

The Univac 90 / 60 Mainframe Computer



Figure 1: Univac 90/60 aka RCA Spectra 70/7

This particular machine seems to have had the Univac signage applied to the CPU but retains the cosmetic features of the Spectra 70. This photo was found on the web at <http://www.rwc.uc.edu/koehler/cshist.html>

Introduction:

The first full-scale computer that I had the opportunity to work with was the UNIVAC 90/60 located at Edinboro State College in the late 1970's and early 1980's. This was a third-generation mainframe computer whose processor architecture and instruction set was based on the IBM 360. Unlike the "clone" and "plug compatible" systems that were made later by Amdahl and others, the I/O architecture was different enough that IBM operating systems wouldn't run on the UNIVAC and user programs needed to be re-compiled.

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Unfortunately, there is currently very little information on the web about these machines. I have been thus far unable to locate a reasonably clear photograph of ANY 90/60, let alone a photograph of the actual system I was able to use.

Even Wikipedia has little to say about the UNIVAC 90/60. The article accessed on 7/21/2007 is reproduced here in its entirety:

UNIVAC 90/60

From Wikipedia, the free encyclopedia

The Univac 90/60 series computer was a mainframe class computer manufactured by Sperry Corporation as a competitor to the IBM System 360 series of mainframe computers. The 90/60 used the same instruction set as the 360, although the machines themselves were not compatible with each other; programs written for one would have to be recompiled for the other, as at the time they were developed, the concept of an operating system being portable separately from the computer system it ran on was unheard of.

The 90/60 was originally developed by RCA Corporation as the Spectra series of computers. After RCA decided to get out of the computer business due to stunning losses, it sold most of its computer and peripheral lines to Sperry; a few were sold to Singer corporation.

The 90/60 series was an enhanced work alike to the 360, as it included special features which were not available on IBM hardware until later in the System 370 series, including virtual memory, demand paging of applications, and good support for terminal-based users (IBM's offerings on mainframes have always provided weak support for interactive computing).

The operating systems which ran on the 90/60 included RCA's TSOS operating system and Sperry's own VS/9 operating system. The 90/60 was superseded by the UNIVAC 90/70 (a work alike for IBM's System 370 and the UNIVAC 90/80.

See also

List of UNIVAC products

There are several personal web-pages that mention the UNIVAC 90/60, at least in passing. One of the better articles was written by Kenneth R. Koehler, who evidently is another admirer of the system. Koehler writes:

"If you'll pardon the poor quality of the photo, here is one of the finest mainframe systems I have ever had the privilege to work on: the RCA Spectra 70/7, using VMOS (the Virtual Memory Operating System). The Spectra 70 non-privileged instruction set was essentially identical to that of the IBM System 370. In addition to virtual memory address translation through content addressable memory (CAM), the Spectra 70/7 provided four privilege levels (P1 through P4) for user

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and supervisor states. VMOS was the virtual offspring of RCA's TSOS (Time Sharing Operating System), and featured a separate virtual address space for each task in addition to a shared address space for the kernel functions, a least-recently-used page replacement policy and task scheduling algorithms based on time-to-next-I/O. VMOS also included one of the most powerful editors I have ever used: EDT. Programming languages available on this system included Fortran (both batch and interactive), Cobol, PL/I, Algol, Lisp, Snobol and of course assembly language."

Somewhat later in the same article, Koehler writes:

"On my first day at a 90/60 customer site there was a SRED waiting for me. The 90/60 was Sperry's version of the 70/7; it ran VS/9, which was Sperry's version of VMOS; and a SRED was a System Resident Emergency Dump, which occurred whenever VS/9 had a panic attack. Those days it sometimes happened every few hours. Things would be running along nicely and suddenly everything would stop and a small message would appear at the bottom of the U100 console saying "Mount SRED Tape". The operator would mount an empty tape and (on a system with 512 KB of RAM) the system would dump the contents of the registers and real memory on about half of a 2400 foot reel. After rebooting, this would be processed into a two inch thick listing and laid on my desk. In order to analyze the dump you had to do virtual memory translation by hand, using the translation tables to convert virtual addresses into real addresses, whose contents you could then locate in the SRED listing. That was REAL debugging – no sissy IDEs with built-in symbolic debuggers!

The 90/60 CPU was a fascinating piece of architecture. From the system programmers point of view it was almost identical to its predecessor. But from the viewpoint of the microcode, there were actually two independent processors which ran asynchronously: one to staticize instructions and the other to manipulate operands. This architecture was the source of one of the highlights of my computing career. One day a programmer at the customer site showed me a program dump of a COBOL program. The program had gotten a paging error, which are normally caused by a bad virtual address. But in this case, the error occurred (at the machine language level) on a BCTR instruction (used in calling subroutines), and the addresses involved were fine. The BCTR instruction happened to be at the end of a virtual page, and by adding innocuous instructions to the program, we were able to move the BCTR from its position at the end of the page and the error disappeared.

I asked the Customer Engineer on site to run diagnostic software to check the CPU, but the software did not run in virtual mode and therefore could not find the problem. So I wrote a small program which I keyed in manually using the CPU console switches. The program included a few virtual memory translation table entries and the code to put the CPU in virtual mode and loop on a BCTR instruction at the end of a page. This enabled the C. E. to see the erroneous

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paging faults and we eventually tracked the problem to a bug in the microcode which affected the synchronization between the two internal processors. It was very cool to be able to track a problem like that all of the way to its source, and the fix we sent in to the designers was issued as a field change order for all 90/60s a few months later.”

My own impression is similar to Mr. Koehler's in that the UNIVAC 90/60 was one of the better thought-out systems that were available in the 1970's and 1980's. Frankly, I was spoiled by the VS/9 operating system. The command language was intuitive, there was excellent online help, and (unusual for the time) there was online documentation and even an online training program called LESTER that would teach you how to use the system.

Time-Sharing at Edinboro State College:

I can thank an introductory class in statistics for my first exposure to the UNIVAC mainframe at Edinboro. Like many students in the late 1970's, I had some experience with small computers – mostly systems like the Wang 2200, IBM 5100, and even the earliest Apple II microcomputers. While the smaller systems had the advantage of access and “freedom of use”, the user was limited by the small memories, lack of mass-storage, and the availability of commercial software. Our statistics class was set-up to allow mainframe access so we could run FORTRAN programs developed by the students and faculty at Edinboro, as well as gain experience using SPSS (Statistical Package for the Social Sciences.) While most of our FORTRAN projects were submitted in batch mode, we were allowed to run SPSS in an interactive session.

The statistics class was being held in Doucette Hall on the west end of campus and we were fortunate to have both an RJE (remote job-entry) station and a selection of terminals available in a basement laboratory. This saved us a walk of about a quarter mile across campus to the main computer center. Given the notoriously severe winter weather in Edinboro, we were most appreciative.

The laboratory in Doucette housed two IBM Model 029 keypunch machines, a model 084 sorter, the RJE station, a single CRT terminal (Lear-Siegler ADM-3) for student use, and half-a-dozen Teletype terminals. The RJE station had a Uniscope terminal, but this was for the exclusive use of the RJE operator and not available for student access. The terminal laboratory was open 24/7 and generally filled to capacity with students, faculty, and even “tourists” waiting for access to the computer.

With the exception of the RJE station, which had a dedicated line, the terminals at Doucette were on dial-up circuits connected to genuine Automatic Electric (GTE) modems and exclusion-key telephone sets. To get your terminal online, you would pickup the handset, dial 732-2222 and wait for the computer to answer. When you heard the tone from the remote modem it was time to lift the exclusion key “button” on the telephone cradle and set the handset aside. With any luck, the lights on the modem

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would indicate a connection and your terminal would come to life. Press the return key to get the computer's attention, and the terminal would scratch out the logon prompt:

```
%WELCOME TO EDINBORO TIME-SHARING, PLEASE LOGON.
```

Messages from the VS/9 Operating System generally began with the percent sign as illustrated above. Likewise, the VS/9 prompt was a slash. The complete sign-in dialog generally went something like this:

```
%WELCOME TO EDINBORO TIME-SHARING, PLEASE LOGON.  
  
/LOGON MHM45498, 998712  
  
%LOGON ACCEPTED FOR USER MHM45498 ON 11-10-77 AT 12:12:00, LINE  
123, TID TTY036  
  
%THE SYSTEM WILL BE DOWN FOR MAINTENANCE ON SUNDAY 11-12-77 FROM  
0800 TO 1500 HRS.  
  
/
```

The exact format of the logon prompt and the system messages changed from time-to-time as the computer evolved towards obsolescence. The content of messages remained fairly consistent and a "Message of the day" was generally printed after a successful logon.

The username generally consisted of the user's initials followed by a five-digit number that was taken from the final digits of the user's social security number. That was strictly a matter of convenience, since the "mailbox" where printouts were distributed was arranged by social-security number. The default password assigned students was their birth date in MMDDYY format, but prudence required you to change this as soon as possible.

Each student was allocated a fairly small ration of total connect time, CPU time, disk space, and overall I/O operations. When you ran out of connect time or CPU time, you were done computing for the semester. Running out of disk space meant that something would be deleted, and this wasn't necessarily up to you! System operators were known to erase offending files on your behalf if you weren't quick enough to purge your workspace voluntarily.

Offline storage consisted of punch-cards or magnetic tape. If your terminal was old enough, you might still have access to punched paper tape. Cards were sold at the bookstore and were readily available. Magnetic tape was harder to find and had to be ordered well in advance of need. Operators were also sometimes reluctant to mount student tapes, so punch cards were still the rule for the casual user.

The main computer center was located in the basement of Hendricks Hall, a V-Shaped building located near the geographic center of the campus. One large classroom was dedicated to the mainframe itself. This room was off-limits to all but duly-authorized

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essential personnel but had the glass windows and doors characteristic of data centers at the time. There was a window through which student jobs could be submitted on punch cards and a large set of mailboxes (arranged by SSN) for student printouts. Adjacent rooms were used by computer center staff as offices. There were two terminal labs across the hall.

The VS/9 Operating System:

VS/9 (Virtual System 9) was the name given to the operating system of the UNIVAC 90/60. It was derived from RCA's TSOS (Time Sharing Operating System) that was first released for the RCA Spectra 70/45 in the late 1960's. TSOS was the first operating system that supported virtual addressing of the main storage and provided each user with the illusion that they had exclusive access to the computer. IBM would later mimic this arrangement with VM/370 and similar products. Beyond that, TSOS provided a consistent interface with nearly identical commands for both time sharing and batch users.



Figure 2: RCA Spectra 70/46

Although UNIVAC phased out use of the VS/9 operating system in the early 1980's, TSOS still exists in the form of the BS2000/OSD operating system used on Fujitsu-Siemens mainframe computers. These systems are still being sold and used (as of 2007), mostly in Europe.

The corresponding Wikipedia entry for the BS/2000 operating system reads like an advertisement, but manages to summarize the chief characteristics of the software:

BS2000 (officially renamed BS2000/OSD in 1992) is the mainframe operating system platform of Fujitsu Siemens Computers.

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Mainframe systems are optimized to enable many programs to be installed in parallel and run concurrently on a computer. This helps reduce the number of computers required to a minimum. Originally this was a way to achieve cost savings, since at that time hardware components were considerably more expensive than now. Today, the advantage of an architecture that gets by with significantly fewer computers is that it greatly reduces the complexity of the IT infrastructure, thus saving on IT running costs and increasing IT robustness.

To avoid different applications and users on a computer adversely affecting one another by contending for resources, mainframe systems must be able to segregate the different users and processes from one another in an optimum manner. They do this by virtualizing all the resources used by the applications and by centralized resource management controlled in a finely graduated way based on access rights and priorities.

At the same time the high degree of virtualization decouples the application software from hardware and implementation details and so creates the foundation for the long-term compatibility, high flexibility, high availability, extensive scalability and great robustness of the services running on mainframes.

Unlike other mainframe systems, BS2000/OSD provides exactly the same interface in all operating modes (batch, interactive and online transaction processing) and regardless of whether it is running natively or as a guest system in a virtual machine. This uniformity of the user interface and the entire BS2000 software configuration makes administration and automation particularly easy.

BS2000/OSD has its biggest customer base in the European market. In Germany, it is the most popular mainframe platform after IBM's mainframe systems. The reliability, availability and scalability bestowed on them thanks to their architecture make mainframes the first choice for many core applications in the public sector, in the banking and insurance environments, as well as in industry.

Looking back over the history of its development, BS2000/OSD has its roots in the TSOS operating system (TSOS: Time Sharing Operating System) first developed by RCA for the /46 model of the Spectra/70 series, a computer family of the late 1960s related in its architecture to IBM's /360 series. It was one of the very first operating systems in which the principle of virtual addressing and a segregated address space for the programs of different users was systematically introduced. Right from the outset TSOS also allowed the data peripherals to be accessed only via record- or block-oriented file interfaces, thereby preventing the necessity to implement device dependencies in user programs.

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1975

In June 1975, Siemens shipped an enhanced version of the TSOS operating system for the models of the Siemens 7.700 mainframe series for the first time under the name BS2000. Even this first BS2000 version supported disk paging and three different operating modes in the same system: interactive dialog, batch, and transaction mode, a precursor of Online Transaction Processing (OLTP mode).

1977

The TRANSDATA communication system marked the entry into modern computer networking.

1978

The introduction of multiprocessor technology brought an improvement in system availability. From that moment on, the operating system had the ability to cope with a processor failure. At the same time the new technology considerably extended the performance range of the system.

1979

A transaction processing monitor, the Universal Transaction Monitor (UTM), was introduced, providing support for online transaction processing as an additional operating mode, and one particularly important for mainframes.

1987

BS2000 is ported to the /370 architecture and now supports 2GB address spaces, 512 processes and the XS channel system (Dynamic Channel Subsystem).

1990

With the advent of the VM2000 virtual machine, multiple BS2000 systems, of the same or different versions, can now run in parallel on the same computer. The new hierarchical storage management system HSMS automatically swaps out infrequently used data to cheaper storage media. As soon as this data is needed again, it is restored, again automatically, to high-speed access media. The Maren tape archiving system supports the connection of robot systems.

1991

BS2000 is subdivided into subsystems that are strongly decoupled from one another. This increases flexibility for ongoing development and in shipment of software. Security evaluation to F2/Q3 completed.

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1992 / 1995

BS2000 is realigned to make it open to application software and from then on bears the name BS2000/OSD (Open Server Dimension). Full support of the XPG4 standard is achieved in 1995 after the porting of the POSIX interfaces in 1992.

1996

BS2000/OSD is ported to the RISC architecture. Although the operating system now runs on different hardware architectures (S servers with /390 architecture and SR2000 servers for the RISC architecture), object-compatible execution is guaranteed for BS2000 applications. Applications produced for /390 can be used on computers based on RISC architecture without recompilation.

1997

With WebTransactions, existing BS2000 applications can be easily internet-enabled, with no need for programmer intervention in these applications.

1999

BS2000/OSD is the first operating system worldwide to be awarded Internet Branding by the Open Group.

2002

BS2000/OSD is ported to the SPARC architecture, leading to the creation of the new SX server line. This marks Fujitsu Siemens Computers' consistent pursuit of its strategy of hardware independence while at the same time maintaining full compatibility.

2004

Support for enterprise-wide storage area networks (SANs) based on Fibre Channel technology enables throughput rates to be increased by as much as 50%.

2007

Release of the new BS2000/OSD version 7.0. Development highlights are: the Snap and Clone functionality of the EMC Symmetrix DMX storage systems made available for BS2000 files and disks; online provisioning for pubsets (this function automatically adds disks from a free disk pool to a BS2000 file system as needed or returns disks to this pool when they are no longer required); autonomous, dynamic control of I/O resources (IORM). Like the priority control

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used in the allocation of CPU timeslices, this function implements a priority control system for processes when accessing I/O resources.

For more information on the BS2000/OSD operating system, Fujitsu-Siemens has a comprehensive website available at:

<http://www.fujitsu-siemens.com/products/bs2000/index.html>

Complete documentation for the operating system and underlying hardware can be found at:

http://manuals.fujitsu-siemens.com/servers/bs2_man/man_us.htm

Programming the UNIVAC 90/60:

As one might expect of a computer used to teach programming skills to the entire spectrum of users in the late 1970's, the UNIVAC was equipped with a host of programming environments. My own experience programming the system began with FORTRAN IV and then progressed (regressed?) to BASIC, COBOL, RPG, Assembly Language, and finally PL/I.

FORTRAN was available as both an interpreted and compiled language. The interpreter was known as FASTFOR and consisted of an integrated programming environment that included a text editor, run-time package, and symbolic debugger. The UNIVAC FORTRAN compiler was full-featured and comparable to the G and H level compilers available on the IBM 360.

UNIVAC BASIC was also rather impressive, with the full complement of matrix functions, string handling routines, and mathematical functions. After using this version of BASIC, most microcomputer versions paled in comparison. Like FASTFOR, the BASIC environment accepted immediate-mode commands and implemented its own editor.

COBOL and RPG were allegedly well-executed, but aside from brief assignments in the respective programming classes, I stayed away from these languages as much as possible. I'm fortunate that I've never had to write a "real" program in either language and really can't comment on their merits. COBOL and RPG programs were entered using the VS/9 line editor, which was actually very pleasant and intuitive to use. The editor used line numbers and had rather powerful search and replace functions. When you consider the logistics of an editor that needs to run on both CRT terminals and teleprinters, the Univac editor was a bit of a miracle.

Assembly Language on the UNIVAC 90/60 was nearly identical to basic assembly language (BAL) on the IBM 360. This was a big selling point for the UNIVAC, and from an application programmer's point-of-view, there was little difference in the

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programming environment. We had our own runtime library for most high-level functions that included input and output. The textbooks we used were actually written for the IBM 360.

PL/I (or “PL/1” according to some references) was the secret weapon on our particular UNIVAC 90/60. Much of the operating system and most of the job scheduling, system accounting, and utility programs were written in PL/I. The language itself was created by IBM as part of the System/360 project and used for system programming across many models of IBM mainframe.

PL/I was described as an imperative computer programming language designed for scientific, engineering, and business applications. It was one of the most feature-rich programming languages and one of the very first in the highly-feature-rich category. Its principal domain was data processing; it supported recursion and structured programming. The language syntax was English-like and suited for describing complex data formats, with a wide set of functions available to verify and manipulate them.

For whatever reason, PL/I never became overly popular as a programming language. A number of versions still exist on a variety of platforms but relatively few programmers take advantage of it.

Fun and Games on the UNIVAC 90/60:

Computer games are nothing new. Even the Manchester Mark I was programmed to play tic-tac-toe as a test of its ability to solve problems in logic. Thirty years later, the UNIVAC 90/60 was well-equipped with games that served to entice, educate, and frustrate the students, faculty, and operations staff at Edinboro State College.

Using several million dollars worth of computer equipment to play games will inevitably create controversy when humorless bean-counters find out about it. Edinboro was no exception. The same administrative types that build a football stadium for the exclusive use of a single team tend to go absolutely bananas when 30 minutes of computer time is used to play Adventure.

Games were an on-again, off-again proposition at Edinboro. When I was first “introduced” to the computer, game playing was encouraged as a way for users to become familiar with operation of the system. It was thought that if you could learn how to log-on, bring up the games, play the game, and remember how to log-off, you could probably learn how to do “real” work on the system.

In fairly short order, new management arrived in the computer center and decided to forbid game-play. Games were removed from the system and a few people were punished for violating the rules. Conspiracies to circumvent these anti-game policies soon arose, and the games were surreptitiously re-installed. A favored tactic was to find senior (tenured) faculty that had little use for the computer and install the game packages

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under their account. Naturally, this required a little hacking to accomplish. The current username and password for the “games” account was circulated; game play resumed and the system load increased until somebody got caught.

Games on the UNIVAC ranged from simple number-guessing programs written in BASIC to complex interactive fiction like the original ADVENTURE. Some of the most popular were TREK (a Star-Trek simulation), BIORHYTHM (hey, it was the 1970’s!), and HOROSCOPE.

The secret to computer games, though, is that the computer itself is the most addictive game. Programmers often start as game players and then progress to writing their own, ever more complex and sophisticated games.

I have a small steamer trunk that’s full of games from the UNIVAC punched on cards; someday I’ll get the card-reader running again and get them transferred to disk so I can port them to a more modern system.

Not all the games played on the UNIVAC were completely above-board. Some targeted unsuspecting students and faculty members with practical jokes, or outright scams.

One practical joke was simply to connect two of the teletypes together, by selecting the lower baud rate (110 baud), enabling “local echo”, and switching the answer / originate tones on the modem. The victim would sit down at the presumably vacant terminal and begin typing. The “system” (actually, another human) might then converse with the unsuspecting operator and manifest some decidedly “non-deterministic” behavior.

Early in the term, experienced students who expected to run out of their allocated CPU time might use this sort of setup (kind of like a Trojan Horse) to “harvest” usernames and passwords from newer students. In this way, the more experienced student could actually steal resources from the victim by logging in using the victims account.

End of the Line:

In 1984, Edinboro State College became Edinboro University and the quality of its computer science program was a source of prestige for the college. The UNIVAC 90/60 was aging and Sperry-Univac was trying to migrate the series 90 customers to the Univac 1100 in order to consolidate its product line. Instead of buying a new UNIVAC system, the university obtained a VAX 11/780 for academic use and a VAX 11/750 for administrative use. The computer center itself was moved from Hendricks Hall to the newly renovated Ross Hall. Originally constructed as a dining hall, the large rooms were perfect for a showplace computer center, complete with glass-walled rooms to show off the hardware, and smaller rooms for classes and terminal areas.

The old Univac 90/60 was salvaged and sold to the United States Navy. I’m told that it went to the Great Lakes Training Center in Chicago, but its final disposition is unknown.

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Images of Univac Third-Generation Computer Equipment and Peripherals



Figure 3: A Univac 90/80 Computer – Successor to the Univac 90/60.



Figure 4: A Univac Model 1710 Card-Punch

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Figure 5: Front Panel to a Univac 9400 – A Close Relative of the 90/60



Figure 6: A complete & functional Univac 9400 System in a German Computer Museum

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Figure 7: Console from a Univac 9200 Computer System

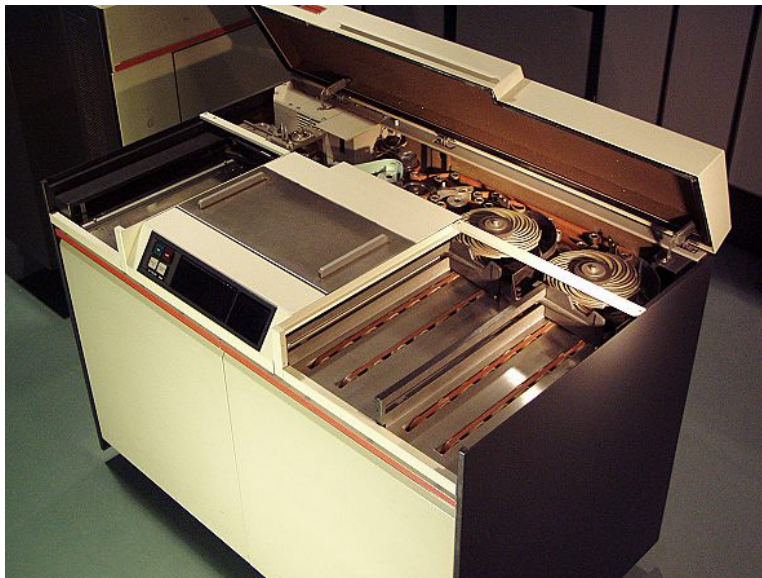


Figure 8: A Univac Card-Reader

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