BARCODE SYSTEM IN LIBRARIES - IT'S USES AND IMPORTANCE

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Barcodes are self contained messages with information encoded in a series of black bars of varying breadths and white spaces between every two of them. These codes have found varieties of applications in different fields, including library and information services. The features, advantages and use of barcode system in libraries with particular reference to its implementation in Space Applications Centre (SAC) library have been discussed.

INTRODUCTION

Barcode is not a new technology, as many of us would think. It has been around since the late 1940s and saw its first commercial use in 1960 as a method for tracking rail road cars. Since then, this automatic method of identification has been found wide acceptance in the grocery and materials handling industries. The reasons for its success are

i) barcode labels are produced with standard printing techniques;
ii) they may be read with great speed, accuracy and reliability using moderately priced reading devices; and
iii) standard symbologies have been developed that allow a label, printed by one company to be read by any other company.

A number of possibilities exist for using barcode. One such possibility is its use in libraries. The Kentish Town branch of CAMDEN Public Library was the first library to use the Plessey Light Pen System in 1972. A U.K. firm, SB Electronic Systems, has a barcoded label. Another method of barcoding, known as Codabar, is used by Geac in library circulation system. The University of Surrey library uses a barcoding method known as '2 of 5' and these labels are 'read' by microprocessor based lightpen terminals. Many American libraries use Code - 48 which includes alphabetic characters.

While the patterns of barcodes have become a familiar symbol for everyone in developed countries due to their appearance in all food and grocery packets, personal products, garments, books, records etc., in India various courier companies, AIR India and manufacturing industries & companies have used barcodes for their products, inventory control & shares. Only few libraries, such as, Sri Jaicham Raja College of Engineering (Mysore), Anna University (Madras), Indian Institute of Technology (Bombay), etc. have made efforts to introduce barcodes for their library activities.

WHAT IS BARCODE

Barcode can be defined as a self contained message with information encoded in 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. These are readable only by a scanner which sends messages to the computer that decodes the number of the digits. The computer identifies such bars as '0's and '1's (Zeros and 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 can be identified by computers only.

CODE AND SYMBOLOGY

A code is the combination of numbers and characters that represents an entity, such as, a part number. The symbology is the language used to represent the code in a machine-readable form. The code represented by a combination of bars and spaces of varying width is called the barcode symbol.
SYMBOLOGIES FOR LIBRARY APPLICATIONS

There are many symbologies for barcodes. In fact, there are more than fifty different coding schemes with five of them being in common usage i.e., (1) European Article Numbering (EAN); (2) Universal Product Code (UPC); (3) Interleaved 2 of 5; (4) Codebar; and (5) Code-39. The first three are only numeric. There is a facility in Codebar to enclose $, -,-,: ,/, ,+, %, in addition to numerals.

Code-39, also known as code 3 of 9, is alpha and numeric. The code can be of any length and all the capital letters of the alphabets as well as numerics and the additional characters of $,-, : ,/ ,+, %' and 'space' can be enclosed. Lower case letter can not be enclosed. Code 39 is always started and ended with an asterisk (*), known as the start/stop character and * may be used only at the beginning and end of the code. In Code 39, bars and spaces are used to encode an individual characters. Each character is represented by 5 bars and 4 spaces. Each of these elements are wide and six are narrow. 43 characters can be encoded using Code 39 which is bi-directional. This means that whether an operator scans a barcode from left to right or right to left, the reader can interpret the symbol and transmit the data in proper sequence.

Today, computers are alpha-numeric, and as a part of basic computer technology, barcodes also should be alpha-numeric. Code 39 is alpha-numeric whereas the other codes are numeric. This feature has been the dominant consideration in its adoption by libraries and by several major industrial segments. Among the symbology codes, available with the Space Applications Centre (SAC) library software for generating labels, Code-39 has been configured.

BASIC REQUIREMENTS FOR BARCODE APPLICATION

The following are the basic requirements for implementing barcodes in library applications. Complete barcode system plan at Space Applications Centre (SAC) library is given in Figure 1. The hardware and software required for this purpose are

i) Personal Computers (IBM compatible);
ii) Barcode Scanner to read the barcode labels, which can be a contact or non-contact type;
iii) On-line Scanner (connected with computer for issue/return process);
iv) Off-line Scanner (useful when there is no light and also for physical verification, user statistics, etc);

v) Decoder (External or Inbuilt) which translates the scanned data into ASCII character stream before it is fed into the computer;
vi) Printer (Dot Matrix, Laser, Thermal);

vii) Communication software;
viii) Printing software;

ix) Books/periodicals (document) database;

x) Laminators (sheets or stickers, laminating roles, membership card pouches, laminating machines, etc);

xi) Membership database; and
xii) Library software.

IN-HOUSE GENERATION OF BARCODES

Different printing technologies - Dot Matrix, Direct Thermal, Thermal Transfer, Inkjet and Laser are available for generating barcodes. Out of these technologies, Dot Matrix printers are capable of printing fairly a low-cost and lower quality symbols. Besides, they are not abrasion resistant. On the other hand, Laser printers are capable of printing high quality labels that tolerate reasonably rough treatment. But, this type of printing is expensive when one or two labels are required. Since the quality is the dominant factor in libraries, Laser printing is considered desirable. At SAC Library, Laser Jet Printer is used for generating barcodes. The procedures adopted for printing barcodes are as follows:

i) Barcode printing software known as Bar print II and Ezybar is loaded into the computer memory. It can print barcoded labels using different barcoding symbologies. Salient features of the software are listed in Appendix;

ii) Configuration file is created in which parameter setting, such as, printer selected (Laser), fixed field and variable fields & matter, is done. Selection of barcode symbology, label format, density, page format, printer type, etc. are carried out before printing the barcodes;

iii) Separate file is created for data to be printed;

iv) Parameter setting is again displayed for making changes in the setting, if necessary;

v) Laser printer is set ready and then print command is typed; and
Fig. 1: Complete barcode system plan at SAC library
vi) Now, the barcode representing the data is printed.

Based on accession number, two labels for each bound volume of periodicals are generated. Each sticker sheet contains eight barcode labels i.e., Barcodes for four bound volumes. Figure 2 provides the example of each labels and membership card. The sticker sheets are laminated with the help of a document laminating machine. Vertical and horizontal perforations are then made to facilitate the preparation of peel-off labels. The two-off labels prepared for each volume are then pasted in convenient places of the volume i.e. front & back.

For members, single barcode, based on the ID number allotted by the SAC Library (i.e. payroll number which is unique for each person), is generated for each member. Library membership cards are printed on Japan drawing sheets and cut. After getting user’s and librarian’s signature, the whole card is then laminated to withstand wear and tear.

Strategies for Generating Barcodes for Readers

Following are the two strategies by which membership cards work can be managed.

i) Use of Personal Names: List of all staff members with their corresponding pay roll number (ID Number) can be prepared in the alphabetical order of their surnames. Barcode cards are also generated in that order. However, in this strategy the problems of personal name, etc. may occur.

ii) Use of Payroll Numbers: A list is prepared according to the payroll numbers. Cards are also printed in that order. After cutting, these are similarly arranged which are easy to locate.

SAC library adopted the second alternative of payroll number and did not find any problem.

Strategies for Generating Barcodes for Books

For books, to reduce the regular processing work of stamping and number writing, a special label is designed as shown in the Figure 2. Sticker sheets with eight labels are printed, laminated and cut to paste on books. For managing label generation and pasting on books followings are the alternatives:

i) By Accession Number: It is possible to generate the barcode by accession number at once and attach them to the books on the shelves. However, while actually working, certain problems are faced. Because of the two different sequences - the books on the shelves and barcodes in hand, it is impossible to locate the barcode strip from a whole lot of preprinted barcodes. It is also not possible for more persons to work simultaneously.

ii) By Class Number: It is possible to generate barcodes by class numbers to match the existing arrangement of books. Likely problems to be faced are that in an open access system, books get misplaced which may take a lot of time to locate; for books which are issued, it becomes difficult to match later the returned books with pregenerated barcodes; barcodes generated for books which have been lost, withdrawn or transferred may also create problem.

iii) By Shelflist Order: Shelflist corresponds with the book arrangement on the shelves. Hence, barcodes can be generated using shelf list cards. It can also be distributed to several groups. Problems hidden in this strategy are: a) shelflist must be properly maintained, b) barcode has to be printed alongwith class number, author mark and accession number, and c) special attention is required to handle barcoded books, books being consulted etc.

iv) Barcoding Individual Books at Hand: Individual books from the stack area and daily return are brought to a room where barcode work is carried out and, only for these books barcode is generated and pasted. This reduces chances of error to a minimum due to thorough checking and rechecking. When books are taken from stack room to the computer room and when shelved back, special care needs to be taken. A book which is under barcode work are not ideally made available to the reader for one or two days. However, this method creates less problem in
Fig. 2: Labels for bound volumes of journals, books and membership cards
normal working of the library. SAC library has decided to carry out work with this strategy.

BARCODE BASED CIRCULATION SYSTEM

Before the details of barcode based circulation system is discussed, it is necessary to study the difficulties experienced in the manual and computer based systems for such activities so that the usefulness of barcode based system is appreciated.

Difficulties in the Manual System

Till the development of automated circulation control system in the recent past, the manual system has been in use in libraries. Some of the difficulties faced for it's operation are:

i) charging and discharging of books are time consuming, as stamping of due dates and other data entry work have to be carried out;

ii) maintaining of records for employees and temporary members occupies more space in the counter. In case cards are used, trays are to be moved from one place to another;

iii) reservation of a book under issue is a tedious job in some cases as, depending upon the system followed, the counter staff may have to verify all the trays to ascertain the borrower and due date. Similarly, difficulty is faced to know the status of a book;

iv) for issuance of a clearance certificate, there is no other alternative than to verify borrower's records and other document trays to ascertain whether any book is pending against a borrower or not; and

v) time involved in the preparation of reminders for overdue books and follow up activities are considerable.

Overcoming the above difficulties for better, efficient and fast services has been possible only with the help of computers for their speed and amount of data storage capability and powerful library software. SAC library has installed Pentium Microprocessor, and automation is managed using LIBSYS, an integrated software package, on Unix platform. Through computer based circulation system at SAC library it has been possible to ensure improved efficiency and better control.

Computer Based Circulation System

In a computerised circulation system, there is no need to maintain and issue multiple borrower cards with unique identification numbers. Each member needs only a single card with unique identification number (viz. pay roll number) to be used by the software to access member database, and the multiple borrowing facility is controlled by the software. In SAC library database, for different kinds of documents different types of unique accession number is given viz., for books, only numeric accession number 1,2,3 etc., for bound volume of journals BV1, BV2, etc., for standards S1, S2, S3, etc., for Reports R1, R1, R3 etc.

In this system, a member presents to the circulation staff his identity card and the document to be borrowed for issue. The circulation staff inputs the identity number and activates his borrowing status which gets displayed on the computer monitor. The circulation staff then, depending upon permissibility of further borrowing, enters the document accession numbers. The software computes the due date for return and accordingly, the entire details are displayed on the monitor. The document can then be issued. The database is also ready for any query on the availability status. Thus, with ease, the entire operation can take place without any loss of information and control.

Though, the computer system is proved to be highly efficient, there is still a need for circulation staff to input data like, member code, accession number etc., into the machine. This often slows down the entire process. Further, there may be data entry errors which reduce the efficiency of the system. For example, if a user at SAC is entitled to borrow 5 books and 3 bound volumes of journals and 2 other documents, and if he/she returns 10 documents and borrows another 10 documents and, if the accession number of the documents consists of eight digits and also, if the digits of staff ID number consists of five digits, the number of digits that the issue counter staff has to key in is $5+10\times8+10\times8=165$. The probability of error in keying the data may be quite high. Time required is also higher as accuracy is essential.
To overcome the above problems and achieve maximum efficiency, there is a need to further improve the automation of circulation system. This can be done only through automation of data entry which can be achieved through barcodes.

**MERITS OF BARCODES**

As has been already described, barcodes are series of black bars and white spaces which represent characters. They are used to automate data entry. The merits of the barcodes over manually keyed entries are

i) **Accuracy:** Accurate data entry is possible with barcode;

ii) **Speed:** Data entry is very fast, typically, key entry personnel enter data at a rate of two to three characters per second. Barcode data entry rates are often 30 characters per second;

iii) **Translation and transposition errors are not there; and**

iv) **Reliability:** Error in barcode data entry is very negligible. Statistics reveal that key operator makes one error in every 300 characters entered. When barcode data entry is used, the error rate can be reduced to one in every three million characters.

**BARCODE READING**

In libraries, barcodes are produced using the symbology CODE-39 that can be read by Pen type scanners and Laser scanners. SAC library uses Laser type scanners. A library must use both online and offline scanner to meet the situation of no power supply. At present, the SAC library has only online scanner. The tip of the scanner is blinked on the code from a distance of 10 cms. to about half a metre. The scanner is connected to the computer terminal through a decoder. When the barcode representing the accession number is scanned, the accession number will be decodified and the details of the book with corresponding accession number will be displayed. Similarly, when the barcode representing the membership numbers is scanned, the details of the member will be displayed. The information is converted into a series of voltage variations. The decoder uses a mathematical algorithm to translate the electrical impulses into binary codes and transmit the encoded data to a computer.

**OPERATION OF BARCODED SYSTEM**

As a first step for introduction of barcodes in circulation control system, it is necessary that the holdings (complete database), accession numbers and member identification numbers are converted in barcodes. The barcodes for documents can be generated in-house in the form of peel-off labels, laminated and pasted on each document. Library membership cards, eight per sheet are printed, cut & laminated with pouches. Once these initial procedures are over, the operation can be instantaneous, as the circulation software is also available. The borrower needs to present his barcoded identity card and the bar coded books for issue. The circulation staff scans with the laser scanner across the barcode on the member card. Immediately, the details of the user are displayed on the monitor and the cursor will stand at the accession number. Next, the barcode on the document is scanned. As in the case of member, the details of the document is also displayed. The document can then be issued to the user. Multiple borrowing facility and computation of due date etc. are taken care of by the software.

As no entry of any codes are involved and with a substitution error in barcodes being as low as 1 in 3 million character, the circulation system can be under the control of a low-cost, accurate, fast and highly reliable barcoded automation. Like-wise, all operation like returns, renewals, reservations, etc. can be performed just by a scan.

The barcoded system with a good circulation software will be a boon to any circulation activity. It is easy to use and very little or no maintenance is required to operate the system. However, it is necessary to educate the users with the need to care for the barcode labels on the books. To avoid wear and tear of labels, SAC library prints the labels using Laser printer and laminates the labels before pasting them on to the document.

Apart from accuracy, speed and reliability in issue and return procedure, there are many other applications of barcodes, once the system is functional. These are mainly for generating user statistics, physical verification of books, etc.
BARCODES FOR GENERATING USERS' STATISTICS

Normally in any library, big or small, a gate register is maintained wherein the members are required to enter their details and sign, as a token of their visit to the library. With the help of the gate register, monthly/yearly statistics cannot be given instantly. Moreover, the data entered may not be accurate in all cases due to mistake or otherwise. When barcodes are used, it is not only possible to overcome these difficulties, but also hourly/weekly/monthly/yearly statistics could be generated instantly. These statistics are useful for various purposes, particularly improvement of library services.

The procedures that can be followed for the implementation are

i) to ensure that the membership database is updated and all the member identity cards are barcoded and laminated;

ii) to install the off-line scanner at the personnel check counter. Off-line scanner is preferred as it is not going to be used continuously. It is used only when a member enters the library;

iii) to ask the member to deposit his barcoded library membership card;

iv) to scan the membership card and return to the user; and

v) to download the data to the computer through communication software after every two thousand scanning or other decided period for statistics.

A good software will help to generate required statistics instantly.

The use of barcodes in this area at SAC library is still in the planning stage, though its use in circulation system is under progress.

BARCODES FOR LIBRARY INVENTORY

There are various methods available for stock verification. One method is based on accession number and the other is based on shelf list cards, prepared for the books. These methods involve considerable time of the verifying staff besides human error. Even in large libraries where computers are used for verification, the accession numbers have to be keyed in to the computer, as they are the key numbers. When barcodes are used for this purpose, data entry is automatic and saving in time is ensured. The possible implementation procedures are as follows:

i) the holdings data-base of the library is to be updated;

ii) it is preferable to use off-line scanner as there may not be adequate plug points in the stack room;

iii) as barcodes have already been pasted inside the books, these may be scanned. Scanning may be done starting from the first stack to the last one;

iv) after every two thousand scanning, the data are to be downloaded from the scanner into the computer with the help of communication software;

vi) with the help of a good software the list of books not scanned can be obtained;

vii) the issues, binding, transfers to other divisions etc. can be consulted and a final list of books not scanned may be prepared; and

viii) this list relates to the books found missing.

BARCODES FOR PERIODICALS CONTROL

For periodicals control system, the primary task is to develop a database of periodicals holdings and assign code numbers for each periodical. Each periodical record may contain information such as, title, volume no., year of publication, frequency, publisher, price etc. The database may be updated periodically. For each periodical, barcode is created, based on the code number, and pasted on the lower card maintained for each periodical in the kardex system.
When a particular issue is received, its respective barcode is scanned for months and issue numbers. With the help of software, a print out list of issues of various journals not received are prepared and reminders generated are sent. However, the procedure described above is still in the conceptual stage and needs to be tested to find out its efficiency.

CONCLUSION

Many libraries in India have already started implementing modern technologies such as, computer technology, on-line technology, CD-ROM technology, reprographic and micrographic technology etc. Barcode system is now being considered as an effective addition to support automation process. Barcodes can eliminate human errors and are considered in terms of reliability of information, ease of use, speed of operation and response. Barcode has distinct advantages over other techniques like, manual data entry, magnetic stripes, Optical Character Recognition etc. SAC has realised this and is making efforts to introduce this technology also to ensure savings, accuracy, increased efficiency and improved services to the users.

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Features of the Barcode Printing Software used in SAC library

Following are the salient features of the software.

* Prints Industry Standard Symbologies as listed in the following:
  
  - Code 39 (with or without check digit)
  - Interleave 2 of 5 [ITF] (with or without check digit)
  - Codabar
  - Code 128
  - UPC-A
  - UPC-E
  - EAN-13
  - EAN-8

* Page Formatting Facilities (Page type, Size, Label Size, Label Gaps)

* Label Formatting Facilities (Eight fields per label, Fixed, Variable, Incremental data type)

* Can print up to 8 fields in a Label. Four of these eight fields can be "Variable Fields", while the other fields should be "Fixed Fields".

* "Variable Fields" can have either randomly "Variable" data made available in an external "Text File" or can be an "Incremental Field".

* Supports wide variety of printers. Currently following printers are supported by the programme.
  
  - Dot-matrix Printers (using ESC-P Command set)
  - Inkjet Printers (using PCL-3 Command set)
  - Laserjet Printers (using PCL-5 Command set)

* Simple User Interface.