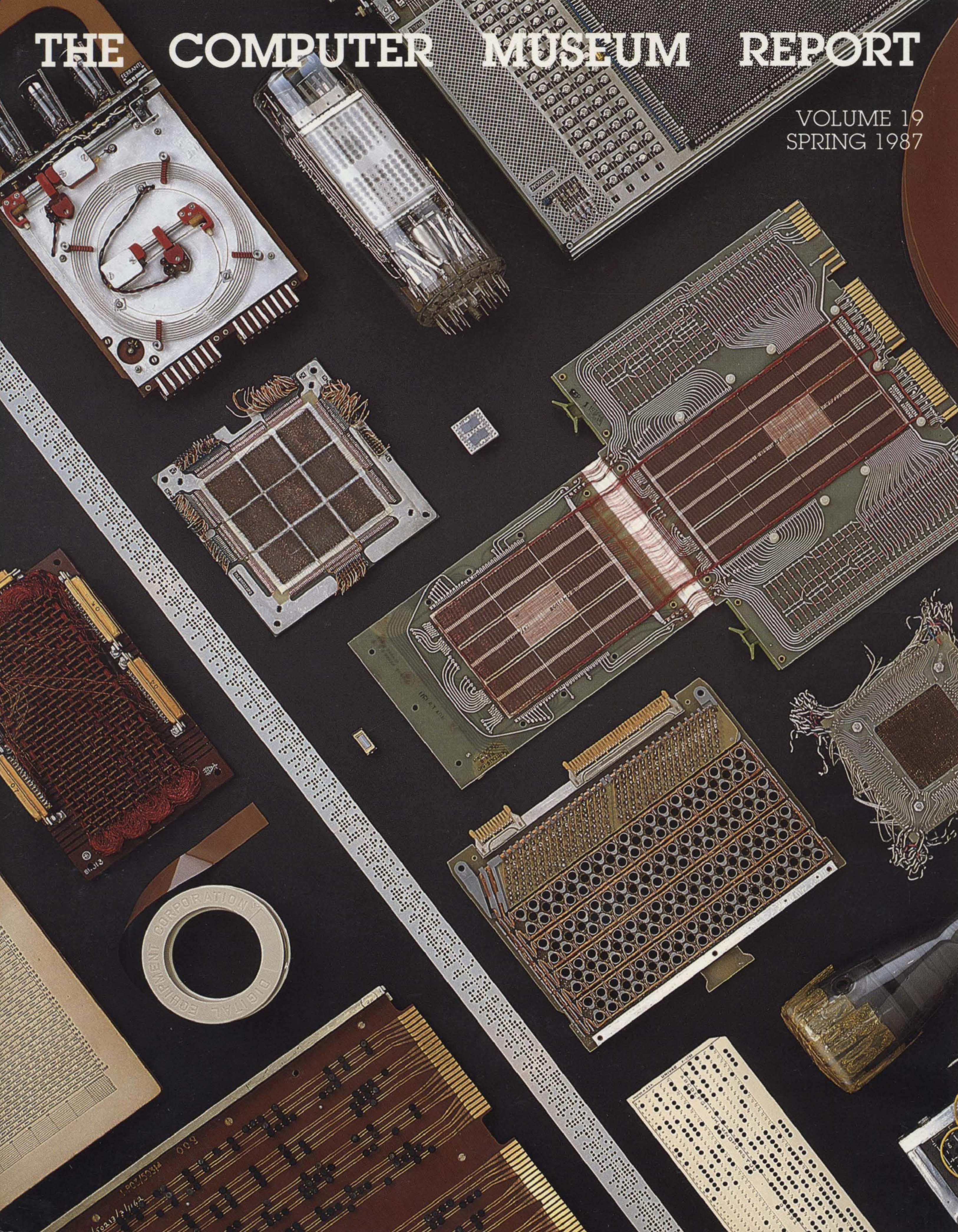
# THE COMPUTER MUSEUM REPORT

VOLUME 19
SPRING 1987



## Operating Grants and Corporate Support

### Sustainer -- $10,000 or more

Digital Equipment Corp.
Hewlett-Packard, Co.
IBM
Institute of Museum Services
Massachusetts Council for the Arts and Humanities

### Benefactor--$10,000

American Express Foundation
Raytheon Company
Sanders Associates
Xerox Corporation

### Patron--$3,000

Addison-Wesley
Amdahl Corporation
Bitstream
Boris Color Labs, Inc.
Burroughs Corporation
Coopers & Lybrand
Data Translation
DECUS
Dentsu, Inc.
Draper Laboratories
Gaston Snow & Ely Bartlett
General Computer Co.
Gourmet Caterers, Inc.
Honeywell
IEEE Computer Society
Lotus
Manufacturers Hanover
MASSCOMP
McGraw-Hill, Inc.
Phoenix Software
Prime Computer Corp.
Ropes & Gray
Sun Microsystems
Symbolics, Inc.
The Travelers
/u/s/r/ group

### Contributor--$1,000

Access Technology
Adage, Inc.
Adelie Corp.
Analog Devices, Inc.,
Analogic Corporation
Apple Computer
Arthur Andersen, Inc.
Arthur D. Little, Inc.
Automatix
Bank of Boston
Bank of New England
BASF
Baybanks
Bolt Beranek & Newman
Boston Consulting Group
Boston Safe Deposit
Cincom Systems, Inc.
Dane, Falb, Stone & Co.
Data Architects, Inc.
Deloitte Haskins & Sells
Eastech Management
E.M.C. Corporation
Executours, Inc.
Foley Hoag & Eliot
Grafik Communications Ltd.
Genrad
Goldman, Sachs & Co.
Gould, Inc.
Greylock
GTE Laboratories, Inc.
Hyams Trust
Index Technology
Innova
Intel Corporation
Interface Group
LTX Corporation
MediVision, Inc.
Mentor Graphics
MICOM-Interlan, Inc.
Micro-Com
Micro Control Systems
NEC Corporation
NYNEX Service Company
Peat, Marwick, Mitchell
Pell, Rudman
Price Waterhouse
PSDI
Russell Reynolds
Shawmut Corporation
Scitex America
Standard Oil
Sterling Hager
SYMEDCO, Inc.
Telectronics
Teradyne
VM Software
Warner & Stackpole
XRE Corporation

### Donor--$500 or more

Ray Duncan
Tom Eggers
Dan L. Eisner
Alan E. Frisbie
Tom and Rosemarie Hall
M. Ernest Huber
Robert Kahn
Martin Kirkpatrick
Raymond Kurzweil
Andrew Lavien
Linda J. Phillips
Paul R. Pierce
Ann Roe-Hafer
Jonathan Rotenberg
O. & K. Selfridge
Thomas F. Stephenson
Seth Stern
William Steul
Leo Yochim.

### Sponsor--$250

Isaac Auerbach
Jordan Baruch
Graham Beachum
G. C. Belden, Jr.
Richard J. Clayton
Richard Corben
David N. Cutler
Donald R. Daykin
Nick De Wolf
James B. Deaderick
Delta Management
Philip H. Dorn
Bob O. Evans
Larry Forte
Branko Gerovac
John Gilmore
Roberto Guatelli
Lawrence J. Kilgallen
Bob King
Marian Kowalski
Sheldon Lavde
Eli Lipcon
Carl Machover
Joe W. Matthews
Tron McConnell
Steven Nevins
Joseph M. Newcomer
Anthony Oettinger
James V. Patton
James A. Pitts
J. Eric Pollack
Audrey Reith
Linda & David Rodgers
Thomas S. Roy II
Michael J. Samek
Charles A. Stott
John V. Terrey
Michael Tomasic
G. Michael Uhler
Christian Walker
Allan L. Wallack
Andrew Wilson.

### Friend--$100

Kenneth R. Adcock
Timothy Anderson
Rolland Arndt
Professor Arvind
Richard G. Bahr
Steve Baine
Dawn R. Banks & Robert M. Praetorius
Mario Barbacci
Steve F. Barneby
John C. Barstow
Alfred M. Bertocchi
Lois J. Bizak
Bontronics
Carol Botteron
Daniel S. Bricklin
Robert E. Briney
Fred & Nancy Brooks
D. F. Brown
Gordon S. Brown
John and Ann Brown
Lawrence Brown
Les Brown
Roger M. Buoy
W. Carlson
Maria L. Carr
George Chamberlain
George Champine
M.H. Coden
James F. Cody
Howard I. Cohen
Michael J. Coppolino,
Howard E. Cox, Jr.
Michael Cronin
Daniel Crowley
CSDP
James Cudmore
Paul Curran
Randall Davis
Harvey Deitel
F. Demeo
Lucien Dimino
Ditargiani Family
Patrick M. Donini
Kathleen Doreau
Theodora Drapos
Dick Dunnington
R. DuVal
Esther Dyson
Joseph J. Eachus
Richard J. Eckhouse and Ruth Maulucci
William Elliott
Lucian Endicott
Thelma Estrin
Andrew Farber
Andrew Feit
Geoffrey Feldman and Sharon Lipp
Harold Fitch,
Philip Fox
Robert France & Ruth Doan
J. Thomas Franklin
Clark Frazier
Daniel Freedman
Kevin and Judith Galvin
Bruce Gee
Bruce Gilchrist
David Goodman
Roger Gould
Roger H. Goun
William Graustein
Stephen Gross
Paul C. Guglietta
Jerrier A. Haddad
J. Scott Hamilton
James S. Harvison
Frank E. Heart
Daniel and Nancy Heff
Paulyn Heinmiller
Thomas L. Hohmann
Grace M. Hopper
Nancy S. Horie
Robert Ingham
Interbase Software Corp.
Roy C. Johnson
Charles A. Jortberg
JSI, Inc.
Richard M. Karoff
Bryan S. Kocher
Josh and Mabel Kopp
Neal Koss
Alan and Judith Kotok
Sieglinde Kress
Stanley Kugell
Robert Laman
Curtis Larock
Tsvi Lavi
Grace Leahy
L. Lein & B Kuipers
John R. Levine
John V. Levy
Joseph L. Levy
Reed Little
George Logemann
Carl D. Lowenstein
Arthur Luehrmann
Joseph MacDonald
Julius Marcus
Barry Margolin
Andrew H. Mason
Robert O. Mason
Sibyl Masquelier
J. Stevadson Massey
Robert Mayer, Jr
Richard McCluskey
F. Warren McFarlan
William McLean
Todd Medlock
Myron Mendelson
Jeanette Middour
Charles Minter
Allen Moulton
J. Craig Mudge
Dorothy Nash-Webber
Isaac R. Nassi
Lee Neal
Tim K. Nguyen
Landon Noll
Bernard J. Nordmann
H. Edward Nyce
James N. O'Boyle, Jr.
Louise O'Donnell
Lawrence & Pauline Oliva
A.M. Oliver
Joseph A. Pallone
Kenneth D. Patterson
Juan Pineda
Michael Pique
John Poppen
James N. Porter
John H. Porter
David Potter
Robert C. Probasco
Brendan Reilly
Audrey Reith
Daniel Rose
David Rose
Thomas S. Roy II
Stephen Russell
Sabaki Corporation
Howard Salwen
Robert Schapp, Jr.
Anne Schwartz
Bennett Schwartz
Andrew Scott
Curtis A. Scott
Sebell Software
Aaron Seidman
R. &. M. Shamel
W. Lee Shevel
John J. Shields III
Charles Sholfield
W. Olin Sibert
Dan Siewiorek
Diane J. Skiba
Allen G. Sneider
Gerald Steinback
Max J. Steinmann
Hugh W. Stewart
Robert and Diane Stewart
J. Michael Storie
Synergetic Systems
David Tarabar
John Tartar
Paul Tedesco
William R. Thompson
Warren G. Tisdale
Tobin Corporation
Noah E. VanDenburgh
Thomas Vaughn
Charles Volkstorf
Thomas E. Welmers
John D. Wick
Hugh Wilkinson III
James Williams
Kevin Willoughby
Roy Wilson
Richard T. Witek
Frederic G. Withington
Paul Wittman
William A. Wulf
D. L. Wyse

## Capital Campaign

### 64K or more

Apollo Computer, Inc.
C. Gordon Bell
Control Data Corporation
Cullinet
Data General
Gardner Hendrie
Mitchell Kapor
Carver Mead
Kenneth Olsen
John William Poduska
Wang Laboratories

### 32K or more

American Telephone & Telegraph
Bank of America
Henry Burkhardt
ComputerLand
Kenneth Fisher
International Data Group
Mitre Corporation
Russell Noftsker
Robert Noyce
Robert M. Metcalfe
Fontaine K. Richardson

### 16K or more

Anonymous
Clark Baker
Robert P. Berkowitz
The Boston Globe
Howard Cannon
Doug Drane
David K. Dyer
Bruce Edwards
August Klein
Thomas F. Knight
James L. McKenney
NEC Corporation
David & Pat Nelson
Paul & Katherine Severino
Ron Smart
William Spencer
Charles E. Sporck
Ivan Sutherland
Min Tomai
Chris Terman
Stephen Watson

### 8K or more

AFIPS
Harlan E. & Lois Anderson
Erich & Renee Bloch
Winston R. Hindle, Jr.
Index Systems
Theodore & Ruth Johnson
John Allen Jones
Stan Olsen
Russell Planitzer
Doug Ross
Software Results Corp.
Ed Schwartz
Erwin Tomash

### 4K or more

American Management Systems, Inc.
Charles & Connie Bachman
Gene Brewer
Roger and Mary Cady
R. Steve Cheheyl
Robert & Eleanor Chinn
Pat Clark
Robert G. Claussen
William Congleton
Alex d'Arbeloff
Arnaud de Vitry
David Donaldson
Robert Everett
Ford Motor Company
Jay W. Forrester
William Foster
General Systems Group
Gaston Snow & Ely Bartlett
Peter Hirshberg
Houghton Mifflin Company
International Computer Ltd.
Jeffrey Kalb
Allan Kent
Jack S. Kilby
Andrew C. Knowles III
David J. A. Koogler
Edward and Debbie Kramer
John W. and Edna W. Lacey
Liberty Mutual Insurance Company
Ralph and Linda Linsalata
Robert Lucky
John Norris Maguire
Richard D. Mallery
Thomas and Marian Marill
Daniel D. McCracken
Thomas and Elizabeth McWilliams
Meditech
Allen Michels
Microsoft
Robert M. Morrill
New York Air
Nolan Norton Company
John L. Payne
Nicholas A. Pettinella
Edward G. Perkins
Robert M. Price
Regis McKenna, Inc.
Ben Robelen
Jean E. Sammet
Grant Saviers
Hal Shear
Alan F. Shugart
Richard L. Sites
Stratus Computer Corp.
Del Thorndike and Steve Teicher
3Com Corporation
Jean De Valpine
Charles and Angela Waite
Harvey W. Wiggins, Jr.
William Wolfson

**The Computer Museum**
300 Congress Street
Boston, Massachusetts 02210

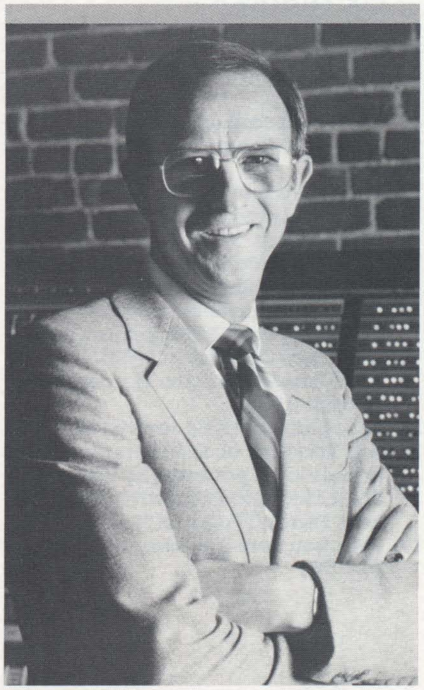
# The Computer Museum Names New Executive Director

The Board of Directors announced the appointment of a new Executive Director, Joseph F. Cashen, 52, one of the seven original founders of Prime Computer, Inc. Chairman J. William Poduska, Sr., formally introduced Cashen at a Board meeting on February 18, 1987. "When we were at Prime together," Poduska commented, "Joe was always a leader. And now as he accepts the responsibility to direct The Computer Museum, an important resource for the whole industry, he again provides a model of service and integrity. We are extraordinarily fortunate to have Joe at the helm."

Formerly an independent consultant to a number of Massachusetts high tech companies, the new director said, "I joined The Computer Museum because I believe in it. The Museum's size and stage of development allows individuals to make contributions that have major impact. I look forward to building on the established base and helping the Museum to grow into a world class institution with a staff of truly dedicated and talented people." Cashen served as Chief Executive Officer of Acorn Computer, Inc., of Woburn, Mass. in 1983. He spent eleven years with Prime, serving as Vice President of Engineering. Previously he was employed in various management positions in the Computer Control Division of Honeywell, Inc.

His appointment highlights an expansion of the Museum's effort to increase the role it plays in educating a wider audience about the technology, applications and impact of computers in today's society. It also marks the beginning of phase two of the Museum's capital campaign . The Museum has raised over three million dollars to date. These funds allowed the Museum to become established downtown. This position must now be firmly secured through the purchase of a half-interest in the building. Campaign Chairman Paul Severino has brought together a talented and diverse team of volunteers, from all corners of the industry, to help raise the three million dollars needed to successfully complete phase two.

Founding President Gwen Bell stated, "I've watched the Museum grow from a lobby to a building; from one person to many; and from static to dynamic exhibits. Many members and supporters have joined along the way. As we enter a new phase of growth, we need further support. There are terrific challenges ahead, in fund raising, membership development, attendance and new exhibits. Please join me in welcoming Joe aboard, and as a loyal supporter, I hope you'll do all you can to help Joe and the Museum meet the important goals ahead."

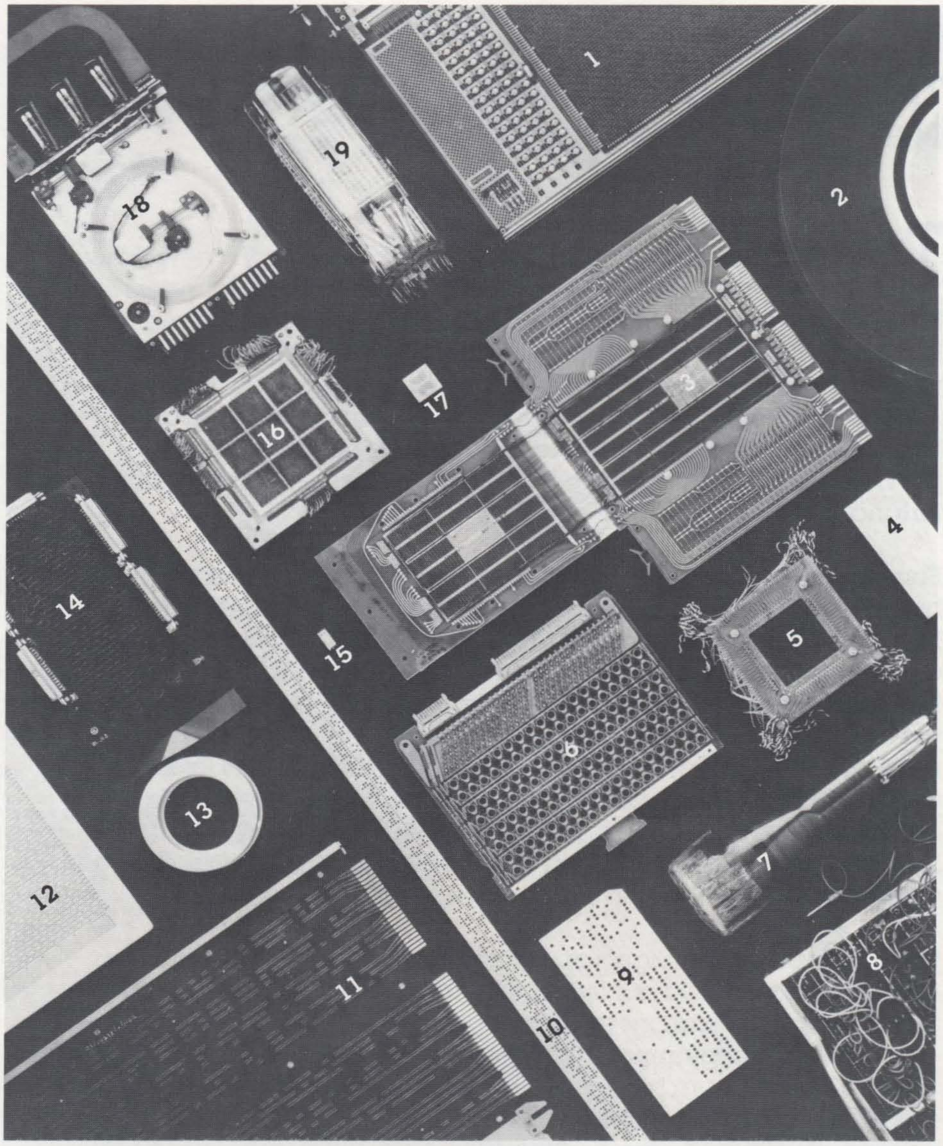


**Executive Director, Joseph F. Cashen**

## Table of Contents

## Memories Poster Directory

1. Read only memory from Honeywell (1970)
2. IBM 1316 Disk Pack (1963)
3. Planar core memory board from DEC (1972)
4. Small Powers-Samas punched card (c. 1950)
5. Block of magnetic core memory from CDC 6600 (1963)
6. Rod cell memory board from Nixdorf 82023 (1969)
7. Williams tube from the Maniac (c. 1950)
8. IBM Plugboard (c. 1930s)
9. Univac 90-column punched card (1951)
10. Fan-fold paper tape (c 1961)
11. Pegboard program tray from Fernati Argus 200 (c. 1965)
12. "Complete Mathematical Chart" by C.W. Goodchild (c. 1900)
13. Dec-Tape magnetic tape (1964)
14. Read only Rope Memory from Apollo Guidance Computer (1963)
15. 256K Random Access Memory by Hitachi (1985)
16. Core plane from Honeywell 58 (1970)
17. 64K Random access memory 8 chip double layer package by IBM (1978)
18. Short Magneto-Restrictive delay line from Ferranti Pegasus (1956)
19. Selection from the Johnniac (c.1950)




| | Readable OR Writeable | |
|---|---|---|
| | **Linear Access** | **Random Access** |
| **Pre-Computer** | Badge<br>Cards<br>Plot<br>Printed Page<br>Punched Cards<br>Punched Paper Tape | CRT<br>Knobs<br>Patchboard<br>Switches |
| **Computer** | Badge<br>Cards<br>Plot<br>Printed Page<br>Punched Cards<br>Punched Paper Tape | CRT<br>Keys<br>Knobs<br>Patchboard<br>Switches |

### Memories Chart

The earliest memories appear in the upper left hand quandrant. They have linear access and are readable or writeable by a machine. The latest and most ideal memories are in the lower right hand quadrant: they have random access and are both machine writeable and readable.

# Memories
*Stories Behind the Devices*

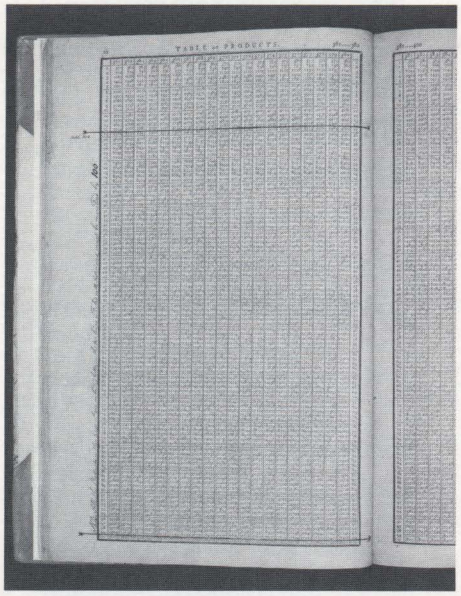
Gwen Bell

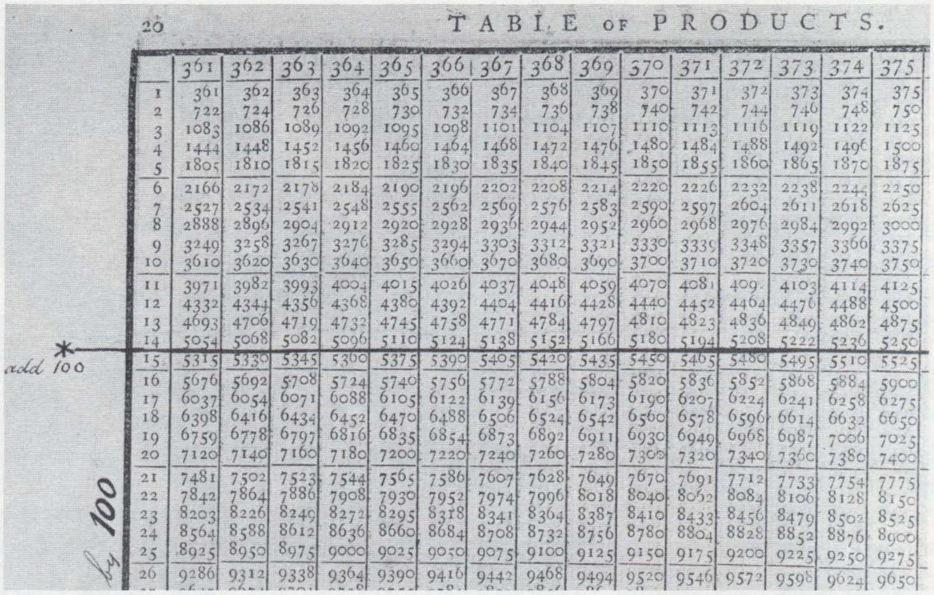
The computer memories on the cover are evocative of the collection of memory devices held by the Museum and of many people's experiences in computing. A large number of these devices were used to store the program, and thus they represent the software as well as the hardware dimension of computing.

The collection of items was made by Dr. Oliver Strimpel and me and was then refined by David Sharpe, the photographer. Our goal was to provide a beautiful and evocative image. In this article I will use the image to tell more stories of the Museum's holdings. In describing the stored program computer, John Von Neumann used the term memory instead of storage because he likened the computer to the human nervous system. Despite a variety of efforts to call computer memory, storage, memory is the word that has stayed with us. Storage is often used for secondary files, such as magnetic tape or discs, and tertiary (archival) memories, such as tape storage that requires human intervention before it is accessed by the computer.

The collection and the poster also include devices for remembering that predate the computer. The PMS classification system described in Bell and Newell's, *Computer Structures*, was used to develop the collection. Their appendix described and further classified memories into three main classes: either machine read or written, machine readable only, and readable and writeable memories. Three other features are considered important: access, portability, and permanency. Of these, the most important is the form of access, i.e., whether it is linear, cyclical, or random. The table shows that the illustrations on the poster are indeed representative of the various sections of the memory taxonomy.

| Machine Readable | Readable AND Writeable | | |
|---|---|---|---|
| **Random Access** | **Cyclical Access** | **Linear Access** | **Random Access** |
| | Delay Line<br>Magnetic Tape<br>Mechanical Disk | | |
| Capcitor Array<br>Compact Disk<br>Diode Aray<br>Inductor/Transformer<br>Integrated Circuit<br>Rope Coupled Array | Delay Lines<br>Magnetic Bubble<br>Magnetic Card<br>Magnetic Disk<br>Magnetic Drum | Magnetic Tape | Core<br>Electrostatic Tube<br>Integrated Circuits<br>Logic Technology<br>Photographic Store<br>Plasma Display |





20 TABLE OF PRODUCTS.

| | 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 |
| 2 | 722 | 724 | 726 | 728 | 730 | 732 | 734 | 736 | 738 | 740 | 742 | 744 | 746 | 748 | 750 |
| 3 | 1083 | 1086 | 1089 | 1092 | 1095 | 1098 | 1101 | 1104 | 1107 | 1110 | 1113 | 1116 | 1119 | 1122 | 1125 |
| 4 | 1444 | 1448 | 1452 | 1456 | 1460 | 1464 | 1468 | 1472 | 1476 | 1480 | 1484 | 1488 | 1492 | 1496 | 1500 |
| 5 | 1805 | 1810 | 1815 | 1820 | 1825 | 1830 | 1835 | 1840 | 1845 | 1850 | 1855 | 1860 | 1865 | 1870 | 1875 |
| 6 | 2166 | 2172 | 2178 | 2184 | 2190 | 2196 | 2202 | 2208 | 2214 | 2220 | 2226 | 2232 | 2238 | 2244 | 2250 |
| 7 | 2527 | 2534 | 2541 | 2548 | 2555 | 2562 | 2569 | 2576 | 2583 | 2590 | 2597 | 2604 | 2611 | 2618 | 2625 |
| 8 | 2888 | 2896 | 2904 | 2912 | 2920 | 2928 | 2936 | 2944 | 2952 | 2960 | 2968 | 2976 | 2984 | 2992 | 3000 |
| 9 | 3249 | 3258 | 3267 | 3276 | 3285 | 3294 | 3303 | 3312 | 3321 | 3330 | 3339 | 3348 | 3357 | 3366 | 3375 |
| 10 | 3610 | 3620 | 3630 | 3640 | 3650 | 3660 | 3670 | 3680 | 3690 | 3700 | 3710 | 3720 | 3730 | 3740 | 3750 |
| 11 | 3971 | 3982 | 3993 | 4004 | 4015 | 4026 | 4037 | 4048 | 4059 | 4070 | 4081 | 409[illegible] | 4103 | 4114 | 4125 |
| 12 | 4332 | 4344 | 4356 | 4368 | 4380 | 4392 | 4404 | 4416 | 4428 | 4440 | 4452 | 4464 | 4476 | 4488 | 4500 |
| 13 | 4693 | 4706 | 4719 | 4732 | 4745 | 4758 | 4771 | 4784 | 4797 | 4810 | 4823 | 4836 | 4849 | 4862 | 4875 |
| 14 | 5054 | 5068 | 5082 | 5096 | 5110 | 5124 | 5138 | 5152 | 5166 | 5180 | 5194 | 5208 | 5222 | 5236 | 5250 |
| 15 | 5315 | 5330 | 5345 | 5360 | 5375 | 5390 | 5405 | 5420 | 5435 | 5450 | 5465 | 5480 | 5495 | 5510 | 5525 |
| 16 | 5676 | 5692 | 5708 | 5724 | 5740 | 5756 | 5772 | 5788 | 5804 | 5820 | 5836 | 5852 | 5868 | 5884 | 5900 |
| 17 | 6037 | 6054 | 6071 | 6088 | 6105 | 6122 | 6139 | 6156 | 6173 | 6190 | 6207 | 6224 | 6241 | 6258 | 6275 |
| 18 | 6398 | 6416 | 6434 | 6452 | 6470 | 6488 | 6506 | 6524 | 6542 | 6560 | 6578 | 6596 | 6614 | 6632 | 6650 |
| 19 | 6759 | 6778 | 6797 | 6816 | 6835 | 6854 | 6873 | 6892 | 6911 | 6930 | 6949 | 6968 | 6987 | 7006 | 7025 |
| 20 | 7120 | 7140 | 7160 | 7180 | 7200 | 7220 | 7240 | 7260 | 7280 | 7300 | 7320 | 7340 | 7360 | 7380 | 7400 |
| 21 | 7481 | 7502 | 7523 | 7544 | 7565 | 7586 | 7607 | 7628 | 7649 | 7670 | 7691 | 7712 | 7733 | 7754 | 7775 |
| 22 | 7842 | 7864 | 7886 | 7908 | 7930 | 7952 | 7974 | 7996 | 8018 | 8040 | 8062 | 8084 | 8106 | 8128 | 8150 |
| 23 | 8203 | 8226 | 8249 | 8272 | 8295 | 8318 | 8341 | 8364 | 8387 | 8410 | 8433 | 8456 | 8479 | 8502 | 8525 |
| 24 | 8564 | 8588 | 8612 | 8636 | 8660 | 8684 | 8708 | 8732 | 8756 | 8780 | 8804 | 8828 | 8852 | 8876 | 8900 |
| 25 | 8925 | 8950 | 8975 | 9000 | 9025 | 9050 | 9075 | 9100 | 9125 | 9150 | 9175 | 9200 | 9225 | 9250 | 9275 |
| 26 | 9286 | 9312 | 9338 | 9364 | 9390 | 9416 | 9442 | 9468 | 9494 | 9520 | 9546 | 9572 | 9598 | 9624 | 9650 |

* add 100

by 100

One of the early books, Charles Hutton's, *Table of the Products and Numbers*, 1781, contains the products of the numbers 1 through 1000 by the numbers 1 through 100, and squares and cubes of numbers. This illustration shows all the figures on a line off by 1000. Page from Hutton's - with correction.

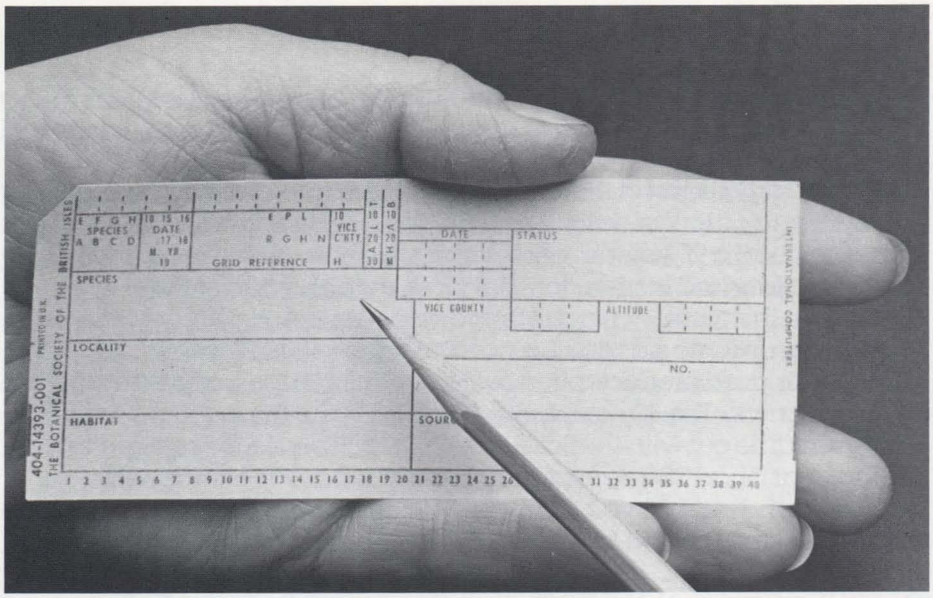
## Pre-computer Memories: Read or Write

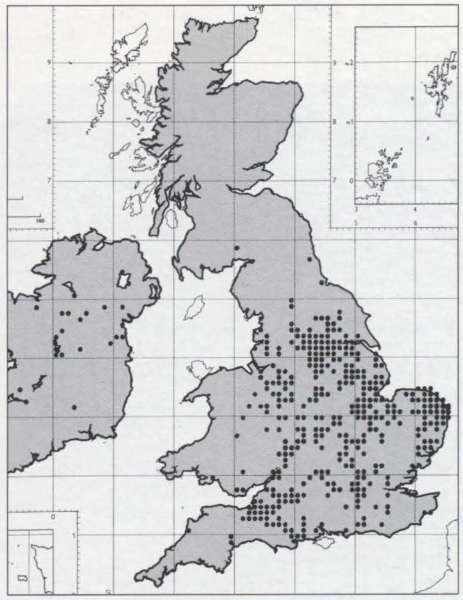
# Linear Access

**Table Look-up.** Napier's Bones, devised at the beginning of the 17th century, were a form of memory for the multiplication tables. Then after John Napier devised logarthms and with the development of calculus, the answers to a series of simple equations were printed and sold widely as books. This phenomena of the book of tables continued through the 1960s. The problem with many of these books was their accuracy. The calculations were done by hand, then the type was set by hand. Sometimes final corrections were made by hand after proofreading..

The Difference Engine was designed by Charles Babbage to accurately produce and print pages of tables of differences. This was later built by Scheutz and produced books of differences. Howard Aiken, whose idea was to produce Babbage's Analytical Engine, desired to produce tables of Bessell Functions of astronomical observations. After the Harvard Mark I had completed these computations, the future use of the computers was questioned

"Complete Mathematical Chart" by Goodchilde, c. 1900 (item 12 in the poster), is two cardboard pages that were available for easy reference. The Museum's collection has a variety of examples of several cardboard pages filled with numbers and very thick books of the thinnest possible paper allowing for as much information as possible. Specialized pocket calculators and computers still maintain frequently used information in lookup tables. General purpose machines perform most calculations rather than relying on lookup tables.



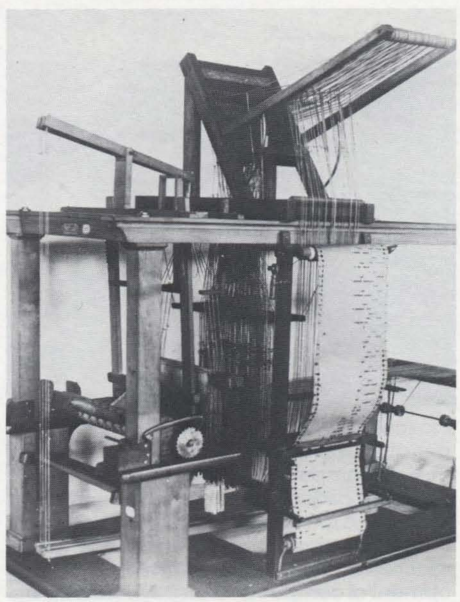
Powers Samas card for recording the distribution of flora and fauna in the British Isles. The map of Abramis was produced directly on a special printer developed for this system.

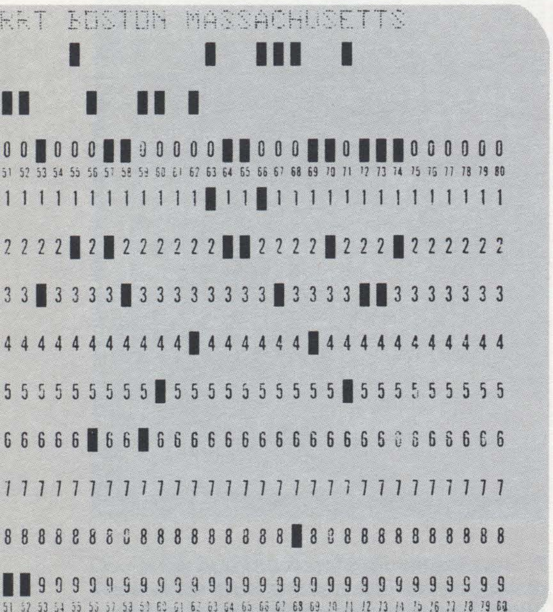
**Punched Cards.** In the 1790s, Joseph Jacquard designed a machine to weave silk patterns based on the ideas of Bouchon, deVaucauson and Falcon. This machine used an automatic harness controlled by punched cards connected in a roll that held the pattern. Babbage was inspired by the Jacquard loom and planned to use card input in the Analytic Engine.

Hollerith's punched-card system for the 1890 U.S. Census was the first to use cards for data processing. The size of the Hollerith card was based on the size of the dollar bill at the time, and the round punches were those used by trolley conductors. Hollerith's Computing, Tabulating and Recording Company hired Thomas J. Watson, Sr., as its President, and in 1924 the name was changed to International Business Machines. While the eighty column "IBM" card with rectagular holes became the standard, other sizes and shapes of holes were used for special purposes and niche markets.

The Computer Museum's collection includes a very special punched card system developed by Powers-Samas for the Institute for Terrestial Ecology in the UK. (Item 4). Field data on the location and species of flora and fauna were written directly on the card to be punched. In the late forties, Professor Maurice Wilkes, who was building the first stored-program computer, consulted on the design and development of a special printer that would take the data from the cards and produce dot maps of distributions in the British Isles.

The 19th century silk looms, where cards were used to create intricate patterns inspired Babbage to use cards to hold other kinds of information.



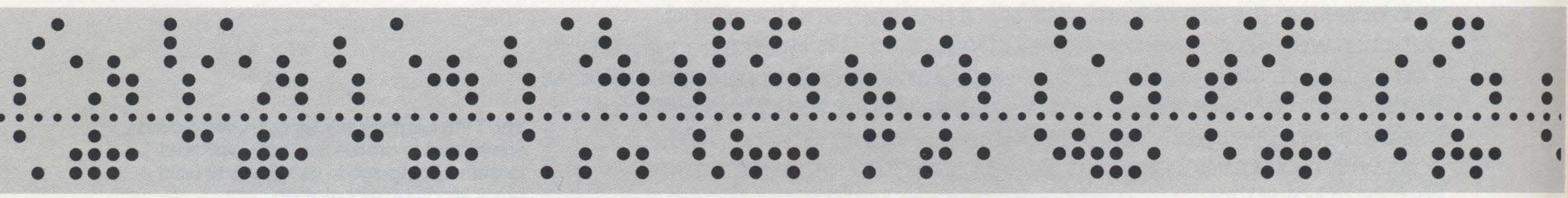



IBM 80 column card with rectangular holes

### Computer Memories: Read or Write
## Linear Access

**Punched Cards.** Most of the first computers adapted card systems for the input and output of data. The UNIVAC, the first commercial computer, had a 90 column card with round holes(Item 9). Setting one's own standard is often done to get or keep one part of the market. At the outset, when all the competitors are scrambling, the "winner," or de facto standard, is not always obvious. Then, those without standard products often make special compensations to win new customers. The 80 column IBM card became the standard, and UNIVAC came out with the Solid State 80/90. "Solid State" referred to the fact that it had 700 transistors and 3,000 ferractors or magnetic amplifiers and only 20 vacuum tubes. " 80/90" meant that it could deal with either the IBM 80 or UNIVAC 90 column cards.

One of the many problems with card storage was their very bulk and lack of density of information. For example, 60,000 cards were required to store the master program for the AN/FS Q7, SAGE system computer built in the late 1950s. They took up 24 cubic feet of space and had to be kept in order. (Later, a reader was developed that could accept cards in any direction or order.) To extend the life of card computing IBM developed System 3 with a smaller card that more than doubled the density of information. This provided no competition, however, for the floppy disk or integrated circuit.

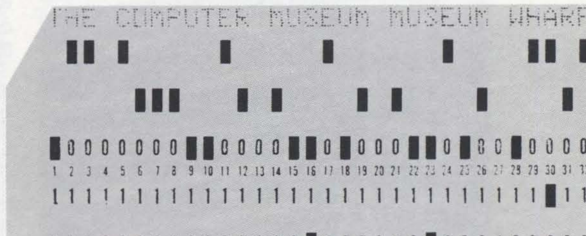


Flexowriters were used to punch the papertape for the input of data for many of the first computers. These machines and their antecedents were cheaper, stored upper and lower case, and had a better human interface than the punched-card machines. They led directly into the development of computers with keyboard input.

**Punched Paper Tape.** While the ENIAC used cards for input/output, the EDSAC, the first stored program computer built by Professor Maurice Wilkes at Cambridge University, used punched paper tape (Item 10). This form of input and storage of programs and data, adapted from telegraphy, was quite common on the early university computers. Flexowriters were used to punch tape that could be spliced together with previously punched subroutines. Flexowriters were replaced by Teletype, later Model 33s. Paper tape continued as a form of input up through the beginning of the micro-computer era. For example, Bill Gates delivered the first BASIC interpreter for the 1975 Altair on punched paper tape.

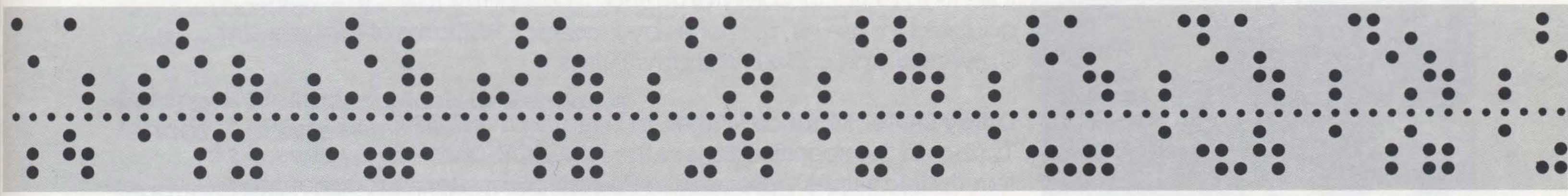
## Computer Memories: Read or Write
## Random Access

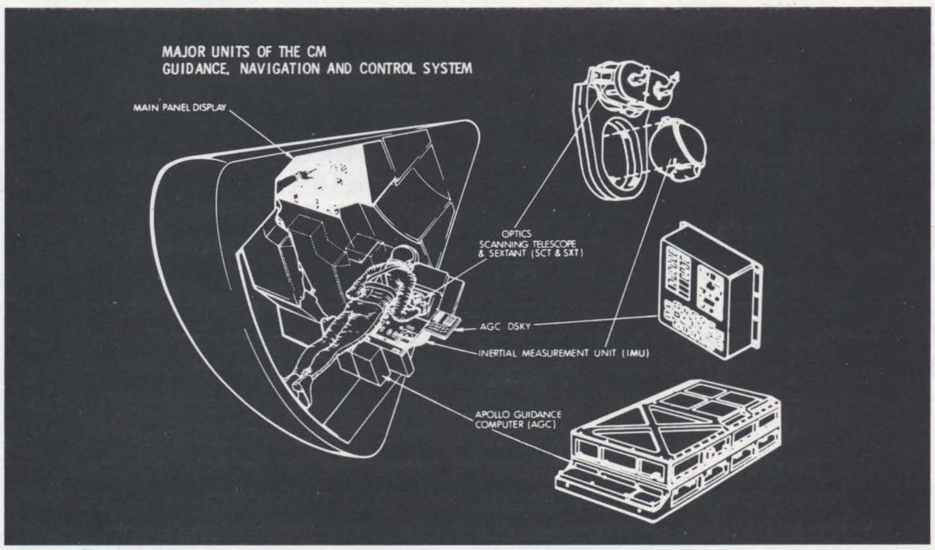
**Patchboards.** The pegboard program tray from the Ferranti Argus 200 (item 11) contained the master program for the machine. Master programs, the precursor of operating systems, were not placed in a read-only memory because the programmers wanted to be able to change them. This meant taking out the tray and replacing the magnetic pegs to make a different set of connections. The early users had even greater difficulty keeping up with the new versions of fundamental operating systems since programmers could come in and change things overnight.



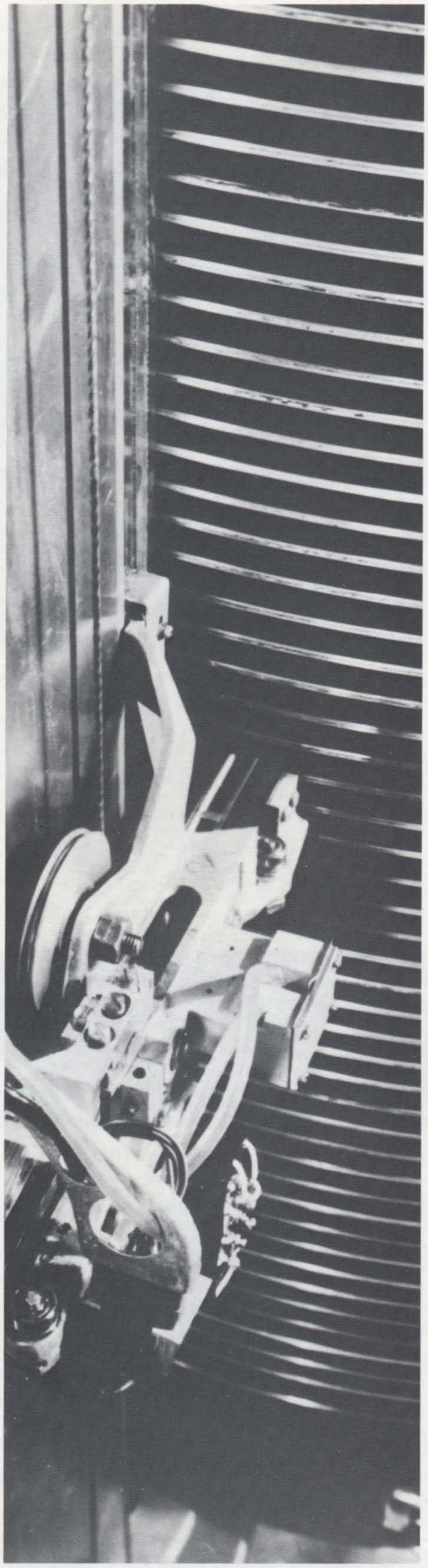

## Computer Memories: Machine Readable
## Random Access

**Rope Memory.** The design of the early space computers in the late fifties and early sixties preceded the availability of reliable integrated circuits. In 1962, the designers of the Apollo Guidance Computer took a bold step in choosing integrated circuits (invented in 1959) for the logic component of the machine, but they went with more conservative choices for the memory. The computer had 1024 16-bit words of core memory and 24,576 16-bit words of read only fixed memory made of wired-in ropes and cores. R. L. Alonso and J. H. Laning , two of the AGC designers, described these as "compact and reliable devices." The truly important decision was that the astronauts would be able to use a computer that had a 2K erasable memory that they could control.






**Major units of the CM Guidance, Navigation and Control System from the MIT Draper Lab.**



**When disks were introduced as a secondary storage device in the late fifties, they had the characteristic of looking like the platter set on a contemporary jukebox. The IBM RAMAC for example had a total of 50 disks.**

For a short while, a small Massachusetts company tried to make a market that specialized in weaving rope memories for computers. This technology was used for the character set for Digital Equipment Corporation's 338 display unit available in the mid-sixties.

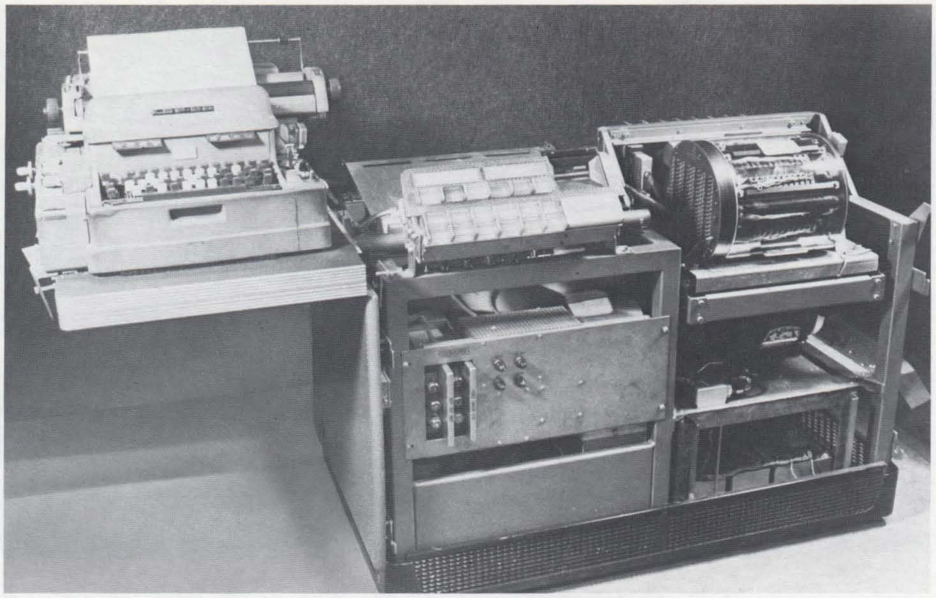
**Computer Memories: Readable and Writeable**

## Cyclical Access

Cyclical memories are still used today primarily as secondary storage in the form of disks and tapes. Prior to the invention of core memory, early computer designers had two choices of primary cyclic memories. Delay lines were reliable but slow and required special talents in logic and programming. The less reliable CRTs were adapted for use as memories by Frederick Williams of Manchester University and called "Williams Tubes."

**Delay Lines.** Maurice Wilkes, in building the EDSAC, and Alan Turing, in the specifications of the Pilot ACE, chose delay lines. As a result, delay lines were used in English computers throughout the fifties.

The short magneto-restrictive delay line is from Ferranti Pegasus (Item 8). In describing the design philosophy of the Pegasus, its designers W.S. Elliott, C.E. Owen, C.H. Devonald, and B. G. Maudsley, discuss the machine's "rhythm." This rhythm is based on the access to the primary memory of 55 single 42-digit word magneto-restrictive delay lines. A basic 3-beat rhythm was established. Beat 1 of one-word time extracts two orders from the memory; beat 2 of two-word times obeys the first order; beat 3 of two-word times obeys the second order. (Clearly a waltz with a first quickstep.) Programmers of delay-line machines learned to optimize the rhythm and were heard to regret the simplicity of programming for all the later machines based on random-access primary memories.



The LGP-30 was one of the many small scale drum computers sold in the fifties. Built in 1956, in 1962 it rented for $1300 a month. The drum on the far right held 4K bits of information.

**Drums and Disks.** Magnetic drums were the earliest form of secondary magnetic storage. Prototype magnetic drum computers included the Harvard Mark III and the ERA 1101. The magnetic drum provided a large amount of slow memory at relatively low cost. Typical drum-storage systems are 8-20 inches in diameter and revolve at 1,500-4,000 rpm. There were literally dozens of magnetic drum computers of varying capacity that were the small to medium-sized computers of the first generation.

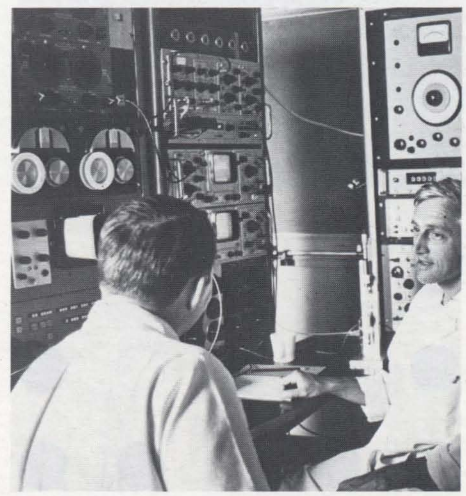
In the late fifties, the IBM 305 RAMAC (random access method of accounting and control) was among the first -- if not the first -- data processing system to employ a magnetic disk file permitting direct random accessing of records. The system, with 50 disks, stored 20 million characters.

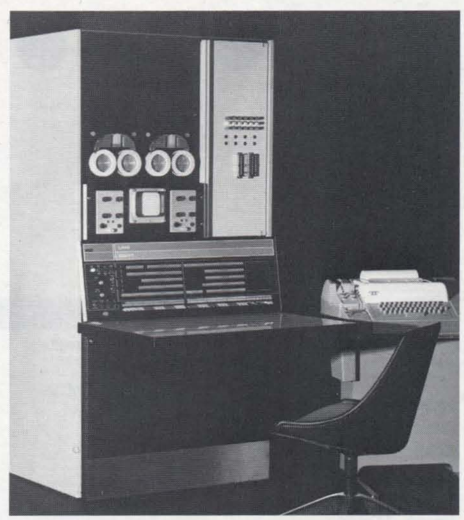
### Computer Memories: Machine Readable
## Linear Access

**Magnetic tape.** Magnetic tape has had the advantage of being a relatively stable product, with specifications for its physical or magnetic properties changing very little. Archival tapes from two decades ago are generally still readable. In contrast, disk technology has rapidly changed.

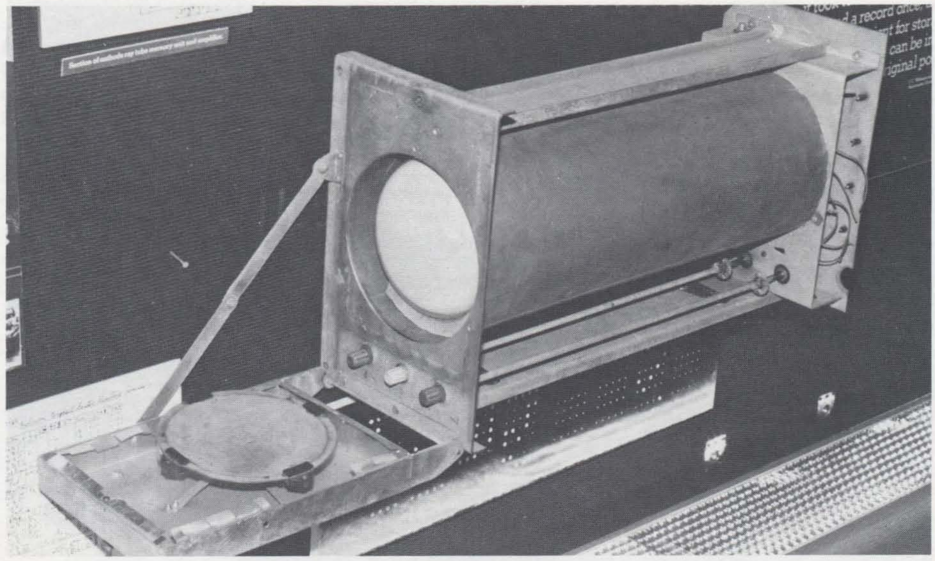
The "DEC-tape" (Item 13) is a non-standard tape that can be thought of as an important component of mini-computers and a precursor to the floppy disk. The small tape units were designed by Wesley Clark for the LINC computer. Two dozen LINCs (Laboratory Instrument Computers) were built by their users at MIT in 1962. The LINC-tape was small, removable and portable. User's could carry their own around, the same way that users today treat their system and data disks. DEC reverse-engineered the tape and used it on its own LINC-8 system and then on the PDP-12.

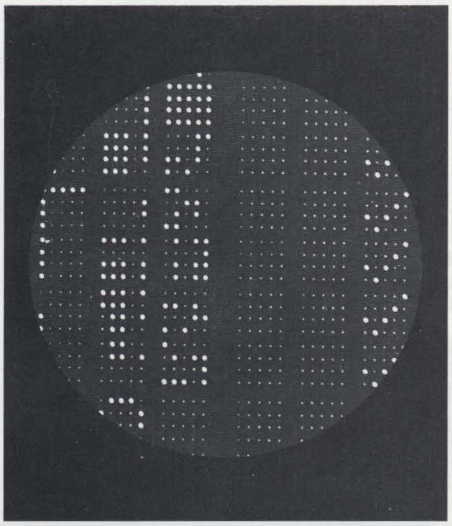
An original hand buit Linc is on the left in use in a laboratory. Several years later DEC sold the Linc as a product.

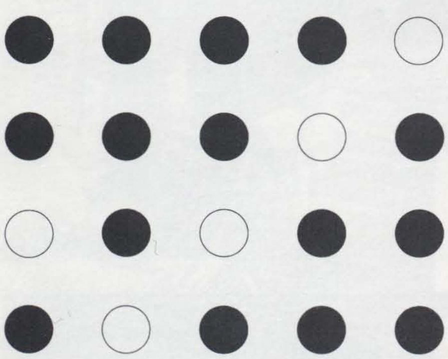




The Williams tube was used as a graphic device. Each instruction was read in twice on the same line. If it agreed then a check mark appeared on the second half of the line. Below is a detail of the screen.







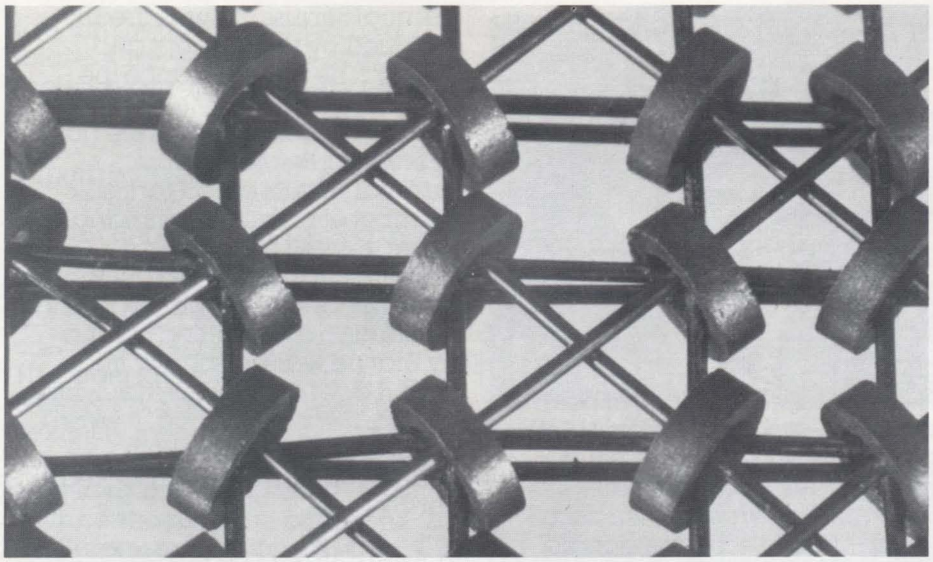
## Computer Memories: Machine Readable
## Random Access

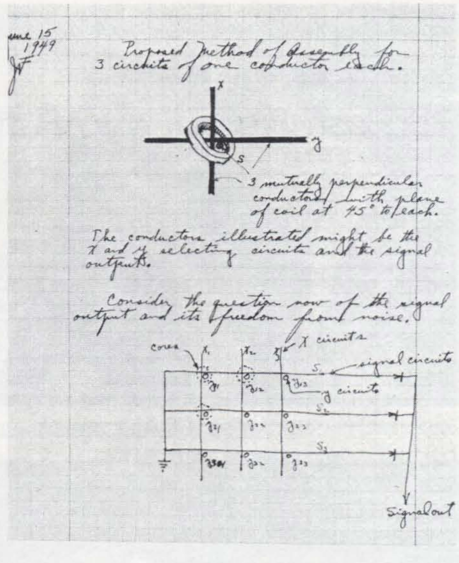
**Williams Tubes** (Item 7). Professor F. C. Williams of Manchester University developed the first random access computer memory. Julian Bigelow, who was building a computer at Princeton's Institute for Advanced Studies with von Neumann, recalls Williams and his lab: "My visit to Manchester was a delightful experience; F.C. Williams was a true example of the British 'string and sealing wax' inventive genius, who had built a primitive electronic computer out of surplus World War II radar parts strictly on his own inspiration — in the middle of which were two cathode-ray tubes storing digits — the "Williams' memory." I can remember him explaining it to me, when there was a flash and a puff of smoke and everything went dead, but Williams was unperturbed, turned off the power, and with a handy soldering iron, replaced a few dangling wires and resistors so that everything was working again in a few minutes. ...The whole technique depends upon clever exploitation of the fortuitous secondary electron emission properties of cathode-ray-tube phosphor screens — phosphors that are chosen and incorporated purely to give good visual response without regard for secondary electron emission. In this sense it was a lucky accident that the scheme worked at all." (Julian Bigelow, "Computer Development at the Institute for Advanced Study," in *A History of Computing in the Twentieth Century,* N. Metropolis et.al., 1980.)

Despite all of this seeming "black magic" around the Williams tube, it was successfully used by IBM on their 701 series of computers.

**Short Chronology of Major Events in the Development of Core Memory Abstracted from Emerson W. Pugh, *Memories that Shaped an Industry*, MIT Press, 1984.**

| 1946 | 1947 | 1948 | 1949 | 1950 |
|---|---|---|---|---|
| 1/46 Jay Forrester proposes a computer at MIT | | | 6/49 Forrester begins documentation in his notebook of a memory using magnetic materials<br>9/49 An Wang describes a shift register using magnetic toroids of Deltamax | 8/50 M.K. Haynes thesis describes his coincident-current magnetic core memory proposal.<br>9/50 Jan Rajchman of RCA files a patent application for a coincident-current magnetic memory.<br>10/50 Forrester initiates ferrite material work at MIT |






The original diagram shows only the coordinate wires for the core. The diagonal wires on the manufactured core plane provide the read element for each core.

**Core Memory.** Both the IAS machine and MIT's Whirlwind made do with a version of the Williams tube as their original memory devices. But in both cases, the concept of using some sort of magnetic random access device was under consideration.

The IAS group was working with Jan Rajchman of RCA to develop a fast parallel memory to operate the arithmetic unit. After two years of development no wholly operative memory had been produced. Julian Bigelow remembers, "von Neumann and I made an attempt to list all the variables which would have to be kept under control to produce a 50% yield of successful Selectron tubes covering a range of digital capacities from the original goal of 4096 digits per tube, down through 2048, 1024, 512 etc. In any event, although the Selectron tube held out intellectural respect and admiration, we had increasing doubts that it would provide something we could use in the near future." Several years after the IAS Computer was running, a 256 digit Selectron tube was delivered to the Rand Group for the Johnniac (Item 19).

About seven years passed between the beginning of the invention of core memories for computers and their delivery to customers within a commercial product. Over the next twenty years, until the late seventies, core memories were the predominant form of primary memory. After 1971, when IBM shipped their first system with all-semiconductor main memory, engineers tried to pack greater and greater density to compete with these new products. The 1972 planar core memory board from DEC (item 3) achieved two bits of information from each core by reading the memory at two different voltages. Core is still used in a few systems to gain the reliability that comes from a stable memory regardless of power failure.

| 1951 | 1952 | 1953 | 1954 | 1955 | 1956 |
|---|---|---|---|---|---|
| 5/51 Forrester files for a patent on his magnetic core memory<br>12/51 Successful operation of a 16x16 array of metallic cores at MIT | 1/52 2x2x2 ferrite core memory built in Hayne's group at IBM<br>5/52 4x4x4 ferrite core memory operates at IBM | 5/53 First ferrite core main memory operates on MIT Memory Test Computer with a 32x32x17 array | | | 1/56 IBM ships 702, 704, and 705 computers with ferrite core memories. |

# Entrepreneurism:

*The Past, Present and Future of Computing in the USA*

William Norris,
Chairman Emeritus
Control Data Corporation

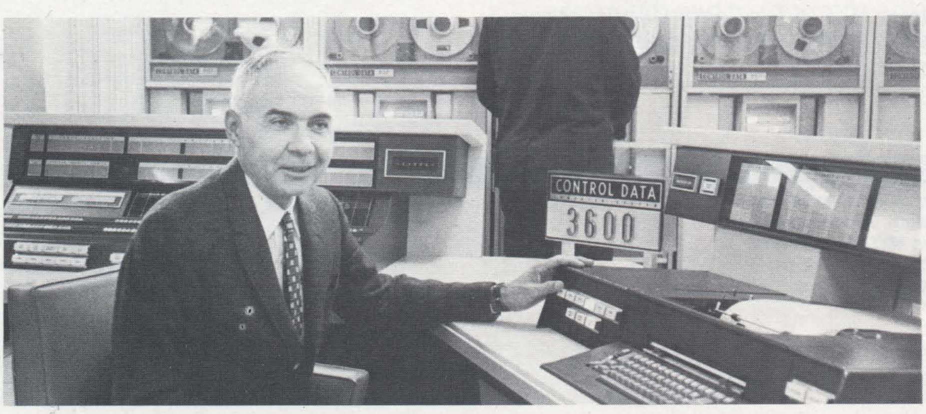
The genesis of Electronics Research Associates (ERA), one of the first computer companies, was the U.S. Navy's World War II Communications Supplementary Activity in Washington (CSAW). Often referred to as "Seesaw" because of its initials, its primary mission was to intercept and decode enemy messages. The mission was of such critical importance that no expense was spared to assemble the best talent and develop the technology needed to assure maximum success.

Toward the end of the War, Dr. Howard Engstrom and I, both members of CSAW, put a plan together to preserve the unity and continuity of the efforts and the team. We suggested that a significant number of the team would form a private company that would make their services available to the Navy under contract. The new company would, at the same time, develop other business based primarily on electronic digital circuit technology. Late in 1944, the Navy accepted our proposal and all we needed was financing.

Venture capital hadn't yet been invented and information about the nature of our expertise was highly classified. About all that we could say was that we had a group of talented professionals with unique expertise in the design of electronic digital circuits that had potential for new products in a number of important fields.

Seventeen companies and a number of individuals in the Washington/New York area were contacted. We visited J. Prespert Eckert and suggested that we undertake a joint activity. Eckert said that the plans for his company had pretty well jelled and that he didn't want to consider that possibility. Later, fate destined us to get together when Eckert-Mauchly became a division of Remington Rand in 1950, as did ERA in 1952.

Admiral Lewis Strauss, Assistant to Navy Secretary Forrestal, was one of the partners of the Wall Street firm of Kuhn, Loeb who were identified as a source of financing. Since security was not a constraint in talking to Admiral Strauss, he was greatly intrigued by the concept and said that he would finance the company personally even if his partners in Kuhn, Loeb were not interested. Before signing, Admiral Strauss asked that a member of his staff, Commander Paget, review the proposal. Admiral Strauss pointed out that Commander Paget was planning to establish a consulting company that he was personally financing. Paget concluded that while our plan was interesting, it wasn't economically viable. Both Strauss and Kuhn, Loeb backed out.



**William C. Norris seated at the console of a 3600 Computer in 1964.**

The final chapter of this incident was written 25 years later when Control Data acquired the Commerical Credit Company, and the firm of Cresap, McCormick and Paget was one of the consultants proposing to help. When their proposal was presented, the introduction contained a message from Mr. Paget expressing the hope that with the passage of time I had forgiven him for his erroneous conclusion. Indeed, 30 years and the success of Control Data, especially the latter, had mellowed my resentment.

Yet in 1945, Admiral Strauss's rejection was a devastating blow because we were led to believe that we had located our sorely needed financing after a long and arduous hunt. Even worse, by then the war had ended and time was running out.

Then, late in 1945, we learned that Northwestern Aeronautical, a company located in St. Paul, Minnesota, that was a war-time contractor for troop-carrying gliders, was looking for a new direction. After several meetings with the President, John Parker, a deal was struck, and ERA had a home in St. Paul.

Incorporated in January 1946, ERA's equity ownership was divided equally between the founder group and the financial group headed by Mr. Parker. 100,000 shares of stock were sold to each group to provide $20,000 total equity. In addition, Parker's group guaranteed a line of bank credit of $200,000.

Superb human capital and effective government contracting methods helped us to meet the requirements of CSAW. The R&D work for this agency was performed under cost plus fixed fee contracts. This was advantageous and effective because it allowed wide flexibility in setting initial specificiations and altering them to gain maximum performance. Such contracts came both from the Bureau of Ships and the Office of Naval Research. This type of contract was a new and enlightened approach by the Navy. In combination with entrepreneurial enterprise, not only were the needs of the Navy met, but many important advances were made in computer technology. In the process of performing a large number of R&D contracts, ERA built up a vast reservoir of technology, evidenced by the large number of spin-off companies that were spawned.

ERA built the first commercially available digital computers, the 1101 and 1103, and also developed and manufactured magnetic storage devices. By 1952, ERA's growth was outstripping its limited capital base, and the only alternative for maintaining growth was to merge with a large company. I stayed on as general manager of the ERA Division of Remington Rand. When Remington Rand merged with Sperry to form Sperry Rand, I became general manager of the Univac Division, where all computer activities were consolidated.

Although Sperry Rand had acquired the industry's two leading entrepreneurial computer companies with a major part of the leading edge technology in the industry, namely Eckert-Mauchly and ERA, they were unable to capitalize on the technology lead. I resigned to form Control Data.

**Contol Data's first day on the New York Stock Exchange, March 6, 1963.**


**The shipment of the First 1604 computer to the U.S. Navy.**

## Control Data Corporation

In July 1957, CDC was incorporated based on an initial financing by the sale of 615,000 shares of stock to the public for $1.00 per share. Control Data was the first publicly financed new computer company. Part of the ERA team came with me and we focused on a line of engineering and scientific computers that included supercomputers at the top.

My definition of a supercomputer is "today's most powerful, general purpose, computer." That definition implies that there can be only one supercomputer at any one time. Since any computer's power varies for different applications, this means that there may be two or three machines that deserve to be called supercomputers at any one time. Thus, in their day, the ENIAC, EDVAC, ERA 1103, CDC 6600, CDC 7600, CRAY 1, and CDC Cyber 205 could all be legitimately called supercomputers. In the early seventies, CDC also initiated the Plato computer-based education system in cooperation with the University of Illinois and the National Science Foundation, because computer-based education is the most significant application area. High quality relevant courseware consisting of more than 15,000 hours on material in a broad range of 150 subject areas is currently available.

## Education and Competitiveness

Computer based education not only delivers and manages instruction, it also provides the capability for reducing or eliminating the time consuming administrative tasks associated with teaching, thereby making more efficient use of instructional resources. This allows teachers to spend more time with students and gives students more time for improving their skills. Unfortunately, utilization of computer-based education has not kept pace with the growing availability of high quality courseware and decreasing costs of hardware and software. The adverse consequences of this lag are especially serious in the K-12 educational spectrum where the basic underpinnings of a skilled work force are formed.

The decline in the ability of our work force to handle comprehensive notions of science and technology translates into an important factor in declining U.S. competitiveness in world markets. Ample evidence is available to show that the Japanese school system far exceeds ours in its ability to prepare educated workers for business and industry. For example, youngsters in Japan spend more time developing their ability to handle science, math and foreign language than in the USA.

Knowledge is becoming an increasingly important factor in the work force. Unless education and training is significantly improved, our technically illiterate work force will place us at an even greater competitive disadvantage. Considering all the constraints, the only practical solution is a massive increase in the use of computer-based education.

**Environment for Entrepreneurship**

Despite the critically important role entrepreneurism has played in the computer industry and indeed in our entire national economy, the environment for small enterprise innovation is deteriorating along with our competitive position in world markets. Most markets suffer from unprecedented domination by multinational corporations, many of them foreign-based, to the disadvantage of medium and small companies with limited resources, especially for manufacturing.

The passage of the Mansfield amendment to the military procurement authorization act of 1970 required that research be related to weapon systems. This act significantly reduced access to technology by small companies and gave large military systems contractors more control over research.

Small companies receive less than three precent of total government R&D funds. Given the record of small enterprise as a major source of innovation, this resource is far from being utilized. The small business innovation research program passed by Congress about 1982 has only helped modestly.

Fortunately, venture capital, a major stimulus to small enterprise innovation, continues to be in plentiful supply. Unfortunately, the innovations are made in the pre-venture capital stage, where government R&D can greatly help. Seed capital is required to advance technology from the research and idea stage to the point where venture capital commitments can be made.

Broadly speaking, our foreign competitors, especially Japan, have greatly accelerated research and development, dramatically increased the number of trained scientific and technical personnel, reduced needless and wasteful duplication of technology development, fostered growth and lowered the cost of capital in carefully targeted industries. The Japanese government has promoted cooperation among industry members at the base technology level as a key ingredient for success.

The declining US competitiveness is largely related to inefficient and, at times, inept management of technology. Public/private cooperation is needed to substantially increase the efficiency of research, development and manufacturing. Three new institutions provide models: The Microelectronics and Computer Technology Corporation; A Job Creation Network; and The Midwest Technology Development Institute.

**The Microelectronics and Computer Technology Corporation (MCC)**

The MCC was established in 1982 in Austin, Texas. It has grown from eleven to twenty-one participating companies from the US computer and semiconductor industries. Base technologies are developed by MCC's scientific and engineering talent and provided to the members. Member corporations can each add their own value and continue to compete with products relating to their own freely selected markets. MCC also licenses technologies on reasonable terms to others, including small companies.

A ten-to-one leverage is gained by the member companies in MCC. If every industry had a similar cooperative arrangement, it would provide a much-needed boost to innovation and competitiveness.

**The Microelectronics and Computer Technology Corporation (MCC) Corporate Membership List.**

**Advanced Micro Devices, Inc.**
Sunnyvale, CA
**Bell Communications Research, Inc.**
Livingston, NJ
**Digital Equipment Corp.**
Maynard, MA
**Harris Corp.**
Melbourne, FL
**Honeywell Inc.**
Minneapolis, MN
**NCR Corp.**
Dayton, OH
**Westinghouse Electric Corp.**
Pittsburgh, PA
**Allied-Signal Inc.***
Morristown, NJ
**Boeing Co.**
Seattle, WA
**Control Data Corp.**
Minneapolis, MI
**Eastman Kodak Co.**
Rochester, NY
**General Electric Co.**
Fairfield, Conn
**Lockheed Corp (Lockheed Space and Missile Co.)***
Sunnyvale, CA
**Martin Marietta Corp.**
Bethesda, MD
**3M Co.**
St. Paul, MN
**Motorola Inc.**
Schaumburg, Ill
**National Semiconductor Corp.**
Santa Clare, CA
**Rockwell International Corp.**
Pittsburgh, PA
**Unisys Corp.***
Detriot, MI
**Hewlet-Pacckard Co.**
Palo Alto, CA

*Companies that have announced they are leaving MCC at the end of 1987.

**Job Creation Network**

The Job Creation Network operates at the community level to improve initiatives for expanding innovation. It consists of three elements.

1) A cooperation office is a non-profit organization that helps a new company shape a business plan, obtain financing, or locate a base technology. The staff is bolstered by a volunteer advisory panel of experts.

2) A seed capital fund is accumulated from a consortium of state and local government and private investors with tax credits made available.

3) A business and technology center provides consulting services, shared laboratory, manufacturing, office or other services to facilitate the startup.

Aggressive programs have been established in Illinois, South Carolina, Minnesota and Canada.

**The Midwest Technology Development Institute (MTDI)**

The MTDI was established in 1985 with nine member states. MTDI has the threefold objective of:

1) expanding technological cooperation among midwest universities and industry to increase the efficiency of research and the commercialization of the results;

2) extending technological cooperation to include universities in foreign countries;

3) providing a mechanism to increase the availability of technology to industry, especially small businesses and to achieve an equitable transfer of technology between the US and foreign countries.

**Unbalanced Technology Flow**

A partial list of reasons for the inequitable technology flow that goes from the US to Japan includes:

* A significant part of Japan's basic research is carried out in government laboratories that are closed to foreigners.

* US companies cannot participate in Japanese government-funded R&D projects that have explicit commercial objectives, nor, for the most part, do US companies have access to Japanese patents.

* Small US companies are a major source of technology for Japan that is obtained by licensing or acquisition. US enterprise does not have a similar opportunity.

* Japan has virtually unlimited access to US research.

* The best Japanese graduate students come to the US and are supported both intellectually and financially and do not repay this capital investment.

* The US has not diligently pursued the acquisition of Japanese technology.

One of the first corrective actions was taken in 1986 with the amendment of the Stevenson-Wydler Innovation Act that gave the directors of the US federal laboratories discretionary authority to deny access to research to any foreign country that does not grant similar privileges to American organizations.

Implementing equitable technology flow agreements with other countries will require that the US keep track of technology transfer. MTDI is playing a major role in establishing a measurement system that will include mechanisms for inventorying and tracking technology. They will also institute a large scale program aimed at helping transfer Japanese technologies to small US companies.

**Technology Momentum**

The flourishing of entrepreneurial enterprise during the decade between 1945 and 1955 provided the momentum that accelerated through the early 70s to put the US into world leadership in the computer industry. A great deal of credit must be given to the Navy, especially the Office of Naval Reserach Program in Computing for the stimulation and support of the development of computer technology until it was ready for commercialization. This early support coupled with entrepreneurism was a major factor in helping to build the momentum . that propelled the United States into world dominance of the computer industry. Indeed, leadership in computer technology was also a catalyst to innovation in other fields and until recently, the US has been dominant in technological innovation in the world.

The position has been deteriorating in the last decade. Unless corrective action is undertaken with massive technological cooperation and with an environment for entrepreneurial enterprise, the erosion will continue. If the corrections are made then entrepreneurial enterpise will again realize its potential and play a leading role in expanding innovation on the scale necessary for assuring the well-being of the country.

# Computer Memories Poster

Mark Hunt

You may have seen the image on the cover of this issue of the *Report* in advertisements in leading computer publications over the past few months. The story of how this public service campaign developed is worth telling because it illustrates how enormously the Museum benefits from collaborative efforts.

In the spring of 1985 Gabe d'Anunzio, vice-president of marketing programs for MICOM-Interlan, suggested to the Museum staff a public service announcement campaign advertising a poster picturing "antique" computer memories.

Gabe put the Museum in touch with Grafik Communications, of Arlington, Virginia. They volunteered to design the poster and the advertisement, and to arrange for free photography and production of the posters in exchange for limited in-kind services for their client, VM Software. VM Software photographed the Museum's exhibits and items from the collection for their annual report.

The key elements still missing were commitments from the publishers to run the ads at no cost and a color separation for each publication.

Our first calls were to David Bunnell, publisher of *MacWorld* and *PC World*, and Harry Brown, publisher of *Byte*. They agreed to run the ads if we provided color separations. Paul Thiel, vice-president of marketing communications at Scitex America Corp., maker of state-of-the-art computer-controlled color separating equipment, then agreed to supply color separations and we were in business.

Almost every publisher we spoke with was eager to participate. Each offered a full-page, full-color advertisement. The total advertising space committed is valued at almost $225,000, with a combined circulation of 3.4 million high-tech readers of 25 publications. The total value of the program is almost a quarter million dollars. All from the hard work of many dedicated friends and staff of the Museum.

Responses to the advertisement are streaming in daily. Readers send a tax-deductable contribution of $25 or more to receive the elegant full-color poster. To order your own poster, check the appropriate box on the membership coupon on page 17, and return it to the Museum with your own $25 tax-deductible contribution.

**Participating Publications**

AI Expert
Boston ComputerNews
Byte
Circuits Manufacturing
Computer
Computer Design
Computer Graphics World
ComputerWorld
Data (Denmark)
Datamation
DEC Professional
Digital Design
Digital News
Digital Review
Electronics Test
Hardcopy
High Technology
Information Center
InformationWEEK
InfoWorld

**People that Made it Happen**

Gabe d'Anunzio
*MICOM-Interlan*
Gwen Bell
*The Computer Museum*
Alex Berry
*Grafik Communications Ltd.*
Mark Hunt
*The Computer Museum*
Judy Kirpich
*Grafik Communications Ltd.*
Megan McCarthy
*Scitex America Corp.*
Renate Brown Neely
*VM Software*
Gail Rosen
*Scitex America Corp.*
David Sharpe
*David Sharpe Studio*
Oliver Strimpel
*The Computer Museum*
Rich Theis
*Scitex America Corp.*
Paul Thiel
*Scitex America Corp.*
David Vanable
*Scitex America Corp.*

**Companies that Donated Services**

David Sharpe Studio
Grafik Communications Ltd.
Scitex America Corp.
Type Studio
Virginia Lithograph

## Calendar *Spring 1987*

**May 3**
**Sunday**
**4 pm**

**Dick Shoup, Aurora Systems.**
*"A Perspective on DigitalVideographics or, How Computer Graphics Can Brighten Up The Evening News".*
Learn about the process and equipment that won Shoup an Emmy for his pioneering work in computer graphics.

**May 17**
**Sunday**
**4 pm**

**Jean Louis Gassée, Vice President of Product Development, Apple Computer, Inc.**
*"The Future of Personal Computers".*
Gassée will share his predictions about what lies ahead in the fast-paced and ever changing world of personal computing.

**May 30**
**Saturday**
**2 pm**

**Bruce Schwoegler, WBZ-TV Meteorologist.**
*"Computers and the Weather".*
Learn how computers are used to gather weather to television viewers.

### Coming Events

**June 18**
**Thursday**

**Opening of SMART MACHINES, a major new gallery on robots and artificial intelligence.**
Visitors will see and interact with the history and current state-of-the-art of intelligent machinery. The gallery will feature over 20 hands-on demonstrations, a unique collection of historic robots, and entertaining film. The working exhibits will include programs with expert knowledge of areas of medicine, geography and art. Others will try to answer questions posed in plain English. There will be working industrial, teaching and toy robots. Members will receive invitations to an exhibit opening and preview.

**June 19**
**Friday**
**7:30 pm**

**Herman Budnick, Herman Budnick & Associates.**
*"Development and Implementation of Videodisk/Videotex Information Systems".*
Learn about the state-of-the-art distributed videotex approach used to create a system of public tourism information kiosks for Boston's Logan International Airport .

**May 9**
**Saturday**
**7pm**

**The Computer Museum's 5th Birthday Party!**
A fun-filled evening of live and silent auctions with entertainment by clowns, magicians and jugglers!

☐ **YES!** I want to become a Member of The Computer Museum.

☐ **YES!** Please refresh my memories by sending my *Memories Poster*. A tax-deductible contribution of $25. or more is enclosed.

| | | |
|---|---|---|
| ☐ **$20 Student** | ☐ **$ 45 Family** | ☐ **$250 Sponsor** |
| ☐ **$30 Individual** | ☐ **$100 Donor** | ☐ **$500 Patron** |

Members receive free admission for one full year, invitations to exhibit previews, advance notice of exhibitiions and lectures, invitations to members-only events, a subscription to our exciting quarterly magazine, The Computer Museum Report, and a 10% discount in the Museum Store. Members who send a contribution of $25. or more are entitled to receive the elegant full color Memories Poster. Check the box above if you want to receive the poster.

Enclosed is my check ,made payable to **The Computer Museum** for $__________

or charge to: ☐ VISA ☐ MasterCard ☐ American Express

Card # ____________________ Expiration Date __________

Signature ______________________________

Name ______________________________

Address ______________________________

City ____________________ State __________ Zip __________

Contributions are tax-deductible to the extent provided by the law.
**The Computer Museum**, 300 Congress Street, Boston, MA 02210

### The Computer Museum

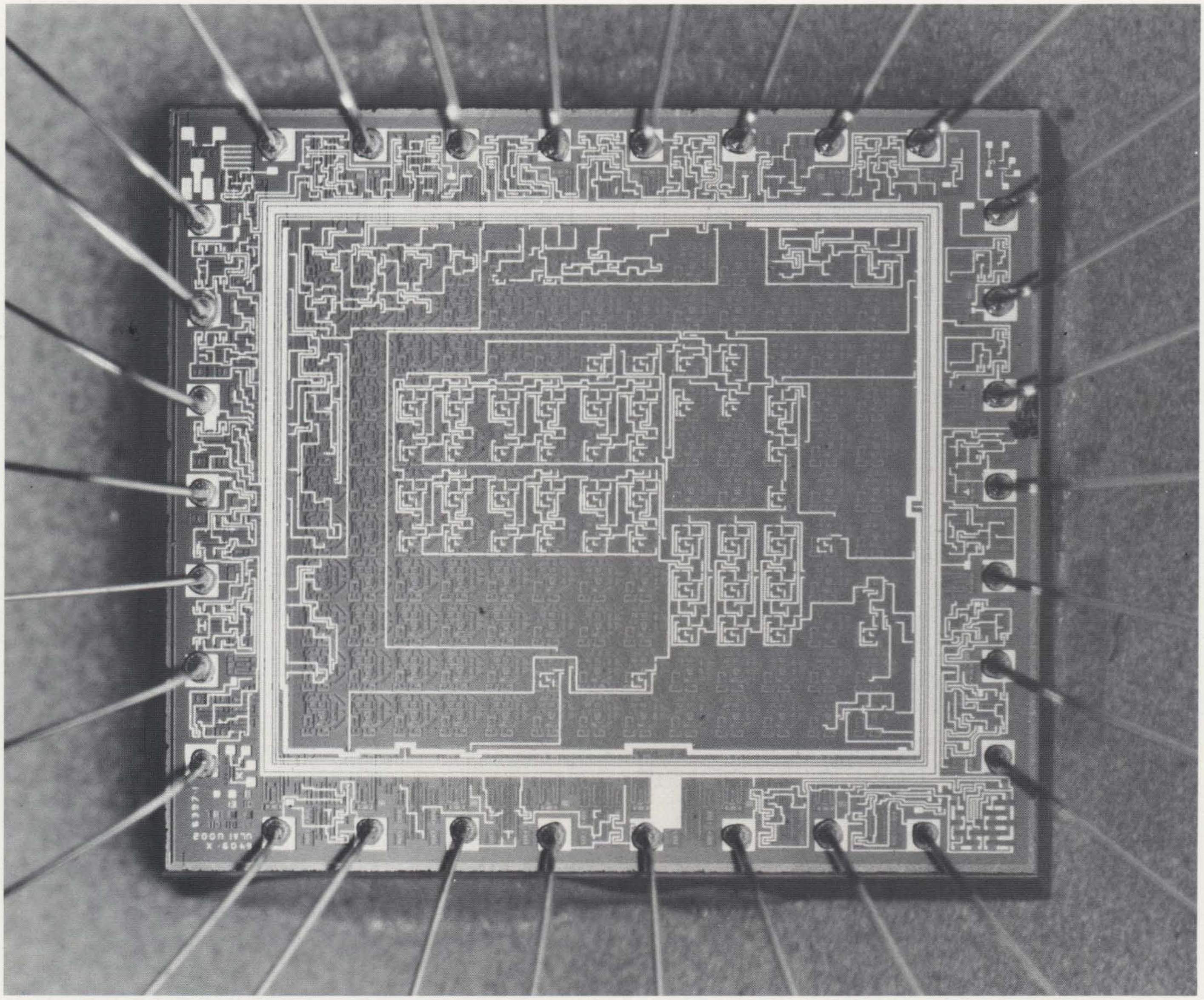
The Computer Museum is a non-profit 501(c)3 foundation that chronicles the evolution of information processing through exhibitions, archives, publications, research and programs.

**Museum Hours:** *Summer:* Open daily 10 – 6, Friday 10 - 9. *Winter :* Open Tuesday – Sunday 10 - 6, Friday 10 - 9. Open Mondays during Boston school vacation weeks,10 - 6. Closed Thanksgiving, Christmas, and New Years Day. Hours are subject to change.

**Membership** All members receive a membership card, free subscription to the Computer Museum Report, a 10% discount on merchandise from the Computer Museum Store, free admission and invitations to Museum previews. For more information contact Membership Coordinator at the Computer Museum, 300 Congress Street, Boston, MA 02210. Telephone (617) 426-2800.

## The End Bit 0000000000000001

This 1984 experimental memory chip by IBM holds 288K bits on a single integrated circuit. It is part of the History of Computing slide sets, available along with the Personal Computer slide set from The Computer Museum Store.



The Computer Museum
300 Congress Street
Boston, Massachusetts 02210

Non-Profit
Organization
U.S. Postage
PAID
Permit No. 110
Fitchburg, MA
01420

Address Correction Requested