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 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."

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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 Ferranti 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)
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)

Memories Chart
The earliest memories appear in the upper left hand quadrant. 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.
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 Strumpel 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.

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<th>Cyclical Access</th>
<th>Linear Access</th>
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<td>Delay Line</td>
<td>Magnetic Tape</td>
<td>Magnetic Tape</td>
<td>Core</td>
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<td>Mechanical Disk</td>
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<th>Delay Lines</th>
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<td>Magnetic Drum</td>
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<td>Photographic Store</td>
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<td>Plasma Display</td>
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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 logarithms 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 Goodchild, 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.
Punched Cards. In the 1790s, Joseph Jacquard designed a machine to weave silk patterns based on the ideas of Bouchon, de Vaucanson 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 rectangular 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 Terrestrial 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.
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.

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. Laming, 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.
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.
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 LINC's (Laboratory Instrument Computers) were built by their users at MIT in 1962. The LINC-tape was small, removable and portable. Users 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.
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**


<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1946</td>
<td>1/46 Jay Forrester proposes a computer at MIT</td>
</tr>
<tr>
<td>1947</td>
<td>6/49 Forrester begins documentation in his notebook of a memory using magnetic materials</td>
</tr>
<tr>
<td>1948</td>
<td>9/49 Jan Rajchman of RCA files a patent application for a coincident-current magnetic memory</td>
</tr>
<tr>
<td>1949</td>
<td>8/50 M.K. Haynes thesis describes his coincident-current magnetic core memory proposal</td>
</tr>
<tr>
<td>1950</td>
<td>10/50 Forrester initiates ferrite material work at MIT</td>
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</table>
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 intellectual 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.

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

The final chapter of this incident was written 25 years later when Control Data acquired the Commercial 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 specifications 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 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 entrepreneurship 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 percent 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.

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<th>The Microelectronics and Computer Technology Corporation (MCC) Corporate Membership List.</th>
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<tr>
<td><strong>Company Name</strong></td>
</tr>
<tr>
<td>Advanced Micro Devices, Inc</td>
</tr>
<tr>
<td>Sunnyvale, CA</td>
</tr>
<tr>
<td>Bell Communications Research, Inc</td>
</tr>
<tr>
<td>Livingston, NJ</td>
</tr>
<tr>
<td>Digital Equipment Corp.</td>
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<tr>
<td>Maynard, MA</td>
</tr>
<tr>
<td>Harris Corp.</td>
</tr>
<tr>
<td>Melbourne, FL</td>
</tr>
<tr>
<td>Honeywell Inc.</td>
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<tr>
<td>Minneapolis, MN</td>
</tr>
<tr>
<td>NCR Corp.</td>
</tr>
<tr>
<td>Dayton, OH</td>
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<tr>
<td>Westinghouse Electric Corp.</td>
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<tr>
<td>Pittsburgh, PA</td>
</tr>
<tr>
<td>Allied-Signal Inc.*</td>
</tr>
<tr>
<td>Morristown, NJ</td>
</tr>
<tr>
<td>Boeing Co.</td>
</tr>
<tr>
<td>Seattle, WA</td>
</tr>
<tr>
<td>Control Data Corp.</td>
</tr>
<tr>
<td>Minneapolis, MN</td>
</tr>
<tr>
<td>Eastman Kodak Co.</td>
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<tr>
<td>Rochester, NY</td>
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<tr>
<td>General Electric Co.</td>
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<tr>
<td>Fairfield, Conn</td>
</tr>
<tr>
<td>Lockheed Corp. (Lockheed Space and Missile Co.)</td>
</tr>
<tr>
<td>Sunnyvale, CA</td>
</tr>
<tr>
<td>Martin Marietta Corp.</td>
</tr>
<tr>
<td>Bethesda, MD</td>
</tr>
<tr>
<td>3M Co.</td>
</tr>
<tr>
<td>St. Paul, MN</td>
</tr>
<tr>
<td>Motorola Inc.</td>
</tr>
<tr>
<td>Schaumburg, IL</td>
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<tr>
<td>National Semiconductor Corp.</td>
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<tr>
<td>Santa Clara, CA</td>
</tr>
<tr>
<td>Rockwell International Corp.</td>
</tr>
<tr>
<td>Pittsburgh, PA</td>
</tr>
<tr>
<td>Unisys Corp.*</td>
</tr>
<tr>
<td>Detroit, MI</td>
</tr>
<tr>
<td>Hewlett-Packard Co.</td>
</tr>
<tr>
<td>Palo Alto, CA</td>
</tr>
</tbody>
</table>

*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 not-for-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 enterprises do 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 Research 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 entrepreneurship 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 enterprise 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.
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-deductible 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.
## Calendar Spring 1987

### May 3
**Sunday**
**4 pm**
Dick Shoup, Aurora Systems.

"A Perspective on Digital Videographics 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**
**7 pm**
**The Computer Museum's 5th Birthday Party!**

A fun-filled evening of live and silent auctions with entertainment by clowns, magicians and jugglers!

### Membership

All members receive free admission and free subscriptions 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 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 Year’s Day. Hours are subject to change.

### Staff

Joseph F. Cashen, Executive Director
Dr. Gwen Bell, Founding President
Lynn Hall, Registrar
Tom Merrill, Exhibits Technician
Dr. Oliver Strimpel, Curator
Michael Bergman, Exhibit Specialist
Dr. Leah Hutten, Exhibits Developer
Marc LeBlanc, Exhibits Intern

Bonnie Turrentine, Education Director
Meghan Hayes, Education Specialist
Kurt Levitan, Education Assistant
Gregory Schwoeder, Operations/Visitor Coordinator

Mark Hunt, Marketing Director
Patricia Fiorelli, Public Relations Manager
Linda Holekamp, Communications Assistant
Kathleen Keough, Functions Coordinator
Michael N. Oleksiw II, Development Director
Jennitut Fields, Benefits Coordinator
Scott Reilly, Development Assistant
Susan Versailles, Membership Coordinator

Matt Murray, Interim Business Manager
Vannette Bastien, Accountant
Yvette Molina, Assistant Accountant
Lisa Moorehead, Office Coordinator

German DRK,
Public Relations Advisors
Jackson-Blum-Shapiro
Advertising Consultants
Michael Sand, Inc.
Exhibit Planning Consultants
Kevin Burke, David Shopper, Martha Everson, Photography

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Northeastern University, Computer Science Department
The Computer Museum, 300 Congress Street, Boston, MA 02210

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The Computer Museum Report/Spring 1987
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.