THE RANDTRIEVER AT ERASMUS UNIVERSITY, ROTTERDAM—1969-1990:

TWO DECADES OF CHANGE IN MECHANICAL BOOKS STORAGE

Leen Meyboom

In April 1969, Remington Rand began installing its automated storage and retrieval system–the Randtriever–at Erasmus University, Rotterdam. The original system never worked properly and uptime was limited to a few hours a day. Erasmus University has subsequently rebuilt the system, installing safety devices, replacing communications systems, and converting the system to computer control (initially using National Semiconductor SC/MP microprocessors and Apple II computers). Today the system is operational 99.9% of the time and is linked directly to the circulation system of the library. It is currently being directly interfaced to the online public access catalog.

Meyboom is head, Automation Department, Erasmus University Library, Rotterdam, The Netherlands.

Introduction

In April 1969, Remington Rand began installing a system for the mechanical storing of books in the basement of the library of Erasmus University, Rotterdam. The system today consists of eight aisles with bookcases containing plastic boxes on both sides. Each box holds twelve to fifteen books. In the aisles, robot-like master columns transport the plastic boxes from the shelves to a system of conveyor belts in front of the aisles. Along these conveyor belts the boxes are carried from the basement to the circulation department two stories higher. In the circulation department, those books that were requested are removed from the boxes. The boxes then continue on their round-trip journey back to the basement shelves.

When installation and implementation of this apparatus began, our goal was to have a system that would work with the highest possible uptime. Achieving this goal has not been easy. The first problem was to get the system into operation. To accomplish this end, several employees from Remington Rand USA were brought to Rotterdam. Finally, in February 1971, the plastic boxes were filled with books. The system initially operated only a few hours a day. Later it was possible to keep the system in operation for all hours the circulation department was open.

© Emerald Backfiles 2007

Operation of the System

The original system never really did function properly. More often than not the system was down, a condition naturally considered unsatisfactory by both the library staff and the technical staff of Randtriever. During a certain period, five men were continuously busy attempting to keep the system in operation.

In April 1974, a committee of experts reported on the machinery and on the steps needed to be taken to get the system to work properly. As a result of this report, it was decided that Remington Rand (in the meantime renamed Sperry Remington) and Erasmus University would renovate the system cooperatively. In the middle of 1977, however, Sperry Remington withdrew, so the responsibility for the reconstruction became exclusively the university's.

Steps to be Taken

Faced with sole responsibility, the university planned two initial steps. First, it was decided to determine whether or not the system could be made computer controlled. Second, an emergency plan had to be executed to get the system more or less working without trouble. Both steps were taken in the next several years.

Emergency Plan

To satisfy the second step, the system was supplied with error detection devices so that the system could switch itself off and avoid a cumulation of errors. By detecting a malfunctioning device early, additional severe damage to the system could be prevented. As a result, when problems developed, the master column for an aisle could be down only half an hour per day rather than several hours a day.

Computer Controls

In 1971, when Intel introduced a four-bit microprocessor, the 4004, it was decided to incorporate this processor in the Randtriever. However, when Intel subsequently introduced an eight-bit microprocessor, the 8008, the eight-bit processor was chosen instead of the 4004.

The testing of the 8008 took one year. The processor was mounted on a master column, and its sensitivity for failure was tested. Certain programs were then developed while the master column was in operation. After the installation of different devices to reduce outside interference with the processor, the results were determined to be satisfactory.

In the meantime, National Semiconductor developed a new processor, the SC/MP (Simple Cost-effective Micro Processor). Technical information supplied with the SC/MP was so impressive that we decided to investigate its possibilities. Results exceeded all expectations. Consequently the SC/MP was selected for installation in the system as opposed to further investigation of the new Intel 8080 processor. The time devoted to evaluation of microprocessors substantially exceeded the time originally projected for this process.

Research was also undertaken regarding communication techniques, particularly communication by means of frequency modulation. This method held potential, but it was felt that the results were not reliable, and that further research was required. The main dilemma was time; a fast and reliable solution had to be found. In the interest of time, several types of "five-core contactrails" were installed in the aisles of the master columns. After a testing period, one type of contactrail was selected.

Reconstruction of the Master Columns

The four final development efforts involved:

- building the central system to communicate with the master columns by means of contactrails;
- installing three SC/MP microprocessors on each master columns, as follows:

  SC/MP 1 for communication between the central operating system of the Randtriever and the operating processors of the master columns,

  SC/MP 2 for operating the picker, (i.e., that part of a master column that takes the plastic boxes from the shelves and returns them), and

  SC/MP 3 for controlling the horizontal movements of a master column and the vertical movements of the picker;
- building different interfaces between the three processors and the motors they controlled; and
- adding hardware and software on the master columns in order to protect against problems.

By the middle of 1980, all these technologies had been assembled, tested, and installed on the master columns. In the next few years, some refinements were made.

For the central controller, an Apple II computer was selected; in 1979, it was the only "professional"

© Emerald Backfiles 2007

personal computer available. Generally the Apple II continues to function satisfactorily, and the system has been in use for ten years without serious breakdown. The time the central controller is down is very low, about 0.25 percent per year. It should be noted that each Apple II computer is used as a controller for five years, and then another two years solely for testing, before it is replaced.

A master column now averages down time of less than two hours a year, which is about 0.1 percent of production time. This downtime is barely noticeable to the average user because the master column is immediately replaced by an emergency spare column. Each master column is serviced once a year and component parts are regularly replaced.

The System of Conveyor Belts

A critical problem in the old system was the performance of the central controller. Control of the master columns was transferred to the Apple II computer, but another part of the operation was still performed by the old data processing unit. In particular, routing the boxes via the conveyor belts continued to cause a great deal of trouble and, as a result, became the focus of the next phase of redevelopment.

When National Semiconductor announced that it intended to stop producing the SC/MP microprocessor, spare units were bought as replacement processors for the master columns. Nevertheless, it was necessary to select another processor for the remainder of the system. The Synertek 6502 processor was chosen over the Intel 8080, despite some possible advantages in the latter, because the Apple II computer is equipped with the former. With this processor, it was possible to develop a system of microprocessor controls—although in the experimental phase, an Apple II computer was used to test the hardware and software and to debug the system. The system, as reconfigured with the microprocessor controls, continues to operate satisfactorily. However, the Apple II computer is now being replaced by a 6502 microprocessor that contains its software in Programmable Read Only Memory (PROM). When this conversion is complete, the system will perform on its own.

At present these functions are automatically controlled by the microprocessor:

- reading of the plastic box labels,
- operation of the Pull-shelves and Pull routing,
- operation of the Refile routing, and
- operation of Console conveyor-belts.

Some operational functions must still be programmed on the Apple II:

- operation of Pull conveyor-belts, and
- operation of Refile conveyor-belts.

Coupling of the Randtriever with the Circulating System

The Randtriever is coupled with the now-automated circulation system. This means that requested books are being delivered directly to the circulation counter by the Randtriever. By means of the local circulation-control computer, a Digital microVAX 3200, all relevant information is sent to the Randtriever to ensure that the right boxes are sent to the counter. Consequently, the time required to respond to requests is reduced. At present, the system does not discriminate between boxes called for taking books out and boxes called for returning books. Installation of routines that give priority in calling boxes that contain requested books, versus boxes for returning books to the Randtriever, are now planned.

Conclusions

An automated storage and retrieval system such as the Randtriever offers a number of benefits. When a library has limited storage capacity, the Randtriever enables the library to store more books in a relatively small area. For a library with closed stacks, it also provides the benefit of reducing the time between book request and book delivery. (Our system currently delivers books in about ten to fifteen minutes; we had originally hoped to reduce delivery time to two minutes. Furthermore, this slower delivery time is only achievable when requesting one book at a time.)

Software currently being developed will allow books to be returned to the shelves in any available box containing adequate space. This enhancement will reduce container traffic on the conveyor belts and master column movements by almost 50 percent, which will significantly improve performance of the system. We will install this software in August 1990. We have also developed an interface between the Randtriever and our online public access catalog, which will facilitate the requesting of books directly from the online catalog. This interface will be installed during the second half of 1990.

© Emerald Backfiles 2007