SEPTEMBER 2003

CORE 4.1

A PUBLICATION OF THE COMPUTER HISTORY MUSEUM
WWW.COMPUTERHISTORY.ORG

ANNOUNCING OUR ALPHA PHASE!

With the extraordinary efforts and support of so many people this year, we have reached another major milestone. The Museum initiated its Alpha Phase on June 2 at 1401 N Shoreline Blvd! This marks the official opening of a new Visible Storage display area, the dedication of the Hahn Auditorium, and the beginning of our public presence in our new home. Yet there's much more ahead to realize our dream—plans are already underway for the Museum's Beta Phase, and Releases 1.0 and 2.0 over the next several years.

It's exciting to see the opportunities our new home has given us. In the new Visible Storage, for example, you will still find many favorite artifacts from the display at Moffett Field. However, we now have an entirely new look, labels for all of the items, and about double the number of artifacts in a larger gallery for a more complete representation of computing history. A great online virtual visible storage can be found at www.computerhistory.org. I know you will be pleased to see how we are bringing that story to the world.

We also opened our new Hahn Auditorium and multi-purpose room, named in honor of the Hahn family, our largest donor to date. Eric Hahn is also a trustee who has helped us grow dramatically and who served as the first chair of the Development Committee in California. This space will become a community gathering place for computing history enthusiasts, host everything from history lectures to major events, and allow us to record important events for posterity.

Our new building has been drawing the interest of corporations, attracting many new volunteers, and allowing trustees, staff, and volunteers to productively work together in one environment. Since June, we have moved most of our collection from offsite storage into unused portions of the Museum building, and we may soon be offering special member tours to explore the deep recesses of our great collection.

Although accomplishments have been great, the economic climate has been extremely challenging. We need your help in finding people and organizations to support us as we grow, and are looking for volunteers to help in many areas, including development. We also reorganized early this year in anticipation of next year's economic situation, and have consolidated some functions. The staff has been tremendous during this difficult time of change, and you will see some of their titles have changed.

With our new presence in Mountain View, you can tangibly see how we are able to grow into a great museum. Yet our programs take support and dedicated people. Please consider increasing your annual campaign support and making a capital campaign gift. In addition, we have just kicked off a great corporate membership program and have created recognition walls for all to see. For information on the member programs and naming opportunities please contact Karen Tucker.

Be sure to read the report on Museum activities. While we've been preparing to open our great building, our public programs have been spectacular. The awesome lectures and events we plan and support have truly brought to life the meaning of preserving the stories of the information age.

The launch of our Alpha Phase is a giant step forward for the Museum. We now have an unparalleled public presence that will be built in phases over time along with great programs and access to the largest collection in the world. Help us to grow and let us know how you enjoy your Museum!

JOHN C TOOLE
EXECUTIVE DIRECTOR & CEO

CORE 4.1

September 2003
A publication of the Computer History Museum

VISION
TO EXPLORE THE COMPUTING REVOLUTION AND ITS IMPACT ON THE HUMAN EXPERIENCE

MISSION
TO PRESERVE AND PRESENT FOR POSTERITY THE ARTIFACTS AND STORIES OF THE INFORMATION AGE

IN THIS ISSUE

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Cover: Celebrating the opening of the Alpha Phase of the Computer History Museum at 1401 N. Shoreline Boulevard in Mountain View, California! See article on page 2.

Kirsten Tashev is Director of Collections and Exhibitions at the Computer History Museum

COMPUTER HISTORY MUSEUM: ALPHA PHASE

BY KIRSTEN TASHEV

The Museum's entrance at 1401 N. Shoreline in Mountain View, Calif.

The Museum reached a key milestone with the opening of its Alpha Phase on June 2, 2003. At an open house celebration held at the new building, the Museum unveiled a 400-person Hahn Auditorium and meeting space, donor acknowledgment walls, and a 9,000-square-foot Visible Storage exhibit area. The opening was a great success and was attended by about 600 people, including city officials, Museum members, trustees, staff, contractors, and guests. The celebration began with a ribbon cutting ceremony and presentations by Executive Director & CEO John C. Toole and Museum trustees, and was followed by tours of the new Visible Storage exhibit area and a reception.

Photo by Earnest J. Ray

After a ribbon cutting ceremony, over 600 guests celebrated the opening of the Museum's Alpha Phase.

Photo by Earnest J. Ray

The open house included tours of Visible Storage and a reception.

In October 2002, the Museum purchased its landmark building at 1401 N. Shoreline Boulevard in Mountain View, Calif. Built in 1994, the building was state-of-the-art for its time and its open concept design lends itself well to the Museum's future plans. But, several key upgrades were necessary to transform the building from office to museum in compliance with public assembly building codes. Renovations were begun shortly after purchasing the building and included such requirements as fire walls, mechanical and safety upgrades to accommodate a larger occupancy capacity, and structural upgrades to support both the increased occupancy of potential visitors as well as the significant weight of some of the Museum's most historic artifacts.

THE HAHN AUDITORIUM

The renovations also allowed the Museum to significantly improve its facilities for ongoing public programs. The Museum's popular speaker series will now be held in the new 400-seat auditorium. The Hahn Auditorium, named after major benefactors Elaine Hahn and Museum Trustee Eric Hahn, is equipped with a high quality sound and recording system that will allow

Photo by Earnest J. Ray

The new Hahn Auditorium was named after Eric and Elaine Hahn, has a 400-seat capacity, and will serve as a multi-purpose space for banquets, receptions, and other events.

the Museum to produce well-engineered events and to support its archival efforts. The Hahn Auditorium also serves as a multi-purpose space, allowing the Museum to hold any number of institutional and potential rental events, including banquets, receptions, meetings, etc. This year the Museum plans to hold the annual Fellow Awards Celebration in the new facility on October 21, 2003.

UNVEILING OF DONOR WALLS

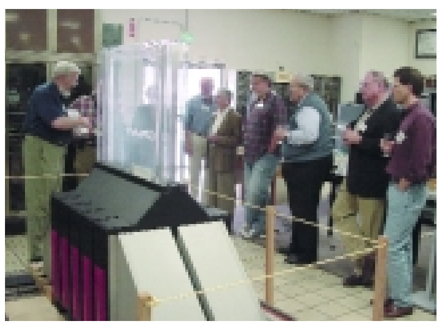
Also at the opening, the Museum unveiled a series of donor walls, including plaques that recognize the early Boston and Silicon Valley founders, as well as the current annual donors, corporate members, and capital campaign donors. The new donor walls are prominently displayed in the lobby reception area and will continue to recognize the financial support of the many individuals and companies who enable the future growth of the Museum.

A series of new donor walls in the lobby reception area acknowledge current annual donors, corporate members, capital campaign donors as well as early Boston and Silicon Valley founders.

A REVITALIZED VISIBLE STORAGE

Key to the Alpha Phase opening was the reincarnation of the Museum's Visible Storage exhibit area. Formerly housed in a World War II-era warehouse at Moffett Field, the original Visible Storage suffered from cramped quarters, poor lighting and climate control, and little to no interpretation in the form of labels or other self-guided explanatory information. Although docent-led tours greatly enhanced the Visible Storage at Moffett Field, docents were often required to double back and point over and between objects in order to provide adequate tours of the history of computing.

As soon as it was clear that the Museum would likely purchase the building at 1401 N. Shoreline Blvd., the Museum's collections and exhibitions staff, along with the exhibit design firm, Van Sickle & Rolleri Ltd., with the input of trustees and other subject specialists, began the work of designing the new Visible Storage. From the outset, the design embraced the concept of a Visible Storage rather than a full-fledged museum exhibit. Visible Storage—sometimes known in the museum field as Open Storage—has become quite popular in the last decade as a legitimate display technique. Unlike a Museum exhibit that attempts to explain more complex information through extensive graphics, audio-visuals, and computer interactives, a Visible Storage relies mainly on artifacts or objects as the primary means of communication along with a limited number of explanatory labels. Since the majority of museums have limited space and can only exhibit between 10 and 20 percent of their collections at any one time, the low-cost method of Open Storage allows them to provide public access to "back end" collections that they otherwise would not be able to display. In the case of the Computer History Museum, this approach allows us to make our collection available to the public while we fundraise to build more content- and multimedia-rich exhibitions.



Visible Storage has been moved from a warehouse at Moffett Field (above) to the new building (below). Many enhancements have been made, including improvements in look and feel, expanded labels, and an organized layout displaying 50% more artifacts.

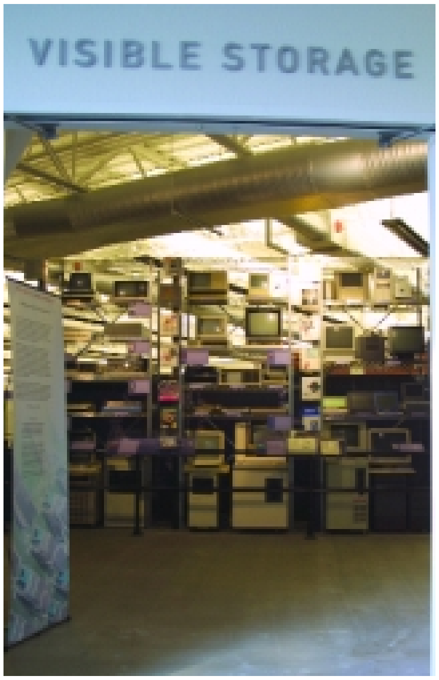
Having worked for a little over a year on the future 15,000 square-foot Timeline of Computing History exhibition scheduled to open in two to four years, the team had a solid outline of the major highlights of computing history fresh in their minds. Although restricted to using the artifacts themselves and to limited explanatory techniques, the team wanted to create a new and improved Visible Storage that would attempt to touch on all aspects of computing, including software, hardware and underlying technology, graphics systems, networking, Internet, and computing precursor systems.

In developing the new Visible Storage, a tension between presenting information chronologically versus thematically presented itself. The end resulted in a compromise, so that the artifacts are laid out in a loose chronological order, yet the plan allows for diversion here and there to show developments by theme in a specific area such as storage or peripheral devices, or supercomputers, etc.

The experience is greatly enhanced by explanatory labels for each artifact. Expanded labels explain more complex or less object-based information, such as computing concepts or developments in the field of software. Although the new Visible Storage is not a full-scale exhibition, nor by any means a comprehensive presentation of computing history, with approximately 600 artifacts, 150 historic photos, and a computer restoration workshop featuring the IBM Model 1620, it offers much greater access to the Museum's rich collection.

FUTURE EXHIBITIONS

While the Alpha Phase opening is no doubt a significant achievement for the Museum, there still remains much to be done in order to preserve and present the amazing story of the computing revolution. The Museum is currently raising funds to expand its offerings through world-class exhibitions in future phases or releases. The Museum plans to create exhibitions that are rich in contextual media and interpretive content, covering all aspects of computing history. These will include a



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1) Enter our new Visible Storage exhibit area, displaying approximately 600 artifacts, 150 historic photos, and a computer restoration workshop featuring the IBM 1620.

2) An organized layout, expanded labels, and protective stanchions are helping to improve visitor experience.

3) An office area of the building was converted for Visible Storage. The carpeting was removed and the cement flooring was re-finished, blinds in the floor-to-ceiling windows are kept shut to protect the artifacts from light, and cubicle walls were re-purposed as dividers between sections.

4) Even though the new Visible Storage has more space and more artifacts, the displays are still fairly dense with a lot of items located closely together. To the interested, the experience can be one of great depth.

5) Just one of the new item labels found throughout Visible Storage.

3

5

4

The Museum is developing a Timeline Exhibit that will be media-rich and highly interpretive. These artists renderings explore ideas for how this Timeline Exhibit could be configured.

The Museum is planning additional building renovations for two upcoming phases, Release 1.0 and Release 2.0. In addition to the Timeline Exhibit and Theme Galleries, plans call for a reference library, gift shop, café, and multipurpose event and classroom spaces.

Timeline of Computing History that will focus on headline stories in a chronological format, five Theme Room galleries that will explore specific topics in more detail and show developments in sub-fields of computing side by side, and a large gallery for changing topical exhibits, the possibilities of which are endless.

Plans also include a rich online CyberMuseum experience to include access to the Museum's collections, and a variety of interpreted Cyber Exhibits. In addition, the Museum plans to offer a reference library, gift shop, café, and multipurpose event and classroom spaces. These amenities will enable us to expand our community and will support the Museum's educational programs, including a speaker series, seminars, workshops, artifact restorations, and other volunteer-led projects.

As I hope you can see, the Museum has a solid base upon which to achieve its objectives, with its deep collection, enthusiastic supporters, promising facility, and public mission. To reach our goals, however, we need your help as a supporter, donor, and volunteer. Please stop by, see our Alpha Phase, and help us achieve our future plans through your support and participation.

Tours of the new Visible Storage are now given on a regular basis, and a Virtual Visible Storage is also now available. For more information, please visit the Museum's Web site at www.computerhistory.org.

THE MCM/70 MICROCOMPUTER

BY ZBIGNIEW STACHNIAK

INTRODUCTION

In early 1972, a small group of computing professionals came together in Kingston, Canada, to design a novel computer system based on emerging microprocessor technology. The result of their work at Micro Computer Machines Inc. (MCM) was the MCM/70 personal computer. The following article details the early stages in the development of the MCM/70 microcomputer. The article is based primarily on development notes authored by Mers Kutt, the first president of MCM. These notes, most likely written between February and May of 1972, are among the oldest records chronicling the coming of the personal microcomputer. Quotations by Kutt, Gordon Ramer, José Laraya, and Morgan Smyth were obtained through interviews by the author between March, 2001, and December, 2002. Kutt's notes and recordings of the interviews currently reside at the York University Computer Museum in Toronto, Canada.

MCM/70 UNVEILED

The MCM/70 computer, designed by MCM between 1972 and 1973, is possibly the earliest example of a microcomputer manufactured specifically for personal use. From the hardware and software engineering points of view it does not have much in common with early hobby computers, such as the MITS Altair 8800 or Apple I, except that these computers were microprocessor-based. By the time the Altair 8800 kit was offered to hobbyists in early 1975, with its 256 bytes of RAM memory and no high-level programming language capability, the MCM microcomputers were providing in-house APL (A Programming Language) support for applications ranging from engineering design, modeling and simulation, to investment analysis and education. By the time the Apple I board was offered for sale in 1976, the MCM machines were being used by Chevron Oil Research Company, Firestone, Toronto Hospital for Sick Children, Mutual Life Insurance Company of New York, Ontario Hydro-Electric Power Commission, NASA Goddard Space Flight Center, and the U.S. Army, to name just a few MCM customers.

The official announcement of the MCM/70 came on September 25, 1973, in Toronto. Two days later, it was unveiled in New York and the following day in Boston. An early prototype had been demonstrated to the APL community in May of 1973 during the Fifth International APL Users' Conference in Toronto. Another prototype was touring Europe in August and September of that year and was showcased by the MCM team in Holland, Germany, Switzerland, France, Italy, and the U.K. Other prototypes of the machine included an early refinement of the Intel SIM8-01 development board, a rack-based wire-wrapped system, a desktop bare-bones system, and even a cardboard mockup.

Announcement of the MCM/70 during the press conference at the Royal York Hotel in Toronto, September 25, 1973. From left: Mers Kutt, Gordon Ramer, Ted Edwards, and Reg Rea. Source: *Canadian Datasystems*, October 1973, p. 49.

The MCM/70 desktop bare-bones system. 3D model created by André Arpin.

Photograph by Z. Stachniak

Mers Kutt speaking at York University, Toronto, October 2001

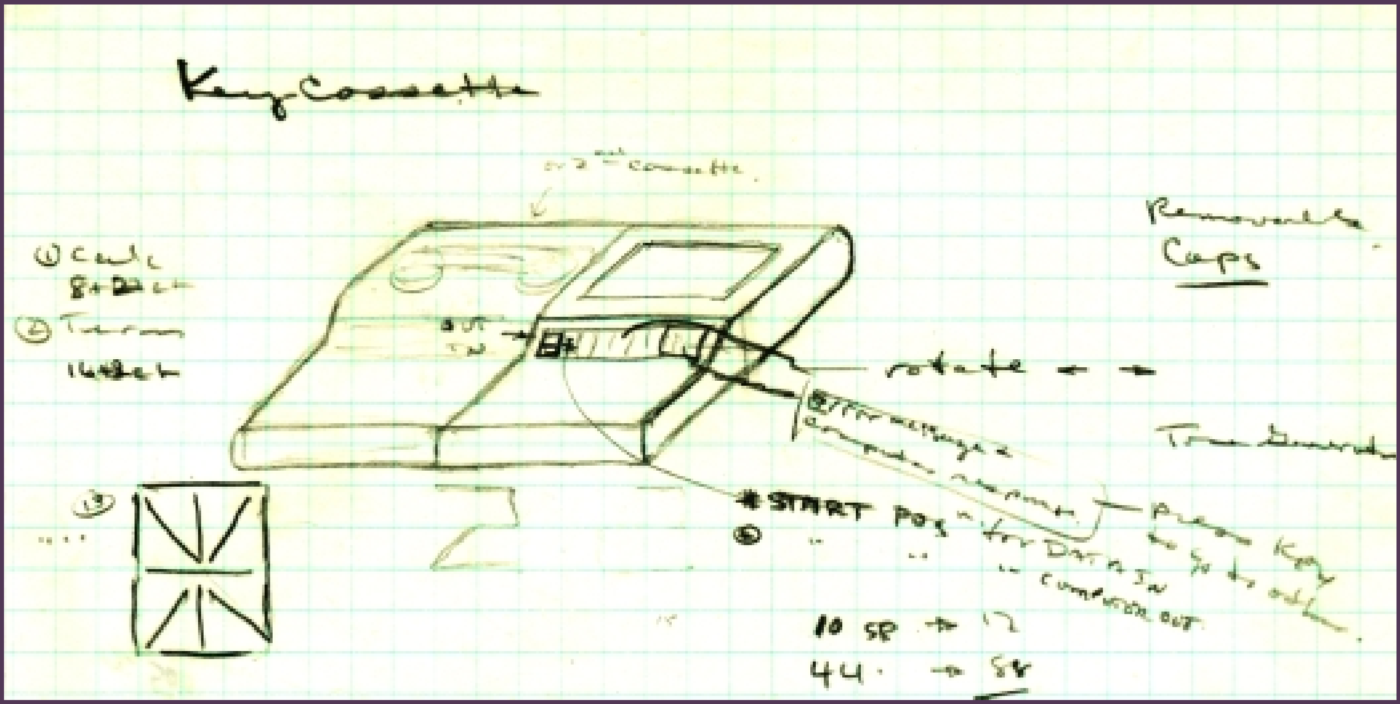
KUTT SYSTEMS INC.

In the fall of 1971, just after he left his first company, Consolidated Computer Inc., Canadian inventor and entrepreneur Mers Kutt decided to develop a small desktop personal computer that could be programmed in APL. Kutt followed technological developments and market trends in the semiconductor industry closely. He personally knew Bob Noyce, then the CEO of Intel Corporation, and was meeting with Intel marketing staff and participating in Intel promotional seminars. He had a good knowledge of the technical specifications and of the developmental progress of Intel's first 8-bit microprocessor—the 1201, later renamed the 8008. For Kutt, the near completion of the 8008 chip in late 1971 was a technological trigger point urging him to move ahead with his personal microcomputer project.

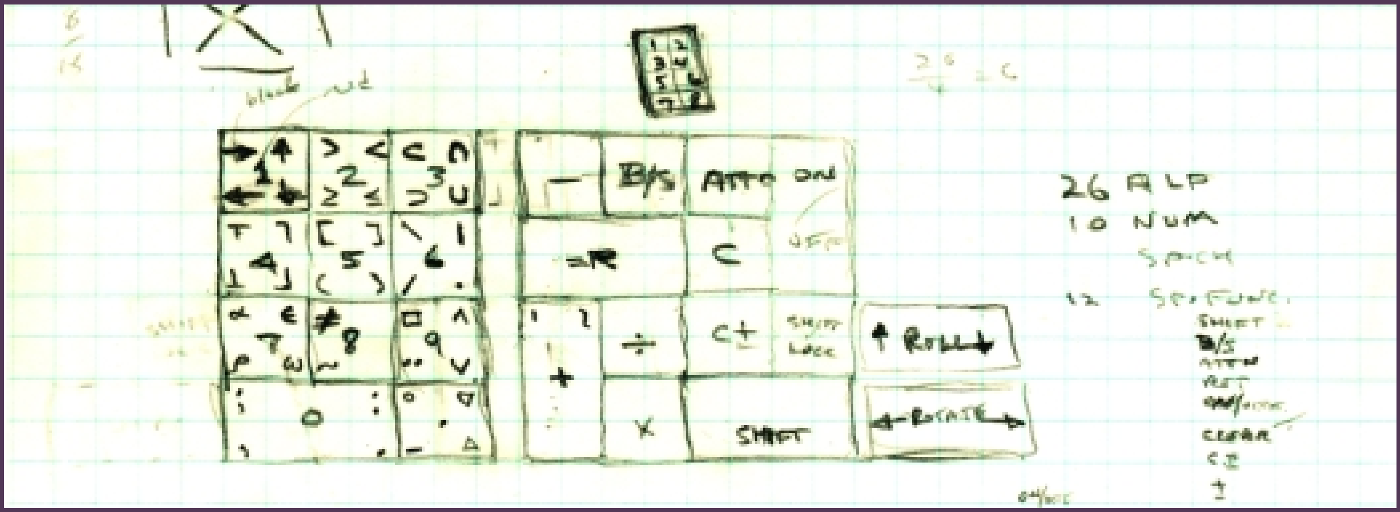
In the beginning, there were just two: Mers Kutt and Gord Ramer, whom Kutt recruited to work on the software aspect of the project. Before joining forces with Kutt, Ramer was the director of the Computing Center at St. Lawrence College in Kingston. Before that Ramer had worked at York University, then on the outskirts of Toronto, and developed the York APL dialect of Iverson's APL language. His experience with space-efficient York APL was critical for the writing of the MCM/APL interpreter, which Ramer initiated even before the 8008 chip was available in quantity from Intel.

The small company was incorporated on December 28, 1971, under the name Kutt Systems Inc. On the same day, Hank Smith, who was in charge of Intel's Micro Computer Systems Group, signed a shipment invoice for a SIM4-01 development system, an MCS-4 chip set, and an MP7-01 EPROM programmer, together valued at $1,231, to be delivered to Kutt at no charge. The second shipment from Intel, on May 23, 1972, delivered a SIM8-01 development board and an MP7-02 programmer. By that time, the company had hired, among other people, a hardware engineer by the name of José Laraya, APL programmers Don Genner and Morgan Smyth, and software engineer André Arpin, whose main job would be to develop the virtual memory system for the MCM/70 computer.

MCM was aiming at a small, microprocessor-based desktop computer that would be affordable, as easy to use as a hand-held calculator, and functionally as powerful as a mainframe computer running APL. Nothing similar had ever been built before. At the time, in December 1971, the news of a CPU on a single chip was only about one month old. Furthermore, APL interpreters were not even available for minicomputers.



The Key-Cassette drawing. Source: M. Kutt's notes



A fragment of the Key-Cassette's keyboard. Source: M. Kutt's notes

Page two of the MCM/70 User's Guide introduces the keyboard layout.

THE KEY-CASSETTE CONCEPT

The company was aiming at a small, microprocessor-based desktop computer that would be affordable, as easy to use as a hand-held calculator, and functionally as powerful as a mainframe computer running APL. Nothing similar had ever been built before. At the time, in December 1971, the news of a CPU on a single chip was only about one month old. Furthermore, APL interpreters were not even available for minicomputers.

The size, price, and usability targets set by Kutt Systems for its microcomputer focused the attention of the company on the calculator market. "The world was full of calculators," recollects Kutt. "They made a real Big Bang." In his notes, Kutt entered, "Try and use existing calculator cover, display, modify power supply, and replace keyboard." Indeed, off-the-shelf calculator components could save the company money. For instance, to package the computer into a case that would match the design elegance of a calculator cover, the case would have to be manufactured using the injection molding technique. But that was expensive: a good quality mold with sharp corners would cost around $25,000.

Kutt's notes provide an early glimpse of the "computer of the future." His drawing, entitled Key-Cassette, is among the oldest preserved sketches of a microcomputer to be manufactured for the consumer market. The name "Key-Cassette" most likely derives from "Key-Edit," the name of the data entry system manufactured by Kutt's former company, Consolidated Computer Inc. The drawing depicts a case in the style of a typical desktop calculator of that time. The lower part of the front panel hosts a built-in keyboard and the top part depicts a single cassette drive on the right and either an acoustic coupler or the second cassette drive on the left. A small display and some switches are placed in the middle of the panel.

The annotated drawing provides enough information to grasp the basic operations of the Key-Cassette. The small 32-key keyboard of the Key-Cassette would allow the user to enter all the alphanumeric characters as well as the APL and special function symbols. To achieve such a degree of compactness, each key was designed to enter up to 5 symbols (using a combination of key strokes). The symbols on the keys would be color coded to distinguish between the symbols that can be entered directly (red symbols in the center of the keys) and those that could be entered via a combination of key strokes (black symbols placed in the corners of the keys).

The one-line display of the Key-Cassette would allow the user to view a single line of APL code, a computer output, or an error message. Using the rotate keys "➔" and "←", the displayed information could be scrolled left and right to fully reveal its contents. Using the roll keys "↓" and "↑", one would scroll through the lines of APL code. The sketch of the Key-Cassette is augmented with two drawings of possible segmented display elements: one comprised of 13 display segments and the other of 15 segments. Finally, the tape cassette drives were to provide external storage.

The production model of the MCM/70 would be equipped with a more "user-friendly" APL keyboard (layout modeled after the keyboard of the IBM 2741 terminal), with a one-line plasma display and up to two digital cassette drives providing over 100KB of storage each. Only the sides of the case would be injection molded, while the rest of the case would be made of cheaper aluminum.

FROM THE KEY-CASSETTE TO THE M/C PROTOTYPE

Kutt's notes contain a detailed analysis of Intel's MCS-4 chip set, the 8008 processor, the SIM8-01 development system, and the MP7-02 programmer. Kutt looks at the technical specifications, pricing, and second sourcing for electronic components. He looks at Intel itself, its marketing activities.

In April of 1972, Kutt paid Intel a visit and learned from Bob Noyce and Hank Smith about the status of the 8008 chip, the availability of the SIM8-01 development board, and its supporting software. He inquired about the possibility of Intel manufacturing custom CPU boards for the MCM computer. In his notes, Kutt entered that standard 8008 prototyping boards, ones that could be used to prototype and test an MCS-8 based system without building his own board, would have a "tremendous impact."

A month later, Kutt received the SIM8-01 board from Intel and gave it to José Laraya for the evaluation and the estimation of its potential for growing an APL machine out of it. Laraya recalls: "Mers brought it [the SIM8-01] in and said, 'Here, see what it does.' It was really computing, it really did things, one little chip." The experimentation with the SIM8 board concentrated on interfacing with various devices (such as the teletype) and on the use of the MP7-02 programmer for the purpose of burning Ramer's APL interpreter into the EPROM chips.

But this early attempt at building a microcomputer, now called the M/C prototype in the notes, was a disappointment. Kutt wrote that the machine "is useless as is," and has to be "drawn up, rewired, and debugged." In the end, Laraya decided to abandon the SIM8 approach and, instead, was determined to build his own hardware from the ground up. He remembers thinking, "OK, this [SIM8-01] is fine, great, interesting, works with teletype…But now, let's build something serious.'' Laraya adds, "Mers got the chips and on the basis of that I developed the rack version.…It was very fast from the time we had the [SIM8-01] development board."

Laraya modularized the design of the M/C prototype. One card included the 8008-based CPU as well as the display and the keyboard interfaces. Another card contained memory. There was a specially designed APL keyboard, with the soft character generator, and a small plasma display (Burroughs Self-Scan 32-character display). The production model would have one more board with the cassette controller and the Omniport interface on it (to connect a variety of peripherals via the Omniport connector at the back of the machine).

The rack prototype of the microcomputer was good enough for Ramer and Genner to start porting their APL interpreter into it. On November 11, 1972, the prototype was demonstrated to shareholders during the Special General Meeting of the Shareholders of Kutt Systems in Kingston, Ontario. During that meeting a motion was passed to change the name of the company to Micro Computer Machines.

THE MCM/APL

In the early 1970s, APL was only available on mainframe computers. The development of an APL interpreter and the memory management system for an 8008-platform characterized by low speed, restricted instruction set, and small memory addressing space was the most challenging aspect of the personal computer project at MCM.

Photograph by Z. Stachniak

Morgan Smyth (left), Don Genner, and Gord Ramer (right) at York University, Toronto, October 2001

The team that developed the interpreter had worked together before. In late 1960s, Gord Ramer designed a dialect of the APL/360 language that he named York APL. He implemented the language with the assistance of Don Genner while both Ramer and Genner held positions in the Computing Center at York University. J. Morgan Smyth was among the first users of the York APL and he was frequently commuting between his work place—Ryerson Polytechnic Institute in Toronto—and York University to discuss the implementation issues of York APL with Ramer and Genner. At MCM, the trio would develop one of the first high-level language interpreters for a microprocessor: Ramer would design the language, Genner would implement it, and Smyth would document it in an excellent *MCM/70 User's Guide* published by MCM in 1974.

The work on the interpreter started in early 1972 even before MCM built any hardware that could be used by the software engineering group. Having only the specifications of the 8008 chip, Ramer and Genner used the IBM System/360 assembler to emulate the 8008. "The 360 assembler was written in such a way that you could use macros to generate code for any hardware," says Ramer. "Thus [we] generated macros for each 8008 instruction and *voila*!" A similar emulator, the INTERP/8 (written in Fortran IV), was later available from Intel. It provided a software emulation of the 8008 chip along with some execution monitoring commands.

When the rack prototype of the microcomputer was finally working at MCM's manufacturing facility in Kingston, the development of the APL interpreter could be done directly on the 8008-based hardware and the interpreter's code could be burned into EPROMs using the Intel MP7-02 programmer. Programming "was really slow," says Laraya, "and you had to program it by hand using switches….We had to put the code and set the switches and the addresses and hit 'program' [the EPROM]. Every time we programmed, Don [Genner] used to smoke one cigarette and say, 'That's how long it takes to program a chip.' He smoked one cigarette, and when he finished, [the chip] was programmed."

In his notes, Kutt sketches the directions for the development of the APL interpreter for the microcomputer. First, the basic, stripped-down version of APL/360 would be implemented. The description of an APL fragment that comprises single dimension vectors, some defined and some system functions, spans two pages in the notes. Then the interpreter would be extended in two directions to support the scientific and business utilization of APL. "When we came up with the APL [interpreter] for our PC," says Kutt, "our prime target was to make it simple to use…so [the user] wouldn't have to become embroiled in the little nitty-gritty things you have to look after in APL."

Programming "was really slow and….every time we programmed, Don [Genner] used to smoke one cigarette and say, 'That's how long it takes to program a chip.' He smoked one cigarette, and when he finished, [the chip] was programmed."

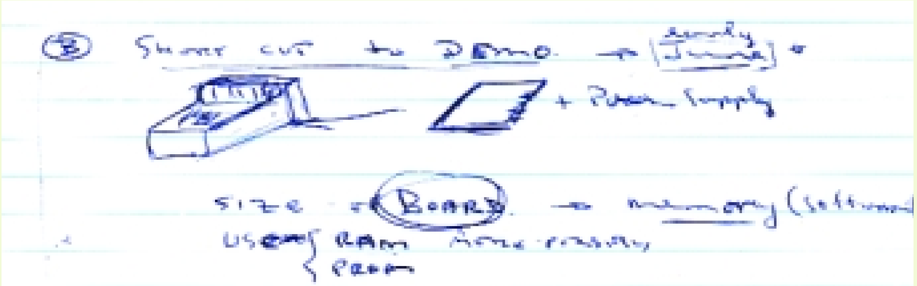
—José Laraya, MCM Engineer

The full description of the MCM/APL interpreter for the MCM/70 computer appeared in the *MCM/70 User's Guide*.

SELLING THE FUTURE

The notes disclose some urgency to prepare a viable demonstration of the M/C computer. Early demonstrations were vital to attract venture capital and finance the operations of the young company. Kutt sketches a "short-cut to demo" in his notes and estimates its completion at the early June of 1972.

The M/C demonstrator was to consist of a single CPU and memory board and a power supply packed into a desktop calculator-like case that featured a built-in keyboard and a small display. It was to be basic hardware with just enough



The Short-cut to demo drawing. Source: M. Kutt's notes

software stored in ROM to demonstrate the way the 8008 could handle a subset of APL. It is unclear whether such a machine was ever constructed. However, a more refined portable prototype of the MCM/70 was built and shown during the Fifth International APL Users' Conference in Toronto, in May of 1973. "I remember we had the fiberglass model there," says Laraya. "It was heating up." Ramer, too, remembers the event vividly: "The demo had to be interspersed with short talks to allow José [Laraya] to exchange the heat-sensitive parts and then restart the system for the next segment of the demo."

With limited RAM and no external storage, that prototype was nothing but an advanced APL-based scientific calculator. However rudimentary, it did attract attention of the APL community and made it evident that in the near future high-level programming languages, such as APL, would be readily available on small desk-top machines. Other prototypes of the MCM/70, including one mounted in an attaché case and powered by batteries, were showcased throughout Europe and North America in the second half of 1973, attracting the attention of daily and technical press.

One of the most successful demonstrators that the company put together had, in fact, no hardware at all. "We had a cardboard mockup of the computer," says Smyth. "It…was a small, slick little box...it was just cardboard. And we went around to a law firm in downtown Toronto and met with the bunch of senior lawyers there….Mers was gonna try to get some venture capital….These guys were quite old and, at one point [during Kutt's presentation], actually the secretary came in with a can of candies….to perk 'em up. And I thought, 'man, we are wasting our time here.'"

Smyth continues, "And near the tail of our presentation, which went on for over two hours, …one of these guys said, 'Now, just a minute. This contradicts what you said at the very beginning.' I'm thinking, 'What?' They were paying attention and I was very impressed… We walked out of there with half a million dollars….It was…just cardboard….He [Kutt] is waving this around: 'This is what it's going to look like!' You are talking about selling the future!"

GOOD LUCK, AND WELCOME TO THE COMPUTER AGE!

The production model of the MCM/70 shared many technical features with the Key-Cassette and the M/C concepts. From its prototypes, the MCM/70 inherited a desktop design with built-in APL keyboard, a one-line plasma display, and cassette drives mounted on the front panel. The computer was powered by the Intel 8008 microprocessor and its ROM chips contained the MCM/APL interpreter.

But other features, not discussed in Kutt's notes, also make the MCM/70 a truly unique piece of microcomputer engineering. The MCM/70's 14KB of ROM contained not only the MCM/APL interpreter but also the cassette and virtual memory operating systems (called EASY and AVS, respectively). AVS, designed by André Arpin, used one of the cassette drives to provide virtual memory by swapping programs and data between the cassette and RAM. With virtual memory, the MCM/70 offered an excess of 100KB of memory. A power failure protection system built into the power supply of the computer allowed continuous operation by battery in the event of power failure. For extended power loss, the computer initiated an orderly shutdown: it automatically provided system back-up by copying the content of RAM to a cassette before shutdown. The system was automatically reinstated when power was restored and batteries were recharged.

Kutt made some market analysis notes looking primarily at the IBM System/360 users who might benefit from a smaller and much less expensive system. He calculated APL university prospects at around 15 in Canada and 75 in the U.S. And indeed, following the announcement of the MCM/70, many academics expressed interest in the MCM hardware: "APL is currently used in all of our introductory courses so that

Photograph by Z. Stachniak

The MCM/70. Courtesy of Harley Courtney

"The complexity of the large computer machines and the complexity of the special computer languages...has till now prevented the general public from using computers directly themselves. But the simplicity of the MCM/70 and its associated computer language...make personal computer use and ownership a reality....Enjoy the privilege of having your own personal computer."

—The MCM/70 Introductory Manual, 1973

the potential for systems like yours at Yale is very high," wrote Martin H. Schultz, Professor of Computer Science at Yale University, to MCM in November 1973. By 1976, an estimated 27.5% of the MCM systems sold in North America went to educational institutions.

The notes, however, do not make any reference to "personal computing" nor to possible marketing strategies aimed at promoting the personal utilization of MCM's microcomputers. This is hardly a surprise as the notes were made in the very early stages of the development of the MCM/70. That situation would change with the publication of the first promotional documents by MCM in 1973. "It has been a combination of the complexity of the large computer machines and the complexity of the special computer languages," reads the *MCM/70 Introductory Manual* published by MCM in 1973, "that has till now prevented the general public from using computers directly themselves. But the simplicity of the MCM/70 and its associated computer language (known as APL) make personal computer use and ownership a reality....Enjoy the privilege of having your own personal computer—It's a privilege no computer user has ever had before the MCM/70....Good luck, and welcome to the computer age!"

It is difficult to explain unequivocally why the MCM/70 was not the commercial breakthrough to launch the personal computing industry. It is also difficult to estimate the number of MCM/70 computers sold worldwide or the scope of impact it had on the APL community and on the rise of personal computing. Even so, it was MCM's historical role to show that with the advent of microprocessor technology, affordable personal computing was at our fingertips. It was not too farfetched to imagine that, "in the coming years the computer field is going to be made of millions of small computers and a limited number of large computers" (Mers Kutt, Boston, September 28, 1973).

Zbigniew Stachniak is an associate professor of computer science at York University in Toronto, Canada. His research concentrates on formal methods in artificial intelligence (automated reasoning, knowledge representation), on symbolic logic in computer science, history of computing, and history of logic.

The author extends his gratitude to the National Science and Engineering Research Council of Canada for supporting his research on MCM.

FURTHER READING

Chevreau, J. "The Third Coming of Mers Kutt." *Report on Business Magazine*, November 1985, pp. 110-115.

Stachniak, Z. "The Making of the MCM/70 Microcomputer." *IEEE Annals of the History of Computing*, May/June, 2003.

The MCM Collection at York University Computer Museum: http://www.cs.yorku.ca/~zbigniew/MCM_col.html

RECENT ADDITIONS

TO THE COMPUTER HISTORY MUSEUM COLLECTION

Two (2) Core Memory Plane Assemblies (1973), X2523.2003, gift of Richard Walters

Two (2) microchip portfolio sets (1976 – 1989), X2497.2003, gift of Hewlett-Packard Company

Three (3) publications relating to early computers (c. 1950-1955), X2529.2003, gift of Gordon Uber

Four (4) original photographs of Steve Wozniak and Steve Jobs (1976), X2554.2003, gift of Joe Melena

Amdahl 470/V6 MCC (Multi Chip Carrier) (c. 1985), X2576.2003, gift of Mr Naoya Ukai

Ampro Computers, Inc., Series 100 "Bookshelf" CP/M Computer, operating software, and documentation, (c. 1982), X2535.2003, gift of Steve Brugler

Anderson Jacobson Model ADC 260 Acoustic Coupler (c. 1975), X2523.2003, gift of Richard Walters

Anderson Jacobson Model ADC 300 Acoustic Coupler (c. 1975), X2523.2003, gift of Richard Walters

Apollo Computer, Inc., "Network Outlet" connection (1983), X2573.2003, gift of Jonathan Gross

Apple Macintosh (1984), X2523.2003, gift of Richard Walters

Apple Macintosh Laptop with Duo Dock (c. 1994), X2523.2003, gift of Richard Walters

Bell Laboratories Picturephone (1964), X2560.2003, gift of Les Earnest

"The Binary Slide Rule" (c. 1940), X2551.2003, gift of Wolfgang Schaechter

Bowmar Instrument Company, MX55 Personal Calculator ("Bowmar Brain") (1970), X2510.2003, gift of Michael Percy

Bowmar Model 901B Calculator (c. 1973), X2577.2003, gift of Mary M Mourkas

Burroughs Adding Machines (two) (c. 1935 and c. 1945), X2525.2003, gift of Chuck Kaekel

Burroughs B1900 Mainframe Computer System (including peripherals) (c. 1985), X2550.2003, gift of the Pennyroyal Center

Canon Cat V777 Work Processor, associated software and documentation (1987), X2538.2003, gift of Paul Cubbage

Canon Cat180 Daisy Wheel Printer with Canon Cat40 Cut Sheet Feeder Option (c. 1987), X2538.2003, gift of Paul Cubbage

Check Point Software Technologies, Inc., FireWall-1 Ver. 2.0 Media Pack (1994), X2513.2003, gift of Check Point Software Technologies, Inc.

Check Point Software Technologies, Inc., SofaWare S-box Internet Security Appliance (2002), X2513.2003, gift of Check Point Software Technologies, Inc.

Check Point Software Technologies, Inc., VPN-1 & FireWall-1 Media Pack (2002), X2513.2003, gift of Check Point Software Technologies, Inc.

Collection of early IBM ephemera, software, and documentation (c. 1950-1970), X2517.2003, gift of Bob Brubaker

Collection of Apple Developer Group CD Series compact discs (c. 1988-1993), X2531.2003, gift of Lars Borresen

Collection of Apple marketing materials on compact disc (1990-1993), X2546.2003, gift of Terry L Kristensen

Collection of artifacts, documents and media related to the WEIZAC and GOLEM computers (various dates), X2556.2003, gift of Gerald Estrin

Collection of computer industry business cards (1982-2003), X2561.2003, gift of Tom Halfhill

Collection of Cray software documentation (various dates), X2514.2003, gift of Warren Yogi

Collection of Digital Equipment Corporation ephemera (various dates), X2524.2003, gift of Judith Burgess

Collection of documents, photographs and slides related to the history of supercomputing, mass storage systems and networking at the National Center for Atmospheric Research (c. 1979-2000), X2548.2003, gift of Basil L Irwin

Collection of early timesharing manuals by Tymshare, Inc., (1974-1984), X2547.2003, gift of Joe Smith

Collection of early Xerox Corporation computer manuals, newsletters and reports (various dates), X2542.2003, gift of Mike Rutenberg

Collection of ephemera related to the development of computer memory (various dates), X2537.2003, gift of William F Jordan

Collection of ephemera, documents and slides related to the history of microelectronics (various dates), X2549.2003, gift of Olive Thompson

Collection of fourteen (14) advertisements for Honeywell computers (c. 1965), X2539.2003, gift of Mark Barnett

Collection of IBM ephemera, documents and media (c. 1955-1967), X2558.2003, gift of Neil Lewis

Collection of machine and program manuals and brochures (c. 1950-1969), X2564.2003, gift of Chuck Baker

Collection of photographs and ephemera related to the IBM Model 1360 "Cypress" Photo-Digital Storage Systems (c. 1967), X2509.2003, gift of Jack Harker

Collection of photographs of the UNIVAC Incremental Computer (1956), X2529.2003, gift of Gordon Uber

Collection of reference manuals, flowcharting template, pocket guides, and programmer reference cards (1964-1985), X2553.2003, gift of Ken North

Collection of selected materials from the Tandem Archival Collection (various dates), X2528.2003, gift of Hewlett-Packard Company

Collection of seven (7) boxes of assorted software and related documentation (1980-1990), X2502.2003, gift of Arel Lucas

Collection of software and documentation related to personal computing (c. 1980-1995), X2557.2003, gift of George Glaser

Collection of the first one hundred Sun Microsystems Laboratories technical reports (1991-2002), X2544.2003, gift of Sun Microsystems, Inc.

Collection of UNIVAC materials (various dates), X2562.2003, gift of Carol Canzano-Zito

Collection of various materials relating to the industrial design of the Xerox Alto (1973), X2536.2002, gift of Terry West

Commodore "SuperPET" SP9000 personal computers (two), dual disk drive, hard drive, software and documentation (c. 1981), X2494.2003, gift of Vladimir Steffel

"Computer Music from the University of Illinois" record album (c. 1963), X2552.2003, gift of Richard Ellis

Computers (Boy Scouts of America Merit Badge Series) (1968), X2493.2003, gift of Dag Spicer

Computran Model AN 7 Computer Trainer (c. 1965), X2514.2003, gift of Warren Yogi

Control Data Corporation Removable Disk Pack (c. 1970), X2523.2003, gift of Richard Walters

Core Memory Plane Assembly (1960), X2523.2003, gift of Richard Walters

"CRAM-80" homebrew computer (c. 1975), X2566.2003, gift of Steven E Young

DEC software and manual collection (various dates), X2571.2003, gift of Kenneth L Voss

Designing with FPGAs & CPLDs (2002) and *Verilog Designer's Library* (1999), X2506.2003, gift of Bob Zeidman

Digital Equipment Corporation "Computer Lab" Digital Logic Trainer (c. 1962), X2518.2003, gift of Rob Keeney

DOS 3.30 for the Dynabyte 5200 Computer Unit (1982), X2535.2003, gift of Steve Brugler

Dynabyte Business Computers, Technical Manual for the Dynabyte 5200 Computer Unit (c.1982), X2535.2003, gift of Steve Brugler

DYSEAC components and documents (1954), X2489.2003, gift of David E Hartsig

E & L Instruments Mini-Micro Designer (MMD) 1 8080 trainer board (c. 1976), X2534.2003, gift of Phil Keller

Electronics Australia EDUC-8 microcomputer (1975), X2520.2003, gift of John Whitehouse

Franklin ACE 1000 with documentation and software (c. 1983), X2523.2003, gift of Richard Walters

Friden Flexowriter (c. 1961), X2515.2003, gift of Richard Leamer

Fujitsu Stylistic ST4100 (2003), X2575.2003, gift of Mr Toshio Morohoshi

Gavilan Mobile Computer, software, and documentation (1984), X2505.2003, gift of Angelina M Jimenez

Gear and arm from Science Museum, London, Babbage Engine construction (2003), X2563.2003, gift Dr Thomas Bergin

RECENT ADDITIONS, CONT'D

Handspring, Inc., Treo 180 Communicator (2002), X2503.2003, gift of Donna Dubinsky

Hewlett-Packard HP-85 Personal Computer (c. 1983), X2523.2003, gift of Richard Walters

Hewlett-Packard HP-97 Programmable Calculator (c. 1979), X2523.2003, gift of Richard Walters

Hewlett-Packard Model 200C Oscillator (c. 1940), X2526.2003, gift of George Durfey

Hewlett-Packard Model 200C Oscillator (c. 1940), X2565.2003, gift of SRI International

Hewlett-Packard production prototype DDS-1 tape drive and data cartridge (c. 1987), X2512.2003, gift of Dominic McCarthy

IBM "Reflexione" ("THINK") Sign (c. 1970), X2545.2003, gift of Tom Reif

IBM 360/30 CCROS card (c. 1965), X2578.2004, gift of Brian Knittel

IBM 5110 minicomputer system, with original CPU, monitor, disk drive, tape unit, printer, documentation, and software library (c. 1978), X2511.2003, gift of Jan Engel

IBM 700-series pluggable unit (1952), X2491.2003, gift of Gwen Bell

IBM AN/FSQ-7 (SAGE) Theory of Programming Manual (1957), X2527.2003, gift of Robert F Martina

IBM core plane (c. 1960), X2499.2003, gift of Art Siegel

IBM Hard Drive Assembly (c. 1970), X2523.2003, gift of Richard Walters

IBM Hexadecimal Adder (1957), X2545.2003, gift of Tom Reif

IBM *Manual of Instruction Customer Engineering* (1946), X2568.2003, gift of Warren Yogi

IBM Model 10 Card Punch (c. 1940), X2523.2003, gift of Richard Walters

IBM Model 5151 Personal Computer Display (c. 1981), X2523.2003, gift of Richard Walters

IBM Time Clock (c. 1913), X2569.2003, gift of Len Shustek

IMSAI 8080 Microcomputers with documentation libraries (two) (c. 1976), X2523.2003, gift of Richard Walters

IMSAI Dual 8" Floppy Disk Drive (c. 1976), X2523.2003, gift of Richard Walters

International Correspondence Schools Computer Code Translator Slide-Chart (1983), X2519.2003, gift of Bill Kochanczyk

Kaypro 2000 Personal Computer and Docking Port (c. 1987), X2523.2003, gift of Richard Walters

Keuffel & Esser Company, Beginner Slide Rule (c. 1954), X2553.2003, gift of Ken North

Let ERMA Do It (1956), X2507.2003, gift of George Durfey

Livermore Data Systems Model B Acoustic Coupler (c. 1965), X2523.2003, gift of Richard Walters

M & R Enterprises Pennywhistle 103 modem, X2559.2003, gift of Bill Hill

Mechanical Analog Computer (c. 1965), X2523.2003, gift of Richard Walters

Monroe Epic 2000 Electronic Printing Calculator (c. 1955), X2530.2003, gift of Dorothy Burkhart

Netronics Research and Development, Ltd., COSMAC ELF microcomputer (1976), X2532.2003, gift of Bill Buzbee

Okimate 10 Personal Color Printer (c. 1984), X2523.2003, gift of Richard Walters

Olympia magnetic dictation machine (c. 1970), X2521.2003, gift of Bob Feretich

Original Homebrew Computer Club T-shirt (c. 1986), X2579.2004, gift of Carrie Karnos

"The Orm" robotic arm (1965), X2574.2003, gift of Stanford University

Packard Bell PB 250 minicomputer and collection of associated software and documentation (1961), X2515.2003, gift of Richard Leamer

PCD Maltron Ergonomic Keyboard (c. 1990), X2523.2003, gift of Richard Walters

Philips Nino 300 Personal Data Assistant (c. 1998) and Nino T-Shirt, X2555.2003, gift of Kevin Turner

Processor Technology Corporation SOL Terminal Computers (two) (c. 1978), X2523.2003, gift of Richard Walters

Programming Systems & Languages (1967), *A SNOBOL4 Primer* (1973), and *Computers and Society* (1972), X2567.2003, gift of Jim Gross

Punch card carrying case (c. 1960), X2504.2003, gift of Herman Griffin

Quantum Computer Services, Inc., America Online Ver. 1.0 (1989), X2508.2003, gift of Adam Gross

Radio Shack (TRS-80) 64K Color Computer 2 (c. 1985), X2523.2003, gift of Richard Walters

Radio Shack (TRS-80) Model 4 Micro Computer (c. 1985), X2523.2003, gift of Richard Walters

"Rancho Arm" robotic arm (1963), X2574.2003, gift of Stanford University

Remington Rand Corporation magnetic tape (c. 1966), X2573.2003, gift of Jonathan Gross

Rockwell International R6500 Advanced Interactive Microcomputer (c. 1979), X2522.2003, gift of Bob Bynum

Russian "Microcalculator Electronica B3-36" calculator (1983), X2514.2003, gift of Warren Yogi

Russian "Olimpik-C" personal computer (c. 1993), X2514.2003, gift of Warren Yogi

Russian abacus (*stchoty*) (c. 1963), X2514.2003, gift of Warren Yogi

Sama & Etami, Inc., "The Concise Conversion Tables and Circular Slide Rule" (c. 1960), X2551.2003, gift of Wolfgang Schaechter

Seagate ST-225 hard disk drive (1984), X2572.2003, gift of Henry Plummer and Robert Lewis

Sharp Corporation Model OZ-7000 "Wizard" Electronic Organizer and Interface Software (date unknown), X2543.2003, gift of Eugene Miya

Signed promotional poster: "Intel Delivers Solutions" (c. 1982), X2533.2003, gift of Stephen Casner

Silicon wafer collection (c. 1965-1995), X2495.2003, gift of Mark Noreng

Smithsonian Institution Annual Report 1874, X2563.2003, gift of Dr Thomas Bergin

Tadpole Technology SPARC-book 2 (1993), X2500.2003, gift of Bill McKie

Tandy 1400 FD Personal Computer with associated cables, manuals and software (c. 1989), X2540.2003, gift of Mark Gilkey

Tandy Acoustic Coupler 2 (c. 1989), X2540.2003, gift of Mark Gilkey

Tandy Corporation TRS-80 III (1981), X2501.2003, gift of Bob Zeidman

Tandy Radio Shack Model 200 Portable Computer (1985), X2523.2003, gift of Richard Walters

Technical Design Labs Xitan microcomputer (c. 1977), X2516.2003, gift of Cappy Jack

TeleSensory Systems, Inc., Speech+ Calculator (English language model) (1975), X2535.2003, gift of Steve Brugler

TeleSensory Systems, Inc., Speech+ Calculator (German language model) (1976), X2535.2003, gift of Steve Brugler

Unisys historic videotape collection (various dates), X2492.2003, gift of Unisys Corporation

UNIVAC Products Handbook (copy) (1959), X2570.2003, gift of Unisys Corporation

Vacuum Tube Flip Flop Module (c. 1975), X2523.2003, gift of

VISICALC 1.0 software (1982), X2490.2003, gift of Mary Cooper

Wozniak "Blue Box" (c. 1972), X2541.2003, gift of Allen Baum

Wyse Technology, Inc., Series 7000i Model 760 MP computer (c. 1994), X2498.2003, gift of Barbara Gasman

Xerox 860 information processing system (1980), X2496.2003, gift of Ken Lehmann

(Dates represent dates of introduction and not necessarily dates of manufacture.)

PRESERVING HISTORY:

THE SDS SIGMA 5 FINDS A NEW HOME

BY LEE COURTNEY

One never knows where one will find hidden treasure. In this case, a photo posted on Usenet contained a serendipitous glimpse of hidden treasure, and this is the story of how an operational 35-year-old mainframe computer system was discovered, donated, and moved to the Computer History Museum.

FINDING A PIECE OF MAINFRAME HISTORY

In August 2000, while perusing the PDP-8 newsgroup, I ran across a query about an old computer (see www.computerhistory.org/projects/pdp8_restoration/). Pittsburgh graduate student Raymond Jensen was asking for information on an old system—the PDP-8 made by the now-defunct Digital Equipment Corporation—he had discovered in a basement laboratory along with several other large unknown computers. He subsequently provided a Web page with photos of the equipment, which indeed depicted a PDP-8 minicomputer. However, one picture also showed a portion of a large tape drive, which I immediately recognized as a Scientific Data Systems (SDS) reel-to-reel tape drive like the one I had used on an SDS Sigma 7 mainframe computer in the early 1970s. Was it possible that a Sigma-series mainframe was attached to that tape drive? By chance had I stumbled across what was perhaps a 1960s-era mainframe still persisting “in the wild?”

I immediately contacted Jensen and told him the machine just outside the picture could be an older SDS mainframe, and might be of interest to the Computer History Museum. A few days later I received an email from him indicating that it was indeed a Sigma 5 mainframe and that it was located at Carnegie-Mellon University (CMU) in the chemistry department’s NMR (Nuclear Magnetic Resonance) Facility for Biomedical Studies. Jensen knew nothing more about the system, its origin, or even its manufacturer, except that it was really big and was comprised of several cabinets. He provided the CMU email addresses of Dr. Aksel Bothner-By and Dr. Joseph Dadok, both of whom were retired from the chemistry department.

CPU and tape drive cabinets

Lee Courney inventories the Sigma 5 shipment after arrival at the Museum.

Console teletype. Through the mid-1970s, most mainframe computer systems used hardcopy terminal as consoles to aid in resource accounting, operator tasks, and general system debugging. The Sigma 5 was unusual in that it employed a TTY utilizing EBCDIC rather than the more common ASCII character encoding.

My immediate thought was that this would make an excellent addition to the collection at the Computer History Museum. I wrote both Bothner-By and Dadok, along with the current Chemistry Department Chairman Richard McCullough, asking for more information on the Sigma 5, its current status, and their interest in donating the system to the Computer History Museum.

Bothner-By and Dadok relayed that the system was indeed an SDS Sigma 5 mainframe first installed at CMU around 1968 and was still operational although no longer used. And the chemistry department was interested in seeing the system preserved at the Computer History Museum. Since the system was still operational, it would be important to make sure it arrived at the Museum in the same condition. This would require careful de-installation, documentation, and packing of the system. Unfortunately, CMU would not be able to provide resources to perform these tasks.

DONATION RECONNAISSANCE AND AGREEMENT

It turned out I was taking a business trip to the east coast in November 2001 and was able to make a side trip to meet with both Dadok and Bothner-By. The purpose of the trip was to examine the system in person, determine a rough inventory of what items would be part of the donation, assess the scope of the necessary shipping preparation, and learn more about the machine's history and possibilities it might have for future use.

I anxiously arrived at CMU and met Bothner-By in his office at the Mellon Institute. The Sigma 5 resided in a sub-basement laboratory in part of the building that has not been renovated since original construction in the 1940s.

We went downstairs through the basement to the sub-basement, with pipes overhead and long corridors stretching into the distance. We passed many offices and labs as we descended deeper and deeper into the building. I felt like I was walking into an episode of the X-Files. Bothner-By explained that the Sigma 5 resided in a part of the building that had housed a small-scale prototype chemical plant during World War II. At the end of one long corridor, we reached the NMR Lab with the magnet and control rooms on the right side of the hallway and a computer room with the Sigma 5 on the left. Dadok, who had emigrated from Czechoslovakia in 1968, soon joined us after an event honoring a visit by the new president of that country.

Entering the Sigma 5 computer room was a step back in time to the days when mammoth computers were isolated in large rooms with raised floors for snaking cables between cabinets and for hiding large power conduits, while air-conditioning units constantly blew cold air to cool the systems. The Sigma 5 sat in the center of the room, as it had for the last 33 years. At opposite ends of the computer room were a 1960s-era PDP-8 system, a 1970s-era Harris minicomputer, and a late-1980s VAX. Racks holding 1/2-inch magnetic tapes used with the Sigma 5 stood along one wall. Various storage cabinets and bookshelves with printouts and systems' documentation covered the other walls. We had to talk loudly over the low rumble of a large air-conditioning unit.

The atmosphere took me vividly back to the early 1970s when I used an SDS Sigma 7 in high school and later worked as the console operator for my university's IBM mainframe. That one moment standing in the computer room with the Sigma 5 made the trip worthwhile.

We talked briefly about the current state of the Sigma 5. One important task I wanted to accomplish on that visit was to capture Bothner-By and Dadok's experiences with the system and stories of its use. I videotaped Bothner-By discussing the work done in his lab and Dadok discussing his careful maintenance of the machine and associated instrumentation during all the years of use. We spent several hours videotaping the machine in operation, with Dadok powering on the system and going through the different components, how the machine operated, and quirks of the Sigma 5. Unfortunately, a hardware error prevented us from booting up the system.

In addition to videotaping the Sigma 5, we also discussed the instrumentation attached to the Sigma 5 and its function and contributions to science over the years. The attached equipment included the original NMR spectrometer, more recent NMR instrumentation, and a custom-built system for controlling the instrument that interfaced to the Sigma 5. The control system was composed of two 19-inch racks containing various consoles and

The card reader, the primary input device for programming the Sigma 5

Button detail

electronic equipment including an SDS A-D (Analog-to-Digital) converter, which converted signals from the instrument and sensors to digital form that could then be stored and processed by the Sigma 5.

Bothner-By and Dadok provided a wealth of information on how the Sigma 5 was used at CMU. Originally the Sigma 5 was purchased by the NIH (National Institute of Health) and installed at the University of Indiana. After a year it became available and Bothner-By wrote a proposal for its installation in his lab at CMU. In 1968 the system was moved to CMU and installed as part of the NIH-sponsored National NMR Facility for Biomedical Studies in the chemistry department. This facility provided access to an extremely powerful nuclear magnetic resonance spectrometer that allowed biologists, biochemists, and other scientists to analyze the chemical makeup and structure of organic compounds.

When introduced, the Sigma 5 was marketed as a real-time and process-control system, as well as a small mainframe for business or scientific computing. True to its real-time nature, the Sigma 5 was the primary control, data collection, and analysis tool used for the spectrometer. Since the Lab was a national facility sponsored by the NIH, users came from all over the United States as well as other countries. For many years, the magnet used in the NMR spectrometer controlled by the Sigma 5 was one of the most powerful of its type.

When a sample was being analyzed, the Sigma 5 was connected to various sensors that collected data that was recorded on a reel-to-reel magnetic tape or a high-speed fixed-head single-platter disc called a RAD. Once collected, the Sigma 5 could reduce, analyze, or display the data. Originally the system was outfitted with a plotter and could produce graphical representations of data. A FORTRAN compiler was also available for creation of programs to perform analysis. However, many scientists using the instrument wrote their data to magnetic tape for later analysis at their home institution.

An artifact of 1960s computing that benefited the lab was that complete hardware documentation and system software source code were provided with the Sigma 5. In addition to I/O designed to facilitate "custom" hardware and interfaces, the complete documentation allowed Dadok to design and interface scientific instruments unanticipated by the original designers and to apply the system to new problems.

Today we would refer to these attributes as open standards, design, and source. By studying the Sigma 5 and its contemporaries, we can see that the concept of "open source" was already a well-established practice even by the time the Sigma 5 came into being in the mid-1960s.

After capturing about four hours of video of the system along with Bothner-By and Dadok describing the lab, instruments, Sigma 5 system, and how all were used in the scientific community, it was time to head to the airport. I had taken this trip to learn what I could about the system in order to prepare a proposal to the Museum for acquiring it. It was apparent that this could be a significant addition to the Museum's collection and could help to document computing history, especially 1960s-era mainframe technology.

APPROVING THE DONATION

Once back in California, it was time to work on the Museum end of things. Each week the Museum receives multiple inquiries about potential donations. Unfortunately, it cannot automatically accept all of them. Currently, the collection occupies over 35,000-square-feet of horizontal storage space, so obvious practical constraints affect the acceptance of new items. Because the Museum must carefully consider the historical value of an artifact before accepting it, a Collections Committee—a group of staff and volunteers chaired by Museum Trustee John Mashey—meets regularly to consider, accept, and decline donations.

Using collective experience as well as formal evaluative criteria, the Collections Committee looks for donations that are relevant to the mission of the Museum—to preserve and present for posterity the artifacts and stories of the information age—and that add to our understanding of computing history.

These items generally fall into one of five categories: hardware, software, documentation and printed matter, films/video/photos, and ephemera. Items currently in the collection range from individual hardware components such as vacuum tubes from early computers to software such as Bill


The cables were hard-wired into the cabinets and had circuit boards attached at various points.


The weave of cables from cabinet to cabinet to power source were like a Gordian knot—almost impossible to untangle without a sword.

Gates and Paul Allen's original BASIC paper tape, to complete mainframe/supercomputer systems such as the Cray-1, and include films and videos of important lectures given by pioneers in the field of computing.

In preparing a proposal for the Collections Committee, I considered how the Sigma 5 would contribute to the collection, its value in establishing an historical record for its era, and how it could provide insight into the evolution of computing. The donation met the Museum's desire to collect items greater than 10 years old, having been installed at CMU in 1968. In addition, I considered the role SDS played as a company in the mid-1960s, the Museum's need for a representative sample of 1960s-era mainframe computing technology, and how a well-documented and operational mid-1960s mainframe would contribute to the understanding of computing. While the SDS Sigma series was not the most prevalent system of its time, it was an excellent touchstone and example of 1960s computing.

This donation would provide the Museum with a rare and very desirable opportunity: to approach an artifact acquisition from a systems perspective. Often items, especially larger ones such as the Sigma 5, arrive at the Museum in partial condition, lacking essential peripherals, software, and/or documentation, or they are too fragile or damaged to be handled or used. Collecting a piece of a system such as part of a CPU or even a set of individual components does not allow the entire system to be studied, understood, or experienced. In this instance, CMU was offering to donate all hardware, spare parts, software, and documentation for a system that was in running condition.[1] The Sigma 5 could perfectly meet the Museum's desire to collect and preserve artifacts that would provide an accurate and complete picture of computing technology.

I proposed to the Collections Committee that we accept the donation of the Sigma 5 and all related pieces that would provide a complete picture of the Sigma 5 system and 1960s mainframe computing, including items such as the metal file cabinet used to store punched cards. The committee saw the Sigma 5 as a valuable addition to the collection and agreed that we should accept the system as a whole. Now all that was left was to arrange de-installation of the system and shipment to the Museum in California.

TRANSPORTATION AND LOGISTICS

Initial conversations with Bothner-By and Dadok indicated there was no rush to move the system. CMU would wait until adequate space became available at the Museum. I began researching the logistics of actually getting the donation to California.

Then one day I received an urgent email from Bothner-By: the system must be moved as soon as possible. The machine room housing the Sigma 5 had been transferred from the chemistry to a different department and was scheduled to be demolished and remodeled. The Sigma 5, along with all other contents of the NMR Lab, needed to be removed immediately!

This put the transportation planning process into hyper-drive. Two significant challenges had to be faced: transportation costs and preparing the system for pickup. Based on our history of transporting similar systems, we estimated that it would cost about $7,500 to prepare and ship the Sigma 5. Unfortunately, the Museum budget did not have an allocation for this. However, I knew that Max Palevsky, one of the founders of Scientific Data Systems, had generously contributed to the initial founding of the Museum. I wrote asking if he would sponsor the move and soon received a phone call indicating he would be happy to. With funds in hand, we began the task of planning the actual move.

For transportation of high-value artifacts that are fragile, heavy, and bulky, the Museum uses a carrier with experience in transporting computers, electronics, and similar equipment. Usually the Museum receives donations of large systems that have been de-installed without planning for future use or study. Cables are often cut instead of being unplugged and carefully packed; software and documentation are missing; and integral pieces of the system have been abandoned or disposed. Even when an item is donated "intact," it is often removed or packed with an eye towards expediency rather than preservation. For example, packing tape may be directly applied to surfaces, leaving damaging residue or pulling off paint and surface material when removed.

Given the excellent condition and completeness of the Sigma 5, avoiding these mistakes was a very high priority. Having facilitated several system moves, I knew that a Museum representative needed to do the actual preparation of the system for shipping to California. We worked out a date and logistics for pick-up and began to plan the de-installation process.

THE DE-INSTALLATION

Again my travel plans coincided with Museum needs and I made a trip to Pittsburgh in June 2002. To help the de-install of the Sigma 5 proceed smoothly, a preliminary written plan was created to document the process with both photographs and a log kept in my notebook computer.

I planned to spend the day documenting the system configuration, uncabling, packing, and staging the donation for pick-up. Consulting with staff at the Museum and others who had direct experience with SDS and XDS—Xerox purchased SDS in 1969 and named the company XDS, or Xerox Data Systems—machines, I learned how to best prepare the system, i.e., what to do or not, what was important, and what could be left behind. For example, a former SDS hardware engineer told me that connectors on peripheral cables were very fragile and would often break when being removed. He provided advice on how to remove a cable and avoid strain that could damage it. This advice proved to be invaluable and insured that many fragile items were handled correctly and without damage.

I met Bothner-By in Pittsburgh on Thursday morning, May 17, about 8:30am. I found the computer room in the same condition as the year before. The NMR Spectrometer had already been disassembled, so the control room equipment and Sigma 5 were left. The plan called to first map the system *in situ*, take photographs, and inventory all the cabinets, spare parts, software, documentation, and other donated items. I inventoried the major pieces that would need to be handled by movers: hardware cabinets, peripherals, and several cabinets holding punched cards and spare parts. We also did a quick inventory of software stored on magnetic tape. Tools for disassembly were located in a helium generation room down the hall, along with some system documentation.

The next step was to pull floor tiles and do a quick assessment of which cabinets to uncable first. Yikes! Removing more and more floor tiles revealed an ever-more complicated Gordian Knot[2] of data and power cables snaking all over the machine room. Usually when de-installing, one would take Alexander the Great's approach to loosen the original Gordian Knot, but because we wanted to preserve the Sigma 5 intact, that approach was avoided. I had an inkling this might take a little longer than I initially thought.

Uncabling the CPU presented several problems. I had hoped to just unplug the power cables and keep them with the system. However, after tracing the paths of the primary and peripheral power cables, I found them running through a hole in the wall into the next room that was (of course) locked and inaccessible. If I couldn't unplug from the building power, I'd just disconnect the hard-wired cables. Although the power was hard-wired into the main CPU cabinet, it fed power to other cabinets in the system, which simplified that part of the disassembly.

Fortunately, the breaker box was located in the computer room. Before disconnecting power, I double-checked that the three-phase 408V power to the system was turned off at the breaker box. Then I checked again.

Separating the cabinets from each other was even more complicated. Unlike modern systems where elements such as disc, memory, tape, and CPU are physically present in a single cabinet, the Sigma 5 CPU was composed of three large interconnected cabinets housing the CPU, floating point unit, and core memory. Tens of cables were laced between, through, and under these cabinets. In addition, cables connected the CPU and peripherals, some of which were physically next to the CPU, and some of which were located at a distance across the room.

Today's cables have connectors on each end that allow them to be disconnected quickly and easily. On the Sigma 5, in addition to the mass of tangled cables snaking between cabinets, each cable had a 4x4-inch printed circuit board hardwired to each end. I soon discovered it got worse. Some cables had not just two, but up to five cards hardwired at various points in-between the ends and were 20 or more feet long. These cards enabled the cables to plug into backplanes or card cages in one or more cabinets.

I saw why most systems of this type are removed from service by cutting the cables. Finding, untangling, and removing what looked to be several hundred cables seemed an impossible task. It made sense to start where the peripherals attached to the CPU. With a lot of patience and gently working with cables that had not been moved in over 30 years, I was provided a detailed lesson in 1960s-era mainframe packaging and interconnect technology.

In addition to untangling the cables between the cabinets, it was important to record exactly where each cable was plugged, in order to facilitate the eventual reconstruction of the Sigma 5. I defined a labeling protocol based on designations present in each hardware cabinet. Each card plugged into a socket and was tagged with a code that indicated 1) cabinet, 2) frame, 3) row, and 4) slot.

By the end of the day on Thursday, I had removed only about a third of the cables, no software or spare parts had been packed, and I was beginning to worry about completing the task by the end of Friday. By working until 3am, I finally disconnected and packed most data cables. The next day, Bothner-By and I started working at 9am with a goal to finish preparing the system by 1pm so I could catch my plane that afternoon. Hope springs eternal. About 3pm, it was obvious that there were several more hours of work and I changed my departure to Saturday morning.

The Computer History Gods must have been smiling on us because the process of separating the system in an orderly fashion became easier and easier with each cable. The core memory cabinet was the first to be completely decabled. Once several bolts holding the cabinets together were removed, it was moved aside for the first time in 30 years. I made a mental note that rubber wheels sitting in one position for that period of time also tend to flatten, so it was as much pushed as it was rolled.

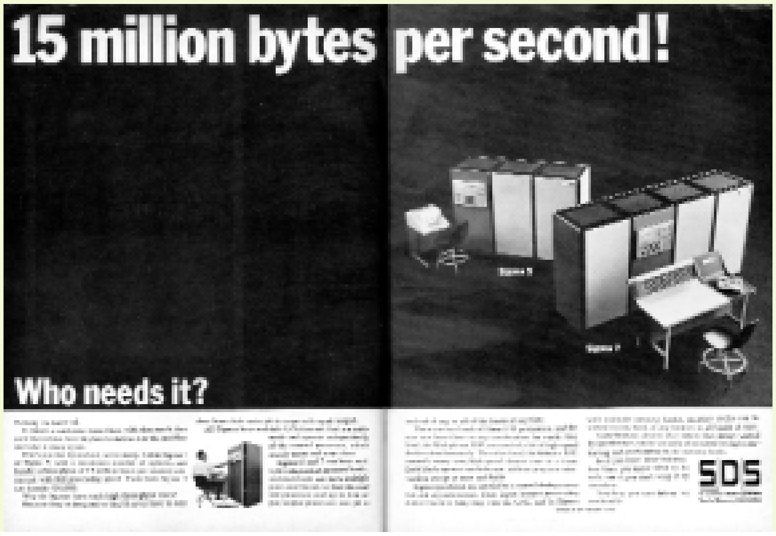
While I concentrated on physically separating the cabinets, Bothner-By was packing away documentation and spare parts. Since the lab closure called for removing all furniture and systems, he just packed all the spares in place in their storage cabinets to be shipped to California. Cabinets of punched cards were likewise secured and locked. The system documentation was packed into six large boxes. I looked through a tape library of about 200 half-inch magnetic tapes, picked those that appeared to contain system software, and packed them into another four or five boxes. In the late afternoon, all cables were disconnected except those in the CPU cabinet with the operator front panel. In the interest of time, these were simply rolled up and packed in a large box on top of the cabinet, leaving one end still connected. This was OK for transport, and the cables would be removed on arrival at the Museum. When this was completed, all cabinets had been separated, positioned, and labeled for pick-up the following week. An inventory was created for the shippers. The de-installation and preparation of the Sigma 5 was complete by about 5pm on Friday.

It looked like there would be some unused room in the shipment. In addition to the Sigma 5, the machine room contained a PDP-8 with two seven-track 1/2-inch tape drives. While the Museum has several PDP-8 systems, I knew of no operational 7-track tape drives. Since these are extremely rare, they would be very useful for reading and converting the Museum's collection of 7-track tape media. Bothner-By and I tracked down Professor Mort Kaplan who owned the PDP-8. He confirmed it was no longer being used and agreed to donate it to the Museum. After a phone check with the Collections Staff to confirm we would accept donation of the PDP-8, it was quickly prepped and moved into place to piggy-back on the shipment.

At 9pm Friday, I left the Mellon Institute at CMU, my original eight-hour de-install task completed after almost 31 hours of work in a 48-hour time period. I was exhausted as I drove to the Pittsburgh airport, but still very excited thinking that soon the Museum would be in possession of an almost mint-condition artifact for the collection.

LESSONS LEARNED

What was learned from this de-install? In addition to learning about interconnect technology on the Sigma 5 and navigating the inner sub-basement sanctum of the Mellon Institute, I also learned that assumptions based on experience with a contemporary system are not always applicable to older mainframe technology. I was reminded how important it is to plan your work and work your plan. A standard set of tools can make the job go much faster.



Sigma advertisements promoted the machine's ability to handle real-time applications while running background processes (far left) and their ability to handle more input and output than existing technologies required. "Anything you deliver we can handle," the ad concludes (immediate left).

Talking with subject matter experts for the Sigma hardware, scoping out the donation and logistics ahead of time, and lots of patience paid off in spades when it came time to actually de-install, prepare, and move the system. Taking notes in real-time on a laptop and annotating with photos from a digital camera was a big help in gauging my progress and should greatly facilitate reconstruction of the system in the future and with other SDS/XDS hardware donated to the Museum. I also learned a lot of dust and debris can accumulate under a computer room false floor over a 30-year period.

THE SIGMA 5 AT THE COMPUTER HISTORY MUSEUM

The Sigma 5 was delivered to the Museum in California about a month after I completed the de-installation. It was initially stored in the Museum's warehouse at Moffett Field. Upon arrival, the different pieces in the shipment were entered into the Museum's collection database. This process records a description of each artifact, physical characteristics, and assigns it a permanent, unique accession number for future reference.

On April 4, 2003, the CPU cabinet with operator panel, card reader, teletype console, and tape drive were moved to the Museum's new building in Mountain View California. A display area was prepared for the Sigma 5 describing the system and its capabilities. The Sigma 5 is on display for visitors in the new Visible Storage eshibit area along with the CDC 6600, IBM System 360, SAGE, and 600 other artifacts from the collection.

WHAT'S NEXT FOR THE SIGMA 5, AND HOW CAN YOU HELP?

With the Sigma 5 acquisition safely in California, many possible projects are envisioned for it. Immediate projects include photographing and making a more detailed catalog of the Sigma 5 artifacts. This will allow the Sigma 5 to be displayed via the CyberMuseum at the component and system level. A more detailed catalog needs to be completed of the Sigma 5 documentation, software, and spare parts.

Longer term projects might include reconstituting the Sigma 5 as a running system, incorporating the system as part of a larger exhibit, scanning the SDS/XDS documentation and ephemera and making them available via the Web, or creating a working Sigma simulator which could run the software donated with the Sigma 5. Completing an oral history project of Scientific Data Systems would provide significant insight into the state of the computer industry in the 1960s when many business and technology innovations were realized.

A more formal set of de-installation guidelines for artifacts based on the notes and log from the Sigma 5 and other artifact donations need to be created and adopted for future acquisitions.

As with other Museum projects, the likelihood of these projects being implemented relies on knowledgeable, reliable, and motivated volunteers. If you have an idea for or would like to participate in a project involving the Sigma 5, or other facet of the Museum, as the volunteer coordinator, I will be very happy to hear from you. Please feel free to send me an email at courtney@computerhistory.org.

And as always, the Collections Committee is interested in considering additional SDS and XDS artifact donations that complement the Sigma 5, from components to software to ephemera to other SDS/XDS systems.

The Computer History Museum is entering a new and exciting phase of its life. Many pieces are coming together to allow the Museum to build a world-class institution documenting the history of the information age. Now the Sigma 5, and other artifacts like it, can be properly preserved for study and enjoyment for past, present, and future generations.

AFTERWARD

Many expectations and goals for this acquisition were exceeded because of advanced planning, foresight of donors, generous contributions, and hard work on the part of volunteers and others interested in seeing computing history recognized and preserved. This acquisition was the result of the efforts of many people.

Thanks go to: Drs. Aksel Bothner-By and Joseph Dadok of the CMU Chemistry Department for their time and effort to keep the system running, recognizing the value of the system to documenting the history of computing, and working to facilitate its contribution to the Museum; numerous volunteers on the Web who provided invaluable information allowing me to successfully complete this project—in particular Keith Calkins, George Plue, and Ed Bryan; and Max Palevsky for his generous support of this project and the Museum in general. Special thanks to the staff in the Collections Department and Collections Committee who approved the donation and helped with arrangements for its safe transport to California. ■

When not serving as the Chair of the Museum's Volunteer Steering Committee, participating in numerous Museum initiatives and projects, and pestering the staff about SDS/XDS items, Lee Courtney is an Engineering Manager at MontaVista Software and harried father of a very energetic three-year-old boy, who also happens to be the Museum's youngest volunteer.

[1]When the Chemistry Department acquired the Sigma 5 in the late 1960s, SDS, and subsequently Xerox Data Systems (XDS), were contracted to perform periodic maintenance on the system. In 1975, Xerox exited the mainframe computer business and sold their customer base to Honeywell. After some false starts, CMU, like many other Sigma sites, opted for self-maintenance. This meant accumulating a supply of spare parts and collecting the documentation needed to maintain the system. In addition to self-maintenance of hardware, CMU opted to maintain its own system software. This was fortuitous for the Museum because it provided a treasure trove of information to accompany the Sigma 5. Additionally, because Bothner-By and Dadok took such care in maintaining and documenting the system, the Museum and its visitors will benefit from a breadth and depth of equipment and information rarely available for this class and age of system.

[2]The Gordian knot has come to represent a most difficult puzzle. According to Greek legend, an oracle prophesied that the future king of Phrygia would come into town riding in a wagon. When the peasant Gordius and his wife did just that, the elders made Gordius king. He dedicated his wagon to Zeus, tying it in front of his palace with an intricate "Gordian" knot as a reminder of his humble beginnings. Decades later, an oracle foretold that the person who finally unraveled the Gordian knot would rule all of Asia. Many, many men tried to untie the famous Gordian knot until Alexander the Great drew his sword, slicing the knot in half.

SIGMA 5 SPECIFICATIONS

Instruction set:	90 instructions
Word length:	32 bits plus parity, EBCDIC character encoding
Memory:	Up to 512K bytes multiport core memory with 2- or 4-way interleaving and 950 nsec cycle time
I/O:	Multiplexed IO processor: 8 to 24 channels each with bandwidth of 450 or 900KB/sec and supporting up to 32 standard speed devices each
Optional selector IO processor:	8 to 32 channels each with bandwidth of 3.3MB/sec
Performance	**Min – Max (all times in usec)**
AW **Add Word:**	2.0 – 3.36
LW **Load Word:**	2.0 – 3.36
STW **Store Word:**	2.5 – 3.94
AWM **Add Word to Memory:**	3.3 – 5.0
BAL **Branch and Link:**	1.3 – 3.22
Technology:	Discrete transistors
Number customer installations:	Approximately 250 as of 1972
Purchase price:	$90-500K
Installed base markets:	Defense, scientific/engineering R&D, space, universities
Primary competitive systems:	IBM 360/40, /44, /50, 370/135, /145; DECSystem 1040, 1050, 1055; CDC 3300, 1700; Univac 418-III
System software:	Basic Control Monitor, Batch Processing Monitor, and Batch Timesharing Monitor; FORTRAN IV; Assembler; COBOL; scientific libraries
Peripherals:	RAD files (fixed head disk), disk, 7- and 9-track magnetic tape, hardcopy TTY and CRT terminals, unit record equipment, paper tape, plotters, datacomm, and A/D & D/A converters

Sources: *Sigma 5/8 Sales Guide*, Xerox Data Systems, January 20, 1972, and the *SDS Sigma 5 Computer Reference Manual*, September 1968

THE SDS SIGMA 5 IN CONTEXT

BY PETE ENGLAND

WITH ED BRYAN AND WENDELL SHULTZ

In 1961, Scientific Data Systems (SDS) started with an objective of providing computers for the scientific, engineering, and education markets. Many of the founders of SDS had pioneered this market while at the original Packard Bell Computer Corp. By using solid-state but serial logic and an innovative memory technology cheaper than core, Packard Bell was able to offer a machine starting at $40,000. Until then, a price below about $100,000 was difficult for manufacturers to offer so a computer priced at less than half that opened up new markets. Crossing a lower price threshold—thus attracting new customers—has happened several times in the history of computers. Once hooked, their demand for capability increases, and prices rise once again.

SDS participated in this trend and provided more capabilities to that same market. The Series 9 machines used core memory with serial solid-state logic for an initial price of $54,000 for the SDS 910 in 1962. However, when the customer finished acquiring necessary peripherals and additional memory, the price would often be two to four times that amount. The Series 9 machines were successfully used in a variety of "embedded" applications where they provided control and captured data from systems, experimental environments, and other real-time situations.

A desire for computers that could combine these tasks with business applications led SDS, with its Sigma line, to focus on multi-use and timesharing capabilities. To meet these requirements, SDS invented a memory map to allow dynamic relocation of programs that were being run at the same time. A fixed-head Rapid Access Disk with storage of up to 3MB supported the high-speed swapping of programs in and out of memory. Reading or writing up to eight heads in parallel on some models gave a transfer rate of 3MB/sec.

In April 1964, IBM announced the System/360, which provided many new characteristics but not capability for timesharing or any significant real-time applications. The 360 incorporated base registers to make programs less sensitive to their location in memory but did not provide a means to relocate programs dynamically. These shortcomings gave SDS an opportunity that it exploited well.

After Sigma architecture was set and the Sigma 7 announced, other timesharing endeavors came to light. IBM started a project working with universities (Michigan, Carnegie Mellon) to modify a 360/65. UC Berkeley modified an SDS-930 to provide a memory map and larger memory. SDS productized and sold that modification as the 940 to the growing timesharing service bureau market until the software for the Sigma 7 could be finished.

The Sigma 7 was first delivered in December 1966, and the Sigma 5 was delivered in August 1967. These machines still used core memory but more of it, up to 512K bytes. The logic was now bit parallel for more speed and early integrated circuits were used for implementing the working registers. The goal of the Sigma 5 was to provide real-time and batch simultaneously, allowing batch capability to be used for software development, data processing from real-time capture, business applications, or processing student jobs—all while the machine remained responsive to real-time needs. The Sigma 5 had the same processing capability as the Sigma 7 although some of it was optional. It had the same interrupt system, flexible I/O, and RAD, but it did not have the memory map. And it found its way into applications similar to many of the original 9 series machines but with the benefit of multi-use.

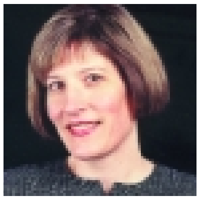
After a few years of trying to support the minimally-configured Sigma 5 at its starting price of $90-100,000, basic requirements were increased and the base price was more like $160,000. But, still, a typical configuration could get to $500,000. The Sigma 7, fully configured, could be well over $1,000,000.

This particular cycle started with computers that cost only $40,000. Another cycle started when DEC introduced the PDP-8s for $10,000. Even with limited capability, they enabled a new set of customers to obtain computers for the first time. As time passed, customer demands increased and the Minicomputer's capabilities and cost grew until it too passed $1,000,000 for some configurations. And then came the Microcomputer or PC... ■

Pete England was the architect of the SDS Sigma series of machines. Ed Bryan and Wendell Shultz developed the operating systems for the series.

REPORT ON MUSEUM ACTIVITIES

BY KAREN TUCKER



Karen Tucker is Vice President of Development, Marketing, and PR at the Computer History Museum

WE HAVE MADE GREAT STRIDES

With the purchase of our new building in October 2002 came an exciting change of direction from the Museum's previous plan to build at NASA Ames, a change that enabled us to "step up the pace" and offer more to our members and to the public than ever before.

And step up the pace we did. In December 2002, less than two months after the completed purchase, with help from volunteers and many others, the Museum relocated to the new building. Construction on a Visible Storage exhibit area and a new auditorium began the following month and was completed in May 2003. On June 2, over 600 people gathered to celebrate the opening of the Alpha Phase. See the article on page two for more details. It was a wonderful evening and gave us all a chance to celebrate how far we have come in so short a time.

Museum lectures and events continue to feature innovators and champions of computing history. Here are just some of our recent offerings.

Photo by Earnest J. Ray

Board Chairman Len Shustek (left) and Executive Director and CEO John Toole officially ushered in the Museum's Alpha Phase in a ribbon cutting ceremony with the city of Mountain View at the new building.

Adobe co-founder John Warnock expressed the importance of "shooting ahead of the duck" when introducing new technology.

Adobe co-founder Charles Geschke described his and Warnock's efforts to create a company culture that was positive and respectful of employees, customers, shareholders, and the community alike.

ADOBE SYSTEMS–THE FOUNDERS' PERSPECTIVE

On November 22, 2002, the 20th anniversary year of Adobe Systems, more than 300 people gathered at Moffett Field to hear Adobe founders John Warnock and Charles Geschke in a talk facilitated by Bernard Peuto. The two spoke about the company's success throughout the years and shared key philosophies and strategies that enabled the company to revolutionize desktop publishing.

From PostScript to Illustrator to Photoshop to Acrobat, Adobe repeatedly introduced products for which there was no market. Warnock said that, "it's really important...not to try essentially for today's market, but to look a couple years out and shoot ahead of the duck." Geschke explained policies and culture that they believe helped the company to experience success and longevity. He said, "We wanted to build...a place that, frankly, we would like to work...And we felt if we did that, we could attract...the great engineers, the insightful marketing people, the dedicated sales people." Over the years, when asked to delineate the "Adobe way," he would reply, "There's really only one rule: if you are confused about how to deal with [someone]...just treat that individual the way you'd like to be treated...and that will be the 'Adobe way.'"

AN EVENING WITH STEVE WOZNIAK

Apple co-founder Steve "Woz" Wozniak engaged an audience of 300 people at Moffett Field on December 10, 2002 with personal stories about his childhood—including pranks he used to play. He recalled his interest in electronics, the inspiration of Tom Swift books, his success in science fairs, and positive feedback he received from his teachers and his parents. He relayed how he became a licensed ham radio operator in 6th grade. He said he "went all the way through high school thinking, 'I'm designing computers right and left, but I don't think they ever have jobs designing computers. I mean engineers, which I want to be, you know, they design TVs and radios and things.'" He described how early on he "measured himself by how few chips" he used and discussed the sequence of break-throughs and events that eventually led to early Apple designs. To learn more, check out the events section of the Museum Web site.

Steve Wozniak told stories about a childhood full of pranks and programming and discussed early innovations at Apple.

Steve Wozniak autographs a *BYTE* magazine.

25 YEARS OF HENNESSY AND PATTERSON

On January 7, the Museum opened the new year with a lecture at PARC with John Hennessy and David Patterson and facilitated by John Mashey. More than 200 people heard these legendary men speak about early RISC development and their work since that time. As assistant professors, both men taught "brainstorming" classes to explore new technology directions. Hennessy recalled the class goal of designing a processor where they "almost naively" assumed, "given that VLSI is going to become the implementation technology, we need to re-look at the question of how processors should be architected when they're not being built from gate arrays or bits-wise kinds of technology." He added, "the fact that we had a limited number of transistors forced us to think really hard about what belonged in hardware and what belonged in software."

Patterson recalled being visited early on by John Cocke, who encouraged both him and Hennessy in their respective work. Patterson surmised that, although Cocke never said it, he visited the west coast to "communicate ideas so they could figure out how" to create the

John Hennessy recollected how he got into computers in the first place, how RISC developed, and how the technology evolved over time.

Dave Patterson was first introduced to computers one semester in college when he took a programming class because all of the math sections were full.

chips IBM was somehow not managing to create. "IBM was super-secretive with ideas, except Cocke would just go talk with a bunch of faculty and grad students…and get us excited…." "This was very controversial stuff. We did this as assistant professors….It was heresy. It got emotional reactions."

Together the two authored *Computer Architecture: A Quantitative Approach*, considered for over a decade to be essential reading for every serious student and practitioner of computer design.

HOW DATABASES CHANGED THE WORLD

Chris Date, Herb Edelstein, Bob Epstein, Ken Jacobs, Pat Selinger, Roger Sippl and Michael Stonebraker, with moderator George Schussel gathered on February 10 to share database stories and lessons learned.

After introductions, Date started the panel with a memorable acknowledgment of relational database pioneer Edgar "Ted" Codd, who was unable to attend (and sadly, passed away just two months later on April 18). Date said, "We are all here…in this room because of what Ted Codd did back in the 70s" at IBM when he proposed the relational database model that "basically put the whole field of database management onto a solid scientific footing."

The panel noted the paradigm shift of relational databases and told stories of the companies and people that developed, used, and marketed database technologies over the past three decades. Marketing was noted as of primary importance to successful products and Selinger discussed some of the user testing that IBM underwent in its decision to stick with SQL, a powerful language criticized as problematic and sometimes cumbersome. Epstein predicted that databases will be used more and more as monitoring systems to process streaming data, where companies will be "passing data through queries instead of passing queries through data." Sippl said, "There is a new revolution coming, not of the algebra of how to deal with tables of data, but how

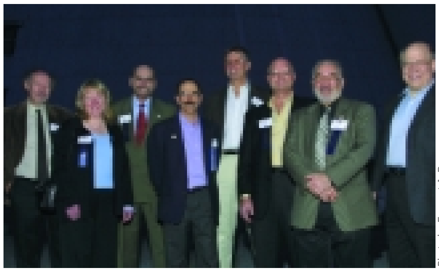


Photo by Earnest J. Ray

The database panel discussed the paradigm shift of relational databases, the incredible growth of the database industry, and ideas about the future of data management.

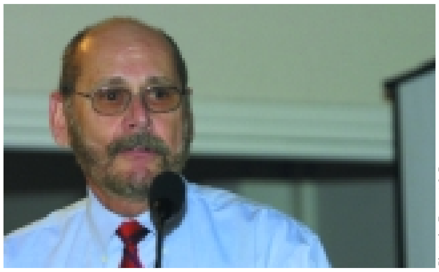


Photo by Earnest J. Ray

George Schussel moderated the database panel.

to deal with combinations of business processes….There's going to be a simple, powerful model for doing that…that will have as big an impact as the relational database did. It's dealing with our processes, not just our data." Edelstein concluded that there is and will continue to be a "vast increase in the scale of information" being processed, where great "complexities come from the nature of data and the rules associated with data." We are going to "need a way to deal with these complexities….Someone [will surface who will] abstract these new complexities into a new paradigm."

NATURE OR NURTURE: ESTRIN'S LIFE IN TECHNOLOGY, SO FAR

Judy Estrin, second-generation computer scientist thrice named to *Fortune* magazine's list of the 50 most powerful women in American business, spoke at a Museum event hosted by Microsoft on March 5. Long-time friend and venture capitalist Yogen Dalal masterfully facilitated the conversation. Estrin described her "rich beginnings" and the "incredible role models in terms of values, ethics, and love of learning" she found in her parents, Thelma and Gerald Estrin, who worked together to build Israel's first mainframe computer, the Weizac. She said, "most of the people who grew up with me knew me as a people person and maybe a facilitator, but not necessarily a leader….I'm not sure that anybody would have guessed that I would have ended up being an entrepreneur. On the other hand," she countered, "I think that I perhaps was destined to be a technologist" because of her family environment, among other things.

Estrin, who has co-founded multiple startup companies and become an expert in organizational management, described her experiences at several companies over the years. She remembers writing her first business plan on a TRS-80 with cassette tape storage. At Zilog, she "learned that marketing matters." She had been quoted from those days as saying that "marketing is an unnecessary evil," but came to believe that "technology for technology's sake doesn't solve anybody's problems because it never gets to the customer." Estrin co-founded her first startup at age 26, her third startup was acquired by Cisco Systems, and she is presently CEO of Packet Design, her fourth startup company.

Photo by Robert Hull

Venture capitalist Yogen Dalal facilitated a conversation with Judy Estrin. The first time he met her, he was "struck by her incredible amount of energy...and adventuresome spirit."

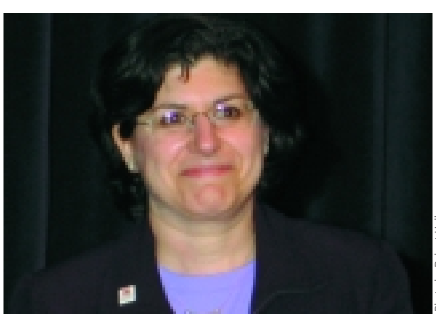


Photo by Robert Hull

Judy Estrin has been a role model for women in business, and always just "assumed" she would succeed in her efforts. She gives credit to her "rich beginnings" within a creative technology family.

Photo by Michael Baxter

Dan Bricklin (left) and Bob Frankston (right) created VisiCalc, the first electronic spreadsheet program.

THE ORIGINS AND IMPACT OF VISICALC

On April 8, Dan Bricklin, Bob Frankston, and Mitch Kapor along with Charles Simonyi discussed the invention of VisiCalc, the first electronic spreadsheet program. Bricklin and Frankston created VisiCalc and Kapor followed their innovation with Lotus 1-2-3.

Bricklin came to understand the need for changeable content and prototyping through observing his dad's printing business. In college, he daydreamed about a "magic, typeable blackboard that would do what I couldn't, which is, when I made a mistake…in my [spreadsheet] homework, I could erase one number and have [the blackboard] change all the numbers."

Frankston reminisced about programming much of the software, creating final code that was just 20KB, including operating system, screen buffer, and disk utilities. Simonyi pointed out that today's Microsoft Excel requires 8.7MB for the software alone.

Kapor admitted that when Frankston gave him the first demo of VisiCalc, he said, "huh?" Then added, "Fortunately that was not the last demo I got!" In creating Lotus 1-2-3, Kapor wanted to "design something that could just stand next to VisiCalc without embarrassment." Bricklin observed that in Lotus 1-2-3, Kapor kept "all the things [from VisiCalc] that ended up being the right things, as opposed to making it different for the sake of different, and then added new features" and changed things that were worth changing.

The lecture was co-hosted and held at Microsoft in Mountain View. Visit www.bricklin.com for a personal history of VisiCalc.

Photo by Michael Baxter

Mitch Kapor followed on VisiCalc with Lotus 1-2-3, wanting to do something that "took it to the next level."

CELEBRATING THE ETHERNET'S 30TH ANNIVERSARY

On May 22, the Museum and PARC co-hosted a special celebration of "Ethernet at 30." The event was sponsored by 3Com, Cisco, HP, and Intel, and held at PARC in Palo Alto, Calif. The first panel of speakers included inventor Bob Metcalfe and early Ethernet pioneers Gordon Bell, Judy Estrin, and David Liddle.

Metcalfe remembered that, in 1982, he thought with amazement, "there are people buying Ethernet whom I have *never* met." He remembers thinking just four years later that "there are people *inventing* Ethernet whom I have never met!" He went on to define several elements that made Ethernet successful, including packets, layering, distribution, the ether itself, and the Ethernet "business model," which consists of *de jure* standards, proprietary implementations, fierce competition moderated by a market committed to interoperability, and an evolution over time that preserves the same base technology. Estrin pointed out the commitment to being a "best" technology, instead of a deterministic one limited by the lowest common denominator. Liddle gave an interesting history of competing standards that enabled Ethernet, although barely at times, to continue to succeed. Bell, who was instrumental in developing corporate alliances, told stories of his advocacy for the technology.

Ann Winblad moderated the second panel discussion on the future of networking with industry thought-leaders Andy Bechtolsheim, Eric Benhamou, W. Eric Mentzer, and Stephen Squires. Bechtolsheim expressed his belief that the hardware and technology evolution

Bob Metcalfe celebrated the 30th anniversary of Ethernet on May 22. Other presenters included Gordon Bell, Judy Estrin, David Liddle, Andy Bechtolsheim, Eric Benhamou, W. Eric Mentzer, and Stephen Squires.

Cake to celebrate the anniversary of this long-lived and successful technology

will continue, but that "the challenge before us is in software, at the intersection of computing and connectivity." Benhamou reminded us that Aristotle defined ether as the substance that surrounded the earth. This vision of "pervasive connectivity will be ever more relevant as we head into the 21st century," he said. Squires characterized Ethernet as an "enduring and multidimensional invention" and envisioned the next 30 years supporting the successful implementation of nano-technology in every aspect of our lives. It "won't be just a little more of the same," he said, "but a leveraging" of current advances—molecular electronics, scalable modules, new abstractions and visualizations to hide the details, systems growth, and applications development—to create comprehensive change.

Mentzer reflected on the continuing "convergence of the digital and real worlds" and concluded the program with high praise for Ethernet, asking, "How many technologies do you know that are 30 years old that you still want to be working on?"

FIST LECTURE EVENT IN THE MUSEUM'S NEW BUILDING

On June 10, the Museum christened the Hahn Auditorium with its first panel event in the new building: "Jurassic Software: A Look Back at The Beginnings of Consumer Software." On the panel, Intuit co-founder Scott Cook; Broderbund Software co-founder Doug Carlston; and Electronic Arts and 3DO founder Trip Hawkins reminisced about the early days and recalled lessons learned in the founding of a new industry. Stewart Alsop, venture capitalist, former *P.C. Letter* publisher, and Demo and Agenda conference founder, moderated the lively discussion.

Attendee Bob Glass remarked, "It was exciting to hear the 'grand masters' talk about the anecdotes that formed the beginning of personal computing! It put a human touch to my knowledge of the evolution of consumer software."

John Wharton said, "What fascinated me at the Consumer Software panel was hearing the inventors themselves describe the context of their work—what they'd been doing when inspiration hit, how they fleshed out their basic concepts, and who helped them hone their ideas to create a successful product. You can't get stuff like that from books"

VOLUNTEERS AND THE MUSEUM: CAN'T HAVE ONE WITHOUT THE OTHER

The Computer History Museum's volunteers are the lifeblood of the organization! Behind-the-scenes volunteers contribute many hours of their time helping with a diverse array of projects. Some help plan new displays,

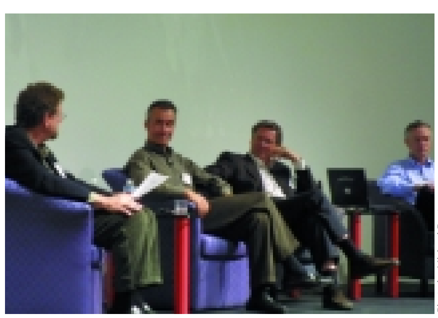


Photo by Michael Baxter

The Museum held its first lecture in the Hahn Auditorium on June 10, 2003. A panel on early software included Scott Cook, Doug Carlston, and Trip Hawkins, with moderator Stewart Alsop.

assist with the Web site, or arrange for future exhibits. Some help with administration at the Museum's office. Still others open the Museum to six public tours each week as well as many special tours and scheduled events. Since moving to the new Shoreline location and opening the Alpha Phase, more than 50 dedicated volunteers have been involved with the staff and their projects.

Also since our move to the new building, 20 new docents have enabled us to increase the number of tours from two to six per week. Tours are now available Wednesday, Friday, and Saturday afternoons. Thanks to Museum volunteers who have taken the training to become docents and greeters—they independently run public tours, welcome visitors, handle sales in our Museum store, and make the collection come alive.

The Volunteer Steering Committee, a representative group that meets with staff regularly, is the voice of the volunteers. The group is headed by Lee Courtney, who serves as chairman. Send requests for information or comments on the volunteer program to Lee Courtney or to Volunteer Program Manager Betsy Toole. For those interested in helping, please visit www.computerhistory.org/volunteer and click on "Become a Volunteer."

YOUR SUPPORT COUNTS

Our members and supporters are providing faithful and generous support for the Museum in spite of the challenges of the current economy. See the list of people on page 28 who are current members at the $100 and above level.

If you have been contemplating joining or lending your financial support to the Museum, we encourage you to "take the plunge!" Not only can you enjoy the benefits of being associated with this great institution, you can take pleasure in your support of important work to preserve and present key objects and stories of this amazing time in history. Please contact me if I can help you in any way. Thank you!!

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Please make your reservation by calling +1 650 810 1013 or emailing: tours@computerhistory.org.

VOLUNTEER OPPORTUNITIES

The Museum tries to match its needs with the skills and interests of its volunteers and relies on regular volunteer support for events and projects. In addition to special projects, monthly work parties generally occur on the 2nd Saturday of each month, including:

OCTOBER 11, NOVEMBER 8, DECEMBER 13

Please RSVP at least 48 hours in advance to Betsy Toole for work parties, and contact us if you are interested in lending a hand in other ways! For more information, visit our web page at www.computerhistory.org/volunteers.

MYSTERY ITEMS

FROM THE COLLECTION OF THE COMPUTER HISTORY MUSEUM

Explained from CORE 3.3

English Electric, DEUCE Mercury Delay Line Amplifier Circuit (1955), XD 4.75, Gift of Murray Allen.

This small section of the British DEUCE (Digital Electronic Universal Computing Engine) computer constructed at the English Electric Company is approximately 2 lbs. and 4 1/8" x 8" x 2 15/16" (HWD). This three-vacuum-tube module formed part of the machine's mercury delay line memory, which translated a digital pulse train into sound waves, sent these waves down a tube, then recirculated the waves back through the tube.

The English Electric Deuce was a general-purpose vacuum tube digital computer, with a serial organization and a 1 MHz clock rate. It was a re-engineered Pilot ACE (Automatic Computing Engine), a landmark machine conceived but unrealized by Alan Turing and developed by the UK National Physical Laboratory. The ACE can be seen today at the Science Museum, London. The DEUCE contained 1,450 vacuum tubes and was nearly twice the size of the ACE prototype.

The DEUCE's word length was 32 bits, and its arithmetic units were capable of performing single, double, and mixed precision binary integer arithmetic. The fast main memory was comprised of 12 mercury delay lines. Eight delay lines held executable instructions, and four delay lines comprised auxiliary storage. The magnetic recording drum (an example of which resides at the Computer History Museum) contained one block of 16 read heads and a separate block of 16 write heads. Each head provided access to a track of 32 words and both blocks could be moved independently to any of 16 positions.

The DEUCE used standard Hollerith (IBM) 80-column punched card machines. Reading and punching transferred one binary word per row of a card and conversion to and from decimal was performed by software.

The first machine was delivered in the spring of 1955. From late 1955 onwards, English Electric began selling the DEUCE 2, followed in 1957 by a DEUCE 2A; these featured, among other things, re-engineered input/output systems. The company sold about 31 DEUCE 1 and 2 machines between 1955 and 1964, priced at around 50,000 UK Pounds in 1958.

WHAT IS THIS?

THIS ITEM WILL BE EXPLAINED IN THE NEXT ISSUE OF CORE.

Please send your best guess to mystery@computerhistory.org before 12/15/03 along with your name, and shipping address. The first three correct entries will each receive a free travel mug with the Museum's logo.

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