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 facilities in early 2003 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 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 people will 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 us 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 many others across the country. We look forward to the day when the Computer History Museum is 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 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.

Please consider an increased or new contribution to our annual fund, a donation to our capital campaign, and funding for our exhibit planning process in Kirsten Tashev’s article on page two.

We owe much to the people at NASA for contributing to the information age. I’m convinced more people will bring artifacts and history alive. It is motivating to meet people everywhere who share our dreams, including early supporters of the Computer History Museum.

Kirsten Tashev
EXHIBITING
COMPUTING HISTORY

BY KIRSTEN TASHEV

INTRODUCTION
Currently the Museum is working on the Schematic Designs—the rough layout and look of the exhibits—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 the fact that 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 ideas 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” exhibit 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 “new 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 the visitor 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. One 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 history. History is a discipline in which we try to take a distant and critical view of the past, while memory is personal and involves 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 people who remember 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 808 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 reshaped 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
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 no longer 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 1943, which was 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 Aircraft 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 machines were 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 find 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 understood an idea 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:

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 cabinets 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 or a silicon wafer is.

CYBER VS. ACTUAL REALITY

“Cannot find REALITY.SYS...Universe Halited.” —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 ORGANIZATIONAL EXHIBIT LAYOUT

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timeline Exhibit</td>
<td>Major headlines in computing history, multi-layered with a rich variety of both people stories and technological achievements</td>
</tr>
<tr>
<td>Theme areas</td>
<td>Chronological focus on developments within key areas of computing history: networking, I/O, software, storage, and processors</td>
</tr>
<tr>
<td>Topical exhibits</td>
<td>Exhibits that showcase special topics such as privacy and computers, AI, robotics, computer advertising, and medicine, games, etc.</td>
</tr>
<tr>
<td>Visible storage</td>
<td>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)</td>
</tr>
</tbody>
</table>

### SUMMARY OF TECHNIQUE EXHIBITS

1. Artifact displays with some “touchability” through a “study collection” (artifacts with multiple copies in the collection) and hands-on explanatory models
2. Docented 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. Reconceived 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
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 Tashév. 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 — and in doing so, merge The Computer Museum with the Museum of Science.

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 to the Computer History Museum, 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 objects 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 of 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.

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 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
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 15 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 (942) 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 control room, along with one of its core memory stacks and a “Flexowriter,” a
classic 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 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 merits 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 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 work. 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.

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 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 emails and more replies, they had built a machine and had plans they would use. They would even machine the gears if we wanted!

More months passed until we received blueprints for the cabinet of the machine. We worked for the plans for the gear mechanisms, but to no avail. More months, and more emails 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.”

Finally, out of the blue, an extremely heavy package arrived from Germany. We looked for the plans for the machine. Completing the machine took on a new urgency. The gear mechanisms, but to no avail.

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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 at 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 his painting 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 surrender away the 24, 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 lump of 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 24—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.
UNIVAC

THE FIRST AMERICAN COMMERCIAL COMPUTER

BY CHRIS GARCIA

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 2003 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 machine, the “UNIVAC,” 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 and became a dual-CPU system, which used “Universal Automatic Computer”) 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 (“BINARY Automatic Computer”). 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 and offered 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 Mickelson, 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 Mickelson 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 station reps 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 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%.

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.

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**UNIVAC I SPECIFICATIONS**

- **Architecture:** serial, decimal, stored program
- **Word length:** 11 digits + sign
- **Memory size:** 1,000 words of magnetic tape (metal substrate)
- **Speed:** Mercury delay line: 400 µs; acoustic delay line: 100,000 words
- **Clock rate:** 2.25 MHz
- **Typical features:**
  - Fixed-point floating-point arithmetic
  - 80-column printout
  - Magnetic tape

**UNIVAC I OPTIONS**

- **I/O:** magnetic tape, punch cards, printer
- **Power consumption:** 124.5 KVA (c) 1987.

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**FURTHER READING**

- Wilkes, M., *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.”]
TO THE COMPUTER HISTORY MUSEUM COLLECTION

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RECENT ADDITIONS

Assorted documentation, including several early Texas Instruments calculator manuals (1972-1980), X2446.2002, Gift of David G. Pitts
Carnetronke, Inc., original Cartelexe (c. 1955), X2468.2002, Gift of Scott Bore
Collection of historic computing printed circuit boards, documents, books, and magnetic media (various dates), X2467.2002, Gift of Shizuan Tae
Collection of 19 antique vacuum tubes (c. 1940-1960), X2455.2002, Gift of Martin B Cowan
Collection of 19 antique vacuum tubes (c. 1940-1960), X2455.2002, Gift of Martin B Cowan
Collection of INMOS manuals and documentation (c. 1995), X2440.2002, Gift of Robert Garner
CompuPro, microcomputer system and software collection (c. 1985), X2467.2002, Gift of NASA Ames Research Center
IBM, commerative reproductions of the PERTAN language manual and programming guide for the 704 (1958), X2462.2002, Gift of Don Ewart
IBM, complete English language documentation for the first official software suite for the IBM PC (1984), X2478.2002, Gift of Paul F May
IBM, mainframe subroutines from a Russian library (1984), X2457.2002, Gift of Michael Lehrer
IBM, ThinkPad Trans Note (c. 1995), X2455.2002, 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
Marchant, ACM add-on machine (c. 1932), X2462.2002, Gift of Mike Smolin
Moro, SimCity VL 0 for Windows (1989), X2468.2002, Gift of Lisa Pegg
NEC, SX-4 promotional video collection (c. 1996), X2457.2002, Gift of Philip Tannenbaum
NL5 chord set keyboard (c. 1972), X2463.2002, Gift of Douglas Gage
Perusa, dual-8mb" disk drive (c. 1977), X2468.2002, Gift of Ira D Bader
Russian "Felix" arithmometer (c. 1932), X2460.2002, Gift of Robert Garner
Scientific Data Systems, Sigma2 computer system (1965), X2473.2002, Gift of Carnegie-Mellon University's NMR Center for Biomedical Studies
SCOPUS, disk pack (c. 1975), X24611.2002, Gift of Jitlou Coursen
Texas Instruments, Inc., TM 990/189 microcomputer board (1979), X2471.2002, Gift of Christopher Garcia
U.S. Census Bureau, UNIMAC I serial number plate (c. 1963), X2459.2002, Gift of Ira D Bader
University of Texas at Austin, computer-generated black and white printout of an elder's marriage ordnance (c. 1975), X2483.2002, Gift of Ira D Bader
X books (various dates), X2474.2002, Gift of Gary Bronstein
GIFTS OF THE MUSEUM OF AMERICAN HERITAGE, PALO ALTO
Abracs (c. 1980), X2469.2002
Assorted flexible disk drives and media, X2499.2002
Assorted optical media and drives (1990-1999), X2499.2002
Dataplay disk (c. 2000), X2499.2002
IBM, Floret disquette (c. 1983), X2429.2002
SmartMedia and Compact Flash card assortment (c. 1998), X2488.2002

MONOCHROME SILVER-HALIDE TECHNOLOGY TO PRODUCE COLOR IMAGES, CULMINATING IN THE INTRODUCTION OF KODACHROME IN 1935

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.

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

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.

REPORT ON MUSEUM ACTIVITIES

BY KAREN MATHEWS

Karen Mathews is Executive Vice President at the Computer History Museum.
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.

The panel was arranged by 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.

MITCH WALDROP: THE REVOLUTION THAT MADE COMPUTING PERSONAL

A reception in the Museum’s Visible Storage Exhibit Area before the “Pioneers of Venture Capital” lecture enabled many local VPs to see the Museum’s collection for the first time.

The performance group Teatro Zinzani 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, Alexa, Colin, Sheila and John Banning, and everyone who came and made the event such fun, “Preserving Computing History: From Teller to Teraflips.”

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, Donna 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.
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 Dan Hoefflinger’s Micro Electronic News. Hoefflinger 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.”

DOCTORS 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, owing to the Museum’s reorganizing, 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.

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 it makes 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.

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 of the event. He explained, “Over the past year, we have worked closely together and greatly appreciated the development of the industry over time. PostScript was selected by the International Standards Organization (ISO) as the standard PDL.”

Said attendees 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, Garmin Hendrie and Karen Johansen, and Len Shustek and Donna Dubinsky. The Guru circle of tables included Alloy Ventures, Gwen Bell, Paul Bortil, Goldman Sachs, John Mashey, and Bernard Potts. 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.

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.

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.
This modern 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 Atanasoff's 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.

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.