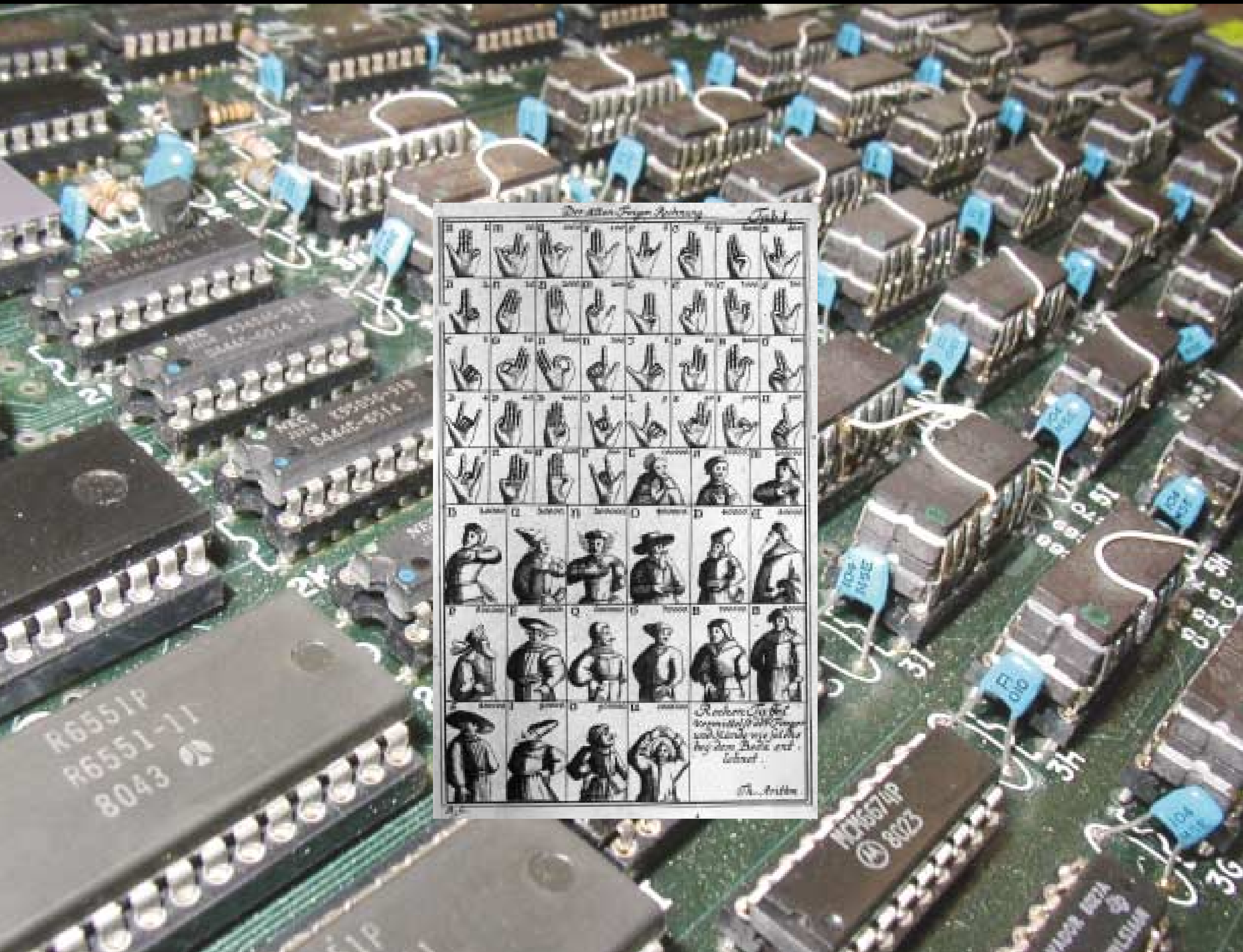
NOVEMBER 2002

CORE 3.3

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



WE HAVE PURCHASED A GREAT BUILDING!

The year 2002 will forever be very special for the Computer History Museum. I am proud to announce that we have acquired a spectacular 119,000 square-foot building on 7.5 acres of land at 1401 N. Shoreline Blvd. in Mountain View, California. With this purchase, we are taking a major step toward realizing our dreams of having a permanent home, owning our own land, directing our future, focusing on programs, and building new relationships with the communities we serve.

The transformation won't happen overnight because we will open this new space in several phases. We plan to move our staff into the building by the end of the year and unveil the first phase of our public presence on Shoreline Blvd. in May 2003 after a few renovations are completed. Read more about our exhibit planning process in Kirsten Tashev's article on page two.

It is awesome to see how we have grown, wrestled with major decisions, and emerged even stronger in commitment, passion, and action—all in the past year or so. In that time, our strategies have definitely changed, but the goal remains the same: to build a major institution that preserves and presents the artifacts and stories of the information age. I'm convinced more than ever that we are setting the course for an innovative future—our mission is unique and focused, and we have one of the best collections of computing artifacts in the world.

We owe much to the people at NASA for their support and help in our own recent history. We will continue to use buildings 126 and 45 at Moffett Field for critical storage for as long as possible. We intend to foster great relationships with partners in the NASA Research Park over time; after all, our building on Shoreline is just one freeway exit north of our current offices! We are neighbors in Mountain View now, with federal and local governments connected to a community of "can-do" people.

We are watchful in this economic climate and mindful of our duty to faithfully fulfill our responsibilities to our supporters. For the important cause we represent, I'm proud to ask you to please consider an increased or new contribution to our annual fund, a donation to our capital campaign, and to help spread the news about the Museum to others. Look carefully at this issue of *CORE* to see what we have accomplished, and remember that you are always a welcome part of our institution.

With the excitement of the new building, don't overlook the simultaneous extensive growth in our public programs, which include world-class lectures that contribute to our historical archive, oral histories, participation in special events to collect computing histories (such as an IBM Stretch reunion, DECWORLD 2001, and upcoming Apple retrospective and database panel events), and numerous exhibitions that bring artifacts and history alive.

It is motivating to meet people everywhere who share our dreams, including early supporters of the Computer History Museum. Although some of you are geographically distant from California, people everywhere want to be part of the Museum. With this encouragement, we are increasingly offering special events and programs targeted to the needs of our "remote" community. It was a pleasure, for example, to be at the Museum of Science in Boston this fall to celebrate the opening of the "Computing Revolution" exhibit, which features many of our artifacts. I hope those on the East Coast will visit that exhibit and experience something of the Computer History Museum 3,000 miles away from California.

Lastly, I want to thank everyone involved for their personal sacrifices, the long hours, and the spectacular execution this summer and fall in acquiring the new building. The passion, persistence, and generosity of our Trustees, staff, volunteers, and supporters has enabled our bold move—I could tell story after story of how each person really made a difference.

It's a wonderful but awesome responsibility to preserve a heritage. I'm proud to report that we have been taking some giant steps forward. Help us continue to grow—the best is yet to come!

JOHN C TOOLE
EXECUTIVE DIRECTOR & CEO

November 2002
A publication of the Computer History Museum
CORE 3.3

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

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

PUBLICATION STAFF

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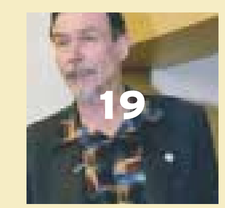
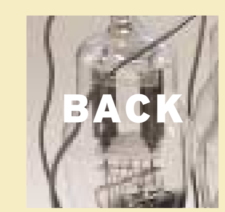
IN THIS ISSUE





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Cover: Humans have relied on calculation for over 2,000 years. Foreground: an early method known since Roman times of storing numbers on the fingers—first described by The Venerable Bede—and here shown in a woodcut from Jacob Leopold's 1727 *Theatrum Arithmetico-Geometricum*. Background: typical Integrated Circuit Dynamic Random Access Memory (DRAM) circuit board used in modern-day digital computers. Photo: Dag Spicer.

EXHIBITING
COMPUTING HISTORY

BY KIRSTEN TASHEV

INTRODUCTION
Currently the Museum is working on the Schematic Designs—the rough layout and look of the exhibitions—for our permanent home. This process is now underway for our Timeline exhibit, which will cover approximately 15,000 square feet (s.f.) and focus on the milestones of computing history. We are finding that while it is easy to select artifacts for the Timeline, it is very hard to determine what to leave out, a problem commonly faced by museums. We struggle to tell the story of computer history even in 15,000 s.f. Fortunately, we are also exploring ways to complement the exhibits with online exhibitions so that the World Wide Web becomes one of our "natural resources" as we build our permanent home.

Another challenge we face is that the story we are trying to tell is unique. There are relatively few computer history museums—let alone computer exhibits—in the world. On the one hand, this gives us a lot of freedom; on the other hand, we have few opportunities to learn from the successes and failures of others. We also face the expectations of our future visitors who have their own views on what a computer history museum should be. As Ed Rodley (see page 6) discovered in his audience research for the MOS exhibit, ironically, many visitors expect a computer history exhibit to be about new stuff. The word "computer," being synonymous in our modern culture with "cutting-edge," seems to neutralize the other word in the sentence, namely "history." Even in working with museum designers and other outside consultants, we've found that people imagine a "tech" museum featuring exhibits full of the latest gadgets. In many ways, our Museum is "the history of the latest gadget," beginning, however, with the abacus! Our challenge is to harness this fascination for the "next new thing" and to find ways to motivate our visitors to appreciate the achievements of the past as the gadgets of *their* day.

MUSEUM STEPS
We are developing the curatorial outline for the Museum's future Timeline exhibit. The Timeline will be divided into four eras, starting with pre-computing and ending with the Internet. For each era, we have developed key messages that we want to convey and corresponding lists of potential artifacts, images, diagrams, audio-visuals, and computer "interactives" that can help to communicate the key messages. One of the challenges that we found in developing the Timeline is an inherent tension between showing advances chronologically versus grouping them according to genre or type. For example, a chronological layout allows visitors to see developments occurring around the same time in various fields of computing and their impact on each other, while a thematic-based layout allows the visitor to see developments in a specific area, such as memory or software, in a linear and comparative way.

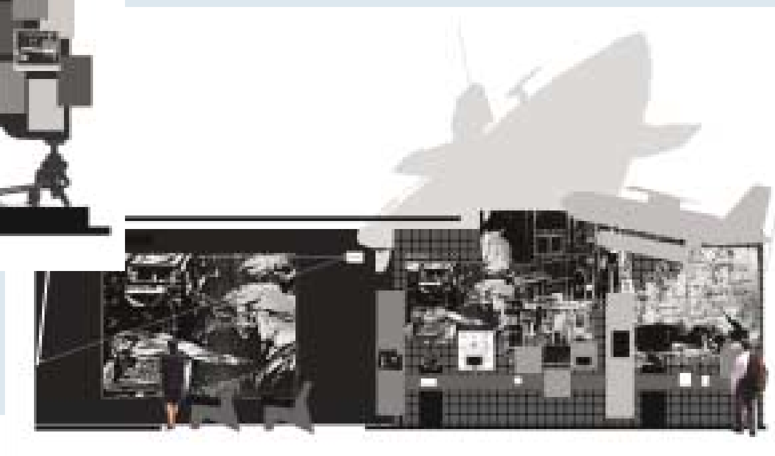
In developing the exhibit in our prescribed 15,000 s.f., we constantly have to ask ourselves whether an artifact or story is a "headline" and thus deserving of a place on the Timeline. In other words, is an achievement *revolutionary* or *evolutionary*? Fortunately, the new Museum will have five Theme Rooms (1,000 to 1,500 s.f. each), which will allow us to explore specific topics in more detail and show developments in sub-fields of computing side by side.

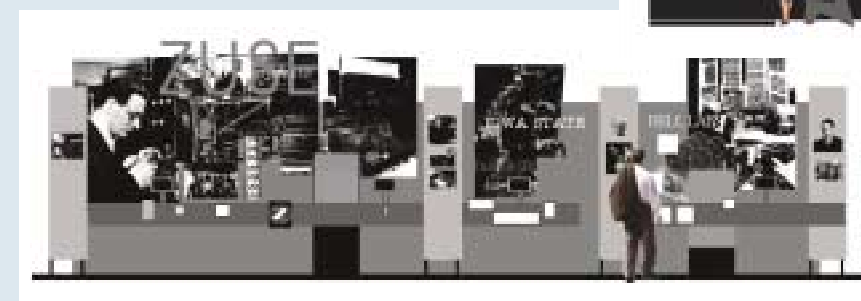
Schematic Design is not just about content, but also about design; we begin to think about how the exhibits will look. The Museum is working with exhibit designers Van Sickle & Rolleri, Ltd. (VSR) to develop conceptual exhibit floorplans and elevations. From our curatorial outlines, VSR begins creating "elevations," or wall views, of each exhibit area. (See elevations on next page.) They also create conceptual floor plans to determine adjacencies of exhibit areas and potential traffic flow. When we saw VSR's visual interpretation of our curatorial outlines for the first time, we were surprised by the sheer scale required to accommodate text, photos, and audio-visuals in creating an exhibition rich in content. It looked nothing like our current Visible Storage Exhibit Area, with one machine lined up next to another. The transformative power of context on an artifact is truly amazing.

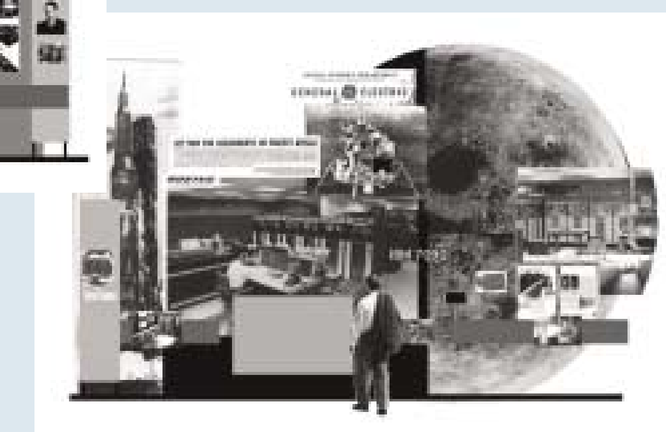
Our next steps are to develop Schematic Designs for the rest of our exhibits, including the Theme Rooms. Then we will begin the Design Development phase, in which each discrete exhibit component is selected and when draft text, photo research, and audio-visual design begin. In this phase, we will more fully flesh out how we will capture different points of view and incorporate multiple layers of content for our diverse audiences.

We still have a lot of work to do to open the new Museum, and many issues to resolve. Some of the challenges that we face in developing the exhibits range from the practical—such as whether the Cray-1 is too heavy for a second floor—to the conceptual, including who our audience is and finding the right balance between technical content, people stories, and societal impacts. I would like to share with you some of our thoughts about these issues.

MEMORY VS. HISTORY
Museums that seek to display contemporary history have a unique challenge: they are about both history and living memory. History is a discipline in which we try to take a distant and critical view of the past, while memory is personal and involves







The Museum is working with exhibit designers to determine how our exhibits will look and how best to use photographs and other supporting materials to communicate key messages. Shown here are several "elevations" from our future Timeline exhibit.

individual connections with the past. The Computer History Museum, which centers around a relatively contemporary topic, is faced with the challenge of balancing memory and history. While exhibits indeed serve a function of commemoration, the Museum must be careful to consider the bias of its sources and obtain information from a variety of places. Exhibits must balance the need for critical distance and objectivity with the evocative power of personal stories. For example, telling the story of the first personal computer inevitably brings together people who reminisce about the Altair 8800 (1975), while the historical record shows that several others preceded it, such as the Kenbak-1 (1971), the Micral (1973), and even the lesser known 008A Microcomputer Kit by RGS Electronics (1974). As English historian Eric Hobsbawm wrote, "Historians are the professional remembrancers of what their fellow citizens wish to forget."

Our curatorial team is conducting research by speaking to both the pioneers of computing history and to the many professionals who contributed to the development of the industry. First-hand knowledge is balanced with information from primary source materials, the input of our historian advisors, and the views of subject-matter experts. We are exploring ways to create exhibits that will capture multiple points of view and we also want visitors to share their stories on the exhibit floor through both low- and high-tech tools.

CONTENT VS. ENTERTAINMENT
Museums have undergone a major transformation over the last 50 years. The days of the "cabinets of curiosities" or the phylogenetic displays of the traditional natural history museums are a thing of the past. In the 1960s and 1970s, museums underwent a renaissance, primarily influenced by developments in the fields of communication, education, sociology, and psychology that had fundamentally re-shaped our understanding of how people learn. These findings forced museums to rethink how they exhibited items. Concurrently, museums faced reduced government funding and therefore had to attract more visitors and increase gate receipts in order to supplement their income. This new focus on attendance pushed museums to be more visitor-focused and to provide more intellectually-accessible exhibits. In order to attract visitors, exhibits had to be not only academically correct but also interesting and even

To understand how much space will be required for an exhibition and determine the best adjacencies of exhibit areas, exhibit designers create space study models such as the one shown here.

entertaining. A new type of museum emerged, namely the science center, which took a hands-on approach to learning. Many world-class science centers were developed, including the groundbreaking Exploratorium in San Francisco, California.

As government funding decreased again in the 1980s, the need to maximize gate receipts increased and the era of the blockbuster exhibit emerged, with a clear emphasis on entertainment over content—or "edutainment," as it was called. More recently, however, the pendulum has swung somewhat in a reaction to "dumbed-down" exhibits. Museums now realize that they can not hope to compete with theme parks and that they shouldn't try. Instead, their unique products are content and access to the real thing. Furthermore, as museums build endowments and use special events to help cover operating costs, they are able to enjoy more freedom and can develop unique, content-rich programs.

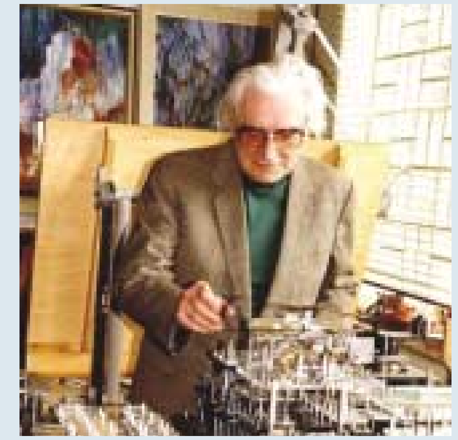
The Computer History Museum will most certainly focus on content, and our goal is to make our exhibits intellectually accessible to both people who have significant knowledge of computers as well as those who do not. The primary target audience of the Museum is adults and the content will be geared for high school age and above. In order to address this diverse audience, we are working on exhibits that tell stories about technological achievement as well as people. For example, in telling the story of Konrad Zuse, you can focus on the fact that in 1941 he began building a machine called the Z3 in 1941, widely considered the first fully functional, program-controlled electromechanical digital computer in the world. You can also mention the fact that it was controlled by punched paper tape and that it could calculate with floating point numbers years before any other machine. On the other hand, there is a great personal story to be told. Konrad Zuse, born in Berlin in 1910, was a young man uncertain about whether to be an engineer or an artist. Choosing engineering, he soon grew tired of the tedious manual calculations required to do his work at Henschel Aviation Company. Zuse quit his job and began experimenting with some early prototypes in his parents' living room. His work was cut short during the war since Berlin was under constant Allied bombardment. Zuse and his pregnant wife, Gisela, fled the city and his Z4 was transported to the countryside under cover of night. Desperate to resume work on the Z4, he survived the difficult years after the war by making woodcuts and selling them. Eventually, Zuse went on to found the first computer company in Germany, Zuse KG, and built 250 computers. He continued to paint throughout his life.

Given that we are working with contemporary history, we are fortunate to have a rich collection of film footage of pioneers telling their stories as well as the opportunity to collect oral histories from the innovators of the recent past and today. Exhibits can provide visitors with the unique opportunity to view this rich archival footage in the context of the artifacts and other supporting documentation. Of course, this is not to say that we won't have the specifications of every machine. We know that our "other" audience—the most astute, detail-oriented, skilled, and knowledgeable "geeks"—will be very disappointed if we don't tell them what the Z4 could do. We are exploring ways to communicate multiple perspectives, including technical data. We have talked about everything from flip panels that reveal a machine's specs to handheld devices that allow the visitor to get the hardware perspective, the software view, and so on. We also recognize that it will be impossible to appreciate the importance of an artifact or story without some understanding of the technological breakthroughs it represents, and for that reason we will provide clear explanations on the fundamentals of how something works for our non-technical visitors where necessary.

HANDS-ON VS. MINDS-ON

"I hear and I forget. I see and I remember. I do and I understand."
– Confucius

While most people associate hands-on exhibits with science centers and children's museums, interactivity also has its place in the history museum. The process of developing exhibitions has been influenced greatly by the work of Dr. Howard Gardner at the Harvard School of Education over the past 30 years. Prior to Gardner's groundbreaking findings, educators had focused on developmental learning stages, where children share similar abilities according to their age group. What Gardner found was that while children did go through developmental stages, they also had different learning styles. These individual learning styles continue into adulthood, making his discoveries applicable to exhibit planning. Gardner outlined several fundamentally different learning styles, including:



Konrad Zuse in his workshop (1986).

1) Narrational: people who learn best by hearing a story or a narrative when presented with a concept;
2) Logical-Quantitative: people who approach a concept by using numerical or deductive reasoning processes;
3) Foundational: people who examine a concept from a philosophical point of view;
4) Esthetic: people who respond to sensory stimuli, and learn through images, sounds, etc.; and
5) Experiential: people who learn best with a hands-on approach, dealing directly with the materials that convey the concept.

Fortunately, museums are ideal settings for people to acquire new information using various learning styles. Exhibits can be rich with text, data, sensory stimuli, and hands-on experiences. Although our audience is primarily adults who tend to be "minds-on," many of them will be attracted to experiential hands-on activities as well. I can't count how many times I have been asked by members and visitors, "will the machines be operational and will visitors be able to play with them?" Of course, for reasons of preservation, it is not possible to allow visitors to "play" with the machines, and it is very expensive to keep them operational. However, we are thinking about software simulation, hands-on models of machines, and, not to fear, select machines restored and operational for visitors to enjoy with the help of a trained docent. For example, the recently-restored IBM 1620 might be fired up once a week. Exhibit cabinetry might have special discovery drawers that hold demonstration pieces for docents to use to explain a concept or to simply allow visitors to feel how light a silicon wafer is.

CYBER VS. ACTUAL REALITY

"Cannot find REALITY.SYS...Universe Halted." –Anonymous

In developing the Museum's physical exhibits, we are exploring how they will interact and complement the CyberMuseum. Many museums have Web sites, some have cyber exhibits, and even fewer have cyber archives that allow direct access to collection information over the Web. We are striving to develop our physical and CyberMuseum concurrently so that each can inform the other. We see the CyberMuseum as the digital hub of the Museum's exhibit halls, where many of the learning experiences will take place either on the exhibit floor at the Museum or in the homes of our virtual visitors. The CyberMuseum will also allow us to exhibit much more content than we could display in the context of a physical exhibition. We are also thinking about creating study areas within the galleries so that visitors can delve more deeply or, more likely, settle a dispute!

Ask your friends what they expect to see in a computer history museum; you might be surprised by what they say. And next time you are in the Visible Storage Exhibit Area, picture the artifacts in content-rich exhibitions and, if you can, try to see if you can decide what artifact to leave out. It's not easy! ■

Kirsten Tashev is Building and Exhibits Project Manager at the Computer History Museum

SUMMARY OF EXHIBIT TECHNIQUES

1. Artifact displays with some "touchability" through a "study collection" (artifacts with multiple copies in the collection) and hands-on explanatory models
2. Docent-led tours that are enhanced by live demonstrations of running machines or hands-on viewing of the "study collection" materials
3. Graphic and text enrichment of displays using diagrams, specs, photos, vintage advertisements, excerpts from technical documents, and visual/numerical metrics for comparisons
4. Recreated environments that achieve a sense of "being there," e.g. an 1890s punch-card office or a 1950s mainframe installation
5. Audio-video stations or mini-theaters that highlight people stories or promotional films from the period
6. Computer interactives that explain concepts, simulate software, or offer access to the Museum's rich cyber archive
7. Hand-held devices that allow visitors to drill down into information with increasing granularity

SUMMARY OF ORGANIZATIONAL EXHIBIT LAYOUT

1. Timeline Exhibit: major headlines in computing history, multi-layered with a rich variety of both people stories and technological achievements
2. Theme areas: chronological focus on developments within key areas of computing history: networking, I/O, software, storage, and processors
3. Topical exhibits: changing exhibits on special topics such as privacy and computers, AI, robotics, computer advertising, computers and medicine, games, etc.
4. Visible storage: access to sections of the Museum's rich collection of artifacts in a densely-displayed area with minimal interpretation (including artifact labels, hand-held audio guides, or docent led tours)

BRINGING COMPUTING HISTORY TO THE PUBLIC

BY ED RODLEY MUSEUM OF SCIENCE, BOSTON, MASSACHUSETTS

Editor's Note: As the Computer History Museum plans and designs its future exhibits, we will share many "inside looks" into our progress, including the update on page two by Building and Exhibits Program Manager Kirsten Tashev. Meanwhile, we have many important collaborations with peer institutions that both educate and highlight the artifacts and stories of the information age. See page 25 for a list of current exhibits that feature Museum artifacts.

One important collaboration is with the Museum of Science (MOS) in Boston, Massachusetts. Over the past year, Museum staff have worked closely with Ed Rodley, an exhibit planner at MOS, in creating an exhibit called "The Computing Revolution," which opened this fall. We have provided artifacts, video footage, and research to support the design process (see sidebar on page ten). This collaboration highlights the shared history between the Museum and MOS and is a mutual opportunity to exhibit important computing history information. Read the details on the Museum's history in *CORE* 1.2 at www.computerhistory.org/core.

In his article, Rodley describes the "behind the scenes" process of exhibit creation, particularly where computing history is being presented at a hands-on science museum. Two machines will be discussed in detail: the MIT Whirlwind, which belongs and will return to the Museum's collection, and a model of Schickard's *Rechenmaschine*, created by master fabricators at MOS.

INTRODUCTION

The opening of "The Computing Revolution," a new exhibit at MOS on computing history, highlights the 1999 merger of The Computer Museum in Boston and the Museum of Science. This exhibition, developed in consultation with the Computer History Museum, will be the first of many anticipated collaborations.

What does a computing history exhibit at a science museum look like? "The Computing Revolution" is not the typical kind of exhibition done at MOS. For the past decade, the museum has focused on developing interactive exhibitions that help visitors develop science thinking skills. Creating a small, artifact-based historical exhibition has been a real change of pace and quite a challenge.

When The Computer Museum in Boston originally opened its "People and Computers" exhibit, it used almost 6,000 square feet (s.f.) to tell the story of computing history. Our gallery for this exhibit is a bit over 1,200 s.f., so clearly it would be impossible to do an encyclopedic exhibition. We chose instead to display even fewer objects than possible but to interpret those objects in greater depth.

Our exhibit follows a chronological order, starting with the development of mechanical calculators and following computing up to the present. The exhibit will have six theme areas, corresponding not to decades, but to eras, based on society's perceptions of computers. The eras are: Computer Pre-History, World War II, Big Machines, Personal Computers, The Internet, and the 21st Century.

Rather than create a typical museum display of objects with small descriptive labels of 50 words each, we selected a dozen "highlight" objects to stand in for entire generations of computers. These items provide focus for conveying layers of historical, social, and technological information. The circumstances that gave birth to the machines will be explored and the items compared to a personal computer of about the year 2000, in terms of power consumption, physical size, memory, processing speed, etc. Since the machines are non-functional, we will bring them to life using media-rich experiences. Visitors will be able to explore how they worked; listen to inventors and users; and take in the sights and sounds of the era, from newsreels to TV ads. This inevitably excludes a tremendous amount of information, but it allows us to do justice to a few objects, and to tell some good stories.

EVALUATION (OR PLANNING FOR SURPRISES)

The longest part of the exhibit development process here at MOS is the formative evaluation phase. Since exhibitions, especially interactive ones, are so expensive to design, we spend as much time as possible testing concepts in prototype, creating a rough approximation that does what we want it to do. Once we've determined that the basic concept works, we'll build a slightly more polished version and test that. This process continues until we are confident that the exhibit will be successful.

For this project, I wanted to know what attitudes visitors would have about a computer history exhibit at the museum. We administered a very brief survey that probed their level of knowledge and interest in computers. It became clear that the artifact exhibit I had envisioned would need some rethinking. When we asked visitors, "What would you *expect* to see in an exhibit called 'The Computing Revolution?'" over half indicated historical objects. In second place, however, came "new stuff." When we asked the similar question, "What would you *like* to see in such an exhibit?" the results were enlightening. Almost half the visitors said they'd like to see "new stuff" and another quarter wanted to know how computers worked. History, even though the visitors knew it was a history exhibit, came in a distant third.

Whirlwind control room, 1954, from the film *Making Electrons Count*. Courtesy of MIT Museum.

Based on this feedback, we tried to identify ways to make the exhibit more appealing to the museum's traditional visitors who are accustomed to interactive exhibits. I decided to add a number of exhibits that had nothing to do with the chronology of computing. These would address some basic aspects of computing—like how a hard drive works, what's inside a mouse, and what "hacking" means—and would be placed throughout the gallery, so that each section would appeal to many people.

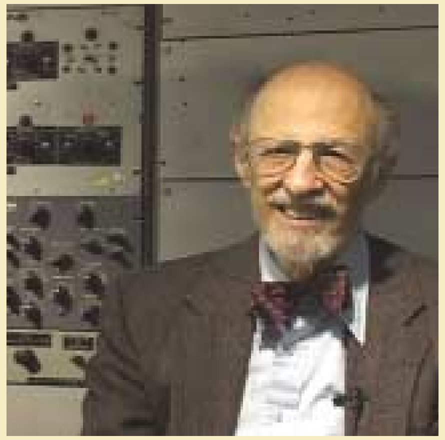
We brainstormed a number of possible interactive ideas and went back out onto the exhibit halls to talk to visitors with our top dozen ideas. We asked them to rate their interest in each idea on a simple four-point scale and to tell us their age and gender. We collected 101 surveys and sat down to the much longer process of interpreting the results.

There were some interesting differences between groups. Women tended to like components that explained how computers worked. Hacking seemed to interest adults in the 19–34 age range. Overall, the most popular exhibit ideas were on WWII code machines, when computers go wrong, and hacking. We liked all these components ourselves, so it was good to get confirmation that the ideas were appealing. The least popular ideas were mechanical calculators and the binary number system. Both of these were important to us, so we knew we had our work cut out for us.

Most troubling was finding that the least popular ideas were all slated for the very beginning of the exhibit. So, we dropped a couple of these ideas and altered the layout to make the initial experience more dynamic and hopefully tempt visitors into the gallery. We moved the 21st Century into the entry opposite Prehistory and moved The Whirlwind so it could be seen as soon as one walked through the door.

WHIRLWIND

A good example of our approach to artifact interpretation is the Whirlwind computer. It is difficult to imagine a more exciting piece of computing history. The first electronic digital



Courtesy of the Museum of Science.

Whirlwind alumnus and ACM Turing Award winner Fernando Corbató went on to pioneer timesharing at MIT with CTSS and later Multics.

computer built at MIT, Whirlwind was a pioneer first-generation computer. It was also the prototype for the United States' first air defense system, known as SAGE. The Whirlwind team, led by Jay Forrester and Bob Everett, invented magnetic core memory to replace the notoriously unreliable electrostatic memory systems then in use. By doing so, they created the dominant form of computer memory for the next 25 years. Throughout the 1950s, Whirlwind was the machine on which a generation of MIT scientists and engineers learned computing and developed a style of human-computer interaction very different from that being promoted by commercial computer manufacturers such as IBM, Remington Rand, and others. Computer hacking (in the non-pejorative sense still used at MIT) started with Whirlwind.

Whirlwind originally occupied an entire floor of the Barta Building (N42) at MIT. The Computer History Museum owns the bulk of the surviving pieces of Whirlwind. For this exhibit, MOS is displaying six racks from the Whirlwind control room, along with one of its core memory stacks and a "Flexowriter," a typewriter-like device used to communicate with the great machine. Thus, we have a non-functional fragment of a machine that doesn't even resemble a computer to a large percentage of our visitors. Our challenge from the outset was, therefore, how to convey that importance and excitement

MITRE Corporation Archives.

Whirlwind was the first real-time, parallel-processing computer with core memory. At left are the marginal checking and toggle-switch test control panels. From left to right: Stephen H. Dodd, Jay W. Forrester, Robert R. Everett, and Ramona Ferenz, 1951.

MITRE Corporation Archives.

The internal workings of Whirlwind. Here, the machine's size dwarfs three technicians (John A. O'Brien, Charles L. Corderman, and Norman H. Daggert) working on the Electrostatic Storage Rack. At left, Jay Forrester and Norman H. Taylor inspect the Arithmetic Element Rack, 1952.

to a lay audience. The most straightforward way to do that was to have Whirlwind users tell their stories. We interviewed a number of Whirlwind alumni, many of whom are still active in computing. Their first-hand accounts of using Whirlwind provided not only technical insights, but also personal views of the project and its people. We will supply the larger context through the use of contemporary film and television footage.

We also decided to add a simple interactive display of the basic concept behind magnetic core memory. Early on, we discussed the merit of spending time (and money) developing interactive material on an obsolete technology. In the end, though, we agreed to make a simple core memory array that visitors could operate. The reasons were two-fold: first, I felt it would be very difficult to interpret the artifact unless visitors could see what it did; and second, core memory was also the last storage

Courtesy of the Museum of Science.

Magnetic core memory, first exhibit prototype at the Museum of Science.

Courtesy of the Museum of Science.

First prototype Schickard *Rechenmaschine* in the workshop at the Museum of Science.

technology in which it was possible to detect what was going on without the aid of complicated sensors. Our test array of eight cores has compasses sitting next to each core. When a core is magnetized, you can see the compass needle move and read the array to determine the value (a "0" or a "1") of each core.

The prototype had several shortcomings that became apparent during testing. Hard ferrite cores aren't easy to come by anymore, so we made do with dirty steel, which required quite a bit of current. When a core was magnetized, the compass needle would gyrate wildly for several seconds before settling down. The cores would stay magnetized for some time, so if the visitor didn't clear the array before writing a number to it, he or she might get an unexpected answer. This "non-volatility" was the major selling feature of core memory, but it proved to be a problem for us. Some of the Whirlwind programmers we interviewed mentioned having had the same problem when core memory was first installed in Whirlwind. The final version of the exhibit will have a better ferrite material for the cores and compasses that are a bit more stable.

SCHICKARD'S RECHENMASCHINE OF 1623

To provide a sense of the deep history of computing and to counter the notion that the only kind of computer is what we see on our desks, we have built a reconstruction of the world's first mechanical calculator, invented in 1623 by a German scientist named Wilhelm Schickard (1592-1635). His *Rechenmaschine* (calculating or "reckoning" machine) combined a version of Napier's bones with two discrete gear mechanisms that allowed the user to perform basic arithmetic operations on numbers up to six digits long. Only two examples of Schickard's machine were ever built during his lifetime, and after his death all knowledge of it was seemingly lost. Records of the machine resurfaced in the 1930s among the papers of the astronomer Johannes Kepler, a friend of Schickard's. These notes were again lost during World War II, only to reappear again in the 1950s.

They came to the attention of Baron Bruno von Freytag Löringhoff, an historian from Schickard's hometown of Tübingen, Germany. Using Schickard's notes and sketches, the Baron spent years piecing together how the machine worked and eventually built a working model. From the 1970s on, he commissioned numerous copies that can now be found throughout Germany. I had been looking for a mechanical calculator to include in the exhibition, so pursuing the *Rechenmaschine* seemed like an easy decision. There must be plans with modern measurements, albeit in German, and it should just be a matter of getting a copy of the plans and building our own. Or so it seemed.

After a year of e-mails and phone calls, I had learned a great deal about Schickard and the circle of scholars studying him, but had nothing concrete on the *Rechenmaschine*. The Baron had died some years ago and there were no plans among his papers. I finally located the company that had built the Baron's reconstructions in the 1970s, only to find that they had destroyed all their plans after his death. But then another hope appeared. A high school in Bautzen, Germany had built a

Rechenmaschine, based on one of the Baron's copies. After several e-mails and more weeks, a reply. They had built a machine and had plans they would let us use. They would even machine the gears if we wanted!

More months passed until we received blueprints for the cabinet of the machine. We looked for the plans for the gear mechanisms, but to no avail. More months, and more e-mails passed as we tried to ascertain whether plans for the gears existed. In the meantime, we built a cabinet and rotating drum assembly so that we could at least test that much of the machine with the public.

Once you learn how to use the machine, you can do multiplications on it faster than you can on paper, but we weren't at all confident that we could get visitors to successfully use the machine. However, after only three days of user testing, it became clear that the machine was very popular. This may have something to do with its appearance. It is the only wooden object in a room full of metal and plastic. Or it may have been labeling the item as "a calculator from 1623." What was clear was that adults and children would spend several minutes calculating with the machine. Completing the machine took on a new urgency.

Finally, out of the blue, an extremely heavy package arrived from Germany. It was full of gears… and nothing else—no plans, no assembly instructions. One of our technical designers sat down with the pile and some photographs of the mechanism and managed to put all the pieces together.

AN EXHIBIT READY FOR VISITORS

Over the summer, we entered the main production phase of the exhibition. By the opening in September, we had prepared the gallery, finalized designs for components, evaluated our remaining prototypes, and installed the artifacts. If you happen to be in Boston this fall, I encourage you to see how it all turned out. ■

Ed Rodley is an Exhibit Planner at the Museum of Science, Boston. In his 15 years there, he has developed exhibitions on topics ranging from the Soviet space program to Leonardo da Vinci. His current research interests involve using handheld computers in a museum setting.

ITEMS ON LOAN TO MOS BY FOR "THE COMPUTING REVOLUTION" EXHIBIT

- Anderson-Jacobson acoustically-coupled modem
- Apollo Guidance Computer logic module
- Apollo memory stack module
- Apple II, Drive II
- Apple Macintosh CPU, keyboard, and mouse
- Assorted punch cards (077 plugboard, 96 col S/3)
- Bell Telephone Labs transistor
- Control Data Corporation memory disk
- Data General core planes (2)
- Digital Equipment Corporation core plane PCB
- Digital Equipment Corporation PDP-8e from the Massachusetts General brain surgery station
- Early IBM brochure
- First black-and-white TV used with an Apple on the East Coast
- Friden Flexowriter
- Hollerith Census Machine model
- Hollerith Electric Tabulation System Pantograph (reproduction)
- Hollerith punch card
- IBM "THINK" sign
- IBM Model 016 keypunch
- IBM PC CPU, keyboard, and monitor
- Internet Worm Source Code
- Marchant adding machine
- MITS Altair 8800
- MITS Altair BASIC source tape
- MS-6502 BASIC, data cassettes (22)
- Paper tapes
- Remington-Rand 1958 UNIVAC brochure
- SpaceWar! source tape
- SWAC Williams tube
- UNIVAC I supervisory control console
- UNIVAC instructional manual
- UNIVAC products St. Paul (1959)
- UNIVAC system routines (1958)
- UNIVAC Uniservo
- UNIVAC Unityper
- US Army firing tables gun, 155-MM, M1 and M1A1 firing shell, H.E., M101
- USAF SAGE background material, photos, press kit, and red book
- USAF SAGE exhibit background references
- USAF SAGE lightgun
- Visicalc for Apple V1.0 (1979)
- Whirlwind core memory stack A 69
- Whirlwind filament transformer panel including table
- Whirlwind indicator panel (s/n 18)
- Whirlwind indicator panel (s/n 78)
- Whirlwind operations matrix driver mating panel #1
- Whirlwind operations matrix driver mating panel #3
- Xerox PARC Ethernet transceiver

BY MICHAEL R WILLIAMS

A PERSONAL PERSPECTIVE ON KONRAD ZUSE

I am privileged to have met many of the great pioneers in computing. Some of them were aloof, some unpleasant, some remarkably friendly, but all were interesting. Of course, many of the earliest pioneers (Schickard, Pascal, Leibniz, etc.) didn't live during my lifespan, and I couldn't meet others such as Russian pioneer Sergey Lebedev due to political considerations. It is possible to research these people's lives, but still, nothing matches the chance to meet someone in person.

Artifacts tell the story of the development of computing, but it is the people behind these devices that I find most fascinating, and among them, I have a great fondness for Konrad Zuse. I first met Konrad in the late 1970s and was immediately struck by his friendly, open ways. We had supper together one night and I spent additional time with him over a one-week period.

He is best known for his early creation of automatic mechanical and relay-based calculating machines: the Z1 through the Z4 and several special-purpose machines that were used on the assembly line of the Henschel Aircraft factory where he worked. He was also instrumental in devising the first high-level language, the Plankalkül, for describing the actions of a computer program. These technical achievements are noteworthy, but he also had other accomplishments that shaped his life.

Zuse was a painter of note. He gave up early ambitions of becoming an architect to pursue aircraft engineering. His interest in cityscapes is clearly evident in his paintings, many of which have abstract futuristic city themes (see photo on this page and on page five).

While at the university, he and a group of friends put on a weekly cabaret. Like many such performances in pre-war (WWII) Berlin, they were satirical and

Konrad Zuse's workshop was filled with paintings made by the pioneer himself.

drew large crowds. One in particular aimed directly at political figures of the day; Hitler's police raided the theater and shut them down, while more severe sanctions were taken against several Jewish performers. This impacted Zuse deeply and although, like many Germans, he worked in the war effort and was intensely proud of his German roots, he remained distrustful of political parties and their leaders for the rest of his life. I well remember that when asked publicly how his machines had contributed to the Holocaust, he was particularly incensed. He quietly explained that such an inquiry only showed a lack of knowledge about his life and views; and, he remained visibly upset for the rest of the day.

In the last days of the war, with Russian troops on the outskirts of Berlin, Zuse and Werner von Braun, the famous rocket scientist, spirited the unfinished Z4 into a farmhouse basement for safekeeping. Later, proud of their accomplishments and hoping to continue their work, the men willingly surrendered to American troops and explained what they had been doing during the war. Of course, the rocket expert was immediately shown off to the press, while Zuse was almost completely ignored. A man from Hollerith, the British tabulating machine company, interrogated him. Although the representative didn't seem to either appreciate or understand the concepts behind Zuse's automatic computing machines, probably only a handful of people in the world at the time could have. He was released to go back to his family.

The next time you tune into a documentary about the end of the war, watch von Braun's surrender closely. Emerging from a DC3, he appears to be raising his arm in a Nazi-style salute. In actuality, he was wearing a body cast from neck to waist, his arm in a raised position. In the effort to squirrel away the Z4, the massive machine had tipped over on von Braun, badly injuring him.

Post-war Germany was not an easy place to start a computer firm. Initially, in genuine hardship, Zuse found himself looking through farmers' fields for the occasional forgotten turnip in order to feed his family. Even when basic food and shelter became more available, it was still surprising to find someone refurbishing a computer—the Z4—and gathering engineers together to create computing machines.

Konrad Zuse was a visionary who always managed to find a way through difficult situations and rightly deserves a place in our memories as both a fascinating person and a pioneer of computing history. ■

Michael R Williams is Head Curator at the Computer History Museum.

Overleaf: A typical IBM System 360 installation. Introduced in April of 1964, the System 360 was a family of software-compatible mainframe computers spanning a 40:1 performance range. The Model 40, one of the smaller models, is shown here. With IBM's legendary sales and customer support, as well as a complete line of new peripherals, the announcement allowed IBM to consolidate its divergent product lines into one unified architecture. The result was near total dominance of the computing market by IBM for the next decade, with half a dozen other companies fighting over only 20% of the market.


IBM
SYSTEM 360

UNIVAC

THE FIRST AMERICAN COMMERCIAL COMPUTER

BY CHRIS CARCIA

Operator (front) at the UNIVAC console while colleague mounts a new data tape on a UNISERVO tape drive.

While an operator looks on, Presper Eckert (standing, left) and a young Walter Cronkite (right) examine UNIVAC's 1952 election prediction results.

When you think of 1950s computers, does the "UNIVAC" come to mind? Besides being the first commercial computer in the United States, the UNIVAC became synonymous with "computer," due in part to the power of a single event: the CBS television coverage of the 1952 election. Now, during the 2002 election season, it seems appropriate to remember that event 50 years ago.

FOUNDATIONS IN THE CITY OF BROTHERLY LOVE

The UNIVAC was the second commercially sold electronic computer in the world, beaten by one month by the Ferranti's Mark I in Manchester, England. A 30,000-pound, room-sized computer with 5,400 vacuum tubes that consumed 125,000 watts of power, the UNIVAC had origins in the "ENIAC," built by Presper Eckert and John Mauchly for the U.S. Army at the University of Pennsylvania's Moore School of Electrical Engineering. The ENIAC was completed by 1946, and design of the follow-on "EDVAC" machine had begun by the time the pair left the school over patent issues in March of that year. Eckert and Mauchly stayed in Philadelphia and founded a partnership, the Electronic Control Company (ECC), to produce computers for both scientific and business use. The company received a National Bureau of Standards grant of $75,000 to study mercury delay line memory systems and tape I/O ("input/output") devices. ECC hired employees and took out space on Walnut Street in Philadelphia. The two soon came to realize that the study could be turned into a complete computer system and changed the name of the company to Eckert-Mauchly Computer Corporation (EMCC). The EDVAC was never formally completed but formed a test bed for the pair's next machine, the "UNIVAC."

Originally referred to as an "EDVAC-type machine," and renamed UNIVAC (for "**Univ**ersal **A**utomatic **C**omputer") in 1947, the research project led to a design contract for $169,000 in June 1948. These amounts did not cover actual costs, but Eckert and Mauchly hoped to recover the difference in sales. They applied for additional government grants and pursued private investors but met with little success. In the climate of the Cold War in the United States, "security issues" were raised about Mauchly and several other employees and the company lost sales to the Navy as well as a nuclear project at the Oak Ridge National Laboratory.

THE BINAC

In the interim, Eckert and Mauchly agreed to build a machine for Northrop Aircraft called the BINAC ("**BIN**ary **A**utomatic **C**omputer"). EMCC accepted the contract in October of 1947, with the ambitious—some would say unattainable—goal of completing the machine by the next May. The BINAC was a dual-CPU system, which used mercury delay lines and a magnetic tape unit for I/O. In August of 1949, EMCC delivered the BINAC to Northrop after several months of operation in Philadelphia. The BINAC cost almost three times as much to build as Eckert and Mauchly had estimated and was of marginal reliability, leading some key members of EMCC staff to leave for firmer ground with companies such as Burroughs and GE that were just entering the business.

BECOMING UNIVAC

After the completion of the BINAC, EMCC contracted with the U.S. government to build three computers, one for the Census Bureau, and one each for the Air Force and the Army Map Service, with contracts of $150,000 for the first machine and $250,000 for the other two. EMCC had also signed deals with the Prudential Insurance Company and A.C. Nielsen—contracts that made IBM stand up and take notice that a new business might be forming. By the time these contracts were signed, EMCC was running out of money, putting the future of the company in jeopardy. Fortunately, a new investor, the American Totalisator Company (ATC), the makers of Tote® boards for posting racetrack odds, saw promise in the UNIVAC for racetrack use, and gave EMCC $500,000 to keep the company afloat. Even with the infusion of cash, EMCC could not cover the development costs of the UNIVAC, and so, on February 1, 1950, Remington Rand Corporation purchased the company, paying stockholders $100,000 plus 49% of profits over the first eight years.

The UNIVAC had one thousand words of mercury delay line memory and a basic clock rate of 2.25 MHz. The machine came with eight "UNISERVO" tape drives, using 1,500-foot reels of metal tape. No punched card equipment was available at first, so the UNITYPER was developed to enter information directly from keyboard to tape. The inability to use punched card equipment with the UNIVAC led many companies to go to IBM for computers that could be used with the IBM accounting machines they already owned. Eckert and Mauchly recognized this weakness and offered a 100-card-per-minute card-to-tape option. Originally designed for 80-column IBM cards, the system was redesigned after the buyout to use Remington Rand's 90-column cards, a system that employed round holes instead of rectangular ones as IBM's did.

THE ELECTION OF 1952

In August of 1952, CBS' director of News and Public Affairs, Sig Mickleson, met with a Remington Rand public relations representative who indicated that they could provide a machine that would help predict the election returns of that year. While Mickleson knew enough about computers to see the fault in this proposition, he thought that the machine could speed up the processing and analysis of the returns, giving CBS an edge over the other networks. Mickelson arranged for several CBS staff members, including anchor Walter Cronkite and reporter Charles Collingwood, to visit the UNIVAC that would be used in Philadelphia. Collingwood arrived late for the meeting, which allowed a mischievous coder to program a Teletype to print, “Collingwood, you’re late. Where have you been?” This simple event completely astonished Collingwood, making him the perfect person to sell the UNIVAC to television viewers.

With only three months until the debut, the UNIVAC team went about designing a way to interpret the results. Max Woodbury, a mathematician at the University of Pennsylvania, wrote a program that would make a prediction based on returns from precincts CBS had decided were most significant. He devised an “if X, then Y” program that would bring the results into focus. It turned out to be a bigger task than expected, and the team had to be expanded to six people in order to complete it in time for election night.

The program completed, the election coverage was set, with Woodbury, Mauchly, and stationed at the Philadelphia site with the UNIVAC serial number 5, and Collingwood and Cronkite at the CBS studio in New York. A Teletype allowed communications between the various teams and a console with blinking lights was set up in New York, with the teletype relaying the output from the UNIVAC in Philadelphia. The election night coverage began at 8 p.m. EST and the first round of results was run at about that time, before the polls had closed in the western states.

NOT THE ANSWER WE’RE LOOKING FOR

The first run of all the returns from the CBS “key precincts” returned an unexpected result: odds of 100–1 in favor of an Eisenhower victory. Pre-election poll results had indicated a very close election with Adlai Stevenson as the front-runner. The word of the prediction sent the crew into hurried debates over whether or not to announce the numbers. Mickleson eventually made the call not to go on air with them and to have the numbers rerun. Woodbury ran another set of information, with the UNIVAC coming up with odds of 8–7 in favor of Eisenhower, which Collingwood announced about 9 p.m. While reviewing the results, Woodbury detected an error in the data: he had added a zero to Stevenson’s totals from New York State. He reran the correct set of numbers, and Eisenhower’s odds were back up to 100–1. At that point, there was no interpreting the results in any other way and CBS became the first network to call the election. As it turned out, the UNIVAC’s calculations were remarkably accurate, with predicted totals for Eisenhower being 32,915,000 votes, while the actual total was 33,936,252—a difference of less than 3%.

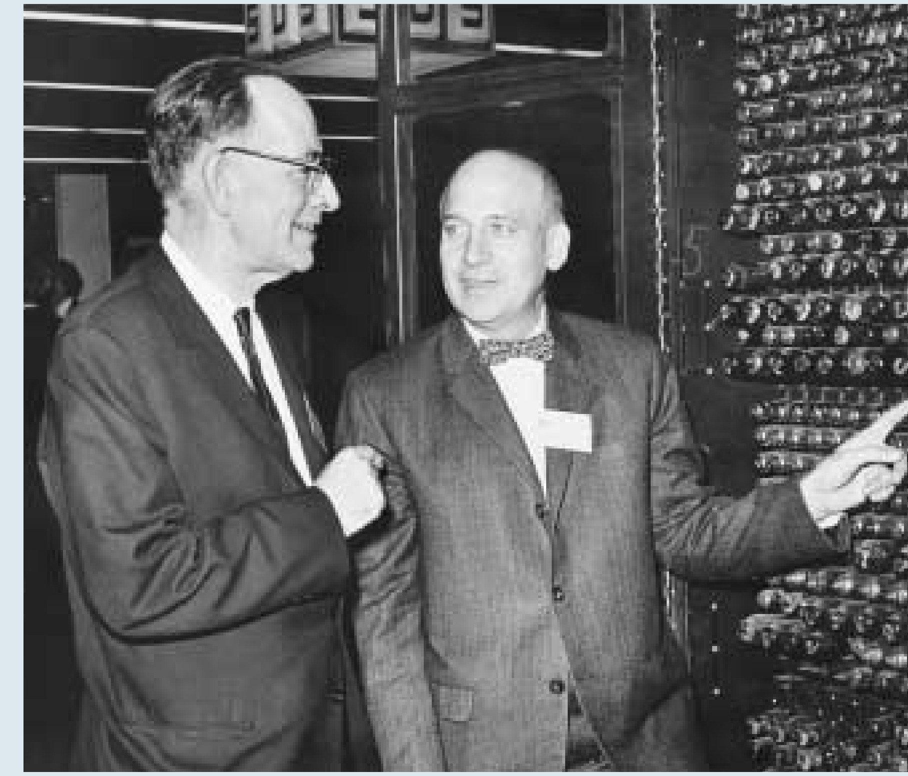
(above and right) With its “UNISERVO” tape drives, the UNIVAC was probably the first commercial machine to use magnetic tape as a storage medium. Customers initially resisted this technology since they could no longer “see” their data as they could with punch cards. IBM salesmen played up this fear, “hinting” that the UNIVAC, if it went out of control, could project shards of metal tape, potentially injuring or even killing customers.

ELECTIONS HAVE NEVER BEEN THE SAME

The effects of CBS’s use of the UNIVAC became clear during the next election when every major network began using a computer to predict the results. As computer speeds increased, so did the ability of news organizations to call elections quickly. As early as 1972, elections were thought to be over as soon as a computer gave an early prediction based on as little as 3% of the total vote. Many have said that the availability of such early computer predictions, often before the polls are closed on the West Coast, have changed the course of elections, giving early front-runners a large advantage with the weight of these computer predictions and discouraging voters in western states from going to the polls.

Significant parts of the UNIVAC I form part of the Computer History Museum’s permanent collection and may be seen, on temporary exhibit, at the Museum of Science in Boston, until 2005. A UNIVAC I mercury delay line is on display at the Museum’s Visible Storage Exhibit Area in Mountain View, California. ■

Christopher Garcia is Historical Collections Coordinator at the Computer History Museum.



John Mauchly (left) and Presper Eckert with a piece of the ENIAC machine at a 1966 conference in San Francisco.

UNIVAC I SPECIFICATIONS

Architecture: serial, decimal, stored program

Word length: 11 digits + sign

Memory size: 1,000 words (Mercury acoustic delay line) + 100,000-word magnetic tape (metal substrate)

Speed: Mercury delay line: 400µs; 12, 800 characters per second

Clock rate: 2.25 MHz

Arithmetic element: fixed-point (software floating point)

Instruction format: 2 instructions per word; 45 instructions

I/O: magnetic tape (“UNISERVO”), 80- or 90-column punch cards, printer (“UNIPRINTER”), paper tape

Technology: vacuum tube (5,800) + diode (18,000)

Power consumption: 124.5 KVA + 35-ton air conditioning unit

Size: 1,000 square feet

Purchase price: $950,000 [1953 dollars] for CPU + 10 UNIVSERVOs

Rental cost: $16,200 per month for a 1 shift, 5 days per week

Weight: 29,853 lbs

First shipment: March 1951, U.S. Bureau of the Census

Number built: 46

Typical customers: U.S. Census, USAF, GE, Metropolitan Life, U.S. Steel, AEC, Westinghouse, Consolidated Edison, Dupont, Chesapeake, and Ohio Railway

FURTHER READING

Bell, C. G., and Newell, A. *Computer Structures: Readings and Examples*, New York: McGraw-Hill (c) 1971.

Lundstrom, D. E., *A Few Good Men from UNIVAC*, Cambridge: MIT Press, (c) 1987.

McCartney, S., *ENIAC: The Triumphs and Tragedies of the World’s First Computer*, New York: Walker and Company, (c) 1999. [Note: this is a popular account; ENIAC was not the “world’s first computer.” –Ed.]

Ralston, A., Reilly, E.D., Hemmendinger, D., *Encyclopedia of Computer Science, 4th Edition*, London: Nature Publishing Group, 2000.

Stern, N.B., *From ENIAC to UNIVAC: An Appraisal of the Eckert-Mauchly Computers*, Bedford (Mass.): Digital Equipment Corporation, 1981.

Weik, M.H., *A Survey of Domestic Electronic Digital Computing Systems*, Report # 971 (December 1955), Ballistic Research Laboratories, Aberdeen Proving Ground, U.S. Department of the Army, Maryland, U.S.A.

Wilkes, M., *Automatic Digital Computers*, New York: John Wiley and Sons, 1956.

RECENT ADDITIONS

TO THE COMPUTER HISTORY MUSEUM COLLECTION

Assorted documentation, including several early Texas Instruments calculator manuals (1972–1980), X2466.2002, Gift of David G. Pitts

Carterphone, Inc., original Carterfone (c. 1959), X2468.2002, Gift of Scott Brear

COBOL document collection (1965–1986), X2461.2002, Gift of Jitze Couperus

Collection of Don Hoeffler's *Micro Electronic News* (1979-1984), X2464.2002, Gift of Thomas S Knight

Collection of historic computing printed circuit boards, documents, books, and magnetic media (various dates), X2487.2002, Gift of Shushan Teager

Collection of 19 antique vacuum tubes (c. 1940–1960), X2455.2002, Gift of Martin B Cowan

Collection of UNIVAC manuals and documentation (c. 1955), X2480.2002, Gift of Robert Garner

The *Community Computerist's Directory*, two issues (1981), X2470.2002, Gift of Stephen Pizzo

CompuPro, microcomputer system and software collection (c. 1978), X2472.2002, Gift of NASA Ames Research Center

Digital Convergence Corporation, CueCat barcode scanner (c. 1998), X2460.2002, Gift of John Levy

E.S.R., Inc., DIGI-COMP I (1963), X2463.2002, Gift of Peter Schwarz

Fujitsu Technology Solutions, Inc., 5990 document and photograph collection (c. 1988–1992), X2458.2002, Gift of Fujitsu Technology Solutions, Inc.

IBM, commemorative reproductions of the FORTRAN language manual and programming guide for the 704 (1982), X2477.2002, Gift of Don Ewart

IBM, complete English language documentation for the first office software suite for the IBM PC (1984), X2478.2002, Gift of Paul F May

IBM, FORTRAN 25th Anniversary videotape (1983), X2477.2002, Gift of Don Ewart

IBM, mainframe subroutines from a Russian library (1984), X2475.2002, Gift of Michael Lehner

IBM, PC Technical Reference Manual (1981), X2456.2002, Gift of Laurel V Kaleda

IBM, ThinkPad Trans Note (1999), X2465.2002, Gift of Steve Wildstrom

IBM, two Japanese language software and documentation packages applications for the IBM PC (1984), X2478.2002, Gift of Paul F May

Lotus, Lotus 1-2-3 documentation (1983), X2456.2002, Gift of Laurel V Kaleda

Marchant, ACRM adding machine (c. 1932), X2482.2002, Gift of Mike Smolin

Maxis, SimCity V1.0 for Windows (1989), X2486.2002, Gift of Lisa Pegg

Metaphor, 1200 ML5 workstation (1988), X2479.2002, Gift of Charles Irby

NEC, SX-4 promotional video collection (c. 1996), X2457.2002, Gift of Philip Tannenbaum

NLS chord set keyboard (c. 1972), X2481.2002, Gift of Douglas Gage

Persci, dual-floppy 8" disk drive (c. 1977), X2483.2002, Gift of Ira D Baxter

Quantum Corporation, hard disk drives collection (1985–1995), X2460.2002, Gift of John Levy

Russian "Felix" arithmometer (c. 1932), X2480.2002, Gift of Robert Garner

Scientific Data Systems, Sigma-5 computer system (1965), X2473.2002, Gift of Carnegie Mellon University's NMR Center for Biomedical Studies

SCOPUS, disk pack (c. 1975), X2461.2002, Gift of Jitze Couperus

Softbook Press, Softbook Model SB-200 e-book (1998), X2484.2002, Gift of Gordon Bell

Sony, Magic Link Personal Intelligent Communicator and keyboard (c. 1994), X2465.2002, Gift of Steve Wildstrom

Summagraphics, MM1201 tablet with light pen (c. 1985), X2474.2002, Gift of NASA Ames Research Center

Synertek, KTM-3 user's manual (1979), X2482.2002, Gift of Mike Smolin

Synertek, MOS data catalog (1979), X2482.2002, Gift of Mike Smolin

System Integrators, Inc., Coyote workstation (c. 1985), X2467.2002, Gift of Paul Saffo

Teletype Corporation, ASR-33 Teletype (1971), X2485.2002, Gift of Tom Kochenderfer

Texas Instruments, Inc., PASS (Portable Analysis Synthesis System) device and microphone (1985), X2472.2002, Gift of NASA Ames Research Center

Texas Instruments, Inc., TM 990/189 microprocessor trainer (1979), X2471.2002, Gift of Christopher Garcia

U.S. Census Bureau, UNIVAC I serial number plate (S/N 1) replica (1963), X2459.2002, Gift of F Grant Saviers

University of Texas at Austin, computer-generated bronze casting of an earless monitor lizard, X2488.2002, Gift of Tim Rowe

WaveMate, Jupiter Processor and associated manuals (c. 1975), X2483.2002, Gift of Ira D Baxter

6 books (various dates), X2474.2002, Gift of Gary Bronstein

10 linear feet of early computing documents and manuals, including an IBM 701 Manual of Operations (1951), X2454.2002, Gift of Gloria M Bauer

GIFTS OF THE MUSEUM OF AMERICAN HERITAGE, PALO ALTO

Abacus (c. 1980), X2469.2002

Assorted flexible disk drives and media, X2469.2002

Assorted optical media and drives (1990–1999), X2469.2002

Dataplay disks (c. 2000), X2469.2002

IBM, Foxtail diskette (c. 1983), X2469.2002

SmartMedia and Compact Flash card assortment (c. 1998), X2469.2002

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

REPORT ON MUSEUM ACTIVITIES

BY KAREN MATHEWS

Karen Mathews is Executive Vice President at the Computer History Museum

A wise person once said, "If you want to predict the future, go to history for advice." In the world of information technology, we seek to provide access to the wisdom of history, every day. Here are some highlights of our activities since the last *CORE* publication.

CARVER MEAD ON ELECTRONIC PHOTOGRAPHY—HISTORY IN THE MAKING

On May 21, AMD graciously hosted 300 attendees for a reception and lecture by Carver Mead, Foveon chairman and Caltech Gordon and Betty Moore professor emeritus. Mead pointed out that the pioneers of photography, like those of computing, have repeatedly stumbled through an array of steps before they were able to arrive at new solutions.

Although the first photographic images were obtained in 1727, it was not until 1837 that a repeatable and useable photographic process was developed. Various schemes were tried over the ensuing century for enabling monochrome silver-halide technology to produce color images, culminating in the introduction of Kodachrome in 1935.

Carver Mead explains in a lecture on May 21 how the electronic full-color imaging technology developed by Foveon, a company he co-founded, addresses a long-standing vision for color-image sensing.

The first electronic images were captured by vacuum tubes, and more recently by solid-state sensors. Once again, the underlying photosensitive process was basically monochrome, and the efforts to convert it to a color technology showed striking parallels with the earlier silver-halide approaches. In 2002, Foveon introduced X3, the first electronic full-color technology, thereby completing the evolution of color-image-sensing and, in fact, challenging the definition of "pixel" to include red, green and blue in one complete picture element.

Attendee Baldwin Cheng, of McCann Erickson, said, "Carver Mead is a fascinating innovator and a true character. His talk was not only an educational review of the history of photographic technology but also an exciting look at its future. Now my 1.3 'megapixel' Olympus seems as advanced as a Kodak Brownie."

REGIS MCKENNA ON EARLY TECHNOLOGY MARKETING IN SILICON VALLEY

Together with the Silicon Valley American Marketing Association, the Museum hosted a lecture by Regis McKenna on June 4 to an audience of 250 at PARC in Palo Alto. McKenna, who has worked with some of the most recognizable companies in Silicon Valley and helped launch many important technological innovations, discussed his personal experiences and observations from 30 years in the marketing trenches. He recalled that, in the 1970s, only science writers were covering technology and prior to 1983, the *Wall Street Journal* would not publish an article about any company not already on the New York Stock Exchange.

One of McKenna's main messages was that Silicon Valley is missing a dialogue with the past. He said, "It's not just re-investing money, it's re-investing knowledge." In this regard, he advised

Regis McKenna reminisced about technology marketing in the Silicon Valley over the past 30 years, and made a few recommendations to current entrepreneurs.

today's entrepreneurs and business people to concentrate on building infrastructure and standards rather than brands. "Marketing is going to follow quality," he said, "and if you are successful it almost doesn't matter what you call the effort."

John Wharton and a crowd of 250 people assembled on June 4 at PARC to hear a lecture by Silicon Valley marketing legend Regis McKenna.

Museum volunteer and lecture attendee Tim Boyd remarked, "I most enjoyed his story of his grandkids. His grand-daughter's [remark] that, 'we don't need software—we just go on the Internet and get what we want' was very on-point, and fun to hear the telling of it. Like other nerds…I've been caught in the middle of the religious argument about whether my friends or family should buy Macs or PCs. Like Regis, I'd concluded that for most people the larger number of software titles gives the PC the nod. About three years back I had the epiphany...that for many people browsing was the thing, along with e-mail, and it mattered not which hardware you choose."

AL SHUGART: HALF A CENTURY OF DISK DRIVES AND PHILOSOPHY: FROM IBM TO SEAGATE

Al Shugart spoke on September 5 to an audience of 250 at Xerox PARC about five decades of rich experience in the disk drive industry. Shugart joined IBM as a customer engineer in 1951 and later participated in the development of IBM's 305 RAMAC, the precursor to today's hard drives. He pioneered the floppy disk at Shugart Associates, and later co-founded Seagate in 1979 (with an eight-page business plan and $500,000 in funding on a handshake) to develop small hard drives for personal computers.

Disk drive legend Al Shugart spoke on September 5 at PARC's Pake Auditorium about 50 years of experience in the industry.

Said Shugart, "One of my earlier recollections of [the] IBM lab at 99 Notre Dame Street in San Jose was watching Don Johnson, one of the pioneers of this development, pouring iron oxide paint onto a rotating 24-inch disk from a Dixie cup. No cleaner, no equipment. The equipment was so crude the Dixie cup didn't look out of place. And I certainly had no idea I was walking into the beginning of a technology and a product development program that would have such a profound impact upon the entire computer industry."

Attendee Pete Delisi said, "It's always awe-inspiring to hear first person from the people who created these industries. I remember very well the disk drive products that Al was describing and remember them as significant shifts every time a new product came out. Now we're dwarfed by progress in every segment of the computer industry and it's easy to lose sight of the tremendous contributions that guys like Shugart made. We 'old-timers' will never forget where we have been."

MITCH WALDROP: THE REVOLUTION THAT MADE COMPUTING PERSONAL

In a lecture on September 19 co-hosted by Hewlett-Packard, author Mitch Waldrop brought us the fascinating story of JCR Licklider and the personal computing revolution. Licklider may well have been one of the most influential—and east known—people in the history of computer science. As a division director in the Pentagon's Advanced Research Projects Agency (ARPA) in the early 1960s, Licklider put in place the funding priorities which led to the Internet and the inventions of the "mouse," "windows," and "hypertext."

Mitch Waldrop spoke at Hewlett-Packard Labs on September 19 about the life and accomplishments of JCR Licklider, further detailed in his book *The Dream Machine*.

Attendee Todd Anderson remarked, "Another great piece of the puzzle… Waldrop showed how quickly a good piece of history and perspective [almost!] slipped past us without anybody capturing it. At least we know we are missing parts."

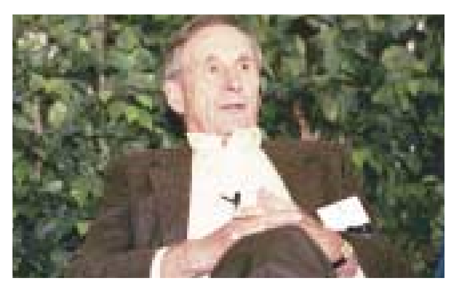
PIONEERS OF VENTURE CAPITAL

Legendary venture capitalists Bill Draper, Pitch Johnson, Burt McMurtry, Tom Perkins, Arthur Rock, and Don Valentine gathered at Moffett Field on September 30 to participate in a panel moderated by Fenwick & West's Gordy Davidson. To a standing-room-only audience of over 300 people, these founders and pioneers of the field told fascinating tales of how they got their start, their "aha" moments, their biggest hits, what they learned, and the ones that got away.

A reception in the Museum's Visible Storage Exhibit Area before the "Pioneers of Venture Capital" lecture enabled many local VIPs to see the Museum's collection for the first time.

Bill Draper (Draper Richards) and Pitch Johnson (Asset Management Company)

Burt McMurtry (Technology Venture Investors) and moderator Gordon Davidson (Fenwick & West LLP)



Arthur Rock (Arthur Rock & Co.)

Tom Perkins (Iolon, News Corporation, and the Hewlett-Packard Company) and Don Valentine (Network Appliance)

The panel was arranged by Museum Trustee Donna Dubinsky, who remarked, "I was most struck by the notion of these pioneers as 'company builders' rather than 'promoters.' I think that concept got lost a bit in the bubble, so it was nice to hear it reiterated."

Museum Trustee Ike Nassi noted, "At the Computer History Museum we often have the opportunity to interact with pioneers, to hear their thoughts. At the VC panel, we had an opportunity to not only see some of the unquestioned pioneers of this revolution comment on what it was like…but to hear them interacting with each other, trading stories…"

Generous funding for the presentation was provided by Allegis Capital and an anonymous donor. Sponsorships like these allow the Museum to fulfill its mission and to produce high-quality programming.

A videotape of this presentation may be obtained through the Museum's website at www.computerhistory.org/store.

DONOR APPRECIATION PARTY

The Museum held a special donor appreciation party on June 8 to celebrate and thank our valued supporters. More than 100 current members—including pioneers, engineers, industry fans, executives, computer users, and VCs—assembled at the home of Alexia Gilmore and Colin Hunter in Atherton, California. Some traveled from as far away as Massachusetts for great food, entertainment, and conversation.

More than 100 Museum members gathered at the home of Alexia Gilmore and Colin Hunter for a donor appreciation party on June 8.

The performance group Teatro Zinzanni delivered a Computer History Museum rendition of The 12 Days of Christmas and a fortuneteller provided readings. Some of the lucky attendees received autographed lecture posters and Museum logo merchandise. Thanks to our hosts, Alexia, Colin, Sheila and John Banning, and everyone who came and made the event such fun.

Members of the performing group Teatro Zinzanni kicked off the donor appreciation party with a lighthearted song and dance about the Museum.

This year's party recognizing annual donors was hosted by John and Sheila Banning, Colin Hunter, and Alexia Gilmore (left to right).

EXECUTIVE DIRECTOR HELPS LAUNCH LLNL MUSEUM

On July 11, 2002, Lawrence Livermore National Laboratory opened the LLNL Computer History Museum exhibit in conjunction with its 50th anniversary. After a brief talk by LLNL Director Emeritus Edward Teller, our own Executive Director and CEO John Toole participated in the event with a presentation, "Preserving Computing History: From Teller to Teraflops." The visit by Teller was a surprise to many, including Toole, who had named his talk after Teller. Toole was privileged to enjoy a photo shoot and conversation afterwards with the pioneer. "Even the 'youngsters' in the audience could appreciate our computer history, though they didn't live through it like some of the rest of the audience," said LLNL Associate Director of Computation, Dona Crawford. The LLNL exhibit features dozens of artifacts it has donated to CHM over the years, and which the Museum lent back to LLNL for the exhibit.

Museum Executive Director and CEO John Toole with LLNL Director Emeritus Edward Teller and LLNL Associate Director for Computation Dona Crawford (left to right).

COLLECTION HIGHLIGHTS

An original Carterfone Communications Corporation "Carterphone" was recently donated by Scott Brear. Manufactured by Carter Electronics in 1959, the telephone allowed mobile radio users

An original Carterfone, which sparked a debate that eventually led to the FCC's landmark "Carterphone decision," allowing third-party companies to manufacture and connect equipment to the public-switched telephone network (PSTN).

to connect with the public telephone network. In 1966, telephone companies challenged its legality, and a lengthy struggle began. Eventually, the Federal Communications Commission handed down the landmark "Carterphone Decision," which allowed an open, competitive market to exist for communications equipment and facilities. This Carterphone is one of a few remaining such devices in existence.

Thomas S. Knight donated a collection (1979-1984) of Don Hoeffler's *Micro Electronic News*. Hoeffler was a Silicon Valley icon who reported on the semiconductor industry for many years. He is widely accepted as the person who, in 1972, first put into print the term "Silicon Valley."

DOCENT TRAINING

The Museum has a small cadre of dedicated volunteers who have provided docent services at the Visible Storage Exhibit Area over the past few years. Now, our exposure is increasing and we have a need for more trained docents to lead visitors through the collection. Head Curator Mike Williams has created a new docent training program and classes are available. If you are interested in becoming a docent, please contact Betsy Toole for information on upcoming training sessions.

Head Curator Mike Williams leads a group of docents in training through the items in the Visible Storage Exhibit Area.

VOLUNTEERS IN MOTION

Over the past months, our volunteers have contributed a tremendous amount of help to the Museum. This help is vital to our operation and growth. Thank you for everything you do.

Once every month, volunteers gather on a Saturday to assist Museum staff with a variety of tasks. In June, volunteers helped build pallet racks in one of our warehouses. It took about 12 hours to move artifacts out of the warehouse, build the racks, then reorganize the items in a much more accessible arrangement. What a difference to the collections and warehouse staff!

Another group of volunteers helped receive and organize a delivery of almost 200 boxes from the Digital Equipment Corporation archive recently donated by HP/Compaq.

Slava Mach assists with the installation of artifact shelving during a volunteer work party.

Volunteers also participated as part of our annual Fellow Awards event team, many and varied fundraising efforts, volunteer planning, and various office duties. Others provided graphic design, web design, and scanning services.

If you are interested in helping the Museum in any of its tasks to preserve and present computing history, please contact Betsy Toole for more information.

ANNUAL FELLOW AWARDS BANQUET

This year, the Museum once again celebrated the inventors and visionaries of the information technology revolution at our Fellow Awards Banquet. About 400 people gathered to honor four new Fellows: John Cocke, Charles Geschke, Carver Mead, and John Warnock. 2000 Museum Fellow Fran Allen delivered an acceptance speech on behalf of John Cocke, who passed away earlier this year.

Master of Ceremonies and Trustee John Shoch, new Fellow Carver Mead, and Executive Director and CEO John Toole (left to right) after the ceremonies at the Fellow Awards Banquet in October

The theme of the evening was "Architects of Change" and attendees were treated to a reception exhibit featuring the stories and artifacts of all 24 past and present Museum Fellows. It was a wonderful opportunity to reflect on the stunning intellect, creativity, and vision that these innovators have brought to our world.

Alloy Ventures general partner and Museum Trustee John Shoch entertained the audience and led the evening as Master of Ceremonies. Board of Trustees Chairman Len Shustek addressed the group about the importance of preserving the artifacts and stories from this incredible time we are experiencing—an information revolution that is creating tools to amplify the human mind. John Toole, Executive Director and CEO, announced the purchase of our new building at 1401 N Shoreline and presented a retrospective multi-media presentation

(left to right): 2002 Museum Fellows John Warnock, Charles Geschke, Carver Mead, and Fran Allen (who accepted the award on behalf of John Cocke)

Barbara Warnock, Peggy Asprey, and Marva Warnock

Museum Trustee Eric Hahn and volunteer Angela Hey

on the Museum's history, from some of the earliest lectures and advertisements, to the move west, through current visions for the building and exhibits.

For those of you who missed this gala event, here are highlights of the contributions for which our new Fellows were honored.

At IBM, **John Cocke** developed the concept of reduced instruction set computer (RISC) technology, a cornerstone of high-speed computer design, relying on a minimal instruction set and highly efficient compiler design. He was a multifaceted talent at IBM, working in compilers and inventing the concept of "lookahead" for the IBM STRETCH computer. He inspired generations of engineers and won the National Medal of Technology (1991), the National Medal of Science (1994), and the ACM Turing Award (1985) for his lifelong achievements in computer science. Cocke graduated in 1956 from Duke University with a Ph.D. in mathematics. He passed away on July 16 of this year.

Trustee Peggy Burke and the 1185 Design table

A reception prior to the Fellow Awards Banquet featured a walk through the accomplishments of all 24 Museum Fellows

Visionary and inventor **Carver Mead** has spearheaded major innovations across many disciplines and made many contributions to the field of microelectronics. He created what is now called HEMT, the standard amplifying device used in communications. He pioneered the design concept for VLSI (very-large-scale integrated) circuits, which is now ubiquitous in the semiconductor industry. Mead has also experimented with neuromorphic electronic systems, which imitate functions of living nervous systems.

A professor for over 40 years at Caltech, Mead also contributed to an explosion of new chips on the market through his mentoring of students. He holds over 50 US patents, has written and contributed to more than 100 scientific publications, and has received numerous awards.

Like many pioneers, **Charles Geschke** and **John Warnock** left the structure of a large corporation to move the industry forward on their own as entrepreneurs. In the early 1980s, Geschke and Warnock were working at Xerox's Palo Alto Research Center to develop a page-description language (PDL) called Interpress. When Xerox did not introduce it, Geschke and Warnock started Adobe Systems, Inc. in 1982 and began to work on solving some of the long-standing problems that plagued the relationship between PCs and printers.

Together, John Warnock and Charles Geschke created PostScript, the PDL that revolutionized the creation and printing of documents and introduced a new computer-based industry—desktop publishing. Over the years, the two men have worked closely together and greatly influenced the development of the industry over time. PostScript was selected by the International Standards Organization (ISO) as the standard PDL.

Said attendee Alex Osadzinski, "I found the Fellows banquet very moving. The montage playing on the screens…reminded me of how this industry is built on the achievements of just a few talented and visionary people. The humility exhibited by the newly-elected Fellows was very inspiring.…These folks are such tremendous role models; we can all learn something from them."

Sincere thanks go to the many people who supported the banquet. Hewlett-Packard Company was our Lead Sponsor, and 1185 Design and Adobe Systems were Patron Sponsors. The Wizard circle of tables included Warburg Pincus, *WIRED* magazine, Garner Hendrie and Karen Johansen, and Len Shustek and Donna Dubinsky. The Guru circle of tables included Alloy Ventures, Gwen Bell, Paul Borrill, Goldman Sachs, John Mashey, and Bernard Peuto. Our gratitude also to the evening's hosts: Robin and David Anderson, Donna Dubinsky and Len Shustek, Elaine and Eric Hahn, and Karla and Dave House.

1401 N SHORELINE BLVD., MOUNTAIN VIEW, CALIFORNIA—THE MUSEUM'S NEW HOME

We hope you are as excited as we are about our new building. Staff, volunteers, and Trustees have been working hard behind the scenes to prepare for operations in the new space. Be sure to check out John Toole's letter on the inside front cover of this issue of *CORE* to learn more about our plans. Stay tuned for details as they develop! And please feel free to contact us if you would like to have more information.

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To correct your listing, please contact liska@computerhistory.org.

UPCOMING EVENTS

Please RSVP for all events. Register by phone: +1 650 810 1027. Register online: www.computerhistory.org

TUE, NOVEMBER 12
ADOBE SYSTEMS—THE FOUNDERS' PERSPECTIVE
John Warnock and Chuck Geschke
Member and VIP Reception—6:00 pm
Computer History Museum, Bldg 126
Lecture—7:00 pm
Moffett Training and Conference Center, Bldg 3
Moffett Field, California

TUE, DECEMBER 10
AN EVENING WITH STEVE WOZNIAK
Steve Wozniak
Member and VIP Reception—6:00 pm
Computer History Museum, Bldg 126
Lecture—7:00 pm
Moffett Training and Conference Center, Bldg 3
Moffett Field, California

MON, FEBRUARY 10
DATABASE PANEL DISCUSSION
Chris Date, Herb Edelstein, Bob Epstein, Ken Jacobs, Pat Selinger, Roger Sippl, and Michael Stonebraker with George Schussel
Lecture—7:00 pm
Moffett Training and Conference Center, Bldg 3
Moffett Field, California

MUSEUM ARTIFACTS ON LOAN

JULY 30–AUG 2, 2002
"TRANSFORMING FANTASY"
DARPATech 2002
Anaheim, California
www.darpa.mil/DARPATech2002/

APRIL–SEPTEMBER 2002
"WORLD'S FAIRS"
San Francisco International Airport
Terminal C3
San Francisco, California
www.sfoarts.org

OCTOBER 19, 2002–FEBRUARY 2, 2003
"GAME ON! THE WORLDWIDE CULTURE AND HISTORY OF VIDEO GAMES"
National Museums of Scotland
Edinburgh, Scotland
www.nms.ac.uk

MARCH 6, 2002–MARCH 6, 2003
"CENSUS CENTENNIAL CELEBRATION"
U.S. Department of Commerce,
Bureau of the Census
On-line exhibit
www.census.gov/mso/www/centennial/

JULY 11–OCTOBER 15, 2002
"50 YEARS OF COMPUTING AT LAWRENCE LIVERMORE NATIONAL LABORATORY"
Livermore, California
Tours must be reserved in advance.
Call +1 925 424 6575 or visit www.llnl.gov/PAO

SEPT 2002 (ONGOING)
"THE COMPUTING REVOLUTION"
Museum of Science
Boston, Massachusetts
www.mos.org

TOUR THE MUSEUM

Tours of the Museum's Visible Storage Exhibit Area are held on Wednesdays and Fridays at 1:00 p.m. and on the 1st and 3rd Saturdays of each month at 1:00 p.m. and 2:00 p.m. Please make a reservation at +1 650 810 1010.

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:

NOVEMBER 9, DECEMBER 14
JANUARY 11, FEBRUARY 8

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.

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Current staff openings can be found at www.computerhistory.org/jobs.

MYSTERY ITEMS

FROM THE COLLECTION OF THE COMPUTER HISTORY MUSEUM

Explained from CORE 3.2

ATANASOFF-BERRY COMPUTER (ABC)

Atanasoff-Berry Computer (ABC), Add-shift module replica (c. 1995), X2446.2002, Gift of John Gustafson.

This modern-day recreation of a critical module in the ABC machine consists of seven vacuum tubes mounted on a sheet-metal chassis wired identically to the original 1942 prototype, and hand-assembled by engineers at Iowa State University's Ames Laboratory in the mid-1990s using authentic antique components. Approximate size: 8" x 5" x 4."

John Vincent Atanasoff (1903-1995) and graduate student Clifford Berry (1918-1963) started on the ABC design in 1937 (completing it in 1942) as a means of solving the thorny mathematical problems they faced on a daily basis. The machine was built into a desk-sized cart and cost about $5,000 (1940 dollars) to develop and build. Using a form of capacitor memory of Atanasoffís own design, the ABC could solve up to 29 simultaneous linear equations in 29 unknowns. While the machine was somewhat unreliable (some question it ever having worked at all), it was involved in one of the most protracted patent disputes in U.S. history (Honeywell vs. Sperry-Rand), centering on the "invention" of the digital computer. Though Atanasoff was legally credited with this invention at the trial's conclusion in 1973, most historians feel this strict legal interpretation to be inaccurate and that credit properly goes the team at Manchester University in Britain for their "Baby" machine (1948).

Whatever one's position on this issue, the recreation is an impressive accomplishment in itself. Costing $350,000 (1997 dollars) to complete, a team of devoted faculty, students, and interested individuals invested thousands of person-hours into research, fabrication, and testing to bring back to life a machine from the prehistoric era of computing. This module is a spare from that reconstruction effort. For more information, see: http://www.cs.iastate.edu/jva/jva-articles.shtml.

WHAT IS THIS?

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

Please send your best guess to mystery@computerhistory.org before 12/31/02 along with your name, shipping address, and t-shirt size. The first three correct entries will each receive a free t-shirt with the new Museum logo and name.

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