td>2.58 min.</td>
<td>...</td>
<td>...</td>
<td>.31</td>
</tr>
<tr>
<td>Complete paperwork to recall item from local storage</td>
<td>.10</td>
<td>10 min.</td>
<td>...</td>
<td>...</td>
<td>.12</td>
</tr>
<tr>
<td>Retrieve item from local storage facility†</td>
<td>.90</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>1.15</td>
</tr>
<tr>
<td>Delay time (in hours)‡</td>
<td>.90</td>
<td>10.88 hrs.</td>
<td>99.84</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Retrieve item from hold shelf and charge item to user</td>
<td>.90</td>
<td>3 min.</td>
<td>...</td>
<td>...</td>
<td>.32</td>
</tr>
<tr>
<td>Complete charge card</td>
<td>.90</td>
<td>1 min.</td>
<td>...</td>
<td>...</td>
<td>.15</td>
</tr>
<tr>
<td>Search for item not found in local storage facility</td>
<td>.10</td>
<td>13.5 min.</td>
<td>...</td>
<td>...</td>
<td>.16</td>
</tr>
<tr>
<td>Notify user of search result if item not found</td>
<td>.10</td>
<td>2 min.</td>
<td>...</td>
<td>...</td>
<td>.02</td>
</tr>
<tr>
<td>Clear item from circulation file at library and at local storage facility</td>
<td>.90</td>
<td>10 min.</td>
<td>...</td>
<td>...</td>
<td>1.08</td>
</tr>
<tr>
<td>Return and reshelve item at local storage facility</td>
<td>.90</td>
<td>3 min.</td>
<td>...</td>
<td>...</td>
<td>.32</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>...</td>
<td>...</td>
<td>99.84</td>
<td>1.00</td>
<td>3.18</td>
</tr>
</tbody>
</table>

**Note.**—Circulation staff labor cost is computed at $7.00 per hour, or $.12 per minute. User time is computed at $10.38 per hour, or $.17 per minute. See the text for an explanation of the derivation of user costs.

*The number of minutes required to verify that an item is in local storage is computed from the weighted average of 7.5 minutes to process the request if the item is currently being cleared from the circulation file, and two minutes to process the request if the item is shelved. It is assumed that 90 percent of the requests are for shelved items.

†Transportation cost is based on an average of thirty items transported per run. Driving time is assumed to be twenty minutes round trip. The time to locate an item at the storage facility is five minutes. The time to check the book out at the local storage facility, including the time needed to tape it to indicate that it belongs in the storage facility, is five minutes. The total cost for this operation is $1.28 per item.

‡It is estimated that 75 percent of the requests will be completed in 6.5 hours while the remaining 25 percent will be completed in twenty-four hours, for an average of 10.88 hours at $10.38 per hour of waiting time.
TABLE 6
UNIT COST OF CIRCULATING AN ITEM STORED AT THE SOUTHERN REGIONAL LIBRARY FACILITY FOR A USER AT UCSD

<table>
<thead>
<tr>
<th>Description of Task</th>
<th>Time Needed for Task</th>
<th>User Delay Cost ($)</th>
<th>User Cost ($)</th>
<th>Staff Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine call number and stack location using card catalog or online catalog</td>
<td>3 min.</td>
<td>. . .</td>
<td>.51</td>
<td>. . .</td>
</tr>
<tr>
<td>Request that item be paged from regional storage</td>
<td>2 min.</td>
<td>. . .</td>
<td>.34</td>
<td>. . .</td>
</tr>
<tr>
<td>Verify that item is in regional storage and place request for it via electronic mail</td>
<td>10 min.</td>
<td>. . .</td>
<td>1.20</td>
<td>. . .</td>
</tr>
<tr>
<td>Transport item from regional storage and return it to the storage facility after loan completed*</td>
<td>. . .</td>
<td>. . .</td>
<td>4.30</td>
<td>. . .</td>
</tr>
<tr>
<td>Process the request at the regional facility</td>
<td>. . .</td>
<td>. . .</td>
<td>3.66</td>
<td>. . .</td>
</tr>
<tr>
<td>Delay time (in hrs.)*</td>
<td>37.5 hrs.</td>
<td>382.50</td>
<td>. . .</td>
<td>. . .</td>
</tr>
<tr>
<td>Retrieve item from hold shelf and charge item out to user</td>
<td>5 min.</td>
<td>. . .</td>
<td>.60</td>
<td>. . .</td>
</tr>
<tr>
<td>Complete charge card</td>
<td>1 min.</td>
<td>. . .</td>
<td>.15</td>
<td>. . .</td>
</tr>
<tr>
<td>Clear item from circulation file at library and return it to regional storage facility</td>
<td>5 min.</td>
<td>. . .</td>
<td>.60</td>
<td>. . .</td>
</tr>
</tbody>
</table>

Total | . . . | 382.50 | 1.00 | 9.36 |

Note.—Circulation staff labor cost is computed in this table at $7.00 per hour, or $0.12 per minute (rounded). User time is computed at $10.58 per hour, or $0.17 per minute. See the text for an explanation of the derivation of the user cost.

*See the text for a derivation of the transportation cost.

†The user delay time of 37.5 hours is computed by assuming that 25 percent of the requests will require a twenty-four-hour delay while 75 percent of the requests will require forty-two hours to be filled.

Summary and Conclusions

This paper has outlined five major costs, in addition to construction costs, that must be considered in deciding which type of book storage facility to use. These include (1) selection costs, (2) processing costs at the local library, (3) transportation costs, (4) processing costs at the storage facility, and (5) circulation costs. In addition, consideration of the delay that users experience in receiving materials should play an important part in the decision.
### TABLE 7
**Summary of Unit Costs of Open Stack, Compact Open Stack, Local, and Regional Storage of Materials for the UCSD, 1986**

<table>
<thead>
<tr>
<th>Cost per Volume</th>
<th>Open Stack ($$)</th>
<th>Compact Open Stack ($$)</th>
<th>Local Storage ($$)</th>
<th>Regional Storage ($$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction cost</td>
<td>15.84</td>
<td>2.78</td>
<td>4.33</td>
<td>2.78</td>
</tr>
<tr>
<td>Selection, processing, and transportation costs:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select material to be transferred to storage (see table 2)</td>
<td>...</td>
<td>.17</td>
<td>.17</td>
<td>.57</td>
</tr>
<tr>
<td>Process material at local library before transfer to storage facility (see table 3)</td>
<td>...</td>
<td>.65</td>
<td>.65</td>
<td>1.31</td>
</tr>
<tr>
<td>Transportation costs to storage:*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Movement of item within local library</td>
<td>...</td>
<td>.19</td>
<td>.19</td>
<td>.19</td>
</tr>
<tr>
<td>Transportation to storage facility</td>
<td>...</td>
<td>.003</td>
<td>.003</td>
<td>.11</td>
</tr>
<tr>
<td>Process material at storage facility†</td>
<td>...</td>
<td>.09</td>
<td>.09</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>...</td>
<td>1.10</td>
<td>1.10</td>
<td>3.18</td>
</tr>
<tr>
<td><strong>Circulation costs</strong> (see tables 4—6):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>User cost</td>
<td>1.62</td>
<td>1.62</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Staff cost</td>
<td>.53</td>
<td>.53</td>
<td>3.18</td>
<td>9.36</td>
</tr>
<tr>
<td>User circulation delay cost (see tables 5, 6)</td>
<td>...</td>
<td>...</td>
<td>99.84</td>
<td>382.50</td>
</tr>
</tbody>
</table>

*See the text for the derivation of the transportation cost.
† The cost of processing materials once they arrive at the compact open stack facility or local storage facility is assumed to be half the cost of moving the materials out of the central library.

Table 7 summarizes the data developed in previous sections of this paper for four alternative types of facilities: (1) open stack facilities, (2) compact open stack facilities, (3) local storage, and (4) regional storage. The table shows that there are significant differences in construction costs for the various types of facilities, ranging from $15.84 per volume for on-campus library space to $2.78 for both compact open stack on-campus facilities and compact off-campus regional storage construction. Clearly, on-campus open stack library facilities are expensive to build when compared to other types of storage.
There are major differences in processing costs when materials are moved to regional storage facilities as opposed to local storage or compact open stack facilities. It costs more to select materials for regional storage because the selectors feel that the decision is harder to reverse and must therefore be made with more care than a decision to send materials to local storage. The cost to process a volume for placement in a regional storage facility is twice that of the cost for local storage or local compact open stacks because all of the items are fully processed, while such procedures as block moves reduce the processing needs of books stored locally. Transportation costs are much higher when a book has to travel more than a hundred miles to its regional storage destination rather than a few miles to a local facility. These factors result in processing costs that are more than three times higher for volumes stored in a remote facility than for those in a local facility.

The construction cost and processing cost to put one volume in a compact open stack facility is $3.88, while the same cost to move a volume to a local storage facility is $5.43, and to a regional facility, $5.96. The cost difference between local and regional storage is not significant and this implies that more careful consideration should be given to on-campus compact open stack facilities.

The major difference between remote and local storage is circulation cost. The cost of circulating a book from local storage is $3.18 per volume and $9.36 from regional storage. The regional storage circulation cost is significantly affected by transportation costs of $4.30 per volume. But even if the transportation costs were entirely eliminated (a totally unrealistic assumption), circulation cost would still only drop to $5.06 per volume because the item must be circulated from the regional facility and the local library.

Figure 1 plots the average cost per circulation for each of the four book storage strategies. Average costs are computed by assuming that the fixed cost of moving a volume into the facility is the sum of construction and processing costs per volume, and variable cost is the cost per circulation. Then, average cost per circulation is the fixed plus variable cost divided by the number of circulations. The figure shows that local compact shelving has the lowest average cost no matter how many times an item circulates. Open stacks become more economical than regional storage facilities when an item circulates more than four times.

A comparison of construction and processing costs with circulation costs for the two types of storage facilities illustrates an important trade-off. It is close to three times more expensive to circulate a volume from a regional facility than from a local facility. It costs almost the same amount of money to construct and process materials for the two types of facilities, even though construction costs alone are nearly twice as expen-
sive for on-campus compact storage as for regional storage. Thus there is a clear advantage to constructing on-campus compact storage as opposed to regional storage.

The best alternative is a compact open stack facility located on-campus. Construction and processing costs are the least expensive ($3.88 per volume) of the four alternatives. Circulation costs are $0.53 per volume, the same as regular open stack facilities, and one-sixth less expensive than local storage facilities. Conversion from regular to compact shelving is also cost effective when on-campus floor loading makes such a conversion feasible.

User delay costs are a significant factor to consider. In the case of the University of California, San Diego, the delay cost to the user of waiting for a volume to be retrieved is $99.84 for local storage, and $382.50 for regional storage. There is no delay cost when compact open stacks are used. Although these are not actually expended dollars, the figures are indicative of the cost of the delay to the user.

It is clear from this analysis that it is insufficient to use construction costs as the basis for deciding the type of storage facility to employ. It is also clear that librarians should think of a hierarchy of storage facilities. Some library materials are used more than others, and some materials must remain in a library's central facility. Other materials might safely be
moved to compact open stacks and others to a storage facility, but the type of facility should be governed by the material's expected future use. The lower the expected use, the safer and cheaper it is to move the item further from the central library.

When a hierarchy of storage facilities is employed, materials will move between them as demand changes. Furthermore, when this occurs, there must be an online catalog in place that will allow location information to be changed efficiently, so that both users and library staff can locate the materials they need.

REFERENCES


