USING BARCODE FOR CIRCULATION IN THE CENTRAL LIBRARY OF IIT BOMBAY

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INTRODUCTION

The Barcode Technology was introduced in the library of IIT Bombay in August 1991. Learning from the experience elsewhere was not possible as no information on the use of the technology in a library, particularly of the size of IIT Bombay, was available. The existing literature on the state of the technology in Indian libraries was too scarce in the first place. Secondly, it was not necessarily relevant in the context of large libraries. There was, a spate of literature discussing 'barcodes' at the theoretical level. But it was hardly useful for taking a crucial decision of introducing the technology in the environment prevailing in the country. The present study, therefore, will be useful for the librarians of large libraries who may be planning to use the technology. It may be stated that ever since its introduction, the technology has never failed and has been yielding the desired results.

BARCODE SYSTEM

The circulation function of the library of the IIT Bombay had been computerised well before the barcode system was introduced. On an average approximately 500 books are issued out of the library everyday and an equal number of books are returned. As examinations and semester-ends approach, the number of transactions rise to 1600 per day. The transactions are not evenly distributed during the working hours from 09.00 to 18.00. At certain hours of the day, for example the lunch time, there is a hectic rush at the counter. Speed is what is expected at such a time. Equally important is the accuracy in the recording of transactions. (As is well known, one error in an issue transaction results into two errors automatically. A book issued to a wrong reader does not get issued to the right reader). The computerisation of circulation function is based on the digits making up the accession number on one hand and the borrower's number on the other. At the time of each transaction it is these digits that have to be keyed in. For example, a faculty member at IIT is entitled to borrow 15 books. If he/she returns 15 books and borrows another 15 books and if the accession number of the book consists of six digits and the reader's code number consists of eight digits, the number of digits that the staff at the issue counter has to key in is $8 + 15 \times 6 + 15 \times 6 = 188$. All these have to be keyed in without any error, in the face of a possible disturbance from an often impatient reader across the counter. The minimum number of digits to be keyed in is six if the reader returns only one book. (For the return operation, the system does not require the reader's code number). The probability of error in keying in the number is no doubt very high. Added to it, is the time that is taken for keying in these many digits. The need for accuracy is very essential. It was, therefore, found necessary to adopt the technology that would not only achieve the required speed but also ensure the accuracy. Barcoding was the answer.

Barcode

Barcode is a series of black bars of varying breadths and white spaces between every two of them. The bars and spaces represent a series of characters or digits. Such types of barcodes are found in foreign countries printed on food packets, consumables, books, etc. These barcodes are readable only by a scanner which sends messages to the computer that decodifies the number of the digits. The computer identifies such bars as '0's and '1's (Zeros or Ones) and white blanks as "off"s or "on"s. Therefore, a barcode is a series of '0's and '1's representing characters or digits in such a form as only the computer can identify.

In order to use barcodes, it is necessary that each...
book or an issuable item in the library collection is attached with a barcode. The barcode needs to be printed with almost precision and pasted on a surface which is absolutely plain. It is also necessary to attach barcode to reader’s tickets in the same manner. The barcodes are read either by a wand or by a laser scanner. The respective advantages of using the wand and the laser scanner have been discussed in the literature.

Issue of books: The reader wishing to borrow books presents his/her barcoded ticket along with the books. The library staff after going in for the Issue-of-Book-Menu scans the reader’s bar-coded ticket and opens the reader’s account. He then scans the barcodes of books with the scanner. Each book thus gets automatically added to the reader’s account.

Return of books: When the reader wants to return the book to the library he presents it at the counter. The library staff goes in for the Return-of-Book-Menu to record the return of the book. He scans the barcode of the book which again automatically gets fed to the computer and the book is cancelled from the issue record. (It is not necessary to have the reader’s ticket while returning books). The whole transaction of returning five books and getting five books issued at the same time takes only two minutes.

The technology proved to be advantageous in two more, rather unexpected, ways. Firstly, it is common experience that in the service sector the beneficiaries have misgivings about mechanisation. The best way to win their confidence is by convincing them about the accuracy the system ensures. When the readers see that the numbers are read accurately, more accurately than even in the manual operation, it is easy to win their faith in the total process of computerisation. This was what was experienced when barcoding was used in the IIT library.

Secondly, the introduction of the technology was received as something ‘great’ especially by the younger generation. The students felt “proud of their library because of the most modern technology being used in it.

IMPLEMENTATION

It is one thing to identify the useful technology and quite another to implement it. There are managerial, administrative and financial problems. It was, however, experienced that the financial problem was not as formidable as it appeared initially. Funds were assured soon after the authorities recognised the benefits of the technology, of course, with a friendly warning to be as economical as possible. The problem of selecting the technology did not arise, as only one vendor in the market offered this technology and it proved, to the relief of all concerned, to be reasonably satisfactory. Thus the major problem was managerial. The task was to assign barcodes to 2,40,000 volumes of books and serials, and 4,500 reader tickets without a single error. The crucial issues were:

a) This was to be done with minimum interruption in the circulation service.
b) It had to be ensured that the new accessions would be barcoded during the period the project was on.
c) It had to be seen that after this operation was over the barcoding function would be integrated into the routine activities of the library so that the barcoding of the new books as well as of the tickets of new members would be continuously done.
d) Provision was to be made for providing barcodes for the existing books and reader’s tickets in case they got soiled, lost or incorrectly printed.

Several alternatives were available for each stage of the implementation. These are described in the latter part of this paper. After assessing these alternatives in the context of the prevailing conditions the implementation strategy was finalised. It was thought appropriate to test the viability of the system and so a pilot project was designed and launched.

PILOT PROJECT

The vendor was requested to provide his barcode scanner for the pilot project. Five hundred books belonging to the library science collection and seventy library staff members as readers were selected for the pilot project. Staff for the project was drawn from among the data entry operators and attendants and the computer time from the existing resources. Barcodes were generated
and the strips were pasted on to the books and reader's tickets. Issue and return of these books was carried out during the specific time during the day. The resources in terms of the time, manpower and stationery were measured. The technique adopted was evaluated. The distances in transport of books were measured and movement of personnel was observed and analysed. The time taken for the issuing and returning of books was measured. So was checked the accuracy in transaction. The pilot project was spread over a period of one month. The results of the pilot project were consolidated and accordingly the final operation was planned.

ALTERNATIVE STRATEGIES FOR IMPLEMENTING THE TECHNOLOGY

Strategy One - By Accession Number

It is possible to generate the barcodes by accession number at once and attach them to the books on the shelves. This, however, presents the following problems:

a) Since books are arranged by class number, it is a very complicated and time consuming exercise to locate the barcode strip of a given book from a whole lot of preprinted barcodes.

b) It is also not considered advisable to record author and the title or part thereof on the barcode to avoid a possible mismatch.

c) Because of the two different sequences, one of the books on the shelves and the other of the barcodes in hand, it is impossible for more than one person to work simultaneously.

d) It is difficult to identify the books which might be subsequently shelved after the barcoding is done.

This process, thus, creates more problems than it solves.

Strategy Two - By Class Number

It is possible to generate the barcodes by class number to match the existing arrangement of books. However, this process also creates its own problems.

a) Shelf arrangement is not necessarily always by class number. A lot of segregation perforce takes place in a large library. As a result, a lot of running after the books will be involved.

b) In an open access system, books get misplaced due to browsing by readers. Thus it may take a lot of time to locate many books.

c) Several books are likely to be out in circulation. It is a difficult task later to match the returned books with pregenerated barcodes.

d) Some books might have been lost, mutilated or withdrawn from circulation. Barcode generated for such books may create a problem.

e) Due to heavy handling involved in this process, the barcode labels are likely to be mutilated which may cause problems in scanning in the future.

f) The pasting of barcodes is an endless job and remains unaccomplished for a very long time.

Thus, whole process takes a lot of time and involves increased costs.

Strategy Three - In Shelflist Order

Since the shelf list corresponds with the arrangement of books on the shelves, the barcodes can be generated using shelflist cards. They can then be distributed to different groups who go on pasting them on the books in the shelves at different points in the library simultaneously. This strategy is also beset with problems.

a) There are two prerequisites- The shelf list must be properly maintained and the books must remain in place for a reasonably longer time. The later, is difficult to ensure particularly in an open access library.

b) The barcode has to be printed along with class number, author mark and accession number for identification of book the shelf.
c) Books which are out on loan and those which are being consulted are difficult to handle. If the number of such books is very large, special attention required to handle them may consume a lot of time and energy. Preservation and instant retrieval of barcodes of such books need special attention.

Strategy Four - Barcoding Individual Books at Hand

In this method, individual books from the stack room and the returned books from the issue counter (before shelving) are brought to a work station set up for the project. Each book is handled separately. A barcode is generated for the book in hand and pasted in the work room itself. The book is then sent to stack room.

In this method, the book is handled individually which makes a thorough checking and rechecking. This reduces the chances of error to the minimum, in fact, nil. As all books are sent to barcode workstation there is no possibility of leaving any book without a barcode. Following are some of the problems and precautions to be take care of in this process.

a) Special care has to be taken to maintain the sequence of books when they are being carried from the stackroom to the barcode room for making their barcode tables, as also when they are carried back to the stackroom for shelving.

b) The books, which are being barcoded, are not ideally available to readers for one working day. In reality, only a fraction of these may be called for by readers.

Strategy Five - Moving the Machine Along the Rack

In this mobile operation, books remain stationary on the shelves. All mechanics, data entry operators and attendants who paste the barcode to the book are moving from shelf to shelf within the stack area. They generate and paste barcodes to the books physically present there in the stackroom. The problems involved in this area are:

a) The manpower required is high and the time it takes is longer.

b) When the machinery is moving along the bays it needs a long line electricity supply, rendering the process unduly cumbersome.

c) The presence of men and machinery in the stackarea is bound to hinder browsing.

Of these five alternatives, the fourth was finally selected and adopted as it offered least disturbance in the normal working of the library. Monitoring the operation was easier and the chances of a chaotic situation developing in the library were almost nil.

GENERATING BARCODES FOR READERS

The clientele of IIT Library consist of the following categories of readers:

a) Institute staff
b) Students
c) Corporate members
d) Alumni
e) Retired staff

For generating barcodes it was decided to use the employee code number in the case of staff and the roll number in the case of students, both of eight digits. These eight digit numbers were not expected to be in conflict with the six-digit accession numbers. Besides, the six-digit limit of accession numbers is not likely to change for at least another twenty years.

The following alternative strategies for generating barcodes for readers were available.

Use of Personal Names

A list of all readers with their corresponding numbers (employee code, roll no., etc.) are compiled alphabetically according to the personal names. The barcode is generated in that order and pasted on the reader’s tickets by inscribing their names on them. As and when the reader comes, his card is identified by his name, and after completing necessary formalities like pasting photographs, attestation, inscribing his signature, etc., the ticket is given to him. This process faces the following problems:
a) All the problems of alphabetisation and those of personal names that one come across in cataloguing are faced while filling and locating the cards.

b) It is likely that all the potential readers do not enroll as users. This is especially true with the secretarial staff. To that extent, there would be a wastage of stationery.

Use of Reader’s Numbers

The barcode is printed according to the reader’s code number and pasted on the card. The cards are arranged by the code numbers. Since the employees and the students know their code numbers and roll numbers respectively, it is easy to identify their cards while issuing. It is possible to keep the cards in separate groups and divide the work of issuing the cards into various groups to finish the job faster. There were, however, two problems:

a) The process depends on the reader’s memory for recalling correctly his number.

b) Errors in the readers numbers during the process of barcoding may create problem.

STATIONERY OPTIONS FOR PRINTING BAR-CODES

It is ideal to print barcodes on self-adhesive labels with the help of laser printer to achieve the precision that is needed for laser scanner. However, this could be expensive and the quality of adhesive used for self-adhesive labels is also not guaranteed. The alternative strategy would be to print them on a reasonably good paper and paste with the help of gum or some other adhesive. This is cheaper but laborious.

LAMINATING THE BARCODED LABELS

Laminating the barcoded labels is ideal. Cost permitting, it can be adopted. Alternatively, labels can be pasted inside the book on the title page and near the date slip at the end to provide the necessary protection to barcodes.

FINDINGS OF THE PILOT PROJECT

The pilot project confirmed the following:

a) The issue and return of the books were easier and speedier.

b) Scanning of barcodes was easy and accurate.

c) Barcoding was the logical extension of existing automation of circulation in the library.

d) The misuse of the library facility was automatically checked. [In the earlier issue system in which presentation of reader’s ticket was not obligatory there was scope for impersonation which was a major problem at the issue counter].

e) During the implementation, the pilot project also revealed the following:

i) One data entry operator (DEO) can enter the required information at the rate of 40 books per hour. Thus, it can reasonably be expected that one DEO can handle 250 books per day.

ii) The printer takes 10 to 15 minutes for printing 200 barcodes (that is for 100 books, if barcodes are to be attached at two places for one book). This provides a key to working out the computer time for this operation.

iii) One sheet of 80 columns of paper can accommodate 30 barcodes (for 15 books).

iv) One attendant can cut and paste barcodes for 40 books per hour.

These findings were helpful in planning the final project.

NEED FOR TAKING UP THE PROJECT

It was obvious that barcoding 2,40,000 bibliographic items and 6,000 reader’s cards was an additional work for the library. It could not be done by stretching the existing resources of the library.

Additional provision had to be made for manpower, material and machines. It was necessary to design a time bound programme to complete
the operation. It was also necessary that during this operation the normal work of the library should not get affected. For all these reasons it was necessary to take this allocation as a project by itself with the required resources.

DESIGNING THE PROJECT

From among the various strategies described above those that were found to be most appropriate were adopted after considering the organisational, technological, financial constraints, and the demands of the library service. Following decisions were made for successful completion of the project:

a) Generating the barcodes and pasting them on each item must be done simultaneously. The book would be retained in the work station as long as it is required for generating its barcode and pasting it.

b) Each book would have the barcode at two places, so that if one gets soiled the other would be available for laser scanning.

c) Books would not be retained for the purpose for more than one working day.

d) The books which were being returned by the readers would be barcoded on priority basis.

e) Small workstation would be set up where generation of barcodes and their pasting would be done. The books would be transported to this workstation.

f) It was decided to see that the transport of books would consume less staff, time and energy and would not disturb readers and the staff in the stack area.

g) To ensure accuracy in the barcodes, it was decided to do checking at least four times during the procedure.

h) 1,000 volumes would be barcoded in a day.

i) The whole operation was to be completed within the period of 11 months.

j) It was decided that the Assistant Librarian (circulation) would monitor the work for books and the Assistant Librarian (journals) for the back runs of serials.

k) Following records would be maintained every day:

- Number of books brought to the work station
- Number of books entered for barcoding
- Number of books for which barcodes are generated
- Number of books for which barcodes are pasted
- Number of books which have been sent back to stacks after barcoding
- Stationery consumed
- Computer consumables used
- Stock provision of the consumables required for the next few days
- Manpower used during the project

LAUNCHING THE PROJECT

Staff

It was decided to employ four data entry operators and four attendants for the project. The staff required for the other services in the operation would be drawn from the existing human resources of the library.

Hardware

Following hardware were made available for 11 months:

PC - Five [four stand-alone for keying in and one for printing.]

Printers - two [the second was a stand-by to keep the work going undisturbed]

Laser scanners - two
Software

Software for generating barcode was supplied at cost by the vendor who supplied the scanners.

Stationery and other requirements were acquired as given in Table 1.

OPERATION PROPER

The work started in the month of February 1991. It was carried out on the working days during the working hours. The six book trolleys were utilised for transporting books from the stacks in the library. The personnel for transport of books from and to the work station were also drawn from the existing staff.

The books returned at the issue counter on the previous day were taken up first for barcoding. They used to be around 500. These books were treated during the first half of the day. In the second half, the books standing on the shelves were being taken for barcoding. The books were first handed over to the data entry operators who entered the data (Acc. No., Author-Title combination not exceeding 30 characters) and kept them in the same order as they were entered. After entering about 500 books, the barcodes were generated.

The barcodes were then pasted on respective books in an assembly manner and the books were kept in the same order as they were received at all stages. The completed lot would be carried the next day morning to the shelves. At this stage also the attendants would have a quick glance to check whether the right barcode is attached to the book by quickly checking the author/title and accession number (also printed on the barcode) of the book.

Throughout the period the average turnover of 1,000 books/items was maintained and the project was completed one month in advance, i.e., in 10 months.

The only snag in the procedure was that the books in circulation which were to be barcoded on a priority basis irrespective of their classification order had to be transported to the work station twice. But it was inevitable.

New books that were being added during the period of operation were treated as the books returned at the issue counter. Thus, the barcode

Table 1.

*Stationery and Other Items Required for Barcoding*

<table>
<thead>
<tr>
<th>Stationery</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better quality paper for printing barcode</td>
<td>20,000 sheets</td>
</tr>
<tr>
<td>Floppies</td>
<td>2 boxes</td>
</tr>
<tr>
<td>Ribbons</td>
<td>100</td>
</tr>
<tr>
<td>Tables for PC's and chairs</td>
<td>7</td>
</tr>
<tr>
<td>Big tables for cutting and pasting</td>
<td>2</td>
</tr>
<tr>
<td>Cutting knives</td>
<td>1 Dozen</td>
</tr>
<tr>
<td>Glass sheets for cutting</td>
<td>2</td>
</tr>
<tr>
<td>Scales</td>
<td>6</td>
</tr>
<tr>
<td>Paste</td>
<td>10 liters</td>
</tr>
<tr>
<td>Book trolleys</td>
<td>6</td>
</tr>
<tr>
<td>Empty racks</td>
<td>4</td>
</tr>
<tr>
<td>Scissors</td>
<td>2</td>
</tr>
<tr>
<td>Soap</td>
<td>-</td>
</tr>
<tr>
<td>Dusters</td>
<td>2 Dozen</td>
</tr>
<tr>
<td>Napkins</td>
<td>-</td>
</tr>
<tr>
<td>Stools</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 2.

Cost Involved in Barcoding

<table>
<thead>
<tr>
<th>Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Two Scanners including installation and maintenance and excluding custom duty.</td>
<td>Rs. 75,000</td>
</tr>
<tr>
<td>Computer time for 5 PCs and 2 printers for a period of 10 months</td>
<td>Rs. 35,000</td>
</tr>
<tr>
<td>Software for generating barcodes</td>
<td>Rs. 8,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Manpower</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Four data entry operators</td>
<td>Rs. 60,000</td>
</tr>
<tr>
<td>Four Attendants</td>
<td>Rs. 46,200</td>
</tr>
<tr>
<td>Hidden cost of two attendants and one supervisor</td>
<td>Rs. 30,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hiring charges</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6 book trolleys</td>
<td>Rs. 6,000</td>
</tr>
<tr>
<td>7 computer tables</td>
<td>Rs. 8,750</td>
</tr>
<tr>
<td>2 big tables</td>
<td>Rs. 1,000</td>
</tr>
<tr>
<td>5 computer chairs</td>
<td>Rs. 3,750</td>
</tr>
<tr>
<td>4 chairs/stools for attendants</td>
<td>Rs. 1,800</td>
</tr>
<tr>
<td>4 single sided book racks &amp; book support</td>
<td>Rs. 4,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stationery &amp; Consumables</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper</td>
<td>Rs. 5,000</td>
</tr>
<tr>
<td>Electricity Charges</td>
<td>Rs. 16,500</td>
</tr>
<tr>
<td>Cutters (4) and blades (4 dozen)</td>
<td>Rs. 600</td>
</tr>
<tr>
<td>Paste</td>
<td>Rs. 1,000</td>
</tr>
<tr>
<td>Foot rule steel (big size)</td>
<td>Rs. 200</td>
</tr>
<tr>
<td>Glass sheet</td>
<td>Rs. 500</td>
</tr>
<tr>
<td>Computer Ribbons</td>
<td>Rs. 24,625</td>
</tr>
<tr>
<td>Dusters</td>
<td>Rs. 200</td>
</tr>
<tr>
<td>Soap</td>
<td>Rs. 200</td>
</tr>
<tr>
<td>Napkins</td>
<td>Rs. 250</td>
</tr>
<tr>
<td>2 boxes of floppies</td>
<td>Rs. 1,200</td>
</tr>
<tr>
<td>Misc.</td>
<td>Rs. 1,000</td>
</tr>
</tbody>
</table>

| Total | Rs. 3,30,775 |
| Rounded to | Rs. 3,31,000 |
| Items (books which were barcoded) | Rs. 2,40,000 |
| Unit Cost | Rs. 1.38 per item |
for them got generated automatically and pasted. After the operation was over the work of generating the barcodes was made a part of the responsibility of Technical Processing Section where the classification and cataloguing are done along with the pasting and writing of labels and book pockets. The section was given a PC and printer along with the software for printing barcodes.

COST

A rough estimate of the cost is presented in table 2. It is worked out as per the prices, salaries as well as the exchange rates prevailing in 1990-91.

CONCLUSION

The technology is performing well and is found satisfactory for both the readers and the library staff. While greater efficiency is evident on the inner side of the counter, an equal amount of satisfaction is visible on the other side of it. While achieving one of the major objectives of library service, the staff shares with the readers the pride and pleasure of taking a stride towards the modernization of one principal library in the country.

Another observation is that the barcode technology may not be cost-effective in small libraries with a small number of borrowers. It may, however, be worth introducing in a library where integrated computer-aided library management is in operation. The total cost in that case would get distributed and benefits, however intangible they are, will get enhanced.

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