2010/2011 COMMEMORATIVE ISSUE

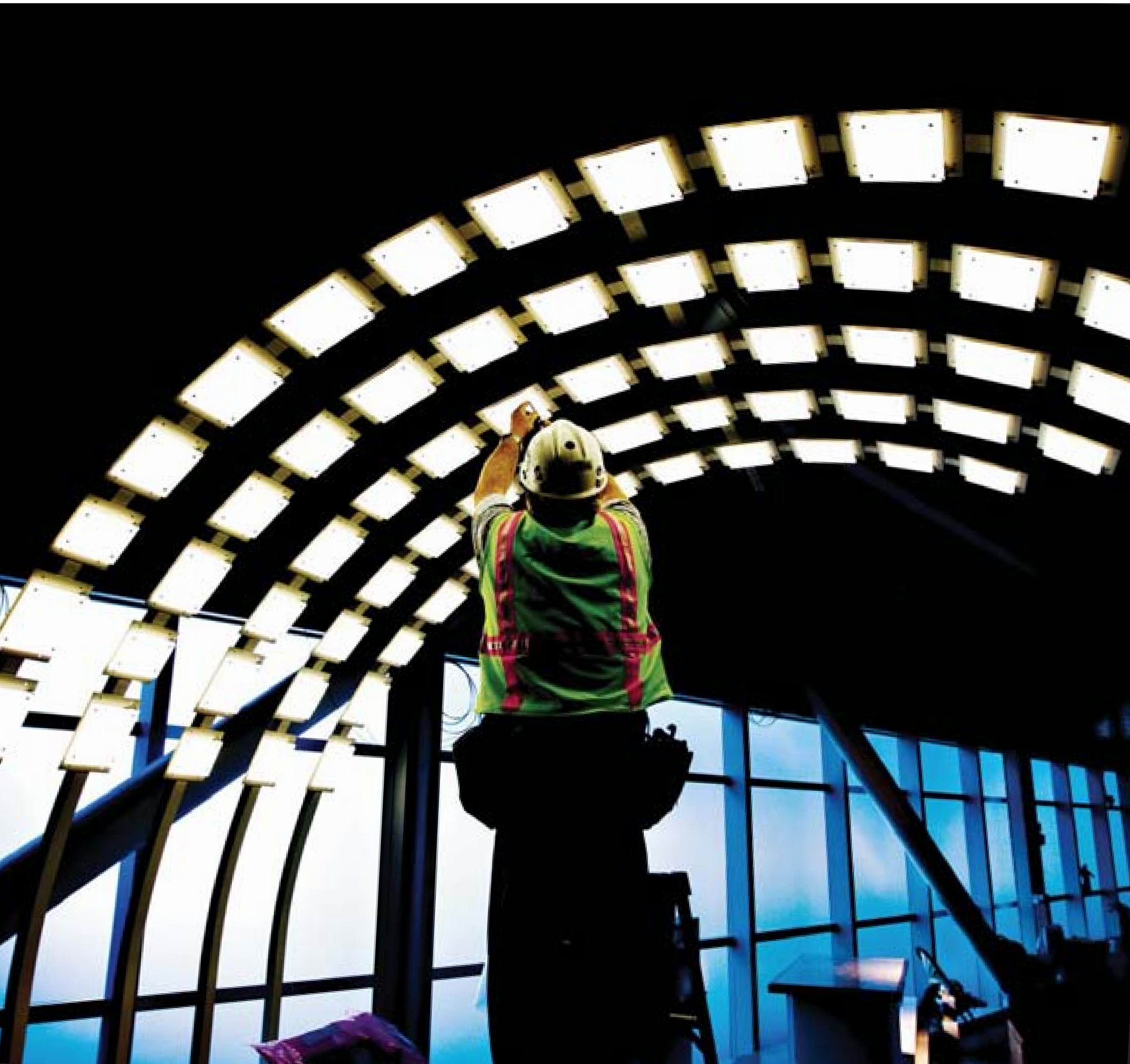
CORE

A Publication of the Computer History Museum

Transforming the Museum

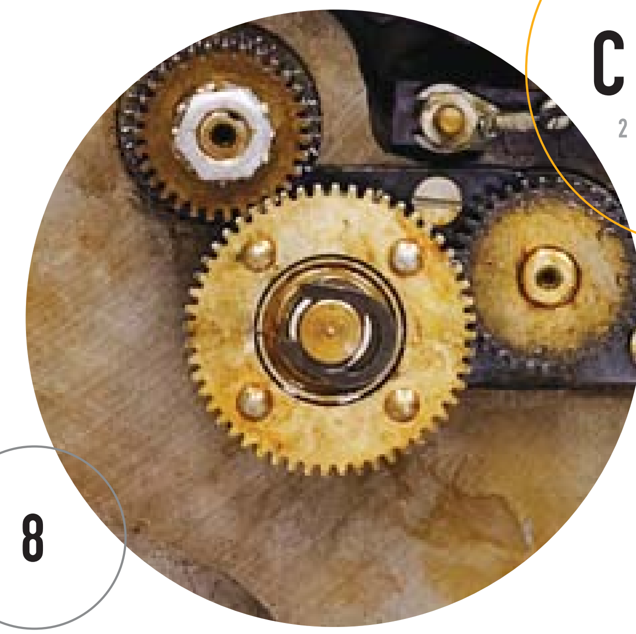
Putting the Finishing Touches on *Revolution*

Why History Matters



Cover: Leon Liebster of Sprig Electric wires the software arches in the Personal Computers gallery

This page: Installers secure the magnifier on an exhibit that allows visitors to see the step-by-step process which transforms a semiconductor crystal into an integrated circuit



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CORE
2010/2011

MARK RICHARDS

The polished terrazzo floor of the Museum's new lobby is also the world's largest punched card. Can you decode the message?

MARK RICHARDS

THE MUSEUM TRANSFORMED

Welcome to the newest edition of *Core*—and to the newest edition of the Computer History Museum.

January, 2011 marks a new beginning for the Museum with the opening of *Revolution: The First 2000 Years of Computing*. The arrival of *Revolution* is accompanied by a new design for the Museum's main lobby, the opening of new public spaces, and the unveiling of a new retail area.

But most of all, *Revolution* reveals the sights, sounds, objects, and stories of one of the most compelling ideas of our time. Computing has transformed modern life and changed the way we think about the potential of the future. We feel its ongoing impact every day. *Revolution* captures that transformation and puts it into a social and historical context.

A large team of content experts, advisors, artists, filmmakers, builders, and historians has worked for years to launch this new endeavor. A large community of trustees, donors, and supporters has enabled it to spring into life. On behalf of all of them, we hope you enjoy this commemorative edition of *Core*, and enjoy the new Museum experience.

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CEO'S LETTER

WELCOME TO THE REVOLUTION

This issue of *Core* commemorates a major milestone in our history: the opening of *Revolution: The First 2000 Years of Computing*. *Revolution* brings the history of computing to life in a vivid, modern exhibition designed for technical and non-technical audiences alike. Its opening is a transformative event in the Museum's life, and we've dedicated most of this issue of the magazine to the subject.

Revolution represents a significant expansion of the Museum. It now occupies more than 25,000 square feet of space never before open to the public. We have put more of our physical collection on public display than ever before. Every word, film, artifact, and image in the physical exhibition is available on computerhistory.org. Most importantly, *Revolution* has enabled us vastly to expand our interpretation of computing's roots and history, its evolution into a singular force in global life, and its ongoing social and historical impact.

As you will read in these pages, *Revolution* is the product of years of planning. Our exhibits team, led by Vice President Kirsten Tashev, has consulted with hundreds of experts, reviewers, historians, and eyewitnesses around the world. They have combed both our vast archive and many outside collections for the best artifacts, images and other representations of major events in computing. They have made more than a dozen original films and produced media for more than 100 areas of the exhibition. It has been a vast undertaking—one worthy of the kind of place the Museum seeks to be, and the kind of place you have long envisioned.

What does this mean for the Museum? With the opening of *Revolution*, the Museum moves into the top 10 percent of museums nationwide in total exhibit area. We expect to be in the top 25 percent of all U.S. museums in attendance and income. Our operating budget will be in the top 20 percent. These figures, measured against 17,000 U.S museums whose data are reported by the American Association of Museums, reflect the fact that the Museum has come of age and is moving into the category of "big museums" nationally.

Our major focus, of course, is not merely facts and statistics, nor the effort that has gone into the new launch of the Museum and *Revolution* itself. Rather, we have done all of this work with you in mind—our loyal supporters and patrons, and the many thousands more we hope to attract this year and in the future. I am convinced that your new Museum experience will be surprising, unexpected, and very satisfying. More than ever, this will be a place where you'll want to bring your friends and visitors. It will be a spectacular new venue and, ultimately, a hub of culture and education in Silicon Valley.

My hope is that you'll come to the Museum often, bring others along and always be proud to say, "I support this work." On behalf of everyone here, please accept my thanks and know that you now have a standing invitation to the *Revolution* every day.

Yours sincerely,

JOHN C. HOLLAR
PRESIDENT & CHIEF EXECUTIVE OFFICER

Adam Ries, Rechnung auff der Linihen und Feder, 1533. This 15th century illustration shows a table-abacus competing against longhand calculations using "Arabic" numerals, which were still new in Europe

ESSAY

WHY HISTORY MATTERS

Finding inspiration in looking back

BY RICHARD S. TEDLOW

Preparing for CBS to use a UNIVAC in its 1952 election coverage, UNIVAC designer Presper Eckert and operator Harold Sweeney show the machine to American news icon Walter Cronkite

"Practical men," John Maynard Keynes once observed, "who believe themselves to be quite exempt from any intellectual influence, are usually the slaves of some defunct economist." This is an important assertion for our purposes, because "historian" could easily and accurately be substituted for "economist." What does this statement really mean?

It means that you are an historian in spite of yourself. You might never read an academic history book because it is dry and irrelevant to anything which might be of interest to a "practical" man or woman. You might never read popular history because you suspect (in many cases justifiably) that it is merely historical fiction from which there is little to be learned.

Nevertheless, you are the "slave" of some "defunct historian" because you carry around in your mind a picture of how things happen and how things got to be the way they are today. There is a climate of opinion about any number of issues which has been shaped by your teachers, parents, friends, ministers, bosses, and so forth. These people have themselves had their opinions shaped by the people they know and what they see and read. Some of this common wisdom has been shaped by the writings of some defunct historians.

Everybody reading these words could provide an explanation for the American Revolution or Civil War. But few, if any, readers could say where those explanations came from. If asked, they would find themselves saying that "everybody knows" the reason, or they might simply say that they don't know.

We study history so that we do know, so that we are not merely immersed in a climate of opinion established by defunct historians but, rather, fully informed of the sources of our knowledge. With that incomparably important information, we can bring to the surface and test our knowledge. How certain are we that what we think is true is, in fact, true? Without knowing the sources of our views, we can't answer that question. It is, as has been said, not what you don't know but what you know that isn't so that will mislead you. It is impossible to tease these things apart without studying history.

There is, sad to say, no easy formula for doing history. When it comes to the simplest, most fact–based issues, we can often (certainly not always) provide objective historical information. I can tell you that Confederate batteries opened fire on Fort Sumter on April 12, 1861. That is an objective, verifiable fact. But as soon as we get a little past that level, objective truth is lost. The man who claimed to have fired the first shot, a claim that is still widely believed, apparently did not. Did he lie on purpose? Was he merely mistaken? We don't know.

And this is nothing compared to the really big questions. For example, we know when the Civil War took place. But we do not know what caused it. We can provide educated guesses. However, what we are left with is nothing approaching a consensus, but, rather, competing points of view.

History is not engineering. It is not science.

Historians cannot provide mathematical proofs for their views on big issues. Great history, such as is represented by the outstanding exhibition at the Computer History Museum, will provide many facts by which we will be greatly informed and which will enable us to discuss the really big questions with as much accuracy and nuance as they deserve. But when it comes to these big questions, we are likely to leave the Computer History Museum with more questions than answers. If these are the right questions, that is progress.

Some of the exhibits do provide answers. Certain advances in computing were made possible by certain people doing certain things at particular times and places.

But when you step back from the exhibits and try to generalize about what you have learned, the task becomes difficult. First of all, it is impossible not to become overwhelmed by the miracle of modern technology. Today, you can hold in your hand a device that will put libraries full of information at your command. Nothing like this has ever happened before—this "revolution in miniature."

These devices speak to you in unimaginable ways. Alfred, Lord Tennyson lived from 1809 to 1892. From 1850 until his death, he was Britain's Poet Laureate. One of his most famous poems is "The Charge of the Light Brigade," composed in 1854. Today—right now—you can go to The Tennyson Page on your computer and hear the author read the poem. Tennyson made a wax impression of it not long before his death, and it lives on the Internet now. His voice reading that poem will live forever and be accessible to everyone.

Once you get past this sense of amazement, you find yourself facing another, bigger question. How did all this really happen? Does technology drive history? Or is it the other way around? Answer-less questions such as this can be discussed with a new depth and sophistication thanks to the outstanding work of the Computer History Museum.

One last thought

Permit me to make a point about history by going a little far afield before returning to the history of technology specifically. Back in 1940, the outstanding historian Garrett Mattingly had the idea of writing a book on the attempt of the Spanish Armada in 1588 to invade England. He concludes this marvelous volume by observing that, "Meanwhile, as the episode of the Armada receded into the past, it influenced history in another way...It raised men's hearts in dark hours, and led them to say to one another, 'What we have done once, we can do again.' "

The magnificent achievements chronicled and catalogued by the Computer History Museum leave us who see them with the same observation—an observation which Andy Grove often used to raise in the form of a question when he was running Intel. It is an important question. It is a question which deserves our thoughtful consideration.

That question is, "if they could do these things, why can't I?"

Thus, history should be studied because, among so many other reasons, it serves to inspire. ○

Richard S. Tedlow is the Class of 1949 Professor Emeritus at Harvard Business School and a leading biographer and historian.

We study history so that we are not merely immersed in a climate of opinion established by defunct historians but rather fully informed of the sources of our knowledge

The IBM Type 77 Collator, designed initially for the Social Security Administration in 1937, could process 240 cards per minute

MARK RICHARDS

R|EVOLUTION

The First 2000 Years of Computing

A Sneak Preview

WHY A COMPUTER HISTORY MUSEUM?

BY LEONARD J. SHUSTEK

Using the past to help create the future

Humans have been creating tools since before recorded history. For many centuries, most tools served to amplify the power of the human body. We call the period of their greatest flowering the Industrial Revolution.

In the last 150 years we have turned to inventing tools that amplify the human mind, and by doing so we are creating the Information Revolution. At its core, of course, is computing.

"Computer" was once a job title. Computers were people: men and women sitting at office desks performing calculations by hand, or with mechanical calculators. The work was repetitive, slow, and boring. The results were often unreliable.

In the mid 1800s, the brilliant but irascible Victorian scientist Charles Babbage contemplated an error-filled book of navigation tables and famously exclaimed, "I wish to God these calculations had been executed by steam!" Babbage designed his Difference Engine to calculate without errors, and then, astoundingly, designed the Analytical Engine—a completely programmable computer that we would recognize as such today. Unfortunately he failed to build either of those machines.

Automatic computation would have to wait another hundred years. That time is now.

The Universal Machine

The computer is one of one of our greatest technological inventions. Its impact is—or will be—judged comparable to the wheel, the steam engine, and the printing press. But here's the magic that makes it special: it isn't designed to do a specific thing. It can do anything. It is a universal machine.

Software turns these universal machines into a network of ATMs, the World Wide Web, mobile phones, computers that model the universe, airplane simulators, controllers of electrical grids and communications networks, creators of films that bring the real and the imaginary to life, and implants that save lives. The only thing these technological miracles have in common is that they are all computers.

We are privileged to have lived through the time when computers became ubiquitous. Few other inventions have grown and spread at that rate, or have improved as quickly. In the span of two generations, computers have metamorphosed from enormous, slow, expensive machines to small, powerful, multi-purpose devices that are inseparably woven into our lives.

A "mainframe" was a computer that filled a room, weighed many tons, used prodigious amounts of power, and took hours or days to perform most tasks. A computer thousands of times more powerful than yesterday's mainframe now fits into a pill, along with a camera and a tiny flashlight. Swallow it with a sip of water, and the "pill" can beam a thousand pictures and megabytes of biomedical data from your vital organs to a computer. Your doctor can now see, not just guess, why your stomach hurts.

The benefits are clear. But why look backward? Shouldn't we focus on tomorrow?

Why Computer History?

History places us in time. The computer has altered the human experience, and changed the way we work, what we do at play, and even how we think. A hundred years from now, generations whose lives have been unalterably changed by the impact of automating computing will wonder how it all happened—and who made it happen. If we lose that history, we lose our cultural heritage.

Time is our enemy. The pace of change, and our rush to reach out for tomorrow, means that the story of yesterday's breakthroughs is easily lost.

Compared to historians in other fields, we have an advantage: our subject is new, and many of our pioneers are still alive. Imagine if someone had done a videotaped interview of Michelangelo just after he painted the Sistine Chapel. We can do that. Generations from now, the thoughts, memories, and voices of those at the dawn of computing will be as valuable.

But we also have a disadvantage: history is easier to write when the participants are dead and will not contest your version. For us, fierce disagreements rage among people who were there about who did what, who did it when, and who did it first. There are monumental ego clashes and titanic grudges. But that's fine, because it creates a rich goldmine of information that we, and historians who come after us, can study. Nobody said history is supposed to be easy.

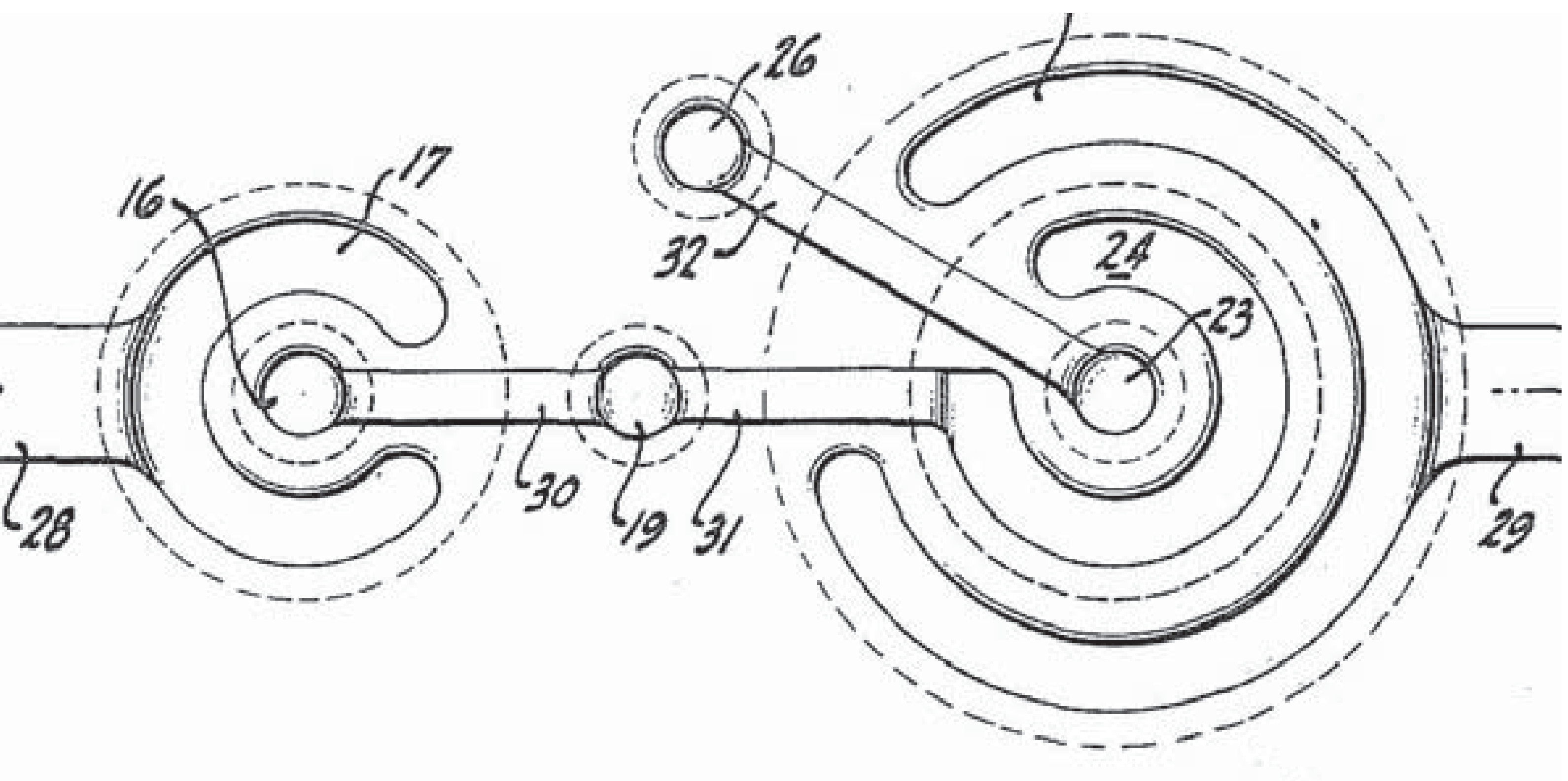
It's important to preserve the "why" and the "how," not just the "what." Modern computing is the result of thousands of human minds working simultaneously on solving problems. It's a form of parallel processing, a strategy we borrowed to use for computers. Ideas combine in unexpected ways as they built on each other's work.

Even simple historical concepts aren't simple. What's an invention? Breakthrough ideas sometimes seem to be "in the air" and everyone knows it. Take the integrated circuit. At least two teams of people invented it, and each produced a working model. They were working thousands of miles apart. They'd never met. It was "in the air."

Often the process and the result are accidental. "I wasn't trying to invent an integrated circuit," Bob Noyce, co-inventor of the integrated circuit, was quoted as saying about the breakthrough. "I was trying to solve a production problem." The history of computing is the history of open, inquiring minds solving big, intractable problems—even if sometimes they weren't trying to.

The most important reason to preserve the history of computing is to help create the future. As a young entrepreneur, the story goes, Steve Jobs asked Noyce for advice. Noyce is reported to have told him that "You can't really understand what's going on now unless you understand what came before."

Technology doesn't run just on venture capital. It runs on adventurous ideas. How an idea comes to life and changes the world is a phenomenon worth studying, preserving, and presenting to future generations as both a model and an inspiration.



Figures from Robert Noyce's planar IC patent, "Semiconductor device-and-lead structure" (U. S. Patent # 2981877) filed in July, 1959

History Can Be Fun

Besides—computer history can be fun. An elegantly designed classic machine or a well-written software program embodies a kind of truth and beauty that give the qualified appreciative viewer an aesthetic thrill. Steve Wozniak's hand-built motherboard for the Apple I is a beautiful painting. The source code of Apple's MacPaint program is poetry: compressed, clear, with all parts relating to the whole. As Albert Einstein observed, "The best scientists are also artists."

Engineers have applied incredible creativity to solve the knotty problems of computing. Some of their ideas worked. Some didn't. That's more than ok; it's worth celebrating.

Silicon Valley understands that innovation thrives when it has a healthy relationship with failure. ("If at first you don't succeed…") Technical innovation is lumpy. It's non-linear. Long periods of the doldrums are smashed by bursts of insight and creativity. And, like artists, successful engineers are open to the happy accident.

In other cultures, failure can be shameful. Business failure can even send you to prison. But here, failure is viewed as a possible prelude to success. Many great technology breakthroughs are inspired by crazy ideas that bombed. We need to study failures, and learn from them.

Where are all the museums?

Given the impact of computing on the human experience, it's surprising that the Computer History Museum is one of very few institutions devoted to the subject.

There are hundreds of aircraft, railroad, and automobile museums. There are only a handful of computer museums and archives. It's difficult to say why. Maybe the field is too new to be considered history.

We are proud of the leading role the Computer History Museum has taken in preserving the history of computing. We hope others will join us.

The kernel of our collection formed in the 1970s, when Ken Olsen of the Digital Equipment Corporation rescued sections of MIT's Whirlwind mainframe from the scrap heap. He tried to find a home for this important computer. No institution wanted it. So he kept it and began to build his own collection around it.

As a young entrepreneur, the story goes, Steve Jobs asked Robert Noyce for advice. Noyce is reported to have told him that "You can't really understand what's going on now unless you understand what came before."

Gordon Bell, also at DEC, joined the effort and added his own collection. Gordon's wife, Gwen, attacked with gusto the task of building an institution around them. They saw, as others did not, that these early machines were important historical artifacts—treasures—that rank with Gutenberg's press. Without Olsen and the Bells, many of the most important objects in our collection would have been lost forever.

Bob Noyce would have understood the errand we are on. Leslie Berlin's book *The Man Behind The Microchip* tells the story of Noyce's comments at a family gathering in 1972. He held up a thin silicon wafer etched with microprocessors and said, "This is going to change the world. It's going to revolutionize your home. In your own house, you'll all have computers. You will have access to all sorts of information. You won't need money any more. Everything will happen electronically."

And it is. We are living in the future he predicted.

The Computer History Museum wants to preserve not just rare and important artifacts and the stories of what happened, but also the stories of what mattered, and why. They are stories of heretics and rebels, dreamers and pragmatists, capitalists and iconoclasts—and the stories of their amazing achievements. They are stories of computing's Golden Age, and its ongoing impact on all of us. It is an age that may have just begun. ○

Dr. Leonard J. Shustek is the Museum's co-founder and Chairman of the Board of Trustees. He acted as chief curator in the development of the content plan for *Revolution*.

BY KIRSTEN TASHEV

INTERPRETING HISTORY

Finding the right balance in telling an epic story

History with its flickering lamp stumbles along the trail of the past, trying to reconstruct its scenes, to revive its echoes, and kindle with pale gleams the passion of former days

WINSTON CHURCHILL

Developing a history exhibition almost always involves balancing the tension of chronology and theme. Chronology is simple: in the case of computers, the approach might be, "The mainframe begat the minicomputer, the minicomputer begat the personal computer, …" Who doesn't like the simplicity and drama of the "Milestones of History" or, for that matter, "David Letterman's Top Ten"?

Organizing by theme is also popular. A historian might say: Let's show visitors a succession of disk drives and let them see the evolution story of how they just got smaller and smaller.

Of course, in reality, history is not so simple, or simply thematic. Many events happen in parallel, breakthroughs come out of left field, connections are often indirect. And so-called obsolete technologies still persist today.

And then there is the physical reality of an exhibition, where designers and curators must choose where artifacts and stories will physically go. In the disk drive example, a strict chronology would place the first disk drive, the RAMAC 305, in 1956, and then IBM's microdrive in 1999. In this layout, the two could be hundreds of feet away from each other, and the drama of contrasting a 24" disk platter next to a 1-1/4" disk platter is completely lost.

For *Revolution*, we chose to balance theme and chronology. To capture the drama of historical milestones, while preserving a thematic framework, we developed a conceptual approach of 19 themed galleries. Each gallery shows the development of computing over time. Yet each also is anchored by a milestone object—an icon—illustrating a dramatic, revolutionary moment in time.

The Memory & Storage gallery transports the visitor back to 1956, when an unorthodox team of West Coast engineers came up with something totally new, the first disk drive, the RAMAC 305. Stored data could be accessed randomly and directly. But the RAMAC isn't the whole story. In the gallery it is surrounded by more stories and a huge array of memory and storage innovation. Some technologies succeeded, some failed, but all form a rich tapestry that represents the evolution of the memory and storage industries.

Another example: In the Computer Games gallery, the visitor travels to 1972 as a young engineer, Al Alcorn, creates one of the first video arcade games, Pong. And with this new arcade game, the pioneering company Atari is born. But Atari isn't the whole story either. Pong is surrounded by a gallery that starts in the earliest days of computing, when computer programmers developed games for mainframes and, later, minicomputers and finally, for the computer game platforms we know today.

Thus, the history of memory and storage is told thematically with the RAMAC 305 as its icon. The history of computer games is told thematically with Pong as its icon. Each gallery is organized in this way. This overall approach gave us the curatorial freedom to highlight objects based on their historical significance as well as their appeal to visitors, and to make them gateways to a larger thematic story.

The Interpretive Challenges

Once we settled on the curatorial structure, we moved to another set of important questions. First, how comprehensive should the exhibition be? A key consideration in exhibition planning is never what to put in, but what to leave out. We had to grapple with the physical constraints of the space, the limits of visitors' endurance, and, most importantly, the Museum's commitment to interpret the story of computing in a way that makes it accessible to a broad audience.

The team decided early on that *Revolution* could not and should not be an exhaustive treatment. *Revolution* is a representation of overarching themes and stories that are significant or representative, and also interesting to visitors. Sometimes (when you are lucky) a story is both important and interesting! The exhibition therefore becomes a kind of introduction to computer history: the technology, the people, the successes and failures. The goal is for the visitor to be intrigued, not overwhelmed, and to want to learn more, either online or through additional reading.

Then we moved to questions of interpretation. Would the exhibition be object-driven or story-driven? In other words, should we only tell stories for which we have objects? How would we create an exhibition about software? What about significant machines that no longer exist?

The decision was clear. *Revolution* would be a story-based exhibition. The objects in the Museum's vast collection would be a springboard for stories about all sorts of things: hardware stories, software stories, people stories, even sociological and political stories. Exhibition techniques, like movies and dioramas, models and photomurals—and, yes, objects—would bring those stories to life.

A third set of questions involved the "voices" for *Revolution*. The history of computers is contemporary. Most of the story happened in living memory. Exhibitions about contemporary history are powerful, because everyone who walks through the door (regardless of age) has some personal connection to the story. A personal connection to a story is a powerful tool for learning.

But we also know that many of our visitors were "present at the creation." Some might even be the pioneers who worked on the objects on display. Here is where history gets messy. Those who have a stake in the story are likely to have a view about how the story should be told. You could call this frame of mind: "I was there, dammit!" Yet the historian is obligated to ask: are they remembering correctly? Do other participants agree?

We chose to embrace the contemporary nature of computing history. The curatorial "voice" in *Revolution* is intended to act as a friendly, informed guide, and we often provide the participants with a platform to tell their stories from their own perspectives. Most of these perspectives are presented in more than 100 media stations, which are rich with stories from the Museum's oral history collection. The curatorial decisions themselves were shaped by consultation with dozens of experts and participants around the world.

The Audience

As we dealt with all of these issues, we always had an overarching question in mind: What about our audience? A particular challenge for the Museum is the range of expertise of our visitors. Some simply use computers and are curious about who invented them. Others are engineers, programmers, and technical experts in the industry. And, of course, some are the legends who've made computing possible.

How can an exhibition be all things to all people? It can't. The *Revolution* team decided early on, therefore, that the primary audience for the exhibition would be non-technical visitors. An exhibition is a lousy medium for the exhaustive presentation of facts. We see *Revolution* as an important, long-term chance to make computer history accessible and compelling to the broadest possible audience.

We then began to think about how we could respond to visitors of different ages, learning styles, and expertise. We set about to create a variety of entry points. There are charts and graphs for quantitative learners. There are atmospheric murals, models, and recreated environments with sights and sounds for experiential learners. There are stories about people and companies for narrative learners. There are hands-on displays and demonstrations for explorative learners. The information is layered so that visitors can go as deep as their interests take them.

Atari founders Ted Dabney and Nolan Bushnell with Larry Emmons and Pong creator Al Alcorn, 1972

Media plays a key role. The team developed more than 100 media elements, including minimovies, animations, atmospheric slide shows, oral history excerpts, and even vintage video games. The media brings objects to life, shows machines as they once operated, captures the personalities of the inventors, and tells stories that are emotive of the times.

We will use media to keep the exhibition fresh. For example, the Museum's oral history program is ongoing and new excerpts can be added over time.

We have years of experience with a more technical audience, and our team has ensured there's plenty in *Revolution* for our lovable "geek" visitors. They often carry the stories in their heads and we know the sheer joy they get just by looking at an old computer and "decoding" it. They value understanding the complexity of computing and the "back stories" of technology.

Thus, the curatorial team tried wherever possible to show complexity and select stories that were less well known in technical circles. Technical specifications for key machines are included. The oral history stations present computing pioneers explaining their technical breakthroughs in their own words. In short, *Revolution* is accessible and engaging but also has "meat"a technical person can sink his or her teeth into.

Design

Finally, we understood that exhibition design plays a key role in creating a high-quality visitor experience. The Museum was fortunate to work with Dennis VanSickle and Andrea Rolleri and their outstanding team at VS&R, an experienced exhibition design firm, on *Revolution*'s design and on the overall visitor experience.

The design team understood from the start that content would take a front seat. Neutral colors ensure that the artifacts, images and media stand out. The walls and floor treatment create intimate galleries so that the 19 themes clearly emerge. A wood floor creates the main path through the gallery and touches each of the icons and milestones. Lighting creates a sense of drama, highlighting objects large and small, and guides the visitor through strategic placement. This design approach allows visitors to navigate through this large and complex exhibition. The goal is to create a space where visitors feel a sense of adventure, exploration, and surprise!

What's Next?

With the opening of *Revolution*, the Museum begins a new chapter. The possibilities are endless for creating thematic connections across the 19 galleries, whether through live docent tours or with handheld technology. The online exhibition allows for significant growth in both breadth and depth. Finally, the extensive infrastructure for media allows us to include additional oral histories and entirely new films in all of the theaters. *Revolution* will evolve, change, and progress—just as the exhibition's subject itself. ○

Kirsten Tashev is the Museum's Vice President of Collections & Exhibitions. She led the development of *Revolution* from the project's inception in 2000.

IN THEIR OWN WORDS: ORAL HISTORIES

"I'm sitting on a curb or some steps outside of a bus terminal, waiting for this guy…and the idea of playing games with a television set resurfaced… The next morning in my office I sat down and wrote a four-page paper… It lays out the whole idea of attaching something to a television set and playing interactive games with it, though I don't think the term interactive was there yet. It was not until early next year that I conferred with a director of R&D, suggested that maybe he ought to put a few bucks into it to make it a legitimate project."

PIONEER VIDEO GAME DEVELOPER RALPH BAER DESCRIBES HIS 1966 "AHA" MOMENT

An art museum curator or historian would give anything if Leonardo DaVinci were still alive to answer a few questions—on videotape. The Museum is blessed with a priceless opportunity: most of the computer DaVincis are still with us. The Museum's Oral History Program has captured their thoughts in more than 300 videotaped oral histories.

Visitors to *Revolution* find themselves face-to-face with the giants in more than 50 oral history clips. MacPaint authors Andy Hertzfeld and Bill Atkinson recall the creation of MacPaint, one of the most beautifully conceived and executed software programs in history. Charles Simonyi describes the genesis of WYSIWYG, which is why the document you see on your screen is exactly what comes out of your printer. Max Mathews shares stories from the early history of computer music.

Our oral histories capture the remarkable personalities behind the technology. Many talk more like artists than engineers. Some are quiet tinkerers. They all like to play—with machines, concepts, problems, and wild ideas. (The man who headed the IBM System/360 project wrote that the engineeer working in a lab perfectly expressed the creative joy of a child making mud pies.)

There are deep, inspiring lessons here. Math and science are fun. Building things that solve human problems is a worthy calling. New problems are a chance for new learning. So are mistakes. The oral histories excerpted for *Revolution* are an appetizer. They can be enjoyed in full at computerhistory.org, as videos or as PDF transcripts.

BY PAULA JABLONER

SEARCHING FOR HIDDEN GEMS

The Museum's extensive collection is a curator's kaleidoscope of possibilities for developing *Revolution: The First 2000 Years of Computing*. The artifacts, oral histories, marketing brochures, photographs, audio recordings, letters, software, films, and ephemera are interwoven to create a tapestry of computing history for the Exhibition.

Since January, 2010, the Museum archivists' mantra has been, "The hunt is on!" They searched the Museum's collection and scoured other repositories in pursuit of the perfect imagery to make computing history come alive on your *Revolution* visit. This was their true reward after years of diligent cataloging. The photographs, documents, graphics, and artifacts all work in concert to provide a sense of time and place, creating a human dimension that everyone can relate to.

The UNIVAC computer cuts a distinctive impression, but The Univac System brochure depicting the UNIVAC as the center of the universe, usurping the sun, raises it to other-worldly status. It shouts of a hubris far beyond the anchored weight and solid lines of the artifact itself. Its space iconography permeates the brochure, almost wrapping you in the 1950s.

Or maybe your fancy will be tickled with a 1956 typewritten letter, in the Analog Computers gallery, from Richard Norberg, who was leaving the University of Illinois. The letter to Professor Nordsieck referenced the transfer of $500 in Nordsieck "spare-parts." Norberg planned to build his own differential analyzer with the parts and the letter's intent was to avoid University red tape.

The heroic glitz of the marketing brochures is contrasted by the functional severity of employee ID badges, with their unflattering DMV-style photos. You can inspect ENIAC co-inventor J. Presper Eckert's UNIVAC badge in the Early Computer Companies gallery, or a youthful Robert Noyce's Intel ID in the Digital Logic gallery. Compare your badge to theirs, and consider whether security or photography has gotten any better over the years.

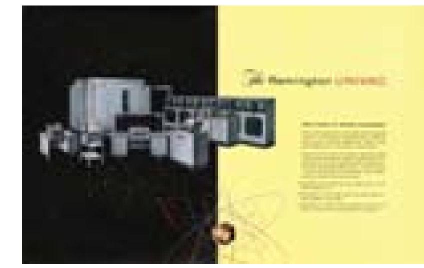
Stroll into the Computer Games gallery and dance to the 1982 classic disco tune, *Pac-Man Fever*. With her background in music, one archivist found her muse in combing through the Museum's audio collection. Could your muse be the LP, *Music from Mathematics played by IBM 7090 Computer and Digital to Sound Transducer*, now embarking on its second life in the Computer Graphics, Music & Art gallery?

Step into the Supercomputers gallery to view *The Cray Way* movie, featuring many artifacts from the collection, including newly animated Cray pamphlets. The Museum shot footage and personal stories in Cray's hometown of Chippewa Falls, Wisconsin. A twist on mining the archives, the new interviews were added to the permanent collection.

The cumulative effect of all the riches gleaned from the Museum's collection creates an impact that any of the items alone would lack. You'll find yourself transported back through the decades. Will seeing that first addictive game you played as a teenager among the illuminated software boxes in the Personal Computer gallery trigger a few high-scoring memories?

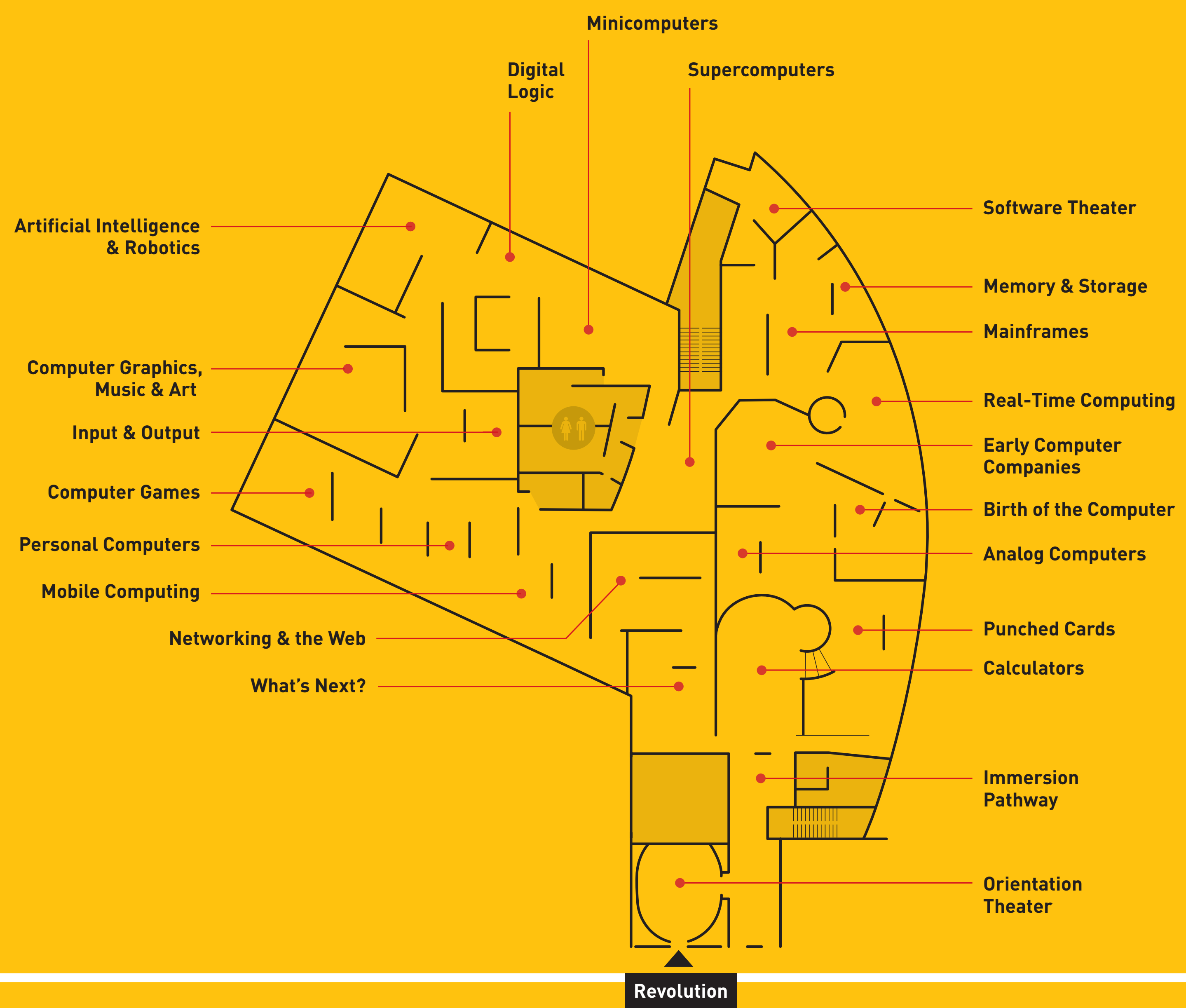
After 35 years of intense collecting, the Museum has amassed more than 5,000 linear feet of archives, 10,000 photographs, 3,000 moving images, more than 450 oral histories and thousands of artifacts, many displayed for the first time in *Revolution*. ○

Paula Jabloner is the Museum's Director of Collections. She directed a multi-year effort to collect, catalog and prepare the extensive number of artifacts in *Revolution*.



Top: The Univac System brochure, 1955

Bottom: The playing field for Namco's Pac-Man, 1980



Floor plan of the *Revolution* Exhibition

REVOLUTION: THE FIRST 2000 YEARS OF COMPUTING

TAKE A WALK ▶

EDITED BY THE CURATORIAL STAFF

PHOTOGRAPHS BY MARK RICHARDS

FIRST STEPS ON THE PATH TO COMPUTERS

CALCULATORS

Banks calculating interest. Kids dividing up cookies. Engineers designing bridges. We make calculations every day. And for as long as we've juggled numbers greater than our fingers and toes, we've sought aids to make computations easy and accurate.

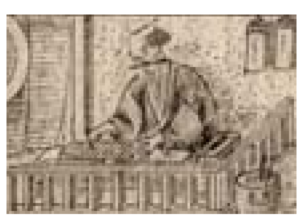
For centuries, calculators were the only machines to help us compute forming a long lineage of devices stretching from the ancient abacus to today's digital computer.

The Versatile, Venerable Abacus

An American soldier and Japanese postal worker faced off in Tokyo in 1946. Pvt. Thomas Wood had an electric calculator. Kiyoshi Matsuzaki held a soroban, a Japanese abacus. Each was a champion at operating his device. In four out of five competitive rounds, the abacus won.

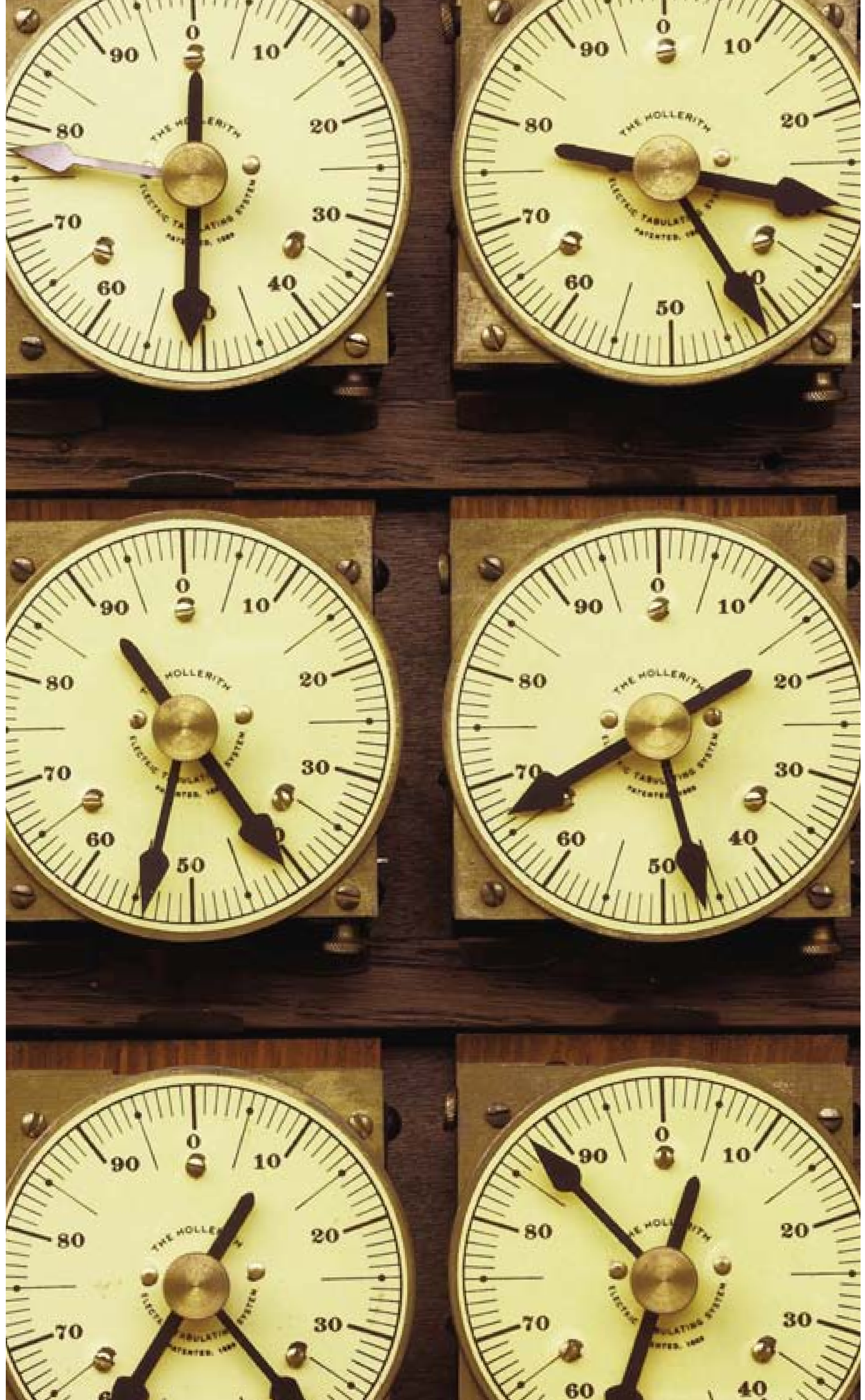
Perhaps the oldest continuously used calculating tool aside from fingers, the abacus is a masterpiece of power and simplicity. Abacuses were widely used in Asia and Europe for centuries, and remain common today.

Abacus from Boston's Hong Far Low restaurant, founded in 1879, on loan from the Museum of Chinese in America. Courtesy of the Family of Louie Shee Wong and Gok Jum Wong



The merchant with his counting frame, ink drawing, probably by Kano, 1878

KANO IMAGE COURTESY OF THE LIBRARY OF CONGRESS



Hollerith Electric Tabulating System (replica) by Roberto Guatelli

PUNCHED CARDS

FROM MATH TO DATA

People used calculators to manipulate numbers. But how do you make machines that also manipulate words or ideas?

Punched cards, a mainstay of early office automation and computing, helped launch the transition from doing math to processing data. Patterns of holes punched in cards can represent any kind of information. Punched cards can preserve data too: just file them away!

Making Sense of the Census: Hollerith's Punched Card Solution

Nothing stimulates creativity like a good crisis.

The U.S. Constitution requires a census every decade. That was manageable in 1790, with fewer than four million Americans to tally. Not so simple a century later, with 63 million. Estimates warned that the 1890 census wouldn't be finished before the 1900 census began!

The government's answer? A contest to devise a solution. Herman Hollerith won. He suggested recording data on punched cards, which would be read by a tabulating machine.

ANALOG COMPUTERS

DIFFERENT WAYS TO MEASURE AND MODEL THE WORLD

Our world is a symphony of infinite variations. Long before digital computers existed, engineers built models to simulate those real world nuances.

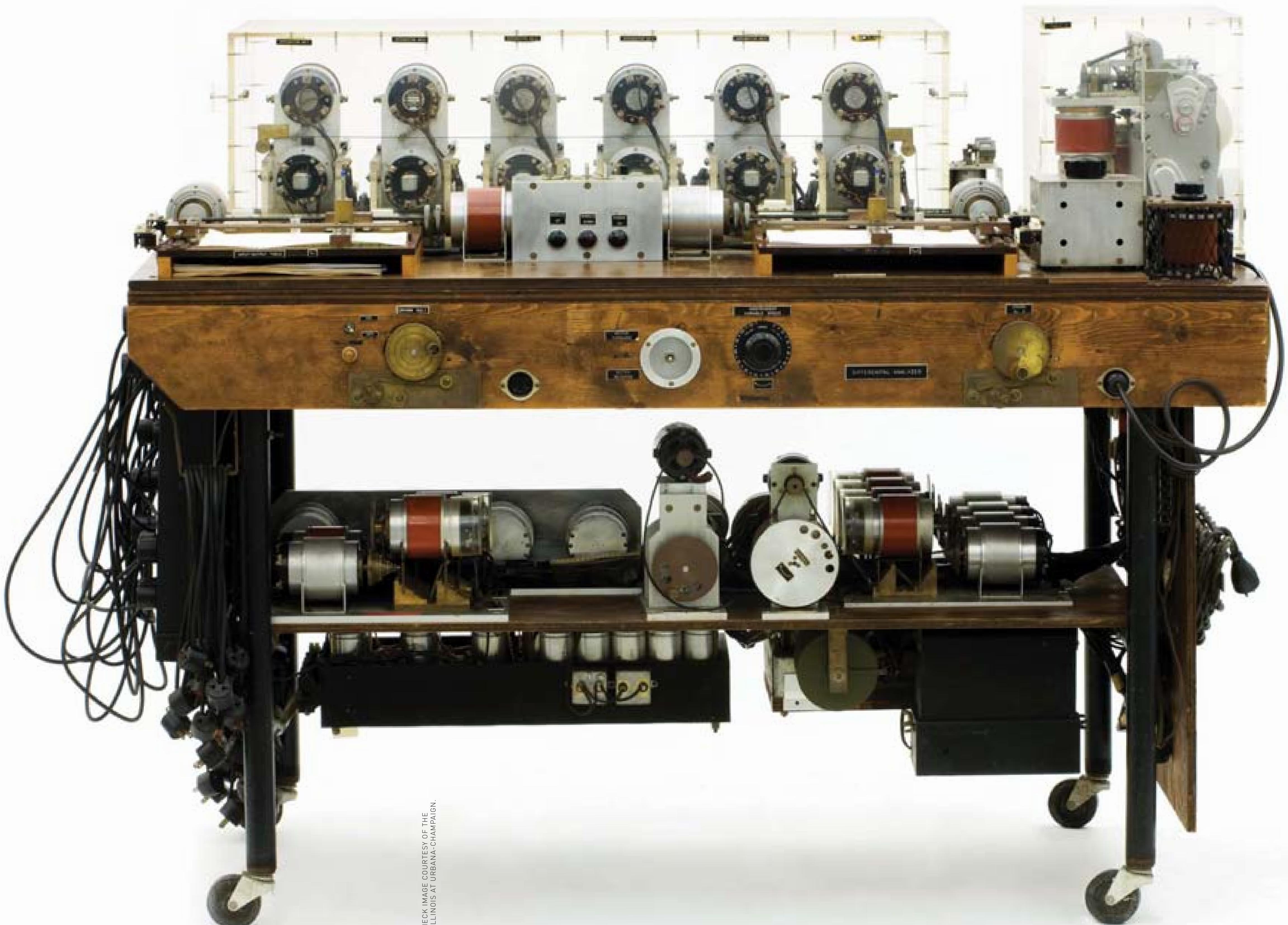
Analog computers continued this tradition, using mechanical motion or the flow of electricity to model problems and generate answers quickly. They remained the preferred tool until digital computers, based on electronic switches, became fast enough for software to do the same job.

Nordsieck's Differential Analyzer
Using $700 worth of surplus World War II supplies, Arnold Nordsieck assembled an analog computer in 1950. It was modeled on differential analyzers built since the 1930s—but with key differences.

For instance, Nordsieck's computer used electrical connections instead of mechanical shafts. And he set himself the priorities of "convenience and simplicity,... portability, and economy." His device's small size and straightforward engineering satisfied the first three requirements. Its $700 price tag satisfied the fourth. ○

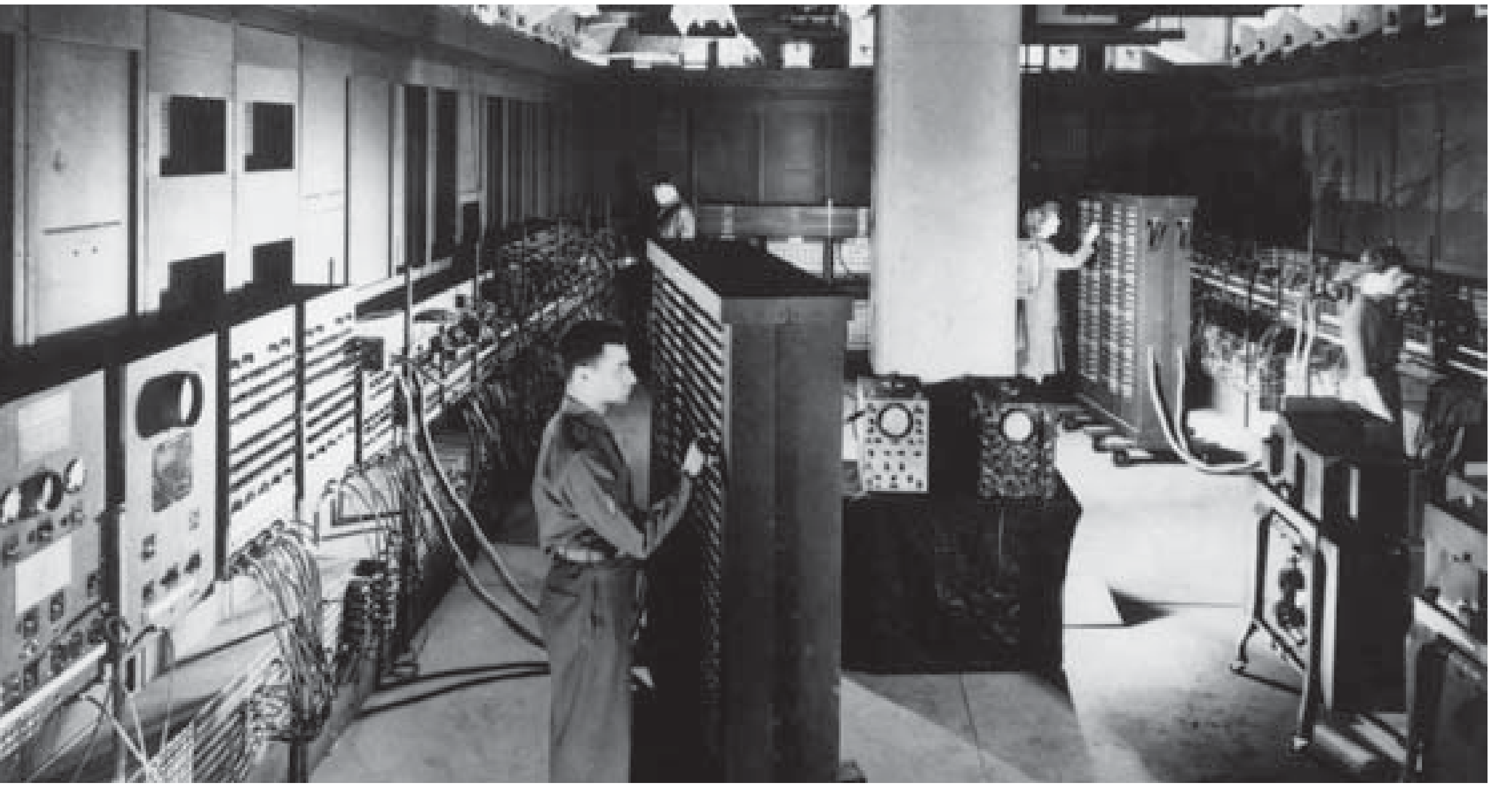
Arnold Nordsieck with the Nordsieck Differential Analyzer, 1950

Nordsieck Differential Analyzer, US, 1956



ARNOLD NORDSIECK IMAGE COURTESY OF THE UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN.

ENIAC, University of Pennsylvania, ca. 1945



COURTESY OF THE UNIVERSITY OF PENNSYLVANIA ARCHIVES

BIRTH OF THE COMPUTER

COMPUTATION BECOMES ELECTRONIC

World War II acted as midwife to the birth of the modern electronic computer. Unprecedented military demands for calculations—and hefty wartime budgets—spurred innovation.

Early electronic computers were one-of-a-kind machines built for specific tasks. But setting them up was cumbersome and time-consuming. The revolutionary innovation of storing programs in memory replaced the switches and wiring with readily changed software.

ENIAC

In 1942, physicist John Mauchly proposed an all-electronic calculating machine. The U.S. Army, meanwhile, needed to calculate complex wartime ballistics tables. Proposal met patron.

The result was ENIAC (Electronic Numerical Integrator And Computer), built between 1943 and 1945—the first large-scale computer to run at electronic speed without being slowed by any mechanical parts. For a decade, until a 1955 lightning strike, ENIAC may have run more calculations than all of mankind had done up to that point. ○

THE FIRST COMPUTER COMPANIES

EARLY COMPUTER COMPANIES

The stored-program electronic computer represented a breakthrough. But if you wanted one, you had to build it yourself. There were no commercial manufacturers.

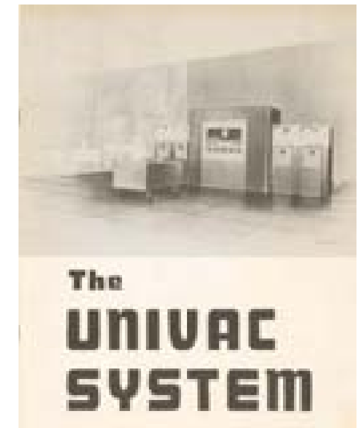
As interest grew, both startups and existing companies gambled that making general-purpose computers for others might prove a viable business. Yet nobody knew how big the potential market was or whether such a venture was savvy or folly.

UNIVAC

Computing burst into popular culture with UNIVAC (Universal Automatic Computer), arguably the first computer to become a household name.

A versatile, general-purpose machine, UNIVAC was the brainchild of John Mauchly and J. Presper Eckert, creators of ENIAC. They proposed a statistical tabulator to the U.S. Census Bureau in 1946, and in 1951, UNIVAC I passed Census Bureau tests.

Within six years, 46 of the million-dollar UNIVAC systems had been installed—with the last operating until 1970. ○



The UNIVAC System brochure, 1955, and close-up UNIVAC I Supervisory Control Console, Remington Rand, 1951

© REMINGTON RAND, INC.

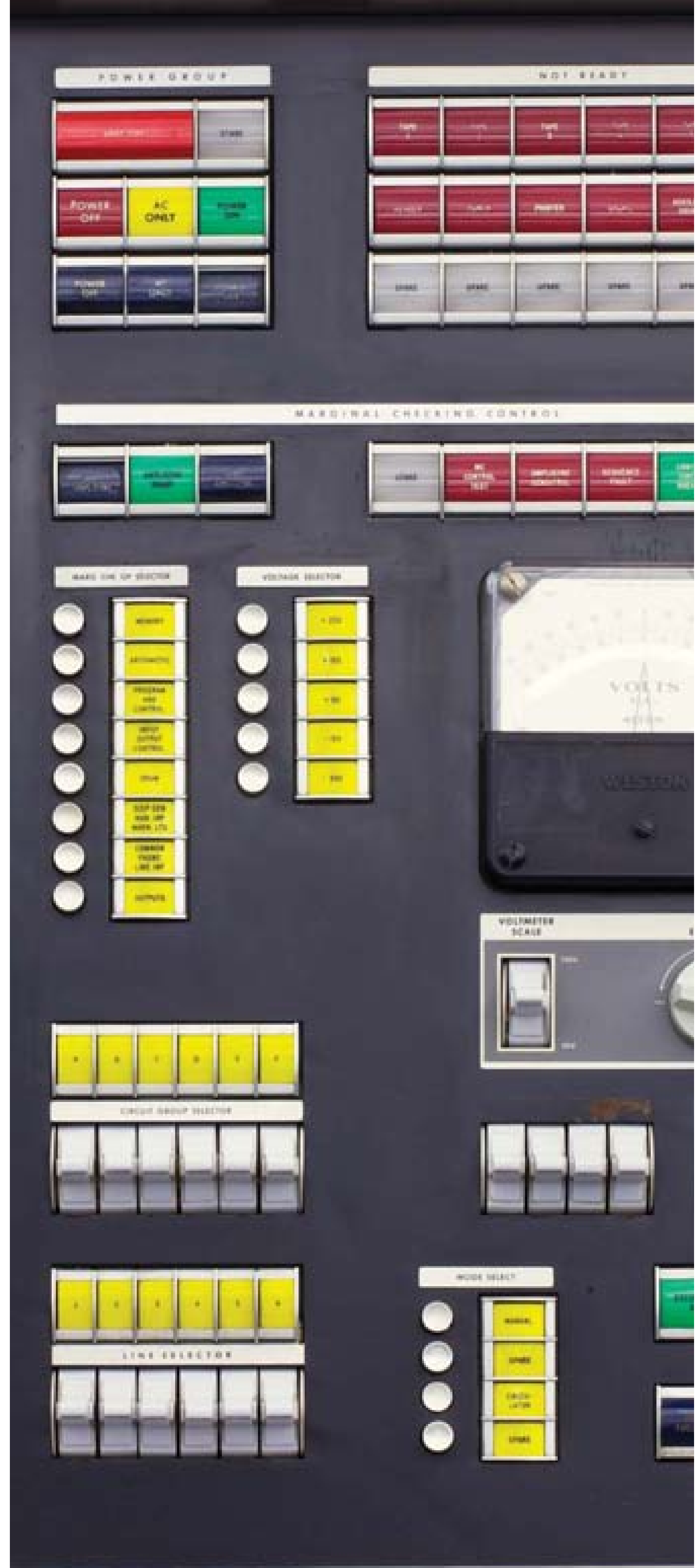
UNIVAC I Supervisory Control Console, Remington Rand, US, 1951

REAL-TIME COMPUTING

REACTING TO THE REAL WORLD

SAGE Weapons Director Console with Light Gun (right) and Intercept Technician Console, 1958

CAPT. CHARBONNEAU IMAGE COURTESY OF THE MITRE CORPORATION



SAGE Maintenance Console, IBM, 1958

Taking a census? You can wait while computers crunch the numbers. Braking your car? Guiding a missile? Running an assembly line? Waiting is not recommended. Time matters.

Real-time computing responds to events as they happen, something even early computers were able to do. Demand for real-time computing began with the military, but swiftly expanded to industrial, medical, and soon, everyday uses.

A SAGE Defense

Fear of nuclear-armed Soviet bombers terrified 1950s America. SAGE, a massive real-time control and communications system developed for the Air Force by Lincoln Laboratories, offered a solution.

SAGE (Semi-Automatic Ground Environment) linked 23 sites across the U.S. and Canada, coordinating weapons systems and processing radar, weather reports, and other data. By the time it became fully operational in 1963, however, the principal threat had shifted from aircraft to missiles, making SAGE's value questionable. Nevertheless, it remained in service until 1982. ○

Capt. Charbonneau sits in front of SAGE's situation display console at the Lincoln Labs' Experimental Direction Center, where SAGE testing took place

THE BACKBONE OF BIG BUSINESS

MAINFRAMES

With technology, what you can do influences what you want to do—which gradually expands what you can do.

Businesses in the 1950s increasingly recognized computers' broad potential. They demanded flexible, large-scale machines able to consolidate varied tasks. The workhorse mainframe computers that met these demands in turn reshaped how businesses operate, increasing centralization and nourishing new demand for powerful mainframes.

Fred Brooks, computer architect, ca. 1965

IBM System /360

IBM dominated computing in 1961, with about two-thirds of the American market. But could IBM hold onto its lead? Its product line was fragmented with incompatible machines, poorly suited to offer companies a single, unified, easily expandable system.

IBM's System/360, a new family of general-purpose computers, changed everything. Programs for one System/360 computer ran on all, letting customers readily consolidate computing capabilities.

Every subsequent IBM mainframe is a descendant of the first System/360s. ○

IBM S/360 tape drives, 1964

Rey Johnson in front of RAMAC, ca. 1956

MEMORY & STORAGE

HOW COMPUTERS REMEMBER

Computers are master jugglers, multitasking as we play music, solve equations, surf the web, and write novels. They also have become vast, searchable libraries of everything from banking records and encyclopedias to grandma's recipes.

These abilities require two kinds of memory: main memory (fast and comparatively expensive) and storage (big, slower, and cheap). Both types have rapidly and continually improved.

The First Disk Drive: RAMAC 350
Computers hold thousands of data records. Imagine if finding the one you wanted required starting with the first, then going through them in order.

High speed, random access memory—plucking information from storage without plodding through sequentially—is essential to the way we use computers today. IBM's RAMAC (Random Access Method of Accounting and Control) magnetic disk drive pioneered this ability.

The RAMAC 350 storage unit could hold the equivalent of 62,500 punched cards: 5 million characters. ○

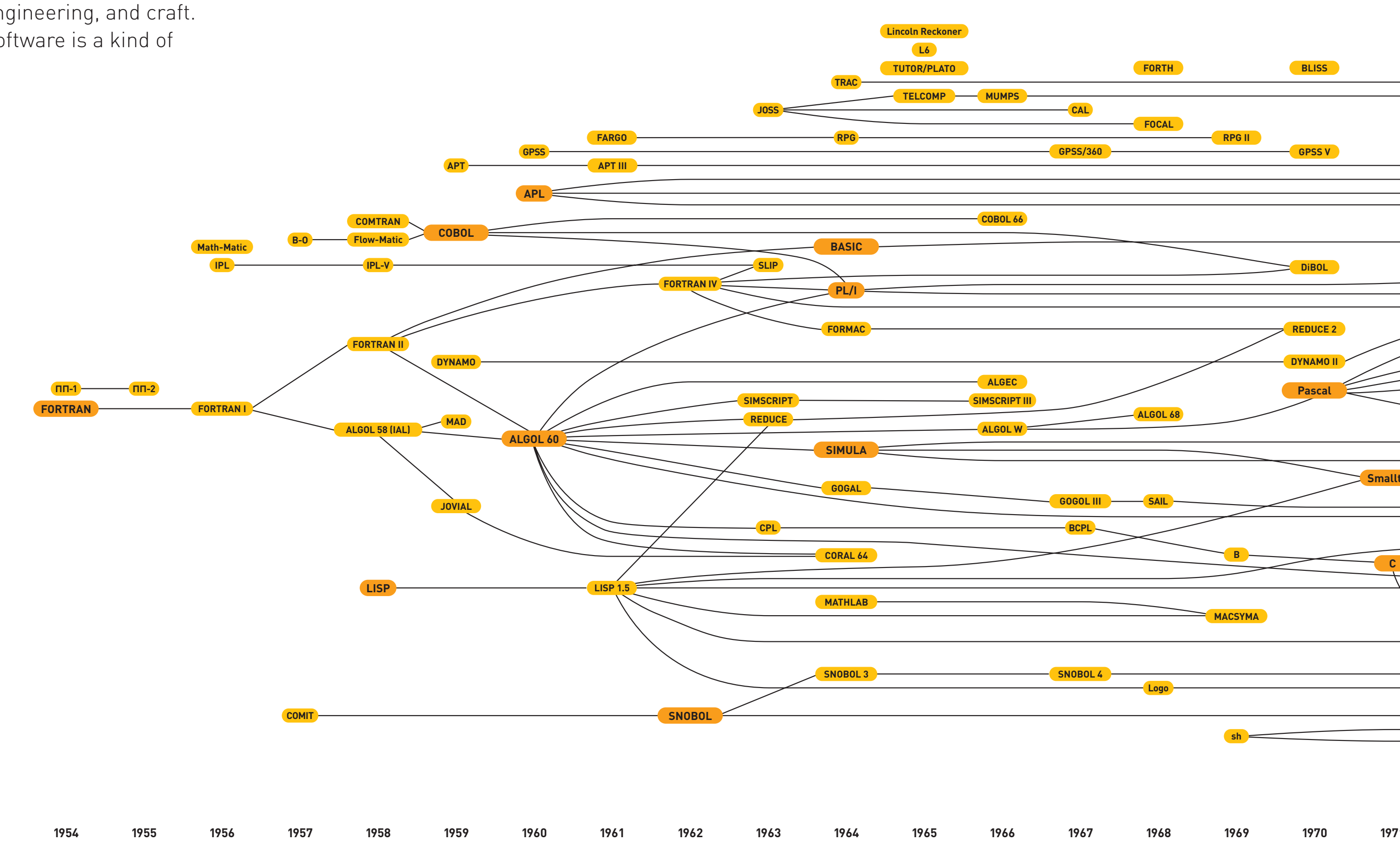
IBM RAMAC actuator and disk stack, 1956, on loan from IBM

TELLING COMPUTERS WHAT TO DO

SOFTWARE

A computer is a versatile machine. It can do nearly anything—but does nothing until instructed by software.

Creating the programs our civilization now depends on involves science, engineering, and craft. Software is a kind of literature, written for both computers and people to read. But it's also a business: making, selling, and supporting it is a multi-billion dollar industry. ○



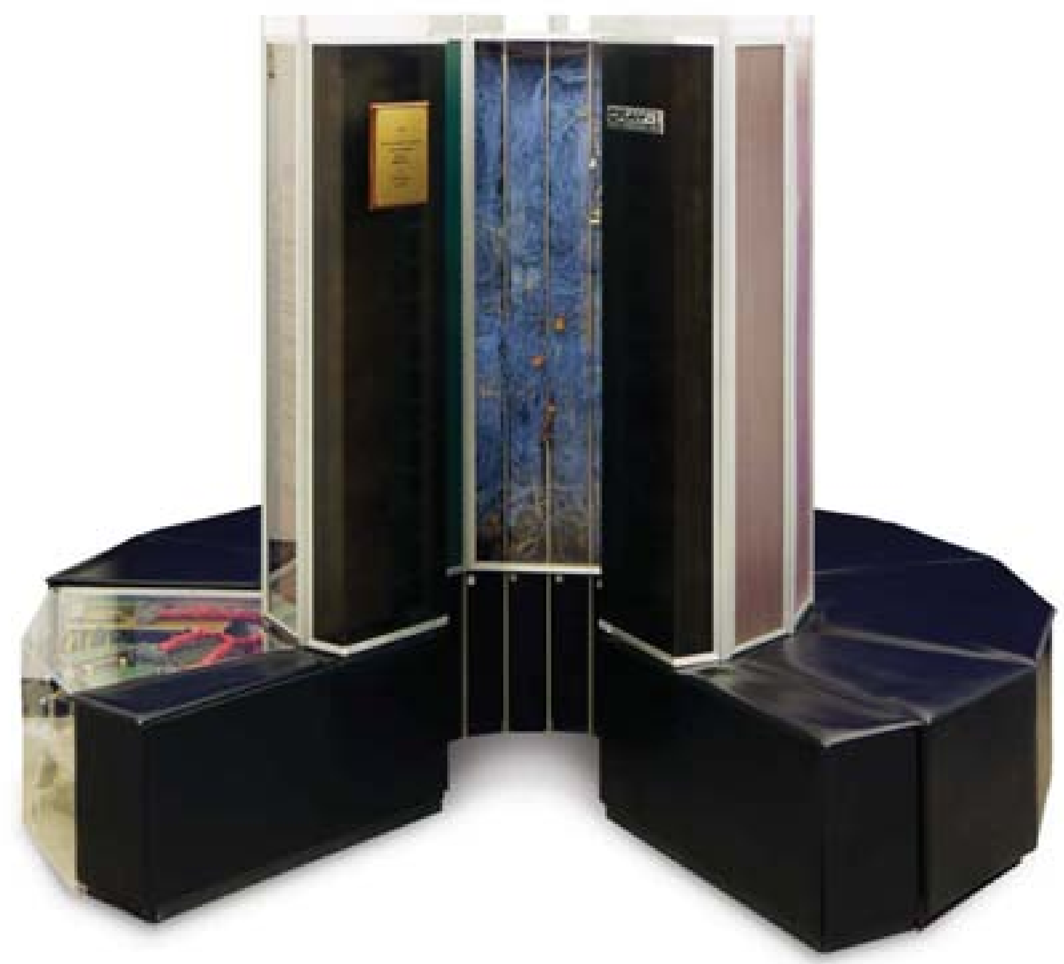
Portion of a chart that shows about 150 of the thousands of programming languages that have been invented

Cray-3 CPU Octant close-up

Seymour Cray usually worked alone or with a small team

THE FASTEST BRAINS FOR THE BIGGEST PROBLEMS

SUPERCOMPUTERS



Cray-1A,
Cray Research, Inc., 1976

How powerful must a computer be to earn the title "supercomputer"?

Super is relative. Every era has supercomputers, but the definition shifts as technology advances. Today's supercomputers may be tomorrow's PCs.

Supercomputers tackle the most calculation-intense problems, such as predicting weather, codebreaking, and designing nuclear bombs. Early supercomputers were one-of-a-kind machines for the government or military—the only customers who could afford them.

The Cray-1 Supercomputer

Featuring a central column surrounded by a padded, circular seat, the Cray-1 looked like no other computer. And performed like no other computer. It reigned as the world's fastest from 1976 to 1982.

Its distinctive design reflected Seymour Cray's innovative engineering solutions and theatrical flair. The round tower minimized wire lengths, while the distinctive bench concealed power supplies. Densely packed integrated circuits and a novel cooling system reflect Cray's attention to "packaging and plumbing." ○

LESS IS MORE: SMALLER, SIMPLER, CHEAPER

MINICOMPUTERS

Close-up of DEC PDP-8 flip-chip modules

This new kind of computer, smaller and simpler than mainframes, was designed to interact directly with users and the outside world. A flexible, inexpensive tool, it brought computers within the reach of a larger and more diverse range of customers.

Minis also sparked a new generation of computer companies. Competition accelerated innovation and reduced prices, spurring broad adoption.

DEC's Blockbuster: The PDP-8

The Canadian Chalk River Nuclear Lab approached Digital Equipment Corporation in 1964. It needed a special device to monitor a reactor.

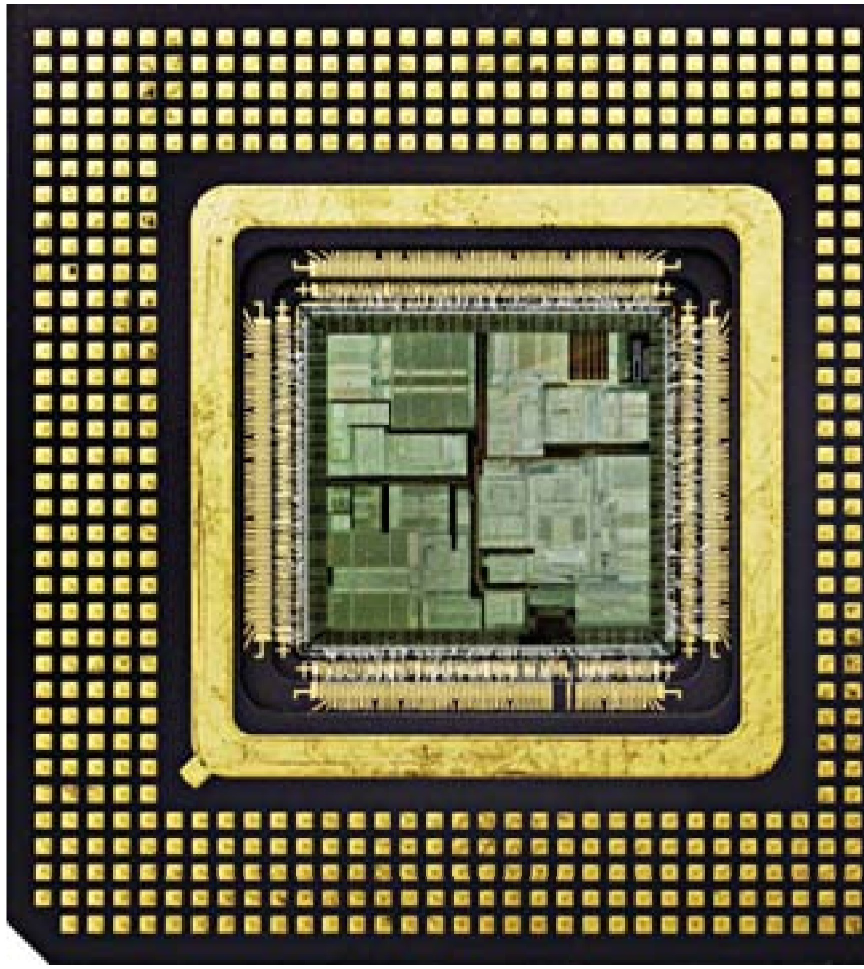
Instead of designing a custom, hard-wired controller as expected, young DEC engineers C. Gordon Bell and Edson DeCastro did something unusual: they developed a small, general purpose computer and programmed it to do the job.

A later version of that machine became the PDP-8, one of the most successful computers of the next decade. ○

PDP-8 in Volkswagen Beetle,1965 and PDP-8 brochure, 1965

DIGITAL LOGIC

HOW DIGITAL COMPUTERS COMPUTE



MIPS R10000 CPU, 1996

All digital computers work on the same principle: manipulating on/off signals to implement logic functions.

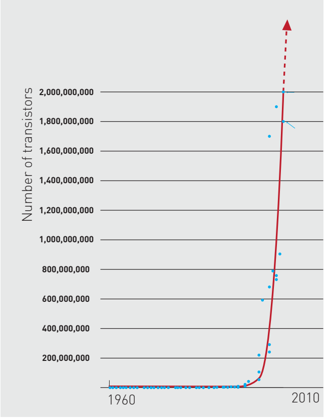
There have been many ways to generate those on/off signals, from mechanical devices to electromagnetic relays, vacuum tubes, transistors, and integrated circuits (ICs). This evolution brought ever-faster, smaller components, yielding dramatic improvements in capacity and cost that transformed computers from specialty tools to everyday devices.

Moore's Law

The number of transistors and other components on integrated circuits will double every year for the next 10 years. So predicted Gordon Moore, Fairchild Semiconductor's R&D Director, in 1965.

"Moore's Law" came true. In part, this reflected Moore's accurate insight. But Moore also set expectations—inspiring a self-fulfilling prophecy.

Doubling chip complexity doubled computing power without significantly increasing cost. The number of transistors per chip rose from a handful in the 1960s to billions by the 2010s. ○



Moore's Law diagram

TRYING TO MAKE COMPUTERS HUMAN

ARTIFICIAL INTELLIGENCE & ROBOTICS

Mechanical servants. Automated employees. We've long imagined machines able to replicate human thought and action.

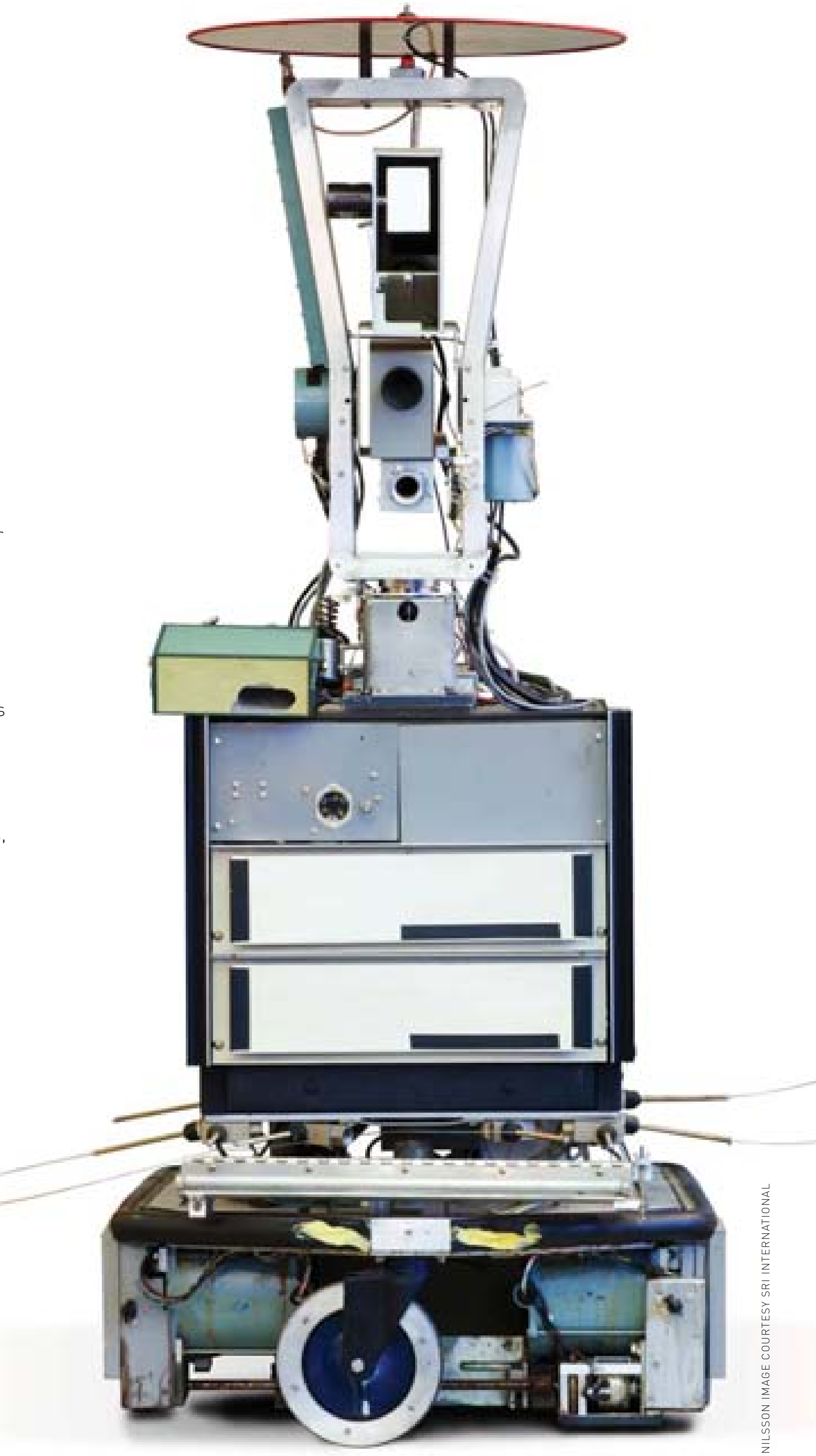
Computers provide the sophistication needed for human-like behavior. But getting machines to actually think like people has proved stubbornly elusive. It's unclear how far we feasibly can go, but ongoing attempts to create Artificial Intelligence have yielded a vast array of beneficial products and services.

Shakey

Robots require intelligence to understand sensory input, make plans, and take actions. That makes them ideal for testing many AI concepts.

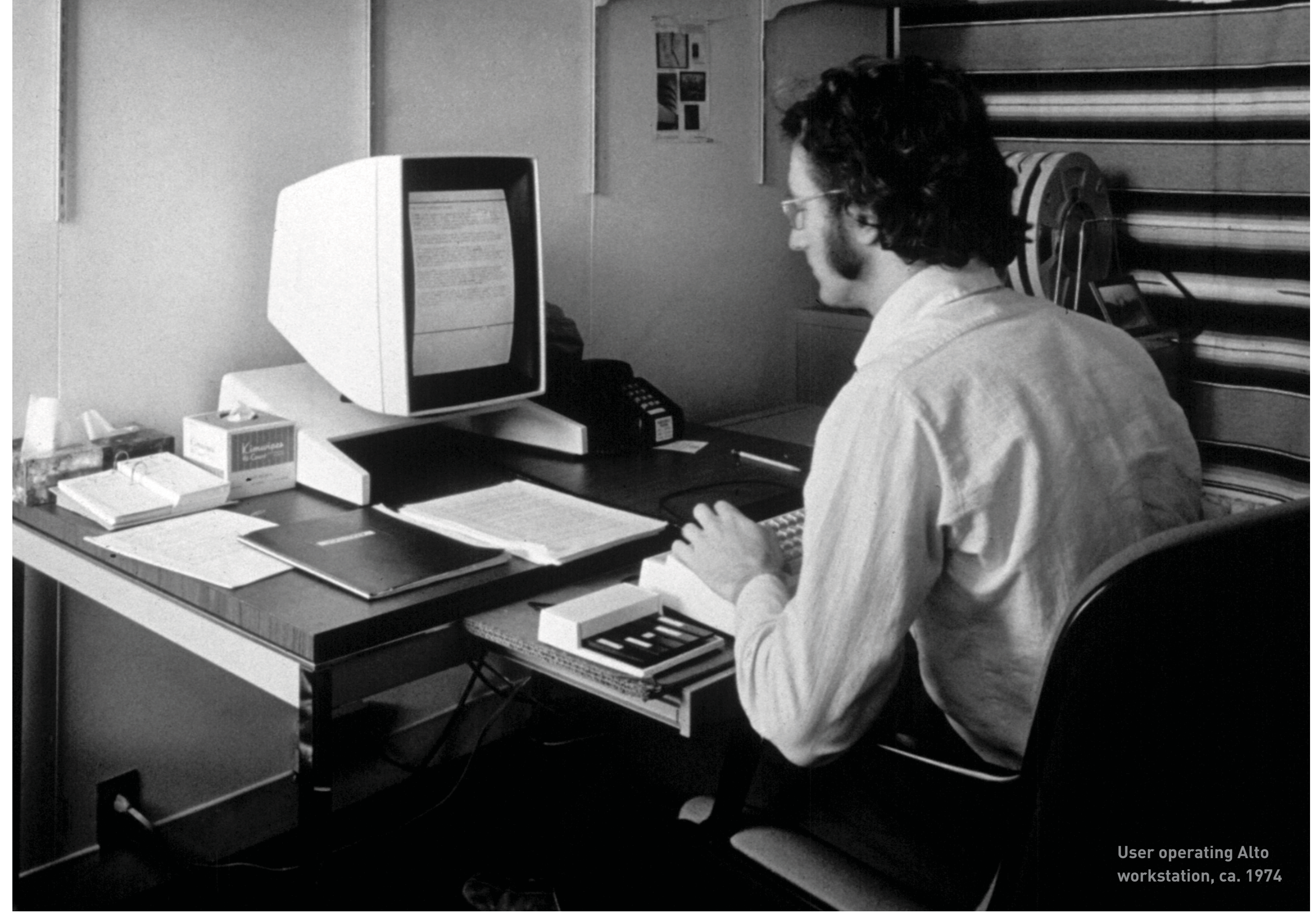
Shakey, developed at the Stanford Research Institute (SRI) from 1966 to 1972, was the first mobile robot to reason about its actions. Shakey's playground was a series of rooms with blocks and ramps. Although not a practical tool, it led to advances in AI techniques, including visual analysis, route finding, and object manipulation. ○

Sven Wahlstrom and Nils Nilsson with Shakey at SRI, ca. 1967



Shakey, Stanford Research Institute (SRI), 1969

WAHLSTROM & NILSSON IMAGE COURTESY SRI INTERNATIONAL



User operating Alto workstation, ca. 1974

COURTESY OF THE PARC LIBRARY

HUMAN-COMPUTER INTERACTION

INPUT & OUTPUT

Computers have always been good at calculations and data processing. But to evolve from specialized devices to a universal tool required more efficient ways to "talk" to people.

Early computers communicated primarily with coded text. Gradually they learned to use images. The development of graphical interfaces was key to creating powerful hardware and software systems that anyone could use.

Xerox Alto

A mouse. Removable data storage. Networking. A visual user interface. Easy-to-use graphics software."What You See Is What You Get" (WYSIWYG) printing, with printed documents matching what users saw on screen. E-mail. Alto for the first time combined these and other now-familiar elements in one small computer.

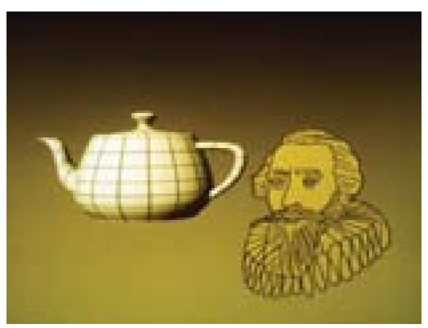
Developed by Xerox as a research system, the Alto marked a radical leap in the evolution of how computers interact with people, leading the way to today's computers. ○

Alto II Computer System, Xerox (PARC), 1973

The Utah Teapot, ca. 1974

COMPUTER GRAPHICS, MUSIC & ART

COMPUTERS & CREATIVITY



Teapot rendering

Computers were originally devised to calculate. But they are increasingly used to create.

Computers have grown into a powerful medium for enjoying, sharing, and creating art, music, and film. We are also continually exploring and expanding the computer's potential to generate new works, redefining the very idea of creativity and testing the boundaries of what it means to be an artist.

The Utah Teapot

Computers manipulate data. So, how do you get them to generate images? By representing images as data.

Martin Newell, at the University of Utah used a teapot as a reference model in 1975 to create a dataset of mathematical coordinates. From that he generated a 3D "wire frame" defining the teapot's shape, adding a surface "skin."

For 20 years, programmers used Newell's teapot as a starting point, exploring techniques of light, shade, and color to add depth and realism. ○

COURTESY OF THE SCHOOL OF COMPUTING AT THE UNIVERSITY OF UTAH

PLAYING ON COMPUTERS

COMPUTER GAMES

To find the earliest computer games, find the earliest computers. Games have always been part of computing. Some were created for tests or demonstrations. Others merely reflect that computer pioneers were human—and humans play.

Games illustrate that "fun" or "entertaining" need not mean "simple." Their increasingly sophisticated hardware and software mirrors the evolution and transformations in the complexity, power, and size of computers.

Pong

"The machine is broken."

That terse message summoned Al Alcorn to Andy Capp's bar in Sunnyvale two weeks after Alcorn had installed the Pong arcade game. Pong's problem? Popularity. Its milk carton coin-catcher was jammed with quarters.

Pong heralded a gaming revolution. Mechanical arcade games like pinball had appeared in the late 1800s. Pong, designed by Alcorn for Atari in 1972, launched the video game craze that transformed and reinvigorated the old arcades and made Atari the first successful video game company. ○

Pong Advertisement, 1972. By 1974, Atari had sold over 8000 units, and would eventually sell 35,000

Pong prototype, Atari, 1972, on loan from Al Alcorn. This was the actual unit placed in Andy Capp's bar in Sunnyvale in 1972. It still worked as of 2002

COMPUTERS FOR EVERYONE

PERSONAL COMPUTERS

Computers evolved primarily for military, scientific, government, and corporate users with substantial needs…and substantial budgets. They populated labs, universities, and big companies. Homes? Small businesses? Not so much.

Over time, however, costs dropped. Equally important, computers grew sophisticated enough to hide their complex, technical aspects behind a user-friendly interface. Individuals could now afford and understand computers, which dramatically changed everyday life.

The IBM PC

Many companies were dubious. Could small personal computers really be serious business tools? The IBM name was a reassuring seal of approval.

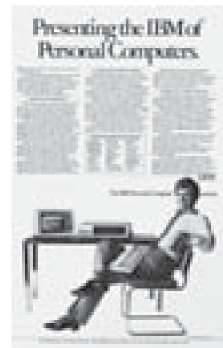
IBM introduced its PC in 1981 with a folksy advertising campaign aimed at the general public. Yet, the IBM PC had its most profound impact in the corporate world. Companies bought PCs in bulk, revolutionizing the role of computers in the office—and introducing the Microsoft Disk Operating System (MS DOS) to a vast user community.

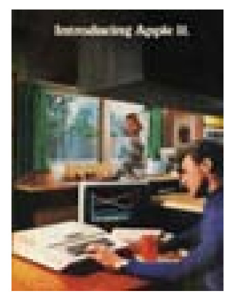
The Apple II

When it debuted in 1977, the Apple II was promoted as an extraordinary computer for ordinary people. The user-friendly design and graphical display made Apple a leader in the first decade of personal computing.

Unlike the earlier Apple I, for which users had to supply essential parts such as a case and power supply, the Apple II was a fully realized consumer product. Design and marketing emphasized simplicity—an everyday tool for home, work, or school. ○

IBM PC, 1981. IBM's first personal computer arrived at least 5 years after others were available, but instantly legitimized the market





Top: IBM PC advertisement, 1981. In promoting their PC, IBM touted their long history of making computers

Bottom: Apple II ad. The rainbow apple logo, with colors chosen by Steve Jobs, emphasized the color display of the Apple II

PC AD COURTESY OF THE IBM CORPORATE ARCHIVE / APPLE AD © APPLE COMPUTER, INC.

Steve Wozniak designed the Apple II in 1977. An available floppy disk drive (1978) and spreadsheet program VisiCalc (1979) made it a blockbuster

MOBILE COMPUTING

YOU CAN TAKE IT WITH YOU

PalmPilot handheld computer, U.S. Robotics, 1996

Above: PalmPilot prototype, Palm, Inc., 1995 This "tethered prototype" let engineers develop software for the PalmPilot before production units were available

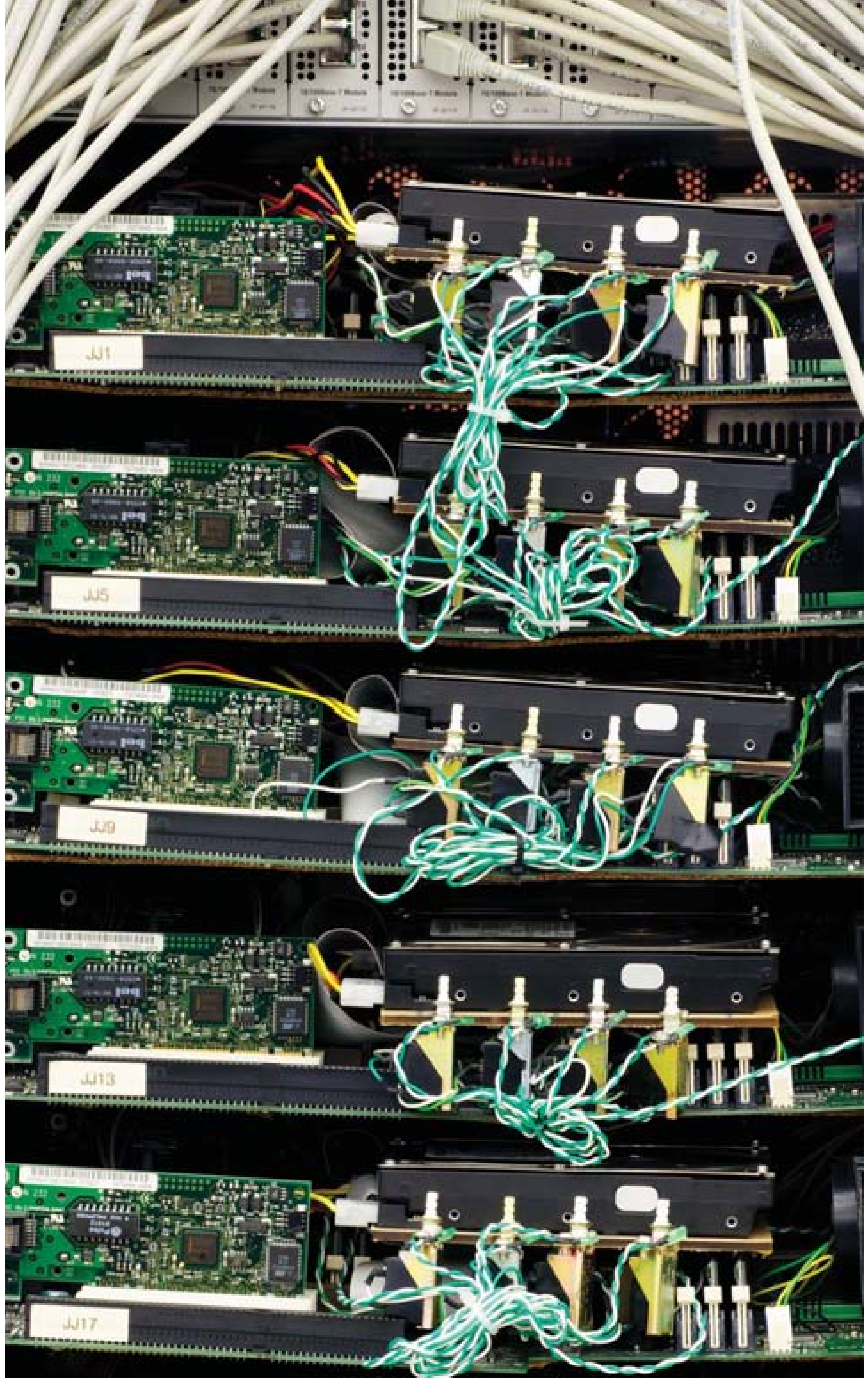
Early computers were so heavy that the floor below them sometimes needed reinforcing. Today, computers slip into purses or pockets and are misplaced as easily as keys.

Miniaturization and falling costs made it possible to take computers everywhere, and to merge them with devices like phones and cameras. Wireless communication over global networks weaves computing into our lives wherever we go.

The PalmPilot

This was the first widely popular handheld computer. Its success helped bridge the previously separate worlds of the electronic organizer, the PC, and, later, the mobile phone.

The PalmPilot succeeded by redefining the handheld as an accessory to the personal computer, not its replacement. Winning features included seamless one-button synchronization with the PC, handwriting recognition that really worked, easy-to-use organizer functions, fast responses, pocket size, and an affordable price of $299. ○



Google server, ca. 1999 Custom software and Ethernet connections turned this rack of 80 off-the-shelf PCs and 2 HP Ethernet routers into a Google search engine

NETWORKING & THE WEB

CONNECTING COMPUTERS, CONNECTING PEOPLE

Networking has transformed computers from stand-alone data crunchers into the foundation of an unprecedented global community. Networking rests on a simple concept: getting computers to communicate with each other.

This requires a physical connection, such as wires or radio links, and a common language (protocol) for exchanging data. Once these are in place comes the layer we see: information systems such as the Web.

Connecting People

Networks connect computers to each other. But how do people use those connections?

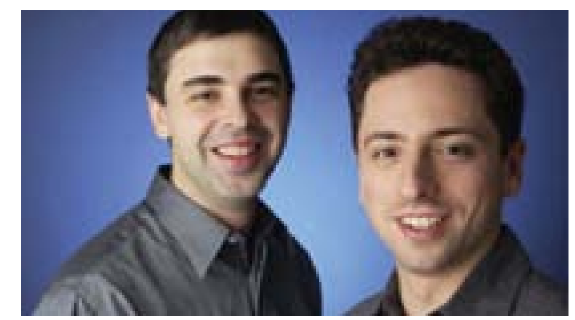
Information systems like the Web let us share content such as text, pictures, or music. The Web running over the Internet has become our global commons, absorbing older media—from video to books and telephone calls—and transforming how we work, buy, and stay in touch.

Google Rack

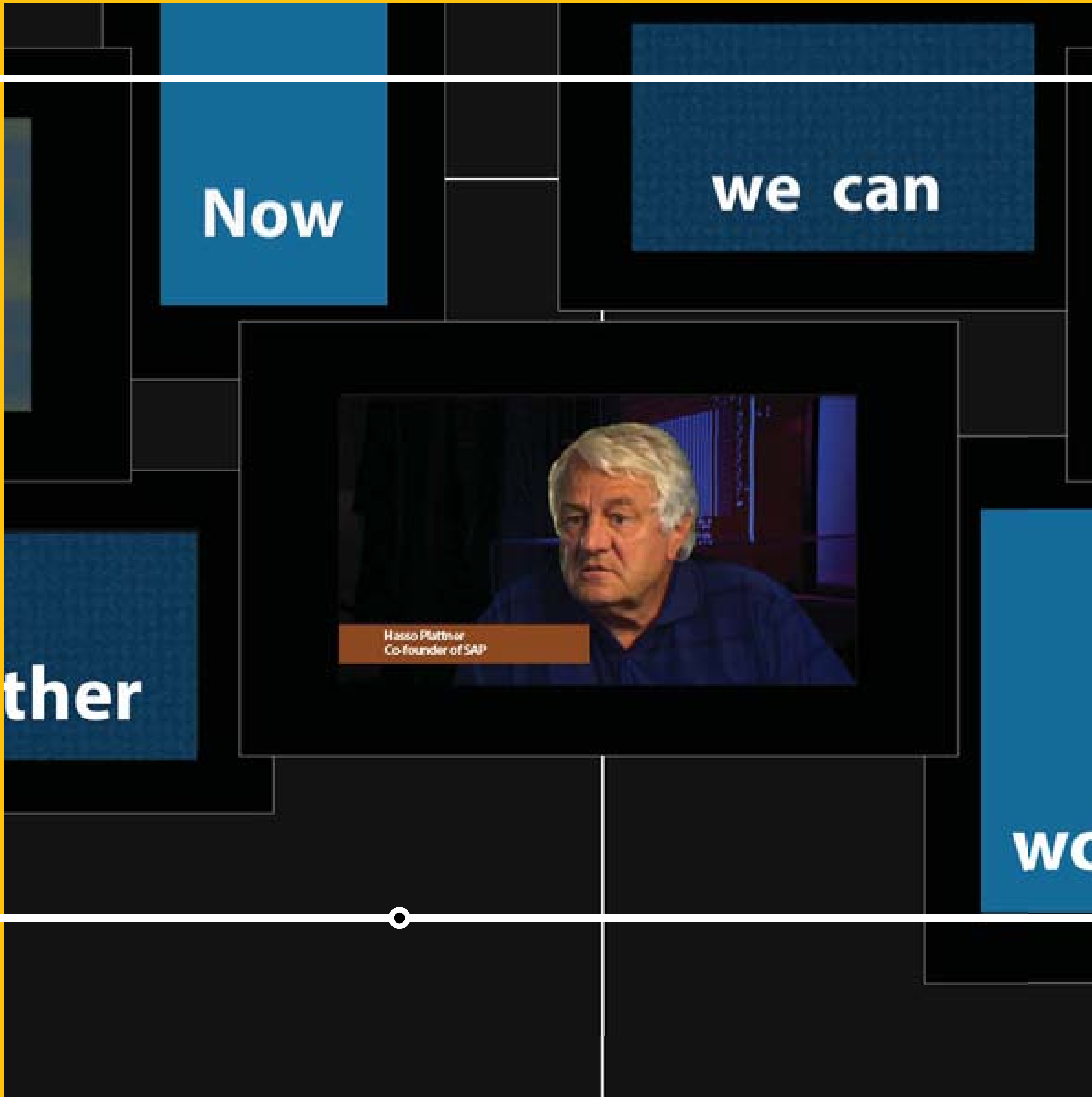
The Internet and Web are about sharing and using information. An important part of that process is finding information, often through search engines like Google.

Search queries go to modern versions of servers such as these. But this isn't a typical industrial computer rack. Google's founders, students at Stanford, excelled at scrounging equipment. That talent later helped them meld generic PC components into racks like this. Clever software turned them into flexible providers of computing power. ○

Larry Page and Sergey Brin met as Stanford graduate students in 1995. They argued constantly but became inseparable friends, sometimes called "larryand sergey" by classmates



Hasso Plattner, co-founder and former chairman of SAP AG, is one of more than 50 people featured from around the world in the What's Next Theater



VOICES OF THE REVOLUTION

WHAT'S NEXT?

In two generations, we have moved from a world with no electronic computers to one with computers in everything from telephones to toasters.

What's next?
That's a tricky question. Breakthroughs spring from a fortuitous but devilishly elusive combination of vision, experimentation, tenacity, and luck. Still, the difficulty of forecasting the future doesn't stop us from trying. The What's Next? Theater explores a provocative array of predictions, prognoses, hunches, and hopes.

The new lobby is where visitors will find the expanded Museum Store and a brand new Cafe

MARK RICHARDS

THE NEW SPACE

25,000 sq. ft. of new exhibition space—quadruple the museum's previous exhibition space

2,500 sq. ft. education center with classrooms

5,000 sq. ft. of open gallery space in the Museum's lobby

FOCUS

A STUNNING NEW VENUE

Creating a new gathering place

"Shoreline Entry" is the original name of the Museum's home at 1401 N. Shoreline Boulevard. From its opening in 1993, our building was, in fact, the gateway to a vast Silicon Graphics, Inc. (SGI) campus in Mountain View—a campus which today is largely occupied by the Googleplex and extends from U.S. 101 to the tidal areas at Shoreline Park.

Studios Architecture of San Francisco designed the building for SGI as "a departure from Silicon Valley's reflective-glass anonymity," as described by James S. Russell in his 1999 book, *The Power of the Pragmatic.*

"The exterior of the building for the first time became much more sculptural, acting as a billboard and recruitment poster," Russell wrote.

The building won numerous awards for architecture and design throughout the 1990s. Among them were two awards for excellence in design from the California Council of the American Institute of Architects.

The Museum purchased the building and land in 2002 for $25 million and relocated its offices and collection from temporary quarters at Moffett Field. "Shoreline Entry" was given a slight makeover by the architecture firm EHDD. The Museum then launched with virtually the entire collection housed in the space now occupied by *Revolution*, and many rare and famous artifacts displayed in the area known as Visible Storage on the west side of the first floor. The 400-seat Hahn Auditorium took shape on the second floor along with administrative offices and open areas soon in demand for Silicon Valley events.

With our expansion to launch *Revolution*, the Museum is now a visually stunning new destination.

The new lobby was designed by Mark Horton / Architecture of San Francisco. It comprises 6,000 square feet of public and reception space for Museum guests. The terrazzo floor is the world's largest punched card—with an actual message embedded in the code. New landscaping opens the existing high glass walls onto Shoreline Boulevard and provides a new, visually attractive vista for traffic and pedestrians passing the Museum.

A new café is situated in the atrium area of the lobby, with ample seating and easy access to the Museum's entry patios. The new Museum store opens onto the lobby and is one of the larger spaces of its kind in Northern California museums.

The new Orientation Theater, every visitor's first stop in the Museum experience, is a multimedia space with 50 seats that opens onto the portal entry for *Revolution*. The 5,000 sq. ft. Gallery area on the first floor has reopened to the public and is adjacent to the permanent exhibition *Mastering the Game* and the alcove housing the Babbage Difference Engine No. 2.

With these changes and the opening of *Revolution*, the Museum carries on the innovative spirit that originally gave rise to "Shoreline Gateway" and adds to it a new dimension: a cultural and community gathering place in the heart of Silicon Valley.

FOCUS

THE EDUCATION MISSION

The passion to keep teaching—and learning

A Museum educator leads 6th–8th grade students in a school workshop, "You + Computers = Making History"

BY LAUREN SILVER

Still vivid in my mind is the wonder and delight with which I—then 13 years old—read the account of the August 7, 1944 Harvard Mark I computer, an elecromechanical marvel for which Howard Aiken was the architect and IBM engineers Clair Lake, Benjamin Durfee and Francis Hamilton were the implementation designers. Equally wonder provoking was the reading of Vannevar Bush's 'That We May Think' paper in the April 1945 Atlantic Monthly.

FREDERICK P. BROOKS, JR., CO-DESIGNER OF THE IBM SYSTEM/360

As with all museums, visitors are at the heart of our institution, and education is at the heart of our mission. A museum is not a museum without the people who come to view its objects, to take part in its events, to scan its website, and, ultimately, to make sense of the ideas and stories that arise from their experiences with its content. Put another way: the artifacts, in and of themselves, are meaningless. Their meanings are created in the minds of the people who interact with them, and it is up to the Museum to facilitate those interactions.

Our core values are in complete alignment with this point of view. In the strategic plan that our staff and trustees adopted in 2009, we articulated a number of people-centered values and aspirations. We took as our explicit obligation the mandate to "meet audiences where they are," delivering our content and messages in ways that would enable people to engage in the kinds of historical inquiry and exploration that others in this issue have described. Among our specific goals were to "promote understanding about the ongoing relevance of the history of computers," "to inspire innovation and creativity," and "to enable our audiences to experience their personal stories in our content and learn through the stories of others."

This is a tall order, however. Museum visitors typically represent an enormous range of interests, learning styles, and educational and professional backgrounds; in our case, we also need to account for variation in visitors' technical knowledge and expertise. *Revolution*—both the physical installation and the online version—was designed with diverse visitors in mind, and with the assumption that it would be supported by programs and materials that would make its content appealing and accessible to anyone—young and old, techie and non-geek alike.

It is an exciting proposition. We have expanded our focus to include not only the "what" of our content, but the how, the why, and the who as well. What is it that we want people to learn? What do we want them to be able to do with their newfound understanding? Why is it important for them to know and do these things? How can we make it possible for them to meet these educational goals? Who are we doing all this for, and how do we need to adjust and flex so that different people will be able—and want—to enjoy and learn from their experiences here? These questions and more are at the core of our educational concerns.

The result of all this thinking about visitors is a set of interactive tours, school workshops, and materials—both in print and online—that seek to stimulate curiosity and motivate people to ask questions and connect with computer history on a personal, almost visceral level. But we need to learn, too! Over the next few weeks, months, and years, we will be continually evaluating, revising, and re-evaluating the efficacy and success of our educational programs, as we find out more about who visits, and what, how, and why they learn here. In this way, the Museum, like history itself, will continue to evolve, teaching us all about the best ways to "explore the computing revolution and its impact on the human experience." ○

Dr. Lauren Silver is the Museum's Director of Education. She designed a comprehensive plan for the Museum's docent team, jointly led the training of more than 40 docents, and led the development of the education plan for *Revolution*.

Below: Docents Tim Robinson (left) and Steve Russell in docent training

THE DOCENT: PART TECHIE, PART STORYTELLER

Museum docents are perfectly suited to the job of bringing computer history to life. Many are retired hardware and software engineers who worked on the legendary machines of the past. (They know the stories that didn't make it into the official corporate brochures and press releases!) Some were pioneers of their generations, developing innovative technologies that continue to enthrall us today. Others got into the business through marketing, research, and industrial design. They range in age from mid-20s to early 90s, cutting their teeth on computers ranging from the IBM 1401 to the TRS-80, and everything in between. All share a passion for computer history and the delight that comes from sharing their stories with others.

Docent training is rigorous. In addition to becoming experts on the exhibition—even before there was an exhibition to learn about—these intrepid interpreters went through a year-long course, devoting hundreds of hours to classes, reading assignments, Museum observations, and outside study and research—not to mention all the time and effort they put into writing and practicing their tours. With all this skill and expertise under their belts, they are ready to uphold the mission of the Museum—to educate and inspire visitors who come here from all walks of life.

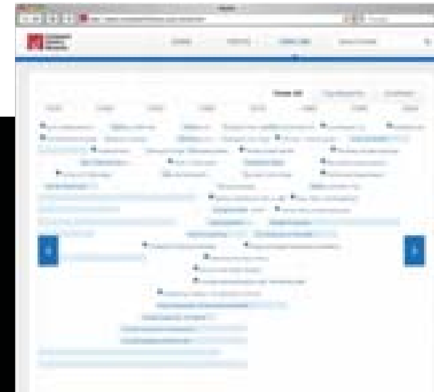
For visitors who wish to explore on their own, *Revolution* offers plenty to see and do. For those who want a more personal experience, there is no better way to spend their time than to engage in a conversation with a docent. You won't find an authentic "I was there" perspective like this in many other museums! But don't get the wrong idea: docents are learning as much from visitors as visitors are from them—and they are having just as much fun doing it. Every time they lead a discussion, answer a question, or encourage a visitor to tell his or her own story, they find out new and intriguing information that only deepens their own love of computer history... and makes them even more eager to get back on the floor and do it again.

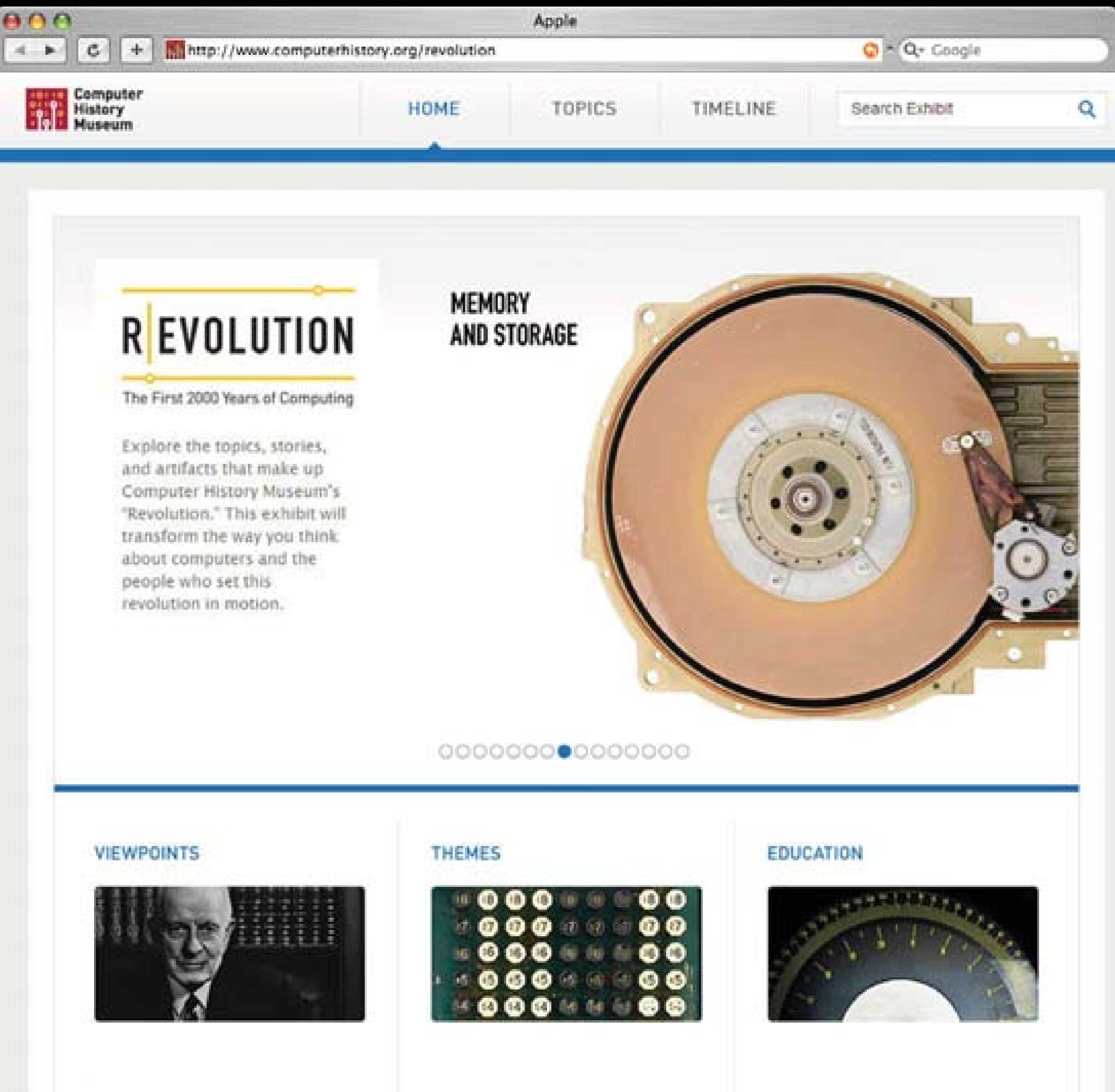
THE WEB EXPERIENCE

Building a comprehensive online exhibition

BY BOB SANGUEDOLCE

The virtual world allows us to display nearly 75% of the Museum's vast collection. *Revolution Online* includes all the galleries, artifacts and media in the onsite exhibition—and much more





Computers get smaller, faster, and cheaper. Museums don't. Without the no-limits world of the Web, our exhibits would be constrained by the size of our building. Most of the Museum's treasures would remain stored in a warehouse.

The new computerhistory.org presents more than 75% of the museum's collection, including all of the content in the on-site *Revolution* exhibition. But it offers many more stories, artifacts, videos, and oral histories—more than 4,000 new pages in all. Visitors can search for and link to topics according to their interests and passions.

The Computer as Storyteller

The computer can tell its own story—a useful trick for an historical artifact. A Civil War cannon can't describe the noise and chaos of combat. But the computer can give a vivid account of itself in words, pictures, and video. Anyone anywhere in the world with a PC, a laptop, or a web-friendly device can have access to the Museum's presentation of computer history—for free.

The history of computing is thousands of stories that all can be joined together in different ways—by timelines, by people, by place, by companies, by technologies. The flexibility of the web allows visitors to create their own intriguing narratives.

For example:

Famous Failures: Most new ideas, products and companies bombed. But those failures created fertile soil for success. The lessons for today's inventors and entrepreneurs are priceless.

Geography: Silicon Valley is a famed epicenter of technology. But computing innovation thrived around the world. What have other countries and regions contributed?

Pop Culture: Computers and technology populate novels, movies, and comic books. Sometimes they're the stars. The most memorable—and human—character in *2001: A Space Odyssey* was easily HAL 9000, the well-spoken, emotionally conflicted supercomputer. The interplay between hard science and popular entertainment is fascinating.

Games: Even brilliant scientists play with computers. That play has led to spectacular advances. The vacuum tubes were barely warm in the first mainframes when programmers at such august institutions as MIT tested their heavy-duty machines by inventing games such as SpaceWar! These early games quickly established the "blow stuff up" esthetic that dominates the billion dollar gaming industry today.

Business: Visitors can follow the stories of companies as they were born and as they grew: Apple, Intel, Xerox—hundreds of companies' fortunes made and lost. It's no use creating a wonderful product if nobody wants to buy it. The marketplace battles, including the TV commercials and sales brochures, are a wonderful resource for anyone with a better mousetrap to sell.

Skim the Surface or Go Deep

The website is layered. The casual visitor can easily capture the core of any topic in computer history. But students, historians, and researchers can also dig deep.

For example, we can display an early version of FORTRAN in the physical exhibition. But the truly obsessed can access an entire programming manual online. The Digital Logic gallery presents a rich overview of computer pioneer Gordon Moore. If that fails to satisfy, the website features a two-hour video of Moore talking about how he came up with his famous law and the future of computing technology.

The Apple MacPaint source code is another story that rewards both casual curiosity and intensive study. We've published the code, in its entirety, on the website. For a programmer who's really into the art of coding, the MacPaint code is an early masterpiece. It's also a business story. MacPaint is one of the first desktop design and graphics programs. It's also a cultural story, because with MacPaint, Apple introduced the idea that computers are about more than computing. They can be an extension of the creative mind.

The website also includes the ability to add the voices of the wider technology community. Input and content from industry leaders, innovators, academics, and others can be added to each history story, providing alternative views, depth, and nuance.

History as it Happens

Computing history isn't over. It's happening now. Many more wonders are yet to come. Computer technology moves forward and new devices come onto the market every week. The Museum will continue its mission of collecting, interpreting, and exhibiting. The Web allows the Museum to record and present history as it happens. It's a lot easier to add web pages than it is to build a new 5,000 sq. ft. building addition.

The warp-speed innovation of computing technology requires that we be nimble in designing the website. Our designers and programmers took care to make the site work well across a wide spectrum of devices: from smartphones and iPads all the way up to giant LCD monitors. We're also now "in the cloud," utilizing cloud servers to deliver *Revolution*'s image and video content.

More than 2 million people visited computerhistory.org in 2010. Revolution Online will bring ten times that number—more than 20 million people a year.

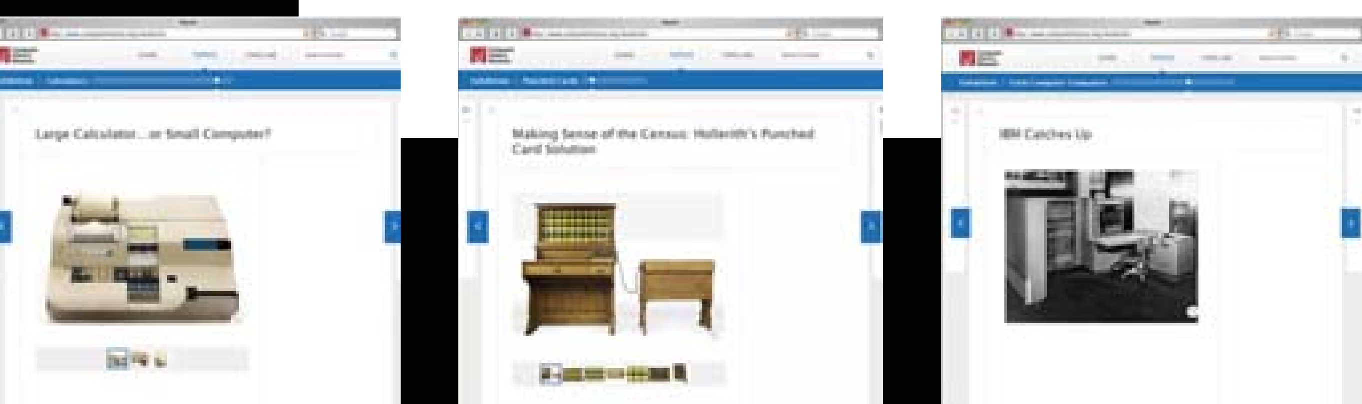
A Global Learning Tool

More than 2 million people visited computerhistory.org in 2010. *Revolution Online* will bring in 10 times that number—more than 20 million people a year. Many of those new visitors are from around the world, as international access to the Museum's website continues to grow explosively.

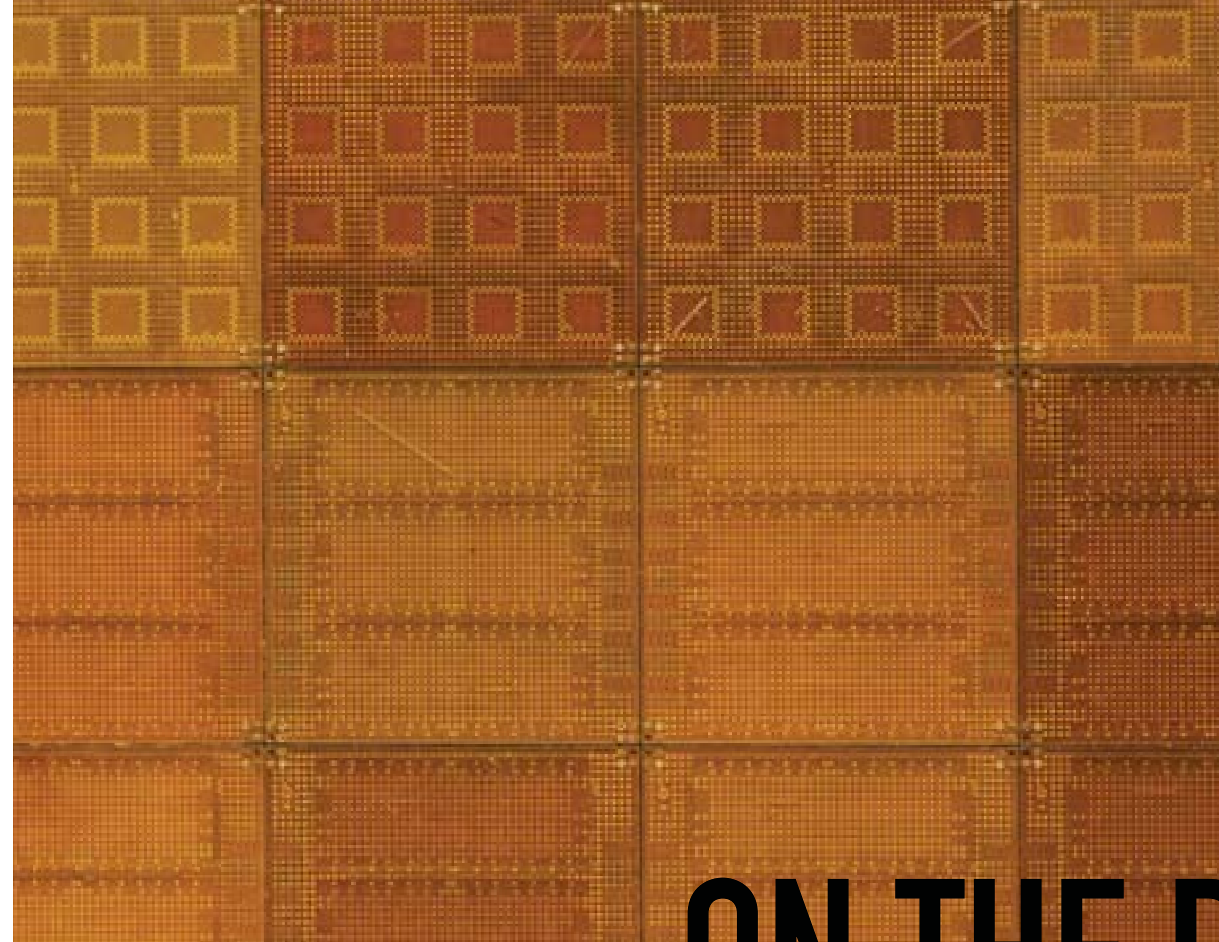
The new website will also expand the Museum's educational tours, programs, and workshops. Now we can tell the inspiring story of computing history, not just to thousands of students at the Museum, but to millions of students all over the world. We're always thrilled when we hear how students and educators are able to access and utilize the Museum's online resources.

Most museums have websites. Few fully exploit the Web's unlimited capacity for access, storage, and storytelling. Our collection and exhibits aren't duplicated by any other institution, and the Internet lets us share our unique resources with the world. Check it all out at computerhistory.org/revolution ○

Bob Sanguedolce is the Museum's Vice President of Technology. He led the design, development, and deployment of the web media and technology for *Revolution*.



The interconnectivity of the Museum website allows visitors to create personal tours based on their passions



Cray-3 CPU section, Cray Computer Corporation, 1995
Unlike Cray's previous designs, the Cray-3 used unproven technology—gallium arsenide and sophisticated assembly robots to build it

ORAL HISTORIES

ON THE ROAD

BY JON PLUTTE

In search of context behind the life of an icon

"Chippewa Falls, Wisconsin. Home to dairy farms… Leinenkugel beer…and…supercomputing."

As Media Producer for the Computer History Museum, I am working with the Museum's curators to make dozens of movies. Some are 1-minute clips of interviews of computer pioneers. But most are high-end productions on a range of subjects from World War II code-breaking to the invention of the World Wide Web. But the movie about Seymour Cray was different.

Seymour Cray is an iconic figure in computing. Widely regarded as the father of supercomputers, he was a quiet Midwestern man closely tied to his hometown of Chippewa Falls, Wisconsin. Unfortunately, he passed away almost 15 years ago, and archival interviews don't reveal much of Cray, the man. To understand him, we needed to get to Chippewa Falls, film the place, and interview some of the people who helped him create his computers.

Founder and Museum Trustee Gordon Bell could connect us with two important people from Cray's life—Les Davis, his trusted assistant, and Gary Smaby, who tracked Cray's company for investment firm Piper-Jaffray. We also found that the Chippewa Falls Museum of Industry and Technology, which has an extensive collection of Cray computers, also had photos of Seymour Cray and his associates that we could use for the new exhibition. They were willing to loan us one of his original notebooks for our new exhibition as well, but they wanted to hand it to a Museum staffer, not ship it.

We were going.

Dag Spicer, the Museum's Senior Curator, and I determined that we would leave the first week of May and stay for about 4 days.

The most critical thing we needed was a film crew. I decided to use a local crew for a several reasons. Most important was that we needed a guide. Where are the best-looking dairy farms? Where is the Leinenkugel Brewery? Can we find Seymour Cray's house?

Fortunately, through a series of recommendations, we connected with Rick Wold of Studio One Teleproductions in Eau Claire, less than 15 miles from Chippewa Falls. Rick had ideas about the best-looking dairy farms, knew where Leinenkugel was, and had actually shot at the Chippewa Falls Museum before. Since we had determined we would interview Les Davis at the museum, we hired Studio One to work with us.

MARK RICHARDS

Leinenkugel Beer sign on Main Street in Chippewa Falls, Wisconsin

Chippewa Falls

Flying out from home always seems easier than the return flight. You are excited about the trip, have a lot to do, and are rested. There always seems to be more room on the plane. No exception this time. We got in to Minneapolis uneventfully, found our hotel, and prepared for our next day.

Monday

This was a packed day. We drove to Chippewa Falls and met Rick and his assistant/wife, Mary Anne, for breakfast at 7 in the morning, the result of a hundred mile drive starting at 5:30. Rick knows everyone in that part of the world and he spent the entire time greeting old friends, asking how their second cousin was, sharing gossip. Not like California, that's for sure.

First stop was the Chippewa Falls Museum of Industry and Technology, right downtown. We were to interview Les Davis in the museum, in front of one of their Cray computers. The museum's Executive Director, Rebecca Kitzberger, graciously came in on her day off to let us use the museum.

Les was articulate and poignant. He talked about how Seymour worked, discussed their work relationship, and also gave us some insights into the personal relationships that the Cray team developed over the years. A truly great interview.

After picking up Seymour Cray's journal, we moved on. We needed to film shots of downtown Chippewa Falls. As we shot in this quaint little Midwestern town, Rick would frequently shake someone's hand, ask how their sister was, then proceed to shoot again.

Next was the Leinenkugel Brewery and its surroundings. The last shot of the day was dairy farms. At this point it was nearing the end of the day, and of course, it looked like rain. One day it went from sunny and cold to sunny and warm, to threatening rain.

Welcome to Wisconsin in the springtime.

Golden Cows

We drove out of town, into the nearby countryside, trying to reach the dairy farms before either the light went away or it rained. We saw the clouds were getting more and more ominous, the sky was getting darker and darker. Then it started to rain. But it was a light rain, so hope prevailed. When we finally reached our dairy (with cows), the rain turned to drizzle, and then it stopped. We were unloading out of the van when I looked up and realized there was a break in the clouds, and that a patch of sun was moving towards us and, more importantly, our farm, and even more importantly, the cows. We scrambled to get the camera set up, and started filming just as the sun burst out in that glorious late afternoon light cinematographers appropriately refer to as "the golden hour." When you watch the film you will see this footage, and it looks great. Bear in mind that we used virtually all of the farm footage we got in that lucky ten minutes. After that adventure, we called it a day.

It poured that night.

Tuesday

We started out Tuesday by shooting a few additional shots in downtown Chippewa Falls. Then came our investigative reporting. In 1958 Seymour Cray convinced Control Data Corporation (CDC) to let him move his operation from Minneapolis to Chippewa Falls. The story goes that he built a house on 65 acres, then "put the CDC lab in his backyard."

We wanted to film that house and lab.

We knew generally that the lab was "by the river," we knew the general location, but there was no findable address, and the directions we got from Les Davis, among others, usually amounted to a broad description rather than actual directions. So we went Cray-house hunting.

After a few missed turns and a few dead ends, we ended up in a sprawling housing area that, quite honestly, just seemed like the right place. As a matter of fact, as we drove up the hill to a small level area, I thought to myself that one of the houses, a low brick rancher, seemed like the place an engineer would build in the late 1950s. When we got to the top of the tree-covered hill, we found ourselves looking at a couple of houses and a low industrial building like you'd find in Mountain View in the '60s. Out in front of that lab was a pleasant-looking fellow raking leaves. Rick decided to have a chat with the leaf-raker, although he (surprisingly) didn't know him.

Rick walked up, sheepishly followed by the producer, and described our Cray mission. A big smile crossed the raker's face. "Oh yeah, Cray's house is right over there, you want to see inside? My sister lives there!" It turns out that his father had bought the old Cray house and they were very proud of it.

The house was built like a fortress, or more accurately, a bomb shelter. Cray, probably rightly, thought that his town might be a Soviet target back at the height of the Cold War, and prepared well. The walls are concrete-filled cinder block. It has a water cistern. Deep in the bowels of the building is a bomb shelter with space for plenty of supplies. Seymour Cray was prepared. And behind the house, past the next hill, was the old CDC lab. For me as a filmmaker, and undoubtedly for Dag as a curator, you live for those moments when you are let into another world, when you are surprised, when all of the pieces fall into place and you get a glimpse of the past.

Today the raker's nephew and his rock band practice in the bomb shelter.

The celebration was short-lived. We had one more stop on our whirlwind tour: we had to drive right back to Minneapolis to interview Gary Smaby, the investment analyst. Gary was another great interview with insights into the workings of Cray's business and Cray himself.

The next day, we headed home.

Our trip to Chippewa Falls gave us more than footage and photos. The trip was important because it gave us insight into what motivated Seymour Cray and his colleagues, helped us understand an important place and time in the development of the computer, and it made the exhibition and movies far richer than they would have been if we had just read books to assemble the story of Seymour Cray. This is, I hope, something the Museum will do more of in the future. We not only gained an understanding of the history, but also the context of that history.

That will make the Museum a richer and more exciting experience now and in the future. ○

Jon Plutte served as the executive producer of all of the media viewable on the more than 100 screens in *Revolution* and their Internet counterparts.

Dag Spicer is the Museum's Senior Curator. He helped create the intellectual framework and interpretive schema for *Revolution.*

The house was built like a fortress, or, more accurately, a bomb shelter. Cray, probably rightly, thought that his town might be a Soviet target back at the height of the Cold War

COLLECTION

RECENT ARTIFACT DONATIONS

BY DAG SPICER

IBM SYSTEM 32— FERRARA MEAT COMPANY INC.

CHM#: 102711734
DATE: 1978
DONOR: Gift of Ferrara Enterprises LLC

A holdout from an earlier era of Silicon Valley slaughterhouses, meat packing, and processing plants, Ferrara Meats was located at 255 E. Trimble Rd. San Jose, CA, in the shadow of high-tech such as Honeywell, Hewlett-Packard, and Unisys.

Ferrara, which was founded in 1933, acquired their IBM System/32 in 1978 for accounting, billing, and inventory, and continued using it until 1998. "It was a complete bookkeeping system," says Bernice Ferrara Seimas, daughter of Ferrara founder Philip Ferrara.

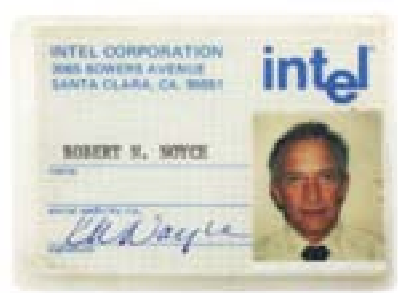
The System/32 was introduced by IBM in 1975 and was aimed at small businesses by providing ready-made software packages for common business functions with the system. With minimal training, a clerk could perform a variety of important business functions. It was built at IBM's Rochester, Minnesota plant and rented for under $1,000 a month. ○

ROBERT NOYCE INTEL ID BADGE

CHM#: 102716219
DATE: ca.1975
DONOR: Gift of Ann Bowers Noyce

Intel was co-founded in 1968 by Gordon Moore and Robert Noyce. Moore was a chemist while Noyce was a physicist and independent co-inventor, with Jack Kilby, of the integrated circuit (IC). Both Noyce and Moore had come from Fairchild Semiconductor, a company with a long list of innovations, but one that struggled with an east coast parent company that did not understand the semiconductor business. Frustrated, the pair left, bringing with them colleague Andy Grove, a chemical engineer and visionary who led the company through its explosive growth in the 1980s and '90s.

Noyce, however, was the spiritual father of Intel and widely admired around the world as an honest, plain-speaking representative of the semiconductor industry. He garnered many honors, including the National Medal of Science and the National Medal of Technology. A heavy smoker, Noyce died of heart failure in 1990 at the age of 62. ○



DYNABOOK PROTOTYPE

CHM#: 102716364
DATE: 2010
DONOR: Gift of Alan Kay

The Dynabook was a hypothetical machine first proposed by computer scientist Alan Kay in 1968. Kay had a cardboard prototype similar to this one specially made for the Museum to serve as an example of what the Dynabook could look like and he used it while introducing the concept to a wide variety of audiences.

Although it bears a striking similarity to the laptop of today, Kay's vision went beyond simply shrinking the hardware into a portable form. It entailed key software developments and an educational curriculum based on its unique capabilities—possibilities that, in Kay's view, remain unfulfilled. ○

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†Includes in-kind donations

ABOUT THE TEAM

Dr. Leonard J. Shustek is the Museum's co-founder and Chairman of the 34-member Board of Trustees. Len was co-founder of the pioneering networking company Network General and has served on the faculties of Stanford University and Carnegie Mellon University. He acted as chief curator in the development of the content plan for *Revolution*.

Kirsten Tashev, Vice President of Collections & Exhibitions, led the development of *Revolution* from the project's inception in 2000. She directed the Museum's curatorial, collections and exhibitions staff and led a team of architects, designers, media producers, writers, and content consultants over a decade of work. Kirsten's many previous museum credits include the Museum of Jewish Heritage in New York and the Mashantucket Pequot Indian Museum in Connecticut.

Gary Matsushita, Vice President of Operations, led the design and construction of the Museum's new public spaces and directed the construction and modification of the Museum's exhibition space. Before joining the Museum, Gary served as the Worldwide Director of Real Estate & Facilities for OpenTV, Inc., and as Senior Manager of Facilities for Apple, Inc.

Bob Sanguedolce, Vice President of Technology, led the design, development, and deployment of the web and technology for *Revolution*. He also directed media production and the creation of *Revolution Online* on the Internet at computerhistory.org/revolution. Before joining the Museum, Bob served as VP and Chief Information Officer (CIO) of eBay.

Dag Spicer, Senior Curator, helped to create the intellectual framework and interpretive schema for *Revolution*. He directed the collection strategy for and curation of the Memory & Storage and Supercomputers galleries. Dag is recognized internationally as an expert in computing history, writes and speaks regularly on a variety of areas in the field and serves on the editorial board of the *IEEE Annals of the History of Computing*.

Dr. Lauren Silver, Director of Education, designed a comprehensive plan for the Museum's docent team, jointly led the training of more than 40 docents with Volunteer Manager **Jim Somers** and led the development of the education plan for *Revolution*. Lauren oversees the development of all education programs and materials for the Museum. She holds a Ph.D. in developmental psychology and has more than 20 years of experience in a wide range of educational settings

CURATORIAL TEAM

Alex Bochannek curated the Analog Computers, Birth of the Computer, Early Computer Companies and Real-Time Computing galleries. Alex is pursuing European and Russian computing history for the Museum and is also a consulting software engineer in Silicon Valley.

Chris Garcia curated the Computer Games, Punched Cards, Computer Graphics Music & Art and Personal Computers galleries. Chris, a member of the Museum staff since 1999, is a regular contributor to *Core* Magazine and writes extensively on popular culture on the Internet.

Al Kossow is the Robert N. Miner Software Curator for the Museum and jointly curated the Software film and gallery. He is an acknowledged expert in the field of software curation and preservation, and works extensively with groups outside the Museum to collect, preserve and document the history of software.

David A. Laws curated the Digital Logic gallery. David has over 35 years experience in the semiconductor industry. He has worked for Silicon Valley companies, including Fairchild Semiconductor, Advanced Micro Devices (AMD) and Altera Corporation, in roles from product marketing engineer to CEO. David also served as staff director of the Semiconductor Special Interest group at the Museum.

Dr. Jim McClure curated the Calculators, Mainframes and Input & Output galleries. Jim holds a Ph.D. in Civil/Geological Engineering from the University of California, Berkeley, and a Master's in Museum Studies. He is the Museum's first Manager of Adult and College Programs.

Marc Weber is founding curator of the Internet History Program at the Museum and curated the Mobile Computing and Networking & the Web galleries. Marc actively collects artifacts and oral histories in the Internet history field worldwide.

COLLECTIONS TEAM

Paula Jabloner, Director of Collections, directed a multi-year effort to collect, catalog and prepare the extensive number of artifacts in *Revolution*. Paula also leads the Museum's ongoing effort to expand public access to our landmark collection through digital cataloging, online research and media accessibility.

Karen Kroslowitz, Senior Registrar and Collections Manager, led the receipt, location, staging, movement and placement of physical artifacts in the *Revolution* galleries. She also directed, where necessary, artifact restoration.

A team of Museum staff in Collections and Exhibitions contributed over many months to locating, cataloging, moving and placing physical items, to photographing and digitizing digital items and to obtaining oral histories and video interviews. They included **Elizabeth Borchardt, William Harnack, Sara Lott, Alex Lux, Judy Strebel, and Heather Yager.**

MEDIA AND WEB TEAM

Jon Plutte, Media Producer and award-winning documentary filmmaker, served as the executive producer of all of the media viewable on the more than 100 screens in *Revolution* and their Internet counterparts. His exhibition production credits all 15 films playing throughout the galleries, the Icon Video segments in each gallery and the design of the more than 40 interactive viewing stations.

Revolution Online was launched through the year-long efforts of **Ton Luong** and **Ganna Boyko** of the Technology team.

A team of producers, editors and researchers contributed to media and web production, including the capture of more than 60 oral histories and interview segments for the What's Next Theater and the extensive search for digital footage and images. They included **Sridhar Dasari, Aimee Gardner, Ken Gruca, and Carol Stiglic.**

PROFESSIONAL SERVICES

The lead architect for the Museum's public spaces was the award-winning firm of **Mark Horton / Architecture** of San Francisco. Mark Horton and Daniel Mason were the lead architects for the project.

The exhibition designers for *Revolution* were Dennis Van Sickle and Andrea Rolleri of **Van Sickle & Rolleri**, an award-winning designer of immersive museum environments. VS&R is based in Medford, New Jersey.

Exhibit Concepts, Inc., an award-winning exhibit fabricator based in Dayton, Ohio, was the lead firm constructing the physical exhibition spaces in *Revolution*. The audio/visual intregration team was **Bowen Innovations** of Indianapolis, Indiana.

LEED-accredited **MAI Industries** of San Jose was the general contractor. MAI Industries collaborated closely with VS&R and Exhibit Concepts to execute the new interior design of the exhibition space and the Museum's new public spaces.

Hillman & Carr is an award-winning Washington, DC based filmmaker that served as producer of the Software and Artificial Intelligence films.

Mark Richards is photographer for *Revolution* and took more than 7,000 images for the exhibition.

Paul Rosenthal is an experienced interpretive writer for museum exhibitions and translated the curated material into exhibit text.

Vision
To explore the computing revolution and its worldwide impact on the human experience

Mission
To preserve and present for posterity the artifacts and stories of the information age

President and CEO
John C. Hollar

Board of Trustees

ABOUT THE MUSEUM

BACKGROUND

The Computer History Museum is the world's leading institution exploring the history of computing and its ongoing impact on society. It is home to the largest international collection of computing artifacts in the world, including computer hardware, software, documentation, ephemera, photographs, and moving images. The Museum brings computer history to life through an acclaimed speaker series, dynamic website, on-site tours, and physical exhibitions.

CURRENT EXHIBITS

Revolution: The First 2000 Years of Computing
Everyone uses computers. Few know the story of how they came to be. *Revolution* is the only historically authoritative exhibition exploring the explosive growth of computers, software and networking. It chronicles the evolution and impact of modern computing from the abacus to the smart phone. This 25,000 sq. ft. multimedia experience is a technological wonderland that immerses visitors in the sights, sounds, and stories of the computer revolution.

Babbage Difference Engine No. 2
The Story of the First Computer Pioneer
Charles Babbage (1791-1871) designed the first modern programmable computer—complete with a printer—but he failed to build it. Engineers at the London Science Museum finally built the first working Babbage Engine in 2002. The Babbage Difference Engine No. 2 on display at the Museum has 8,000 parts, weighs five tons and measures 11 feet in length. Learn more about this extraordinary object and the people who built it.

Mastering the Game: A History of Computer Chess
The history of computer chess is a five-decade long quest, beginning in the earliest days of computing and reflecting the ongoing advances in hardware and software. Chess presented the perfect computing challenge: a simple set of rules enabling games of stupefying complexity. Learn more about the journey to build a computer that challenged the world's best chess players.

PDP-1
Digital Equipment Corporation's (DEC) PDP-1 was the first commercial computers designed to interact with a single user. The Museum's restoration team brought the PDP-1 back to working condition. They retrieved data from its main memory, restored all the peripherals and loaded the machine with vintage games, including SpaceWar!

HOURS

Wednesday–Sunday:
10 am–5 pm

CONTACT

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Computer History Museum