Changing Library Buildings & Organization
Automated Storage System in Japanese Libraries

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In the 1990s various new computer technologies started to have a major impact on the nature of materials, services, and management systems utilized within Japanese libraries. Automated storage systems are the latest type of computer-controlled, high-density, compact storage for library books, and are the result of integrating industrial technology with online library catalogues. Today, I would like to introduce and share with you the system that was installed in the new library building at International Christian University, Tokyo, as the first model built in Japan.

A new library building, an extension of the existing building, was completed in 2000, and the storage system was installed underground on two floors. It attracted the attention of many librarians and library directors throughout the country who were facing space shortage problems. They watched with great interest to see how this system would work, and as soon as the building was completed, we received visitors from no less than 50 institutions. Apparently the visitors thought it a success. In the five years between 2000 and the present day, 16 automated storage systems of many designs and sizes have been built in the country by university, public and special libraries by Nippon Filing Co. Three others were built by other manufacturers and a few more are being planned. (Fig. 1) I would like to discuss the background that led to the installation of the automated storage system, the software and hardware of the system by showing you a CD-ROM, and then discuss the benefits and issues raised by the system.

Although it is bit too early to fully evaluate the system in five years, I can state that it has proved to be an effective tool in providing a flexible approach to restructuring our library services and organization in the hybrid environment of printed and digital resources, and especially when we are expecting more changes to come.

Background of Installation

Japan is one of the largest publishing countries in the world. The statistics provided by the national publishers association shows 77,000 titles were

published in 2004, over 95% in the Japanese language. 10,000 titles are said to be scholarly or academic books that are purchased by libraries. Many large academic libraries buy multiple copies for divisional libraries and they also purchase general or easy reading type books, so that the annual average increase in titles held in collection for over 500 private universities is 7,000 books. The Internet, digitization and many other factors have hit the publishing industry, resulting in a decline in total sales for many years. However, the statistics show that the number of published titles is steadily increasing instead of decreasing, and some analysts attribute it to an amplification of interest of the public, which has been aroused by various new media.

The figure shows the number of holdings of university libraries. I am certain this total library holding is very large compared to that of many countries in Asia. The national university accounting system does now allow the easy weeding-out or withdrawal of library books from the collection and most universities regard the possession of a large collection in a beautiful and distinguished building as a proud and valuable asset. A nation-wide library network provides a very effective interlibrary loan system and photocopy services, resulting in a higher degree of shared materials which eases the pressure on individual libraries' holdings. Digitization may affect library holdings sooner or later. However, at present, the library holdings continue to increase. For all university libraries, shortage of space is a serious problem especially in metropolitan areas, where land prices are incredibly high.

The International Christian University was established in 1953 in the suburbs of Tokyo. The mission of the university, as the name implies, is to educate students to become international citizens in the basis of Christian teaching. The ICU is small, with 3000 students, teaching is bilingual, and is the only liberal arts college in Japan. Built after the American model of undergraduate libraries, the ICU Library has made unique steps in Japan to encourage use of library materials as the primary goal of the library, while most university libraries at that time developed as research libraries.

Among the unique features of the ICU library are its bilingual collection and reserve books, its central library system and a policy to lend unlimited numbers of books to students. Although it is common in all libraries today, our open stacks, which were new to university libraries in the1950s, subsequently became a model for libraries throughout Japan. As a result of these features, the level of library use is very high, represented by the highest circulation record in the country. Today, each student borrows average of over 60 books a year.

In the 1980s, when the holdings reached the limit of 300,000, the library began to send the excess holdings to a remote commercial storage. Although these books were mainly research materials or comparatively less used items, it caused great inconvenience to users and the student body and faculty naturally considered this to be a serious crisis. By the mid 1990s, one third of the holdings were in the remote storage, and this represented a significant and increasing cost for the University Administration.

Finally, in 1995, the Board of Trustees approved an extension of the library building. The extension plan was based on a paper submitted by the Library Director after an extensive assessment project conducted by the library staff. The mid-1990s witnessed the start of a multitude of changes within libraries in Japan. The nation-wide academic network and internet access became available for all libraries. It was the beginning of shared cataloging, library consortiums, and library cooperation. Information technology was expected to change library materials from printed to digital formats. It was expected that these changes would eventually affect library user behavior and library management, and learning at the university itself. All the library related papers stressed "from holding to access", and analysts discussed decline of the traditional type of library.

The paper made a projection for next generation library services and proposed that the Library building had to be designed to meet the needs of future students and be able to accommodate an unpredictable scale of change. The paper discussed how books should be kept and provided in the future, and proposed the alternative to open stacks, which were considered a major benefit in encouraging library use. Open stacks were especially welcomed in our bilingual collection to enable easy access and browsing regardless of language. However, it was not possible to indefinitely add more shelves or create additional space. Given the high cost of floor space in Japan, space would be of greater benefit for use by people than for the storage of books. Among the various storage systems considered, the paper recommended the Planning Committee to explore the possibility of an automated storage system.

UC Northridge Library built the first automated storage system in the USA in 1990, and a few years later in Japan, Nippon Filing Co., a library equipment manufacturer, began building and testing a model of an automated storage system. Discussion on storage systems continued for more than a year. Efficiency, safety, cost-effectiveness, management costs of closed stacks, electric movable shelves and automated storage were all scrutinized and compared, and finally the Board of Trustees approved the installation of the automated storage system in underground floors. Technical matters and efficiency were certainly a major issue, but questions

of durability and safety against emergencies and earthquakes took long hours of research to convince the Board members.

Building and Installation

The design of the storage and software systems began in 1998, and construction started in 2000. I will show you a video in a minute, but the storage system size is 50m long, 17m wide and 5m high and is composed of steel racks. The capacity of this storage system is 500,000 books. There are four isles of racks that hold 13,014 containers, each of which can hold a maximum of 50 books. Four computer controlled stacker cranes between the isles retrieve and replace containers. When a system receives a message to retrieve a book, the cranes takes out the container from the racks, bring it to a horizontal carrier then to a lift to bring it to the operating station on the user floor. Retrieval is directed from any terminal on campus, and when a container is moved to the operating station, the operator, directed by a display on a PC, picks up a book and places it on a bookshelf. The required time for retrieval is about two minutes so that by the time a user walks to the shelf, the book is ready and waiting. 40 containers may be brought up to the station in an hour. Returning the item to the container follows the same procedure in reverse and requires the same amount of time.

The new building was designed based on the structure and size of this storage. Prior to the completion of the building, all the 550,000 books were barcoded to link the system with our OPAC. One of its special features is the free location system, whereby any book can go into any container. This feature was particularly effective in storing 150,000 books smoothly and speedily in the three weeks following the completion of the storage system. It started operation in September 2000.

View CD

Benefits and Issues Raised by the System

Saving of space: The major benefit of ASRS is a dramatic reduction in storage space. One report says it could store books in 1/12 of the space of open stack shelving at a 1/4 of the cost. [1] Our 1995 paper reported that the ideal shelving density in open stacks is 150 books per square meter, allowing space for new additions and including walking space between the

[1] Sarah Elizabeth Kirsch, Automated Storage and Retrieval—The Next Generation: How Northridge's Success in Spurring a Revolution in Library Storage and Circulation, ACRL, Ninth National Conference, April 8-11, 1999, Detroit, Michigan ` www.**ala**.org/**ala**/acrl/acrlevents/kirsch99.pdf -

shelves. Our open stacks squeezed 230 books in the same space, which meant there was no extra space on the shelves unless some books were removed. In contrast to the capacity of open stacks, the automated storage system is able to house between 1,380 and 1,460 books per square meter depending on the structure, whereas the capacities for multi-tiered and movable shelves are 491 and 550 books per square meter respectively. Fig 2 shows the comparison of space required, and the reduction of space results in huge saving in construction cost. I will discuss the cost later, but it is one of the reasons why so many libraries have chosen this storage system over the last five years. (Fig 2)

Saving of manpower: At our university, one method of calculating the shelving cost is by the total hours of student help required. An experienced student assistant may shelve about 100 books an hour, and the total hours will increase with the volume of circulation and the collection size. Whereas, for the automated storage system, once the retrieved books are sorted to return to the storage, it is a very simple process for an attendant to scan the barcode and put it into a container, whilst carrying out other duties. At the completion of the building, the rate of storing was approximately 1,000 books an hour.

Collection management: Operational records may be used for collection management. We tried to use this storage as a means to make open stacks more attractive. Initially, materials with low frequency use were placed in the automated storage. Subsequently, analysis of frequency of use was used to transfer items, based on their changing popularity, to the open stacks, thereby optimizing the access of materials by the users. Each library staff member is assigned certain subject shelves and is given a record of retrieval from storage to help manage the shelves.

The automated storage enabled us to be flexible in managing the physical collection. For example, the history faculty argued browsing was essential in their subject, whereas natural science students or faculty do not especially comment on browsing because their main use is journals. Then, we assigned more open stack shelves to history than to other subjects.

We found that it was especially efficient to store journal back issues, and now more back issues are moved to storage rather than occupying space on open stacks.

Accessibility: While some libraries installed the storage for housekeeping purpose, where a user does not have direct access, we intended to make this storage accessible for all library users by integrating it with our OPAC. A short guidance is given to all new students and it encourages the use of the

automated storage system as easily as the open stacks.

Collection preservation: We must protect our collection against heat, humidity and disasters. The storage facility is ventilated throughout the year, and air-conditioning and lighting is minimized because no staff need to enter the storage area. An ideal storage environment is maintained throughout all seasons.

Assuring safety: The equipment is designed to withstand an earthquake of 400 gal (equivalent to an earthquake with an intensity of 7 on the Japanese seven-stage seismic scale). The storage at UC Northridge had very little damage from the earthquake in 1994. The system is designed with many safety measures such as a stopping device to prevent the dropping of containers during powerful earthquakes. Further, the system has extensive fire protection capabilities and the computer system is protected against power failure by an uninterrupted electricity supply.

Issues:

Cost: You must be wondering about equipment, construction and operational costs, as I am sure this appears to be a very expensive system. ALA's report gives some figures,[2] and says it is very expensive. The cost may vary in each country. Fig.2 shows the space required, and the equipment and building costs, which are roughly compared using published figures as one example.

The construction cost for an automated storage system is calculated with a higher figure per square meter than for open stacks because of the heavy load of books on the floor. Yet, this figure shows that because of the great reduction in storage space achieved, the building and equipment costs are comparable to other types of storage. Operational cost includes annual maintenance charge, but our estimate was that savings in building costs by reduced space, operational costs in heating and lighting, and labor costs, will pay for the cost of the system within ten to fifteen years of its installation date. We had very little technical failure in five years.

Browsability: As I discussed above, some objections were raised in the initial period, but we will keep one third of the collection on open stacks which will be better managed by this storage. As users became accustomed to the system, very few comments were received about loss of browsing

[2]Richard W., Boss, Automated storage/retrieval and Return/sorting systems. http://www.ala.org/ala/pla/plapubs/technotes/asrsystems, htm

capability.

Library Reorganization and the Storage System

The automated storage system was a solution for our library to create space for information services, as well as to reorganize library work and staff allocation. Regarding the space, while we maintain open stacks for 300,000 volumes in the old building, we have a place to house another 500,000 books, which is sufficient additional capacity for the next 30 years. Further, this storage capacity is virtually free of daily maintenance and has liberated a large space for dedicated computer use.

We were able to assign two floors completely for digital library services, for which the expression 'Information Commons' is used in the USA, where 120 PCs are provided for free use by students for information access, word processing, and various other activities, such as self-study for coursework. The building also has three group study rooms, a Multimedia Room for classes and Reference Service Center.

For the library management, installation of automated storage required two years of system preparation to achieve completely computer controlled stock management and circulation systems. Then, it freed library staff from managing the physical collection and now only one full-time staff member is assigned to manage the collection of 640,000 and the circulation record of 220,000. At the completion of the new building, additional features such as technical support for the 120 user PCs, new information services, library instruction and guidance resulted in a great increase in workload. In addition, the proliferation of e-journals, databases and the demands of subscriptions have further intensified the workload. This occurred during a time of severe staff cut-backs in all businesses and education in Japan. We are constantly engaged in library reorganization and the creation of teams for completing specific, targeted, purposes and the effect of automated storage is significant in shifting staff to immediately required tasks.

Our library is now open for 14 hours, 6 days a week, with only 13 full-time staff with the help of part-timers and students. A year after the new building was opened, we were pleasantly surprised when our library entry count increased by 30% and the circulation record increased by 25%. We were especially pleased that the installation of automated storage did not decrease the book usage, but enabled easier access to all of our collection.

How do we see our future? In the current complex and changing environment, it appears that each library needs to plan its own specific

individual direction in support of learning. As a liberal arts college, we believe that books will continue to be the basis of our library services, but we must be prepared for forthcoming changes by upgrading staff skill and expertise. For these reasons we believe that the automated storage system was a great success enabling us to focus and explore the next generation library services in our response to user needs.

I would like to conclude my talk by saying that we are proud to have been the first library in Japan to install and integrate an automated storage system with our services and management. The automated storage system enabled ICU to increase its productivity and expand its storage capacity whilst raising user participation and service levels. Given the increasing level of user expectations in combination with Japan's high labor and land costs, it is likely that automated storage systems will be the option of choice for many new and renovating libraries in the future.

Fig. 1

List of Automated Storage System s Built by Nippon Filing between 2000 and 2005

Library	Place	Opening	Capacity
International Christian Univ.	Tokyo	Sep-00	5,000,000
Chiba City Central Library	Chiba	Apr-01	4,000,000
Kyoto Prefecture Library	Kyoto	May-01	4,000,000
Aoyama-University Library	Kanagawa	Mar-04	5,000,000
Daitoh Bunka University Library	Tokyo	Sep-03	2,000,000
Takaoka City Cenrtal Library	Toyama	Apr-04	1,500,000
Ritsumeikan University Library	Shiga	Apr-04	3,500,000
Kyushu Univ. Library	Fukuoka	Apr-04	60,000
Yuhki Library	Ibaraki	May-04	120,000
Okayama Prtefecture Library	Okayama	Sep-04	420,000
Nishihara-cho Library	Okinawa	Aug-04	140,000
Kuwana City Central Library	Mie	Oct-04	160,000
Nara City Northern Library	Nara	Aug-04	20,000
Tokyo Univ. Lib. Kashiwa Campus	Chiba	(Spring 05)	5,000,000
New Nara Prefecture Lib.	Nara	(Summer 05)	1,000,000
Iwate Prefecture Lib.	Iwate	('06)	400,000

Fig. 2

Comparison of Space Required, Equipment and Construction Cost

	Auto Lib -1	Auto Lib -2	Steel Multi-tiered Shelves	Compact Shelves
Book Capacity	503,840	529,920	500,000	500,000
Book /㎡	1,460	1,380	491	550
Total floor space required	345	384	1,018	909
Equipment Cost (￥)	375,000,000	505,000,000	349,320,000	200,000,000
Construction Cost (￥)	241,500,000	268,800,000	509,150,000	454,545,000
Total Cost (￥)	616,500,000	773,800,000	858,470,000	654,545,000