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AUTOMATIC SHELVING AND BOOK RETRIEVAL: A CONTRIBUTION TOWARD A PROGRESSIVE PHILOSOPHY OF LIBRARY SERVICE FOR A RESEARCH LIBRARY*

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In a society which is rapidly changing its social and technological ways, one would expect the research library to be taking a leading part in this tendency toward experimentation and change. Perhaps the research library is indeed providing the information which the scholars need to carry out their research. This research undoubtedly is generating those ideas that are fostering the technological advances that are being made throughout this era. Yet the librarians themselves are in many ways archaic in applying technological techniques to their own functions and in introducing progressive ideas to their philosophies of service for the sake of their patrons.

While computers are being used for various library functions, they have a limited usefulness until the problem of what to do with the books is solved. One librarian wrote:

The information [retrieval] problem would be easy if it weren't for the damn books. The computer engineer can make an important contribution to the architecture of tomorrow's librarianship, but we cannot leave to him the solution of the problem of information retrieval, for he will not know what to do with the

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damn books. Always there are the damn books——everything must begin with them——they are the hard core of the library problem. In automation, as in architecture, form must follow function, and in its bibliographic applications it still has a considerable distance to go before it catches up. The closing of this "gap" is the task of the new librarians.¹

Meanwhile, library practices are geared to teach the student how to use the library with the idea that he will use it on his own thereafter. Yet it should be obvious how self service by the patron cannot compete in speed and extent of subject coverage with automated information retrieval service by a librarian whose training makes him a specialist in providing that service. Furthermore the student "...may need information rather than guidance when its use is more important to his education than his experience in finding it."²

For nearly a century the libraries in both the old world and the Americas have used such various types of shelving as rolling ranges, hinged shelf units, drawers and standard adjustable bracket shelf book cases; yet today the librarians are still discussing the merits or the inconveniences of such shelving. It seems that the more compact the shelving system becomes, the more inconveniences that system presents to the library's staff or its patrons. In a recent article on shelving, one librarian explained various methods of shelving which are used to save space, and then added: "If a combination of methods is used, both savings and disadvantages are compounded."³

But rather than innovating new shelving systems to eliminate those inconveniences, the librarians have been discussing whether or not the inconveniences and the resulting poorer library services are worth bearing as the price they would have to pay to save space in their overcrowded libraries. It is this writer's intention, therefore, to suggest a possible new way of shelving books. It is his intention further to demonstrate how this new shelving system may contribute toward a new philosophy of library service which would be more beneficial to the student and research scholar patrons of a large university library.

Let us deal with the technical problem of shelving first. Current methods of shelving books, finding them for the patron, and delivering them to him from the stacks of a multimillion volume library have become a bottleneck in an otherwise possible method of rapid retrieval of desirable information. For example, Ralph R. Shaw's Rapid Selector is capable of selecting and presenting to the research scholar in four minutes all the cards and pages dealing with a particular subject out of a total of 70,000 pages of a catalog, which is imposed on a single roll of microfilm. The time which is saved in this case is that time which it would take the scholar to examine some seven sixty-tray card catalogs.⁴
Even when the stacks are open, where the librarian is leaving it up to his patron's own ingenuity or luck for finding the books which he wants, the time a scholar spends looking for material is extremely frustrating in this era of haste. It is known:

The research scholar's time is limited and the older he becomes the less he is interested in spending it on irrelevancies that stand between him and his immediate concerns. As libraries become large, the more obstacles they present to the research scholar.... 5

Many of these obstacles can be eliminated with automatic shelving. With automatic shelving and book retrieval, all the librarian (or more likely one of his staff members) will have to do to shelve a book in the stacks is to place it on an elevator. From that point on, until the book reaches its place in the stacks, it would be handled entirely by machinery. At the time when a patron should want that book, he would present its call number to the circulation attendant. The attendant would dial the call number, just as you dial a telephone number, and the desired book would come sliding down a chute from the stacks. Automatic shelving and book retrieval is the obvious means to the quick service which is the ideal of the modern research-oriented library.

Below is a technical explanation of how this is mechanically possible today. As a matter of fact, it was mechanically possible as long ago as the last decade of the nineteenth century. It was possible then, because the principle is fundamentally that which made the linotype machine a working possibility at that time. 6

The principle that is referred to here is the principle of the keyed matrix. Rather than dwelling on how the keyed matrix finds its location in the type case of the linotype, let us make a keyed matrix and fix it to a thin light aluminum container which would hold within its six walls (one of them removable) the book which we wish to shelve in the library stacks. Unlike the linotype matrix which selects its location in only one row above the type case, our matrix also will have to select range rows and tiers as well as the final storage location of the book we wish shelved. Since our matrix first of all will have to guide the book vertically to the desired tier, then horizontally to the desired row of ranges, then horizontally again but at right angles to its initial horizontal movement along the range row to its ultimate shelved location, our matrix will have to be keyed in three ways. For two of these directional movements, it could be keyed to similarly keyed rails as in the case of the linotype. For the vertical movement it could be keyed to complete an electrical circuit at a specific tier level only (see Figures 1 and 5). The matrix and book container would appear as shown in Figure 1. The keys of the matrix from direct front and side views in actual size would appear as in Figure 2, which also shows an end view of the keyed rails on which the matrix would be hung.
The keyed matrix allows the book to fall off the rail on which it slides at the appropriate place in the stacks. This is accomplished by having the rail groove (on which the matrix hangs) terminate its flanged extension at that place. If our matrix is keyed with a flange at position 4 (as in Figure 2) it will remain sliding along the rail until the flange in groove 4 of that rail no longer exists (see Figure 3). At that point the matrix would fall off. If below that position there was an aluminum pocket large enough for the matrix and its book container to slide into, then our book would be shelved (see Figures 3 and 4). Because our matrix and its rail has 40 grooves, by the above simple method, 40 books could be shelved in the first range in the row of pockets below that rail. By using a combination key of two flanged positions, the system of keyed matrices and rails could shelve 39 more books for each of 39 additional ranges in the same row, along the same rail. By using three flanged positions, 38 books each for 38 more ranges could be shelved, and so on by the formula of \((x - y) - 1\) where \(x\) is the number of positions that can be used, while \(y\) is the number of flanged positions used in combination at any one time for the key.

Now that we know the principle used for shelving books, let us see how we can retrieve them. To begin our explanation, let us locate the book we want by its tier number, its row number, and its individual number in its particular row. Let us assume our book is on tier 4 which is designated "T4." It is in the 26th row (numbered from one side of the stack building wall). This location is designated by the symbols "R26." Let us further assume that the book we want is in a pocket shelf which happens to be the 114th pocket from the feed or leading edge of row 26. This is designated by "N114." Our book's shelf number would therefore be "T4R26N114." 

Let us assume that at the bottom of the pocket shelf (which holds the matrix and its book container with the book inside) there is a metallic bolt which is the only object which prevents the matrix and its container from slipping right through the pocket and out of its bottom end. To that bolt is attached a coil spring which keeps the bolt extended at least across part of the bottom end of the pocket. Near the bolt, but on the side of the pocket, is an electromagnet which is capable of withdrawing the bolt clear of the bottom opening of the pocket, should an electric circuit be completed. That circuit can be completed by dialing "T4R26N114" on a telephone type of dial at the circulation desk and then pressing a button. Just as the telephone dial completes an electrical circuit when you dial a number and it rings at the other end, so the same principle can be utilized here to withdraw the bolt which was holding the book and matrix in place.

Should the book be in circulation at the time, its empty container and matrix would not be heavy enough to suppress a spring switch which would operate a signal light at the circulation desk (this principle is equivalent to
that of the busy signal on a telephone). Should the book be there, it would suppress the switch which would give another colored light signal at the desk after the book's number was dialed to signify that the book was available.

By pressing a button after seeing that the book was available, the circulation attendant would release the matrix book container with its book from its pocket shelf. This container and its contents would slide onto a conveyor chute running directly below the row of pocket shelves. A conveyor chain would propel this book and its container to the leading edge of the row. The book and container would then fall into another similar conveyor chute running at right angles to the first one (see Figure 4). This second conveyor chain would carry the book to the corner of the stacks building and then slide the matrix book container unit with the book inside onto a steep spiral chute which would wind its way down to the circulation desk (see Figure 6).

At the circulation desk, the attendant would snap off the bottom end of the matrix book container, pull the book out, and charge it out to the patron. The attendant would then snap the matrix book container closed again and place it on a vertically operating elevator belt. The elevator belt would have attached to it at intervals rectangular boxes with two pairs of rods on or in each box (see Figure 5). One pair would fit through the holes in the matrix (see Figures 1 and 2). It would be on these rods that the matrix and container would ride vertically upward on the elevator belt. The matrix would remain firmly in contact with the rectangular box on the belt by virtue of a magnet. This close contact would have to be assured to enable the electrical circuit key on the matrix to work properly. This key would consist of 40 possible electrical contact positions for a 41 tier stack building (see Figures 1, 2, and 5). Only one such contact point on the matrix would be imbedded in an otherwise insulated strip of material which would fit next to the contact points on the rectangular box. Since the contact points on the rectangular box would be supplied with electricity opposite their designated tiers, that one contact point on the matrix would complete an electric circuit for the mechanism in the rectangular box only at a point directly above a certain specific tier (see Figure 5). In the case of our example this would happen above the level of tier 4. At the moment of completing the circuit, an electromagnet would release a spring-loaded mechanism in the rectangular box which would thrust out the second pair of rods. Because there would be no holes in the matrix for this second pair of rods, the matrix and its attached contents would be forced off the two other rods by which the unit was being lifted.

The matrix and container would fall onto a short slide chute which would guide the unit onto a device which would be triggered off by the impact of the
FIGURE 1
A MATRIX BOOK CONTAINER UNIT IN 3 DIMENSIONS
(Not to scale)

40 position keyed matrix
18 position keyed matrix

Strip of electrically non conductive material
One of 40 possible electric circuit points

Holes for elevator rods

Book container part of the entire unit
Book container opens from the bottom end to insert or take out the book
FIGURE 2
MATRIX RAILS, KEYED MATRICES
(Actual size)

Note flange at position 4. With no flange on groove 4 on rail "A" the matrix would drop off the rail.

Strip of electrically non conductive material
One of 40 possible electric circuit completion points
Holes for elevator rods

Note that this matrix is keyed to a combination of 2 flanged positions. The rail above the matrix is flanged on all of its grooves. This would enable the matrix to slide along the rail until both flanges opposite the 2 flanged positions on the matrix would no longer exist. At that point the matrix would fall off the rail.
FIGURE 3
SIDE VIEW OF RAIL GROOVE PRINCIPLE AND POCKET SHELVING
(Not to scale)

Flanged grooves on the rail are darkened and numbered 1 to 8.
"C" is a matrix book container keyed to position 4 falling off groove 4 on rail.

"D" is a row of pocket shelf ranges.
Matrices for range 2 are keyed with flanges in position 1 and one other position. Matrices for range 3 are keyed with flanges in position 2 and one other position except position 1. For the sake of demonstration only 8 grooves and positions are shown in this diagram.
FIGURE 4

DIAGRAM OF CONVEYER PRINCIPLE
(Not to scale)

Rail "B"

Matrix book container

Slide guide and pushing device

Reversible electric motor

Switch to stop motor

Propelling screw

Switch to reverse current to reverse motor

Conveyer chains

Conveyer rods

Pocket shelving

Conveyer sprockets

Matrix book container on conveyor chute on its way to the Circulation Desk

This diagram depicts a horizontal cross section view of a tier of conveyers and a row of pocket shelving. The lower conveyer is part of the next tier lower down to show how the conveyer for one tier is at the same time a conveyer for another.
FIGURE 5
THE ELEVATOR MATRIX BOOK REJECTOR BOX IN 3 DIMENSIONS
(Not to scale)

Rectangular box housing push rods and their operating mechanism

Holes through which the push rods emerge

Fixed rods on which matrix book containers are hung

Strip of electrically non-conductive material

One of 40 possible electric circuit completion points

Curvature of box to allow for rotation over pulleys at ends of the elevator. Pressure of the pulleys against the belt toward the curvature of the box could operate a device to retract the push rods to make them ready to push off the matrix book containers that might be placed on the elevator during the next ascent of the box on the elevator belt.

These are 42 strips of electrical conducting material on the under side of the belt. One strip remains constantly in contact with a supply of current while 41 of the strips only come into contact with an electrical current at the matrix rejection point for each of the 41 tiers. Only when the circuit contact point on the matrix coincides with the contact point on the box which is wired to a specific strip on the belt to complete a circuit does the matrix rejector mechanism become activated thus rejecting the matrix at its appropriate tier level.
The diagram shows only one sliding guide shute to start the matrices along the rows of "A" Rails. Yet in reality such a guide shute would be necessary for every row. However, only the one "B" Rail is required for each tier along with its matrix starting sliding guide shute. Similarly only one "A" Rail conveyer chain and conveyer shute is shown, yet one for every row is also required.
matrix book container unit to push that unit onto rail "B" in Figures 2 and 4 which would carry the matrix to its row (in our above imaginary sample, to row 26). At that point a short slide guide and pushing mechanism similar to the device near the elevator belt would start the matrix on its way along the rail "A" which runs the length of the row (see Figure 4). To propel the matrix along this rail and the other one for that matter, the same conveyer chain is used which operates the conveyer apparatus for the same row but in the tier above (see Figure 4).

This completes the cycle of the principle of automatic shelving and book retrieval except for a few minor matters not yet explained. The push rods on the elevator belt which pushed the matrix off the other two rods, would be withdrawn automatically into the rectangular box, thus reloading themselves mechanically after reaching the full length of their thrust. They would then be ready to repeat the same task on other matrix book container units. A similar reloading mechanism would be needed in the case of the two other pushing devices, used to guide and to start the matrices along their way on the rails (see Figure 4). It is perhaps not necessary to add that when a book is returned from circulation, the attendant (by dialing as explained above) must withdraw its empty matrix book container unit from its pocket in the stacks in order to put the book inside that container before being able to reshelve it. Nevertheless, apart from this manual task and the task of hanging the matrix onto the two fixed rods on the vertical elevator for shelving, the rest of the work would be done completely automatically if this system became a reality in some large university library.

What possible impact could this system of shelving have on the functions and philosophy of library service of a large university library? As an example of the size of the library that is being considered, let us take the imaginary case of a building whose structure is 250 feet square with 100 feet of height for stacks which would be built above three or more floors of other library facilities (see Plans 1, 2, and 3 on pp. 13, 15, and 16 for an idea of the type of facilities which could be typical).

Let us first consider the capacity of such stacks. In the first place, the stacks would not require floors for pages or patrons to walk on. Nor would there be any necessity for aisles. But because the rows of stacks on each tier would have rails with spaces below them to allow the book containers to move freely above the pocket shelves plus the height of the pocket shelves themselves to store the matrix book containers, then each tier would have to measure three times the height of the book container plus the height of its attached matrix, plus 1 1/2 inches for metallic framework bracing.

It is obvious that the books shelved by this method need not be shelved in any classified order since the stacks would not be open for the patron's
PLAN 1
THE MAIN FLOOR AND MEZZANINE OFFICE SPACE
(Scale: 1 cm. equals 20 feet)

A  Circulation Desk and entrance
B  Reference Library entrance
C  Bibliography Area entrance
D  Staff entrance
E  Mezzanine (Washrooms and cloak rooms are under cover of this floor except under rooms 1, 6, 7, 12, 13, 18, 19, and 24. This area is left open as part of the wide aisle which goes all around the library.)
F  Mail Room and Acquisitions area.

G  Cataloging Area
H  Periodicals Processing Area
I  Subject Specialists Evaluation and Indexing Area
J  Non Processing Library Staff Office Area
K  Author-Title Catalog
L  Catalog Work Tables and Bibliographies
M  Classified Subject-Topic Catalog
N  Rapid Selector Machines and Files of Index Tapes
O  Order and Receipt Files and Catalog

(Explanation note continues on following page.)
(Explanation note from plan 1 continued.)

a Book Elevator and Spiral Shute
b Reference Desk
c Reference Library Stacks
d Reference Study Tables
e Pillars and Buttresses
f Freight Elevators
g Passenger Elevators
h Rectangular Spaces in rows representing areas 4 x 5 feet
to accommodate a desk and chair in each space. There is
an aisle of at least 4 feet wide between each row of
desks. Since book trucks might be used in these aisles
in the regular processing procedure, there are aisles on
both sides of each desk. In this way, the trucks could be
confined to alternate aisles, thus leaving an aisle free
of book traffic for the library staff to have easy access
to each desk.

The book processing traffic in this library could be
made to flow in an orderly manner from the moment that the
accessions reach the mail room from the door or from a loading
platform next to the mail room to the time when these accessions
are ready for circulation from the stacks or any of the other
special collections libraries such as the current periodicals
library planned for the lower floor. By following the arrows
in plan 1 the accessions would be processed initially in the
Acquisitions Area. The Order and Receipt Files and Catalog located
near both the Acquisitions Area and the Accountants or Bookkeepers
offices in the Non-Processing Library Staff Area would enable the
process traffic to move without loss of time due to congestion or
due to excessive coverage of space. After the initial processing
in the Acquisitions Area, the accessions would move on to be
cataloged. Periodicals and other serials would move into the
Periodical or Serial Processing Area. From both the Cataloging
and the Periodicals Areas the accessions would be ready for indexing by Subject Specialists' Assistants. The Subject Specialists
would then be in a position to evaluate the accessions and to
code their evaluations along with the indexes on tapes for future
use by the rapid selector machines. Their desks could be placed
near the selector machines and near the Catalogs and the Bibliography
Tables. From this area in the processing part of the Library, the
accessions could be shelved automatically from the Circulation Desk
or taken to any part of the library building for future use.
PLAN 2

THE LOWER FLOOR

1 Archives
2 Manuscripts
3 Rare Books
4 Special Collections
5 Browsing Library
6 to 21 Seminar and Conference Rooms
22 Photo Reproducing Laboratory
23 Current Periodicals Room
24 Motion Picture Theater
25 Projector and Ticket Room
26 Lounge and Lunch Room
27 Kitchen
28 Print Shop and Bindery
29 Tool Room, Furnace and Utility Area
30 Carrels for Microform Readers and other Audio-Visual Equipment
f Freight Elevator
g Passenger Elevators
m,w Washrooms

Freight Elevator
Passenger Elevators
Washrooms
There are 1,074 carrels. The smallest is 4 x 6 feet in area. The narrowest aisles are 4 feet.

As many carrel floors should be added above the first one as will be required by the institution to accommodate its predicted future student, faculty and research scholar population.
perusal. They may be shelved strictly by size, and shelving by size even in standard stacks increases capacity considerably. Because the greatest space is consumed vertically by the principle of automatic shelving, it may be wise to store the books on their spines in their enclosed containers to have a minimum of height consumption. An advocate of storing books by sizing and turning claims a 60 per cent increase in capacity by combining these two methods of shelving on standard shelving ranges.

It may not be possible to compare the number of books that can be stored per tier in the same area between the system of automatic shelving and the system of standard shelving because each tier in automatic shelving would store only one book per vertical height. But for the same height, say 100 feet of vertical stack space, the number of tiers would be forty-one according to the tiers by book size breakdown as shown in Table 1; whereas only twelve tiers of eight feet each are possible in the same vertical height for standard shelving methods.

Nor can any comparison be made between rows of standard shelving with rows of automatic shelving. In automatic shelving each book and each row would be directly adjacent to the next one (separated only by the thickness of the walls of its aluminum container and the aluminum pocket shelf--see Figure 6) throughout the entire tier area with the exception of pillar space required in the building's structure and the space required for maintenance catwalks. For this reason the area of a square 240 feet along each side would be about the right estimate of usable space for automatic shelving in a building 250 feet square (outside measurement) with 50 foot modules supported by pillars one foot square. There would also have to be a dividing framework between each group or section of tiers which would store the same size books, because, if you will recall, the conveyer chains which would be used to propel the released matrix book containers below each row of pocket shelves, are the same chains that would normally be utilized to slide the matrices along the rails for each of the tiers below. When book sizes change between tiers, however, the rows would not be vertically in line any longer; therefore, these sections would have to be separated by a metallic bridgework. This bridgework, however, would contribute to the strength of the building. But even with these space-consuming factors caused by the technical nature of the system and the construction requirements of the building, the automatic shelving stacks in the cubic space of 250 x 250 x 100 feet would house 12,798,460 books (see Table 1).

This calculation is based on the percentages of book sizes in a collection as given by Fremont Rider in his book, Compact Book Storage. This capacity might increase or decrease depending upon the actual ratio of books per sizes for any particular collection. Lacking any figures for a complete breakdown of book sizes other than those given by Rider which are primarily for documentary material, his percentages were utilized in the calculations.
as shown in Table 1.

For automatic shelving it is also important to know the percentage of a collection which would have books, let us say, under 2 inches thick, 2 to 3 inches thick, and 3 to 4 inches thick. Most contributors to library literature agree that 2 inches is the average thickness of a volume in their calculations of shelving capacities. For example in one article the following quotation appears:

Six volumes equals the average capacity of shelving per linear foot if the collection is classified and space is provided throughout for growth. This is a commonly accepted, conservative formula for a college, university, or research library. 15

But for purposes of saving space in automatic shelving, exact thicknesses must be known. Because there is an absolute lack in library literature of any figures of this nature, 16 for the purpose of arriving at a capacity figure for compact shelving it was estimated that half of the collection's space would be occupied by books under 2 inches thick, a quarter by books up to 3 inches thick and the final quarter by books up to 4 inches thick (see Table 1). It might be commented upon here that the estimate is very likely to be extremely liberal for the thicker books; thus the total capacity calculated would be a low estimate rather than a high one so as not to make more out of the space saving point in this paper than realities would allow. It might also be added here that for practical purposes two thin volumes or even several pamphlets could be stored in the same matrix book container without complicating the retrieval or shelving procedures here proposed. 17 Should this be the case, even a greater number of individual items could be stored in the space which is here calculated to hold 12,798,460 volumes.

However, for purposes of comparison, an estimate has been made of the number of volumes which the same cubic building 250 x 250 x 100 feet would hold if standard shelving for multi-tier stacks were utilized. The estimate is given as 11,737,440 volumes. This would give automatic shelving an approximate 8 per cent increase in capacity for the same volume of building space. This increase is not as spectacular as the figures given by some of the compact shelving systems, 18 but automatic shelving does enable certain gainful advantages that can be geared toward better library service.

In the first place, the circulation staff could be reduced tremendously to a few attendants capable of handling the simplest of routines. This would free many library staff members to do other things. Because automatic shelving would close the stacks to the scholars and students, the library staff might take it upon themselves to provide more and better bibliographic service to their patrons. They could maintain, for example, two bibliographic catalogs. 19 One could be a classified subject catalog which would provide the
### TABLE 1

**CAPACITY CALCULATIONS FOR AUTOMATIC SHELVING**

Volume of shelving space considered is 240 x 240 x 100 ft. or 2880 x 2880 x 1200 ins.

<table>
<thead>
<tr>
<th>Book sizes in inches</th>
<th>Per cent of each book size per total number of books</th>
<th>Height in inches for each book size</th>
<th>Number of rows of books for the same book size</th>
<th>Number of books per each row in inches</th>
<th>Number of books 2 to 2 inches thick</th>
<th>Number of books 3 to 3 inches thick</th>
<th>Number of books 4 to 4 inches thick</th>
<th>Total number of books for each size of book in the stacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 x 8</td>
<td>25</td>
<td>24</td>
<td>9</td>
<td>9</td>
<td>216</td>
<td>320</td>
<td>2,073,600</td>
<td>691,200</td>
</tr>
<tr>
<td>6 x 9</td>
<td>29</td>
<td>27</td>
<td>10</td>
<td>12</td>
<td>324</td>
<td>288</td>
<td>2,488,320</td>
<td>829,440</td>
</tr>
<tr>
<td>7 x 10</td>
<td>25</td>
<td>30</td>
<td>11</td>
<td>11</td>
<td>330</td>
<td>261</td>
<td>2,067,120</td>
<td>689,040</td>
</tr>
<tr>
<td>8 x 11</td>
<td>11</td>
<td>33</td>
<td>12</td>
<td>5</td>
<td>165</td>
<td>240</td>
<td>864,000</td>
<td>288,000</td>
</tr>
<tr>
<td>9 x 12</td>
<td>4</td>
<td>36</td>
<td>13</td>
<td>2</td>
<td>72</td>
<td>221</td>
<td>318,240</td>
<td>106,080</td>
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<td>10 x 13</td>
<td>3</td>
<td>39</td>
<td>14</td>
<td>1</td>
<td>39</td>
<td>205</td>
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<td>49,200</td>
</tr>
<tr>
<td>12 x 15</td>
<td>3</td>
<td>45</td>
<td>16</td>
<td>1</td>
<td>45</td>
<td>175</td>
<td>126,000</td>
<td>42,000</td>
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<tr>
<td>Totals</td>
<td>100</td>
<td></td>
<td>41</td>
<td>1,191</td>
<td></td>
<td></td>
<td>8,084,880</td>
<td>2,694,960</td>
</tr>
</tbody>
</table>

1The combined number of books of each thickness per each 2880 inch row.
same convenience plus faster service than open stack browsing would provide. The scholar does not choose a book because of its physical color or appearance, even if it might attract his attention on an open shelf, but rather he chooses it because it contains information on the particular subject which interests him at the moment. An entry in the classified subject heading catalog could inform the scholar what the contents are of the book it represents.

Another catalog might be an alphabetical author-title catalog for those patrons who are seeking a particular book which is known to them. Because automatic shelving would shelve books by chronological order of their accession for each book size, there would be no reason why the author-title catalog would not be able to be kept nearly up-to-date with the latest acquisitions since the classified catalog entries might take somewhat longer to prepare. The author-title catalog would require only that the call numbers be added to the normal bibliographic entries. Both catalogs would provide, among other bibliographic information, the location call number of the book by tier, row, and book number. The retrieval of the book would be dependent upon its location call number. Any classification number used in the classified subject catalog entry would be useful only to the cataloger for filing purposes.

Still another service might be provided for the scholar. If every processed book in the library had its index coded and recorded on film strips, the Rapid Selector machine could be utilized. Those books without indexes could be indexed by student assistants or other non-professional library staff trained to handle automatic computer indexing machines.

The inventor of the Rapid Selector machine, Ralph R. Shaw, wrote:

Where intensive interpretation of the content of the literature, including analysis of every idea on every page of every issue of thousands of journals or reports, is essential, it may become possible, by use of machines like the Rapid Selector, to perform more bibliographic work than has been possible in the past, and perhaps even to perform bibliographical work of higher orders than could be performed by manual means.

The scholar would only have to present a topic to the bibliographic services librarian and within minutes he would have a comprehensive list of books and page numbers, perhaps even evaluatively coded as to whether the information was primary, secondary, documentary, comprehensive, current, and so on. Within another few minutes, with automatic shelving and book retrieval he would have the sources in his hands from the circulation desk.

The location codes on the Rapid Selector tapes could be designed in a
way so as to perform the same selection circuit closing function that the book selector dial would perform at the circulation desk, provided an interpretation machine of this kind for those tapes was also installed in the library. If this were the case, then all a person would have to do is feed the topic to the Rapid Selector machine and pick up the books which would begin coming down the retrieval chute very shortly thereafter. In other words the attendant would not even have to dial the location call numbers, and the scholar or student could take out a comprehensive collection of sources or have the selector set to retrieve only those sources of certain evaluated coded categories, such as documents or periodical articles and so on.

Service of this kind would not only meet the requirements of current scholastic needs but would even aid the student. From an article on the question of open or closed stacks, we learn of a librarian who closed his formerly open stacks for the following reason:

The closing of stacks seem justified because we felt that open stacks contributed to a general slacking in the systematic use of the library which seems a proper contribution of the library to undergraduate students. In short, there seemed to be too many students seeing just what the library happened to have on the shelf and not really learning what the resources are through proper conjunctive use of the card catalog and bibliographies.

Because this presentation is not intended to be a polemical dissertation against the merits of open stacks, it is only suggested here that the above situation of the student avoiding the bibliographical tools which are available in the library would become a less frequent occurrence if automatic shelving could shift more of the library's staff into work which would make the use of the bibliographical tools less of a burden to the patron.

The burden would not only be lessened by the use of this system for research and study book retrieval, but the service to the patron would improve notably if subject specialist librarians supervised the compilation of subject-topic indexes and evaluated their given reference sources. It is that kind of work which the subject specialists should be employed in rather than spending much of their time doing the clerical attendant duties in their departmental libraries, as is the case to a considerable extent today. With automatic shelving and Rapid Selector bibliographic service, departmental libraries and decentralized subject collections would become obsolete. They would become obsolete because a centralized automated quick retrieval system would serve the needs of any departmental faculty more quickly and with more bibliographical information than could be provided by the typical departmental libraries as we know them today.
Furthermore, duplication of acquisitions to meet the needs of the various departmental libraries as we know them would be reduced. This duplication today may be explained as follows:

The needs of many scholars do not coincide with the subject classification of books in a library. For example, scholars working in the new institutes in geographical areas will find some of their materials classified in practically all divisions of the classification system. Scholars don't want to spend much time working all over the stacks. What they want is to be able to assemble the library materials according to their new needs.²⁴

With a centralized circulation system, the library would have a better chance of really becoming the heart of the modern campus. This cliché would become a reality if the automatic shelving and book retrieval system in the library proposed here would become supplemented with carrels for every student and study rooms for the entire research faculty.⁵ In the suggested floor plan for a carrel floor (see Plan 3), it is possible to have 1,074 carrels with aisles at least 4 feet wide between double rows of carrels. Each carrel would be large enough to be furnished with shelves from the desk top to the ceiling as well as a full height book shelf from floor to ceiling behind the carrel chair. This would provide ample room for the students to keep their books there. If the carrels were enclosed and fairly sound proof, the students would probably do all of their studying and typing there. For the student, such a study carrel would be private and near a supply of additional books and abundant reference material, should these aids be required in the course of his studies. It would also be wise, therefore, to keep the library open twenty-four hours daily or as long as people can be found to staff it with at least attendant service at the circulation and reference desks.²⁴

Audio-visual rooms and microform reader and reproduction carrels also should be made available for use for long hours. They should be sound-proof and have rheostatic light intensity controls for the lighting fixtures, which in turn should be made adjustable for quick and easy positioning so that glare and shadows could be eliminated from the microform reader screens while at the same time providing ample light for the notebooks or typewriters that may be used in conjunction with those machines. Innovations such as these are entirely possible by utilizing present-day technical knowledge. They should be incorporated into a well-­planned and designed library.

In planning the library, the flow of traffic should be considered as well as other things. In the main floor plan (see Plan 1), the entrances to the library are placed at the four corners of the library. From these four points, different kinds of library use traffic would be initiated. Accessions and library
personnel could enter at "D" (see Plan 1). The book process could utilize an assembly line system which would advance the accessions in the direction of the arrows until the processing procedures would be completed nearest the circulation desk from which point the books could be shelved. Wash rooms and cloak rooms are placed conveniently near each entrance in the plan. The catalogs are placed in a direction leading toward the circulation desk. The subject specialists could have their desks near the Rapid Selector machines and the catalogs so as to be easily accessible to the patrons who would desire to have their help. The Reference Library at the opposite corner from the processing room has the aisles of its reading tables pointing toward the reference stacks. The rows of the stack ranges are at right angles to the reference desk. This enables the reference librarian and his assistants to have easy access to the stacks also.

In the lower floor plan (see Plan 2), traffic moves in either of two directions from each entrance. The print shop and bindery room are below the main floor processing area, therefore utilizing the same mail, delivery, freight elevator, and personnel entrance as is used on the main floor. The current periodicals reading room and the browsing room are near the lounge and lunch room. A lounge where students, library staff, and faculty members can take rest periods, discuss matters informally with their colleagues, or have lunch is an essential part of the library if the patrons and employees are to work in the library for long hours and if the library indeed is to become the heart of the university. Around the perimeter of the building are located rooms for special display collections, archives, manuscripts, rare books, and seminars or conferences. These rooms can take advantage of the natural light from the windows. The audio-visual rooms, the photo duplication laboratory, and the microform reader carrels are in the center square of the building. Most of these rooms require artificial and controlled lighting, therefore they need not be located on the perimeter of the building.

The building itself should be designed to withstand tremendous weight. Books are an extremely heavy commodity to store. Also the building should have large windows around its perimeter to allow maximum utilization of daylight. The main floor should be at least 18 feet from floor to ceiling with office rooms 9 feet high on mezzanine floors at each corner of the building. The carrel floors above the main floor should be at least 8 feet from floor to ceiling. Ceiling to floor thickness would need to be 2 feet if the bridgework bracing principle were to be utilized rather than reinforced poured concrete floors. A somewhat vertical extension of the building over the poured concrete principle of construction would be compensated with larger floor area modules between pillars. It is area of floor space that is more important to leave free of obstructing pillars rather than to crowd the building with pillars in order to have thinner floors. The dimensions given in this plan allow the
modules to be in multiples of five feet. An 8 or an 18-foot ceiling plus 2 feet of floor thickness would give vertical module dimensions of 20 and 10 feet respectively.

Good lighting throughout the library should be compulsory. James M. Ketch wrote:

It is obvious that reading, and other difficult visual tasks encountered in libraries, determine the objectives of lighting quantity and quality which are necessary for the visual comfort and efficiency of the visitors and employees.26

Air-conditioning should also be considered for the library. Ellsworth said:

Research is needed on all aspects of ventilation in libraries, particularly modular libraries, because they are 100 per cent dependent on artificial ventilation.

It may be, of course, that engineers know all they need to know about ventilation but that they are seldom allowed a free hand in planning, but I doubt if this is true. I am sure that the average architect and engineer has no conception of how to ventilate a research library.27

Air-conditioning, therefore, might present some serious problems in a library with a room as large as the entire main floor or as small as an enclosed carrel, but if any successful system can be developed, it should be kept in mind that a moderate temperature contributes to one's better ability to work and to study.

Horizontal modules of 50-feet square were chosen for the suggested library because such modules are about as large as are technically possible without having to have extremely great thicknesses of bridgework and cross bracings between the ceiling and the floor in between any two consecutive stories. You may note that the larger the module, the more space you have between the building supporting pillars. This matter was mentioned when the stack row dimensions were being described for the principle of automatic shelving. It might be suggested that because bridgework bracing enables large modules to be constructed, such bracings also enable extremely heavy loads to be supported by them. For this reason it might be suggested to the library architects and the structural engineers to construct a rather strong bridgework at the top of the building in order to suspend from it the tiers of stacks. Suspension of these tiers would not require more than a bridgework of thin angle iron, channel iron, and "I" beams to support the many volumes as well as the shelving machinery in the stacks. A suspended stacks structure
of this nature would not buckle under force of gravity, and reinforced concrete would be necessary only for the pillars and wall buttresses which would support the bridgework at the top of the building.

Therefore by cutting down on the amount of reinforced concrete in the building structure (which would otherwise only add to the weight of the building), by cutting out the necessity of having heavy poured concrete floors (which are found typically in most libraries with standard stacks), by utilizing the principle of suspending the heavy stacks (therefore eliminating considerable structural weight and space-consuming bracings), and by proposing a greater use of the bridgework principle in the construction of the floors for the suggested library (for more strength and less weight), it is this writer's opinion that the savings so made would largely offset the increased cost over standard shelving ranges for manufacturing matrix book containers, for manufacturing and wiring the pocket shelves and the elevator, for cutting the keyed rails, and for making the conveyer chains. Although it is impossible to know the exact cost of such a project without an extensive study of blue prints to estimate the hours required to manufacture all the necessary parts and to know the exact weights and costs of all the metals that would go into those parts, it is this writer's opinion that the cost would not be as fantastic as the project itself might seem to a lay audience.

From the charts of library construction cost figures for the years 1949-1954, it may be noted that the larger the library, the lower its cost per square foot. For example among the university libraries built in this period, the cheapest was at the State University of Iowa which had an area of 120,000 square feet built at a cost of $10.50 per square foot. The most expensive library built was the Lincoln University Library in Missouri which was only 12,810 square feet in area. Its cost of construction was $46.83 per square foot. In the case of automatic shelving stacks in a large library, it is worth considering that the cost of building the structure to house the stacks would be reduced considerably from the cost of building conventional multi-tier stacks of the same dimensions because there would be no floors or finishing required in the former case. A mere shell around a suspended bridgework of bracings, pockets, and simple machinery is all that would be required for the automatic shelving stacks.

Even if the principle of automatic shelving is fantastic, the idea may have merit for the reason given by Fremont Rider:

In invention, as in pure research, one can never tell what idea, in itself so fantastic as to appear utterly beyond the range of possibility, may, by some little quirk of change, lead to another idea that is at least remotely possible, and this in turn, by still another little quirk of change, to a third idea offering compelling practicality.
FOOTNOTES


6. The principle of the linotype and the system of monotype matrix casting was invented by Ottmar Mergenthaler and Tolbert Lanston, respectively, in 1885. Automatic type casting machines were, therefore, perfected and in extensive commercial use by the turn of the century.

7. The word "range" here refers to the group of book pockets which would be filled with as many books as any single flange combination would allow according to the keyed matrix principle.

8. It would be convenient for the library staff to imprint the location call number on the side of the matrix book container.

9. A possible method of operating this withdrawal of the rods is mentioned in a note in Figure 5.

10. In Figure 4, the reloading mechanism is dependent upon a reversible electric motor, but other methods of reloading could be devised.


12. In Table 1, where the dimensions of the rows are given, it is obvious that there would be 9 tiers for the section that would store the books 5 x 8 inches. On the other hand, there would be only one tier in the section for books 12 x 15 inches in size.

14. There are available statistics for book sizes from surveys done by Melvin Dewey and Burgoyne before the turn of the century. Also there are statistics on surveys of book sizes at Yale and Brown Universities according to Henry Van Hoesen and Norman Kilpatrick. But these statistics were made for the purpose of determining the average height of book shelves and give such figures as 87.5 per cent of the books are less than 26 cms. high rather than giving the exact percentages of all the other possible existing book sizes. For these general figures, see: Kaplan, Louis. "Shelving." In Ralph R. Shaw, ed., _The State of the Library Art._ New Brunswick, N. J., The Rutgers University Press, 1960, Vol. 3, Pt. 2, pp. 5-8.

15. Metcalf, _op. cit._, p. 103.

16. The studies of Robert W. Henderson of the New York Public Library yield some information regarding "Cubooks," which he defines as "the volume of space required to shelve the average size book in a typical library." His statistics present the average thicknesses of books from various categories such as fiction, reference, history, law, and so on. They also present the number of volumes of various sizes that can be shelved per bookstack section, but his figures do not give ratios or numbers of books out of an entire miscellaneous collection which would be of this or that size and thickness. Such ratios or percentages of books of various thicknesses would vary from library to library depending on the types of collections involved and for that reason perhaps there are not even estimates for such ratios in today's library literature. See: Wheeler, Joseph L., and Githens, Alfred Morton. _The American Public Library Building: Its Planning and Design with Special Reference to its Administration and Service._ Chicago, American Library Association, 1950, pp. 414-415.

17. Micro forms, slides, films, tapes, and records also could be shelved in the automatic shelving stacks. A row for special sized containers for the large reels and records could be arranged in the stacks. For many of the smaller audiovisual forms such as microfilm, microfiche, microcard, and small reels of films and tapes, matrix containers could be made into suitable sizes to hold a multiple number of units without wasting space. For example, a container 8 x 8 x 2 inches could hold four reels of microfilm. Even if the four films were in no way related in subject matter, the entries for each of these reels in the catalog would give the same location call number. The patron may only want one of these reels, therefore, leaving the remaining three to be returned to the stacks by the circulation attendant. The attendant would have to return the matrix container to the stacks anyway, even if the patron took all four of the reels.

19. These catalogs could be either computer printed book catalogs or card catalogs if space and time permits and experiment demonstrates that the card catalog is still more efficient than the book catalog.


23. As a matter of fact, in the suggested floor plans in this presentation for the Reference and other special collection libraries (see Plans 1 and 2), open stacks are advocated. The advantages of open stacks, however, diminish manyfold when their capacity is measured in millions of volumes.


26. Ibid., p. 21.


Additional References


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