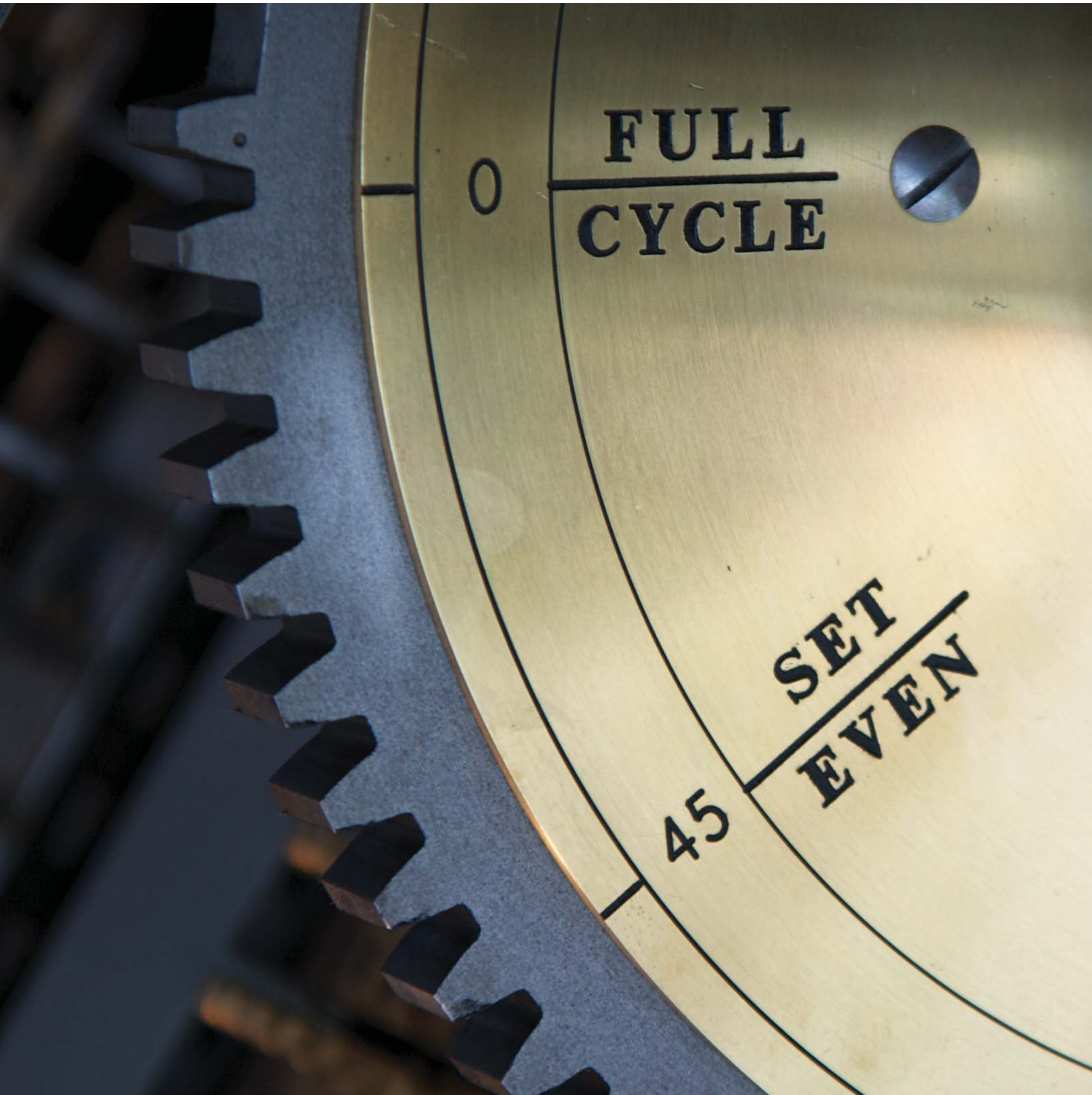
2008

CORE

A Publication of
the Computer
History Museum



Cover: The Babbage Engine's chapter wheel indicates progress throughout the calculating cycle.

This page: Babbage Engine's bevel gears transmit power from the crank to the camstack.

Opposite: The distinct "teardrop" geometry of the first planar transistor invented by Jean Hoerni of Fairchild.

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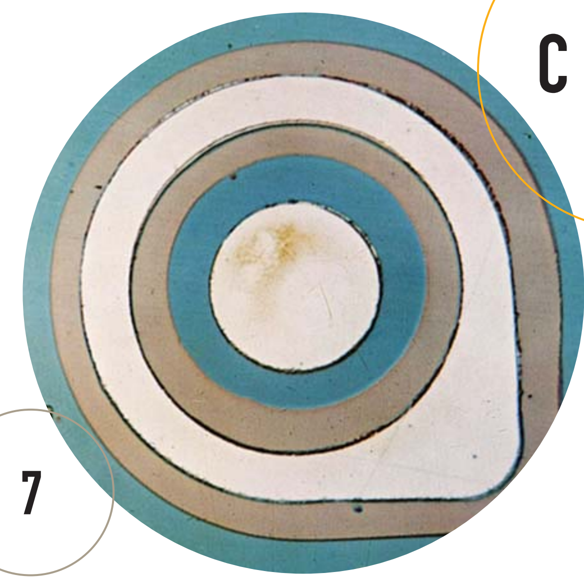

7

CURATORS

CHM Curators' favorite computer-related quotes

DAG SPICER

SENIOR CURATOR

"There's an old story about the person who wished his computer were as easy to use as his telephone. That wish has come true, since I no longer know how to use my telephone."

BJARNE STROUSTRUP

AL KOSSOW

SOFTWARE CURATOR

"If builders built houses the way programmers built programs, the first woodpecker to come along would destroy civilization."

GERALD P. WEINBERG, AUTHOR OF *THE PSYCHOLOGY OF COMPUTER PROGRAMMING*

ALEX BOCHANNEK

CURATOR

"Man is still the most extraordinary computer of all."

JOHN F. KENNEDY

CHRIS GARCIA

CURATOR

"I do not fear computers. I fear the lack of them."

ISAAC ASIMOV

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CHAIRMAN'S LETTER

OUR NEW CEO

Welcome to John Hollar, our new President and CEO:
Most of you already know the wonderful news about our new President and CEO: after months of looking for a great person to lead our institution, we were able to convince John Hollar to take that role and help move CHM to the next level in our growth.

The diverse worldwide experience and business insights John brings from his major roles at the FCC, at PBS, and at Pearson in London are extremely valuable to the Museum. He combines enthusiasm for the evolution of technology with relevant experience in creating and distributing media and web-based content. His professional leadership and fresh approach have already injected a new palpable excitement. For more information about John Hollar's background, see the press release at: computerhistory.org/press.

John's priority will be to continue our momentum toward becoming a full-time exhibiting institution and world-class destination. The next phase includes the development of a comprehensive plan for exhibits and programs, completing the $125 million fundraising campaign, and adding education and research components to the Museum. One of John's top goals is to drive the launch of a major exhibit on computer history, tentatively called "Computer History: The First 2,000 Years," which is scheduled to open both in the building and on the web in 2010. We are making great progress on developing this complex and comprehensive exhibit using a mix of staff curators, volunteers, and outside experts.

I hope you enjoy the changes you see in this issue of *Core*. We try to make it an entertaining mix of computer history and information about the Museum. Our field is a rich one, so read about colorful pioneering individuals like Charles Babbage, Andy Grove, and Gene Amdahl, and the remarkable story of Fairchild's role in developing the semiconductor industry. Learn how the CHM collection, the largest collection of computing artifacts in the world, is managed and how it continues to expand. And as always, give us your feedback and stay involved.

Regards,

LEN SHUSTEK
CHAIRMAN, BOARD OF TRUSTEES, COMPUTER HISTORY MUSEUM

CONTRIBUTORS

Core 2008 Contributors give us their take on computer history

DAVID A. LAWS

Who has 'made it'?
Fairchild Semiconductor

What milestone contributed the most?
The conception and creation of the first monolithic integrated circuits (ICs). That itself involved three distinct milestones. (1) Jean Hoerni's invention of the planar transistor manufacturing process. (2) Bob Noyce's insight that the oxide insulation layer feature of the process would enable the interconnection of multiple transistors on a chip. And (3) Jay Last and his team's creative engineering efforts that turned these concepts into the reality of the modern integrated circuit. Fairchild called its first ICs "Micrologic."

Why should we celebrate it?
Fairchild's planar integrated circuit is the foundation of just about every computer chip that has been produced in the succeeding 50 years. Today the computer is the chip.

Why is CHM important?
CHM gives us the opportunity to celebrate these important milestones and the stories of the people who made them happen and to record them for posterity. Together with the Chemical Heritage Foundation and the IEEE, CHM will host events in Spring 2009 to celebrate the 50th anniversary of the events that led to the development of the IC.

DAG SPICER

Who has 'made it'?
IBM

What milestone contributed the most?
The IBM 7030 ("Stretch") project resulted in profound changes in the way IBM researched, developed, and manufactured electronic computers. It laid the blueprint for dozens of technical innovations in computing that are still in use today and it laid the foundation for IBM's groundbreaking System/360 mainframe computer system.

Why should we celebrate it?
We celebrate any event to reflect upon the past and to look to the future. We celebrate to see how companies succeed or fail due to any one of dozens of complex, interlocking reasons and to learn what factors contribute to success and which to failure. Finally, we celebrate for nostalgia—to satisfy the perpetual longing for an imagined "simpler time."

Why is CHM important?
CHM is home to the world's largest collection of computing artifacts, software, media, documents, and ephemera. Since it began collecting in the mid-1970s, it has acquired many of the most important machines and technologies in computing—works that are masterpieces of the machine age. CHM is the Louvre of computing.

DORON SWADE

Who has 'made it'?
Tim Berners-Lee. By foregoing patents, royalties and other commercial benefits from his work creating the Web, he succeeded in realising a network with access for all. He transcended the supposed imperatives of financial self-interest—a remarkable accomplishment—and created something bigger than a "commercially successful product." Well, so far anyway.

What milestone contributed the most?
The microprocessor.

Why should we celebrate it?
The cost-performance of large-scale integration was the engine of the computer's remarkable rise. I choose the microprocessor as a symbol of semiconductor integration.

Why is CHM Important?
The institutional mandate of museums of science and technology is to maintain a material record of technological change. Inseparable from this is historical interpretation of significance as this informs all their cultural outputs and informs acquisition of objects for their collections.

Computer-related devices are arguably the most successful new technology of the last half-century and the preservation of its history is therefore pre-eminently important. CHM is the largest single institution with this historic mission. It is important because the history of computing is important.

RICHARD S. TEDLOW

Who has 'made it'?
Intel

What milestone contributed the most?
Intel's decision to act as the sole source for its 386 microprocessor instead of licensing its technology to other companies.

Intel took a big gamble that IBM would buy its 386 even though there was no competing manufacturer. In fact, IBM was slow to accept Intel's 386. By 1986, however, the "clone" market had developed and Compaq had become a major player in the PC industry. Compaq used IBM's tardiness to establish a leadership position. That is why Compaq purchased Intel's 386 and incorporated it into its own next-generation PC—the Compaq DeskPro 386.

Why should we celebrate it?
This caused leadership in the PC industry to migrate from the assemblers (such as IBM) to the component suppliers (Intel and Microsoft). This was a change of historic importance. IBM, Intel, and Microsoft are all still very much alive but IBM no longer manufactures PCs.

There is often a battle in the value chain of an industry concerning leadership. In the automobile industry, the assembler is the most important player. But sole sourcing of the 386 made the suppliers more important than the assemblers in the computer industry.

Why is CHM important?
This industry, more than any other, perhaps, is about the future. It also wants to hang onto its heritage.

The last minutes of Electronic Arts' *EA-Land*, captured on August 1, 2008 by Stanford University's "How They Got Game Project" for its Archiving Virtual Worlds collection.

PRESERVING VIRTUAL WORLDS

MUSEUM UPDATES

> "Capturing oral histories now, is critical...wouldn't you love to be able to hear Michaelangelo talk about what it was like to paint the Sistine Chapel?"
> DONNA DUBINSKY
> CEO OF NUMENTA,
> AND MEMBER OF CHM'S BOARD OF TRUSTEES

Virtual worlds like *Second Life* have gotten a great deal of press attention in recent years. Few know they have a rich history stretching back to the 1976 computer game "Adventure." Multi-User Dungeons (MUDs), the invention of virtual reality, and full-blown simulated cities were some of the markers along the way. But most of this history is being lost because the complex interactive environments of virtual worlds are so challenging to archive.

In an effort to preserve records of these worlds, CHM curator Marc Weber, Bruce Damer of the Digibarn, and Kevin Hughes of CommerceNet are developing wiki timelines that Henry Lowood and the "How They Got Game" Project of the Stanford Humanities Lab will use as part of a new project, "Preserving Virtual Worlds," funded by the U.S. Library of Congress through the National Digital Information Infrastructure Preservation Program (NDIPP). Groups at the University of Illinois, University of Maryland, and Rochester Institute of Technology are also partners. Henry Lowood is a long-time friend of CHM's activities and is Curator for History of Science & Technology Collections at Stanford, which include the Silicon Valley Archives and Silicon Genesis oral history project.

Weber, who is founding curator of CHM's Internet History program and co-founder of the Web History Center and Project, is working with Damer, Hughes, and timeline company, Dipity.com to adapt a wiki-like timeline system that will let pioneers enter and edit recollections and materials at: nethistory.org/timelines/virtual_worlds. This effort is an evolution of digital library ideas Hughes and Weber first posted online in 1996, which are now greatly aided by the maturation of wiki-like systems.

Damer's 1997 *Avatars! Exploring and Building Virtual Worlds on the Internet* (Peachpit Press), was the first book about shared social Virtual Worlds. He is co-founder of the Digibarn Computer Museum, and has donated over 175 hours of unique historic video to the Virtual Worlds video archive, now hosted by the Internet Archive. He also engaged the community in pioneering experimentation that helped to define the medium, such as the first cyber-conference held in 1998.

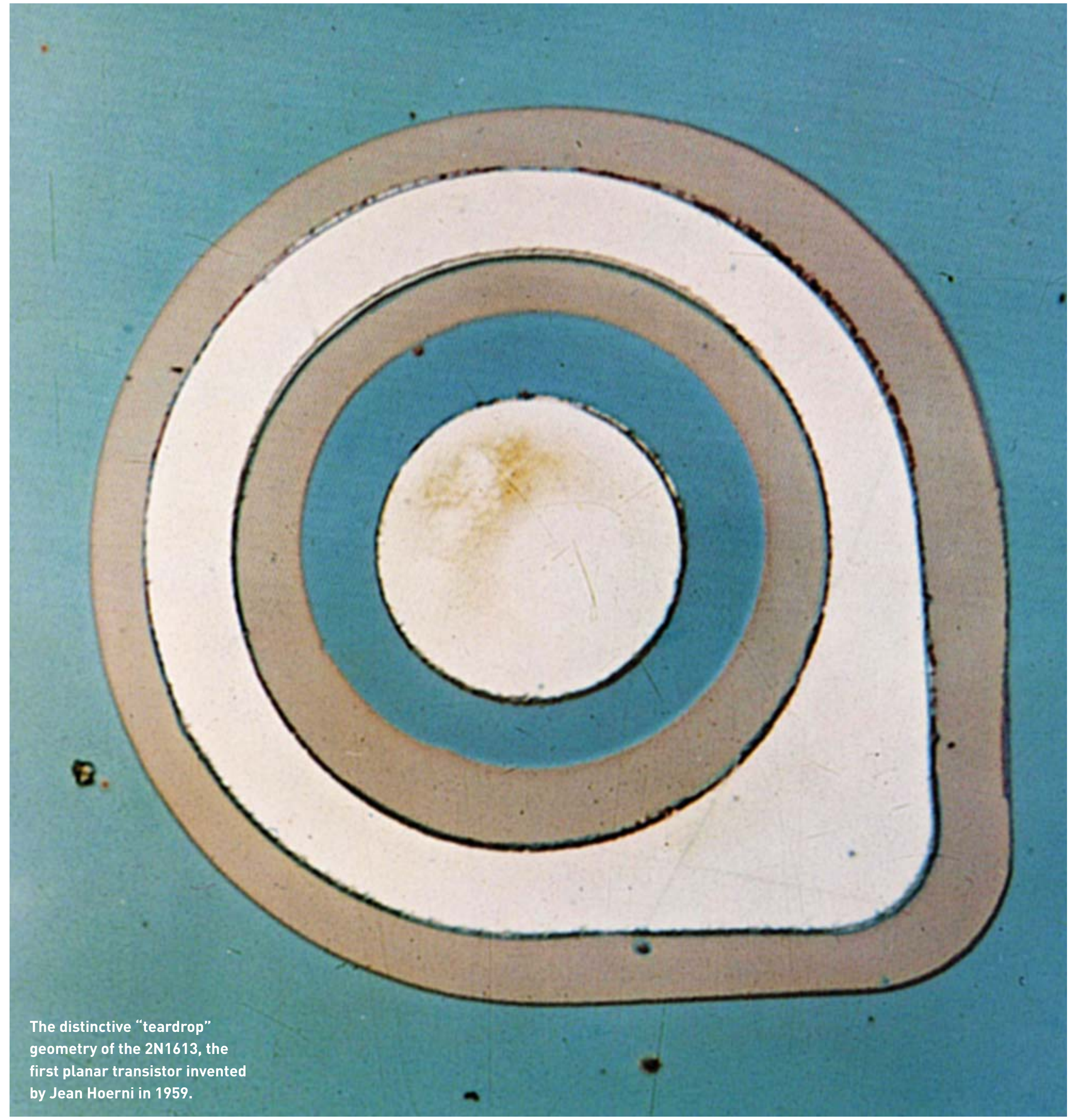
In Spring 2009, CHM will collaborate with Damer, Lowood and Weber to produce a lecture program exploring the history of Virtual Worlds. ○

> **Virtual worlds like *Second Life* have...a rich history stretching back to...1976...**

THE SILICON ENGINE

Semiconductors are the silicon engines that have powered computers toward ever greater capabilities and speeds over the last 50 years. The Computer History Museum's new Silicon Engine web exhibit explores the history of semiconductors through a timeline of major development milestones, biographies, and snapshots of the companies responsible for them. It also includes a section on resources for students and teachers. The exhibit was created through a collaborative effort of the Museum's Semiconductor Special Interest Group and the Museum's Exhibit and Information Systems teams, and made possible by a grant from the Gordon and Betty Moore Foundation. The Silicon Engine online exhibit can be found on CHM's website at: computerhistory.org/semiconductor. ○

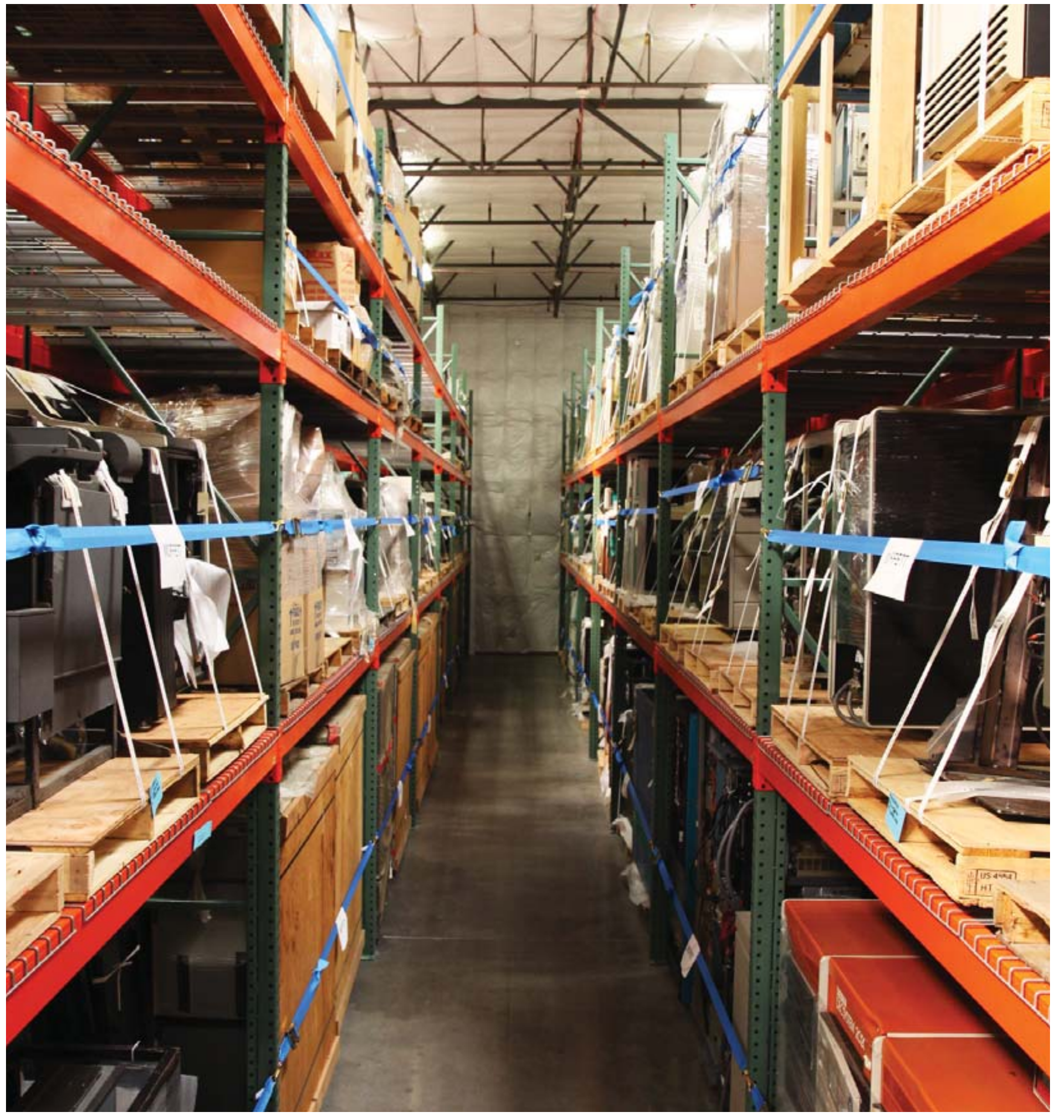
> "I think young people can come to the Museum and think, 'Wow, look how they started with such simple little things.'"
> STEVE WOZNIAK
> CO-FOUNDER OF APPLE
> AND CHM FELLOW



FAIRCHILD CAMERA & INSTRUMENT CORPORATION

The distinctive "teardrop" geometry of the 2N1613, the first planar transistor invented by Jean Hoerni in 1959.

> "Computing technology is such a remarkable revolution that it would be tragic if we didn't record and save the information necessary for future generations to understand how it happened."
>
> LEN SHUSTEK
> CHAIRMAN OF CHM'S
> BOARD OF TRUSTEES



After cataloging was completed at the Museum, objects larger than a miniature refrigerator have been palletized and carefully stowed, floor to ceiling, in offsite storage.

DOCUMENTING A WORLD-CLASS COLLECTION

A museum ensures the safe-keeping of its collections, determines how to grow them, and decides which items to make publicly available through exhibits, programs and reference centers through the fundamental processes of inventorying, photographing and cataloging its artifacts. In July 2007, the Computer History Museum received a federal two-year grant of more than $144,000 from the prestigious Institute of Museum and Library Services (IMLS) to support CHM's Collection Cataloging and Reconciliation Project (CCARP).

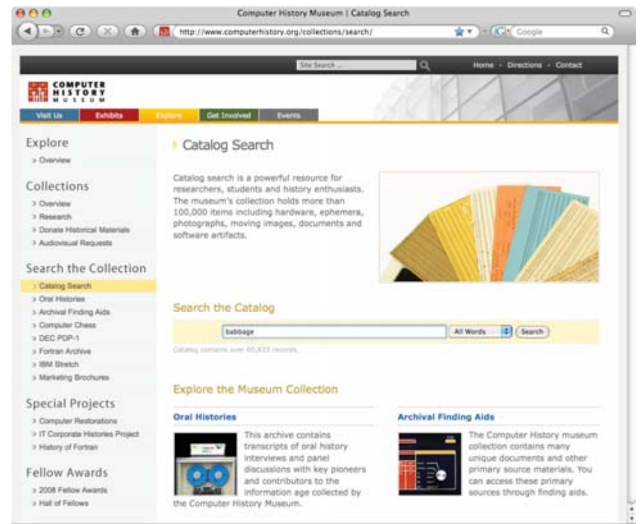
The project's goals are to catalog and photograph 9,000 new physical objects and to attach an additional 11,000 digital photographs to pre-existing records within the artifact database. In early November, CHM happily reported that our staff and volunteer catalogers exceeded the two goals by achieving 9,222 new object records and attaching 14,264 digital images. The Museum's online Catalog Search now contains more than 61,000 artifact records. ○

400,000

CHM videos have been viewed on YouTube in just the past year

JUST A CLICK AWAY

The Computer History Museum's collection of artifacts including hardware, software, documents, ephemera, photographs and moving images is now available using the new online Catalog Search feature, which is a result of the Collection Cataloging and Reconciliation Project. More than 61,000 items from our enormous collection can now be viewed on CHM's website, using the Catalog Search. You will now find improved search tools and an integrated image viewer. Even the Museum's Special Collections can be searched and viewed online: Oral Histories, Computer Chess, DEC PDP-1, IBM Stretch, Fortran Archive and Marketing Brochures. Additionally, new artifacts are frequently cataloged and added to the vast collection. The new Catalog Search tool can be found on CHM's website at: computerhistory.org/collections/search. ○



CHM's Collection Catalog Search webpage—over 61,000 artifact records now available on the web.

The CHM YouTube channel—with more than 50 computing history lectures and historic videos, such as the video below of our legacy institution, The Computer Museum.

CHM'S YOUTUBE CHANNEL

Did you know you can drop in on CHM from anywhere in the world? Thanks to an in-kind donation from Google, CHM has created a fully branded YouTube channel that highlights the Museum and brings CHM's lectures and video collection to a huge worldwide audience. Since the channel opened in November 2007, the CHM YouTube channel has been visited by more than 325,000 people. And more than 2,000 people have subscribed to the channel so they can receive email updates about new videos.

Thousands more have clicked through from the YouTube channel to CHM's own website to explore the Museum's online exhibits. The Computer History Museum's YouTube channel can be found at: youtube.com/computerhistory. ○

> "The computer is the single most important invention in the second half of the 20th century."
>
> DAG SPICER
> CHM'S SENIOR CURATOR

VOLUNTEER SPOTLIGHT: MARCIN WICHARY & HERB KANNER

Marcin Wichary (left) and Herb Kanner (right) in front of the Museum's Visible Storage exhibit.

Computing changes so much and it's likely that children can't imagine life without the Internet, computer graphics, or mice.

Volunteers continue to be the backbone of the Computer History Museum. *Core* talked to two of our valued volunteers, Marcin Wichary and Herb Kanner, who between them have provided over 2,000 volunteer hours.

Please tell us about your background.

Marcin: I got into computing at the early age of 8 with a cheap 8-bit machine. It didn't come with software so I was forced to learn to program it.

I finished my Master's in Computer Science in Poland, followed by a doctorate in human-computer interaction in the Netherlands. As I was wrapping up my thesis, I began thinking of my future career, and sent my resume to those dream companies that I was sure would never hire me. But I didn't have anything to lose. I sent my first resume to Google, and I was hired as a user experience designer, off that first resume, in 2005. After a stint in Switzerland, I moved to California in 2006, and have been volunteering at the Museum since 2007.

Herb: I actually started out studying music at the Music Conservatory of Oberlin College (Oberlin, Ohio). Because of insufficient interest in music, I eventually transferred to the University of Chicago to major in physics. When World War II intervened, I joined the army and the Metallurgical Laboratory, which was a code name for the Chicago part of the Manhattan Project, from 1942 to 1946. I entered graduate school at University of Chicago in 1946 and got a physics PH.D. in 1951. I then worked at Shell Development Company in Houston, Texas, and while working there, I became fascinated with computers, playing with an IBM 650.

Other jobs throughout my career included Assistant Professor of Applied Mathematics at the Institute for Computer Research at the University of Chicago, manager of what they called the Advanced Technology Department at Control Data Corporation, and stints at RCA, International Computers Limited in England (a subsidiary of NCR), Mohawk Data Systems, Tymnet, and the Development Systems Group at Apple Computer.

How did you both become interested in computing and computer history?

H: I was hired at Shell Development in 1952 as a physicist. In less than a year there, I started an operations research group. This led me to using computers for some of the group's problems. That early, I saw that computers would create a second industrial revolution and decided to switch to that field.

M: And I am a product of this revolution (laughs). As for computer history, there was no one single moment I can recall. While other people were moving on to newer and faster computers, I never did. With time, I actually started slowly going back in time. The more I learned, the more fascinated I was. After a while I realized this is was becoming a serious interest, and I decided to do something about it. Volunteering at CHM was one result of that. The other was creating guidebookgallery.org.

What draws you to the Computer History Museum?

M: The idea of preserving, exploring and demonstrating the ever-changing relationships between computers and people. The fact that many people volunteering or visiting the Museum actually shaped computing history themselves means I get to meet my demigods on seemingly a weekly basis! Also there are so many different opportunities for volunteers. I never operated a video camera nor cranked a Difference Engine before I came here!

H: It was former CHM CEO John Toole's introductory talks at several lectures I attended that drew me to the Museum. The first was at Moffett Field. He made me realize the importance of preserving the artifacts and the stories. And I decided to volunteer.

What thrills you about showing the Visible Storage exhibit to new visitors?

H: I think the biggest thrill is when I encounter a visitor who worked on one of the exhibited machines and I learn something significant and interesting about the machine that I did not know.

M: Agreed! And I love seeing kids in the Museum, especially as CHM is not otherwise terribly kid-friendly. Computing changes so much and it's likely that children can't imagine life without the Internet, or computer graphics, or mice. The micros from the 1980s are more ancient to them than vacuum tubes to me—it must be fascinating for them to be able to look back at computers this way. I'm hoping that, for some of those kids, seeing the Difference Engine No. 2 in action, or one of the first videogames, or realizing their cell phone has more computing power that the old refrigerator-sized machine they're looking at will be a transformative event—perhaps one that will make them want to join the computer industry themselves.

What advice do you have for people who want to become volunteers?

M: Don't be afraid! Even if you think you don't know anything about computer history, you'll have many opportunities to learn—and tons of fun while doing it. Plus, even people who've been doing this for decades are still learning!

H: Jump in. You'll have fun and meet some great people. ○

424

volunteers contributed 18,885 hours total in FY2008

"We were great 'finishers'! We didn't just do the fun parts of a project and people always gave us jobs because of it."

JEAN BARTIK
ENIAC PROGRAMMER AND CHM FELLOW, ON WHY SHE WAS SO SUCCESSFUL

WAYNE MILLER/MAGNUM PHOTOS

The Fairchild Semiconductor founders, circa 1960. From left: Gordon Moore, Sheldon Roberts, Eugene Kleiner, Robert Noyce, Victor Grinich, Julius Blank, Jean Hoerni, and Jay Last.

INDUSTRY TALES

FAIRCHILD AT 50

BY DAVID A. LAWS

The Museum hosted a celebration for a pioneering company

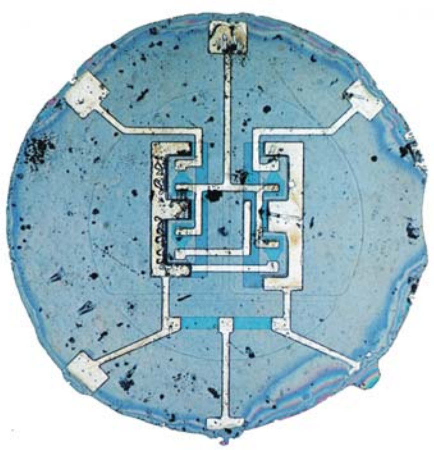
In October 2007, the Computer History Museum and Stanford University hosted a gala celebration of the 50th anniversary of the founding of Fairchild Semiconductor. According to Wyn Wachhorst, the founding of Fairchild "will be seen in centuries to come as an epochal turning point in human evolution."[1]

Alumni and friends of Fairchild traveled from around the world to remember the legendary company that delivered some of the most exciting, professionally rewarding, technologically challenging, and frustrating experiences of their careers. Fairchild and its technologies changed the world in ways its founders could never have imagined. And then it faded into obscurity in the 1970s.

In the Beginning

Fairchild Semiconductor was founded in 1957 by eight young engineers and scientists from co-inventor of the transistor William Shockley's Semiconductor Laboratory in Mountain View, California. Described by Michael Malone as "perhaps the most extraordinary collection of business talent ever assembled in a start-up company,"[2] Fairchild employees pioneered an entrepreneurial business culture; spawned manufacturing and marketing techniques that gave birth to the phenomenon later dubbed Silicon Valley; and reshaped the worldwide semiconductor industry. Fairchild went on to develop some of the most important innovations in 20th century technology and sow the seeds of the microelectronics-driven computer industry and personal digital products of today.

Fairchild and its technologies changed the world in ways its founders could never have imagined. And then it faded into obscurity in the 1970s.



Die photograph of the first planar integrated circuit. The Fairchild type "F" flip-flop, comprising 4 transistors and 6 resistors, was introduced in March 1961.

The planar process, developed by co-founder Jean Hoerni in early 1959, is the jewel in the crown of Fairchild's technological achievements. Hoerni's approach revolutionized the production of semiconductor devices and enabled the development of monolithic integrated circuits (ICs). It allowed semiconductors to be manufactured in a high-volume production environment that was amenable to continuous reductions in cost at the same time that it delivered extraordinary increases in the number of transistors on a chip and improvements in their performance. Even today, his basic concept continues to inform the manufacture of billion-transistor microprocessor and memory chips. Historian Christophe Lécuyer ranks it as "the most important innovation in the history of the semiconductor industry."[3]

Fairchild Semiconductor was initially funded as a division of Fairchild Camera and Instrument Corporation of Syosset, New York. It grew rapidly and was highly profitable. At the peak of its influence, the division controlled over 30 percent of the market for integrated circuits. By the late 1960s, it reached $150 million in annual sales and employed some 30,000 people.

A Vital Diaspora

Despite—or perhaps because of—the rapid growth spurred by the division's extraordinary outpouring of ideas and innovation, the young company ran into difficulties meeting customer demands, retaining employees, and managing operations. Rather than invest in expanded semiconductor manufacturing capacity and personnel, though, the Syosset headquarters decided to drain its semiconductor profits to finance other ventures.

Even though Fairchild was an early leader when it came to granting stock to engineering employees, the number of shares it offered was extremely small. So the management team had a difficult time supporting and rewarding the many new ideas spawned by its engineers. Many of these entrepreneurial-minded engineers were spurred to leave Fairchild and form companies of their own. The results of this entrepreneurial outpouring include Advanced Micro Devices (AMD), Intel, and National Semiconductor. This exodus of talent combined with a capacity shortage, an increase in competition, and a steep economic downturn brought about the end of Fairchild's glory days just ten years after it was founded.

1 Wachorst, Wyn. "The Real Revolutionaries," *Gentry Magazine* (Menlo Park, California, February 2008)

2 Malone, Michael S. *Bill & Dave: How Hewlett and Packard Built the World's Greatest Company* (Portfolio, April 5, 2007)

3 Lécuyer, Christophe. *Making Silicon Valley* (MIT Press, 2006)

Revival Efforts

In 1968, C. Lester Hogan (1920–2008), previously from Motorola, headed a new management team that attempted to revitalize the flagging company. He moved the corporate headquarters to Mountain View, expanded capacity, and invested in new technologies and products. Revenues grew substantially under this regime but the company didn't regain its former profitability and prominence.

Next, French oilfield services conglomerate, Schlumberger, purchased the company as a diversification move. But when it, too, was unable restore the company to its previous fortunes, Schlumberger sold the assets to National Semiconductor in 1987.

Finally in 1997, National Semiconductor divested a number of former Fairchild mature product lines in a leveraged buy-out to a group of executives based at Fairchild's former South Portland, Maine facility. And today, the reborn Fairchild Semiconductor is once again a public company with annual revenue of more than $1 billion.

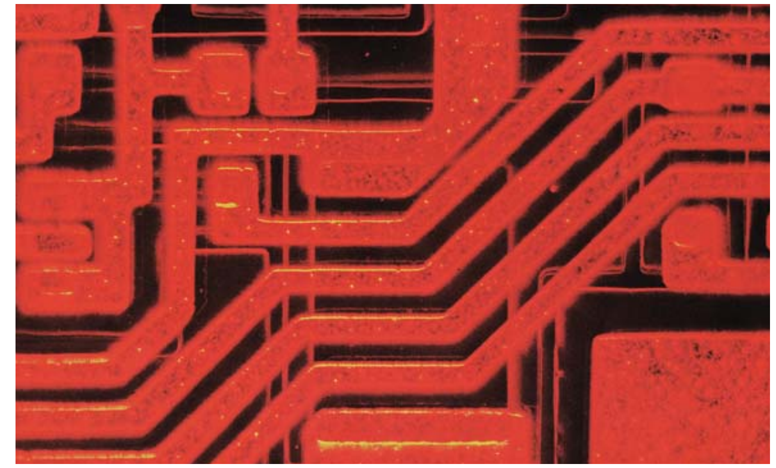
But the legacy of the original Fairchild also lives on through the worldwide diffusion of its technology and culture, which spread through the diaspora of former employees. There are hundreds of companies—among them systems, software, and service businesses—in the San Francisco Bay Area and beyond who can trace their roots back to Fairchild.

A Celebration of the Legacy

Fairchildren, as former employees of the company are often called, are famous for their affection for the company and their gratitude for the semiconductor industry training and ex-

THIS AND OPPOSITE PAGES: FAIRCHILD CAMERA & INSTRUMENT CORPORATION)

ACCOMPLISHMENTS



Metal interconnect lines on an integrated circuit. Photomicrograph by Richard Steinheimer of Fairchild Semiconductor, circa 1968–1969.

Other important contributions to computer history from the company's engineers:

The first high-speed silicon transistors, developed for the CDC 6600 supercomputer, on display in the Museum's Visible Storage exhibit.

"Micrologic," the first monolithic integrated circuit family. It powered the computer that guided the Apollo space missions.

The first commercially successful analog. also known as "linear," integrated circuits. Because of their role in interfacing real-world analog signals such as sound, temperature and speed to the language of the digital computer, these form one of the most important segments of the industry.

Early work in understanding and commercializing the MOS (Metal-Oxide-Semiconductor) technology, including the important silicon-gate process that is the basis of 99 percent of ICs produced today.

Invention of the CMOS (Complementary MOS) process that consumes the lowest possible power and permits battery operation of many of our most popular electronic devices.

The observation now known as Moore's Law, which stated that the number of transistors that can be placed inexpensively on an integrated circuit doubles approximately every two years. It has provided a yardstick against which technology progress has been measured for over 40 years.

The first commercial CCD (Charge Coupled Devices) optical imaging sensors used in digital cameras.

Some of the earliest dedicated semiconductor memory devices, including the first commercial shipments of all-semiconductor computer main memory systems; see the ILLIAC IV supercomputer, also in the Visible Storage exhibit.

Panel discussion: Julius Blank, Jay Last, Gordon Moore, and Arthur Rock, moderated by Leslie Berlin on October 4, 2007.

perience they gained there. This is an industry that has treated many of them very well. And although Fairchildrens' legendary capacity for "working long days and partying long nights" has no doubt been diminished by the passage of time, that didn't stop nearly 1,000 former employees and friends of the company from reuniting for three days in October 2007 to rekindle friendships, swap stories, and celebrate their heritage.

On Thursday, October 4, at the Stanford University campus, Julius Blank, Jay Last, Gordon Moore, and Arthur Rock—three Fairchild Semiconductor founders and the banker who helped them—discussed the firm's significance and its early years in a panel discussion. The panel was moderated by Leslie Berlin, biographer of Fairchild and Intel cofounder Robert Noyce. Stanford University President and CHM Fellow, John Hennessy introduced this panel of esteemed speakers.

Friday, October 5 began with a series of afternoon panels at the Computer History Museum. The panels surveyed eight aspects of the Fairchild experience. In order of presentation, the topics and session moderators comprised:

- The Founding Years & R&D - Harry Sello
- Bipolar Digital Products - Bill Welling
- Linear Products - Norman Doyle
- MOS Products - Gil Amelio
- Manufacturing and Support Services - C. E. "Ed" Pausa
- Discrete Products - George Wells
- International Sales & Marketing - Robert Blair
- North American Sales & Marketing - Bernie Marren

In all, more than 30 panelists recounted—and no doubt embellished—stories from their days at the company. These sessions were recorded on video and the content was transcribed and added to the Museum's oral history archives at: computerhistory.org/collections/oralhistories.

Before a packed house in the Museum's Hahn Auditorium, Fairchild alumnus and noted venture capitalist Floyd Kvamme led three distinguished industry leaders through the "Legacy of Fairchild." The noted speakers were all chairmen emeritus from industry giants: Wilfred Corrigan of LSI Logic, Gordon Moore of Intel and W.J. "Jerry" Sanders III of AMD. They gave a wide-ranging and entertaining discussion of their early careers at Fairchild. A video of this session is posted on the CHM YouTube Channel at: youtube.com/computerhistory. The transcript is available on the Museum's oral history page.

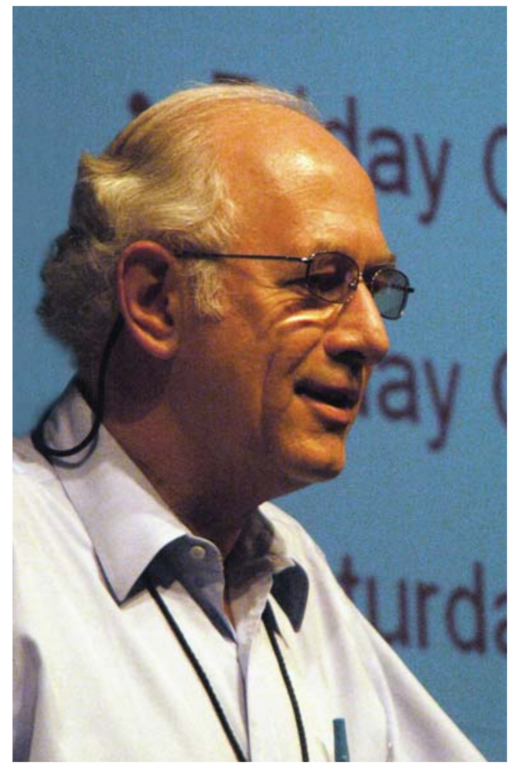
Saturday, October 6 concluded the celebration with a gala reunion party held at the Museum, which was decorated with photographs, posters, and banners of memorable people and products. Attendees circulated through an exhibit of Fairchild artifacts and documents donated by attendees. The celebration also featured a tour of objects associated with the company in Visible Storage, a video theater showed *The Fairchild Chronicles* movie, and multiple projectors displayed continuously changing still images of employees in various states of decency onto giant screens. There was also a room of Fairchild-produced consumer products and video games. The highlight of the décor was a re-creation of the popular company watering hole, "Walker's Wagon Wheel," which included wagon wheels from the Museum collection and a section of the original bar rescued from the demolition site. Founders Julius Blank, Jay Last and Gordon Moore ceremonially cut a "Happy 50th Birthday" cake.

There are hundreds of companies in…the San Francisco Bay Area and beyond who can trace their roots back to Fairchild.

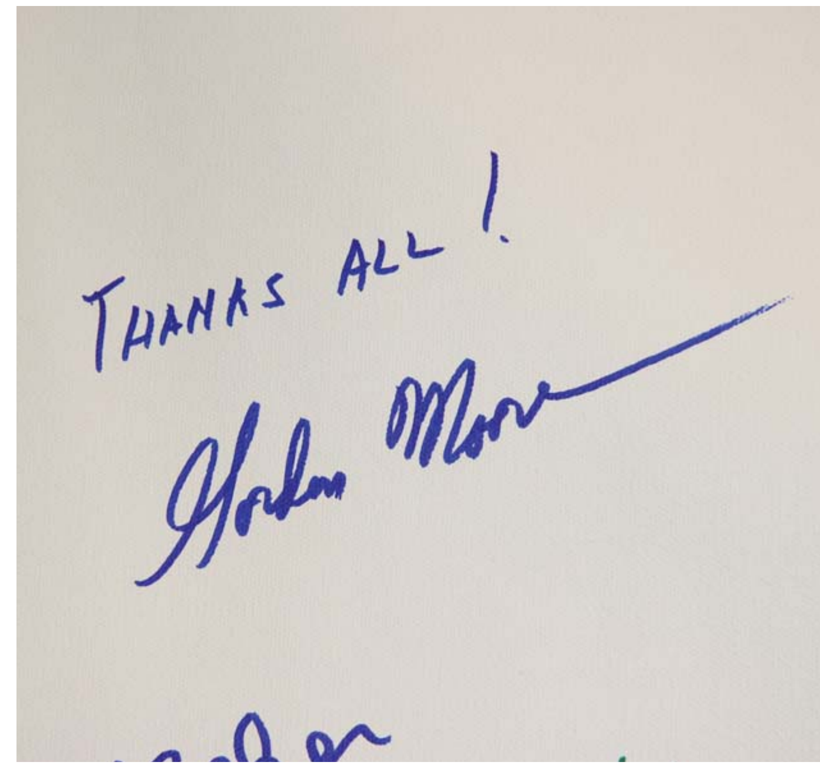
The events held at Stanford were co-sponsored by Stanford Libraries and the Bill Lane Center for the Study of the North American West. Celebrations that took place at the Museum were made possible through the generous donation of funds, materials and time by dozens of dedicated alumni volunteers, Fairchildren and family and friends, as well as the Computer History Museum.

David A. Laws joined Fairchild affiliate SGS-Fairchild in London, England in 1966. He moved to the Silicon Valley headquarters in 1968, where he later worked for Advanced Micro Devices, Altera and other companies in senior management positions.

Although Fairchildrens' legendary capacity for "working long days and partying long nights" has been diminished…that didn't stop nearly 1,000 former employees and friends from reuniting…



David A. Laws, Fairchild alumnus and former Director and a member of the CHM Semiconductor Special Interest Group, addresses the audience.



Signature of Fairchild co-founder Gordon Moore.

LEFT: MIKE DUBINSKY / RIGHT: JULIE HENDRIKS / OPPOSITE: MIKE DUBINSKY.

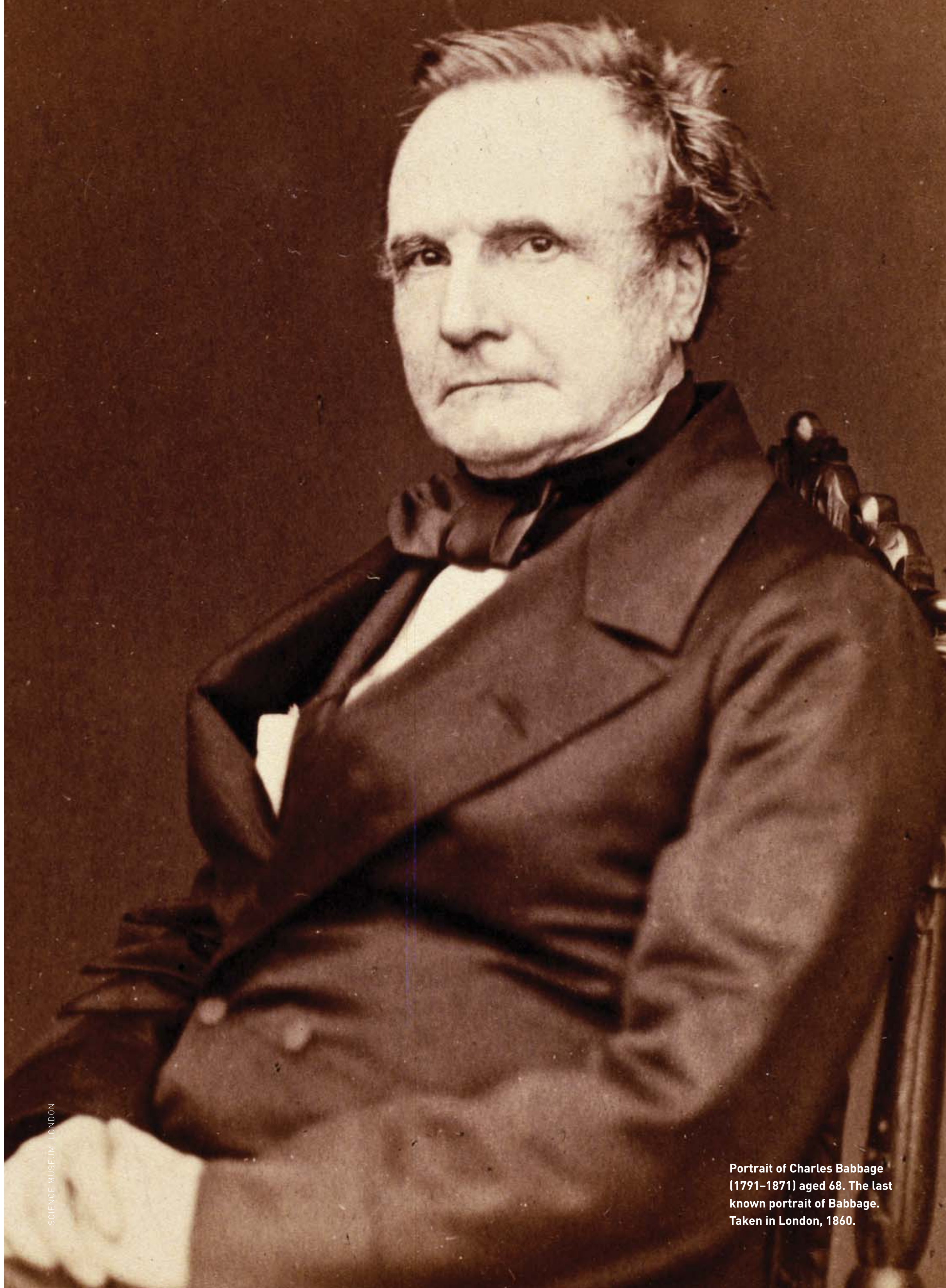
FEATURE

LEGACY AND LEGEND

Charles Babbage and modern computing

BY DORON SWADE

Charles Babbage (1791-1871) is routinely referred to as the father, grandfather or forefather of the modern computer. The language of fatherhood implies an unbroken line of descent to our own age with Babbage as the patrilinear source. His designs for vast but unbuilt mechanical calculating engines were the first to embody the essential principles of automatic general-purpose digital computation. Because he was the first it is often assumed that the modern computer has descended directly from his work. But the lineage of the modern computer is not as clear-cut as these genealogical tributes imply.

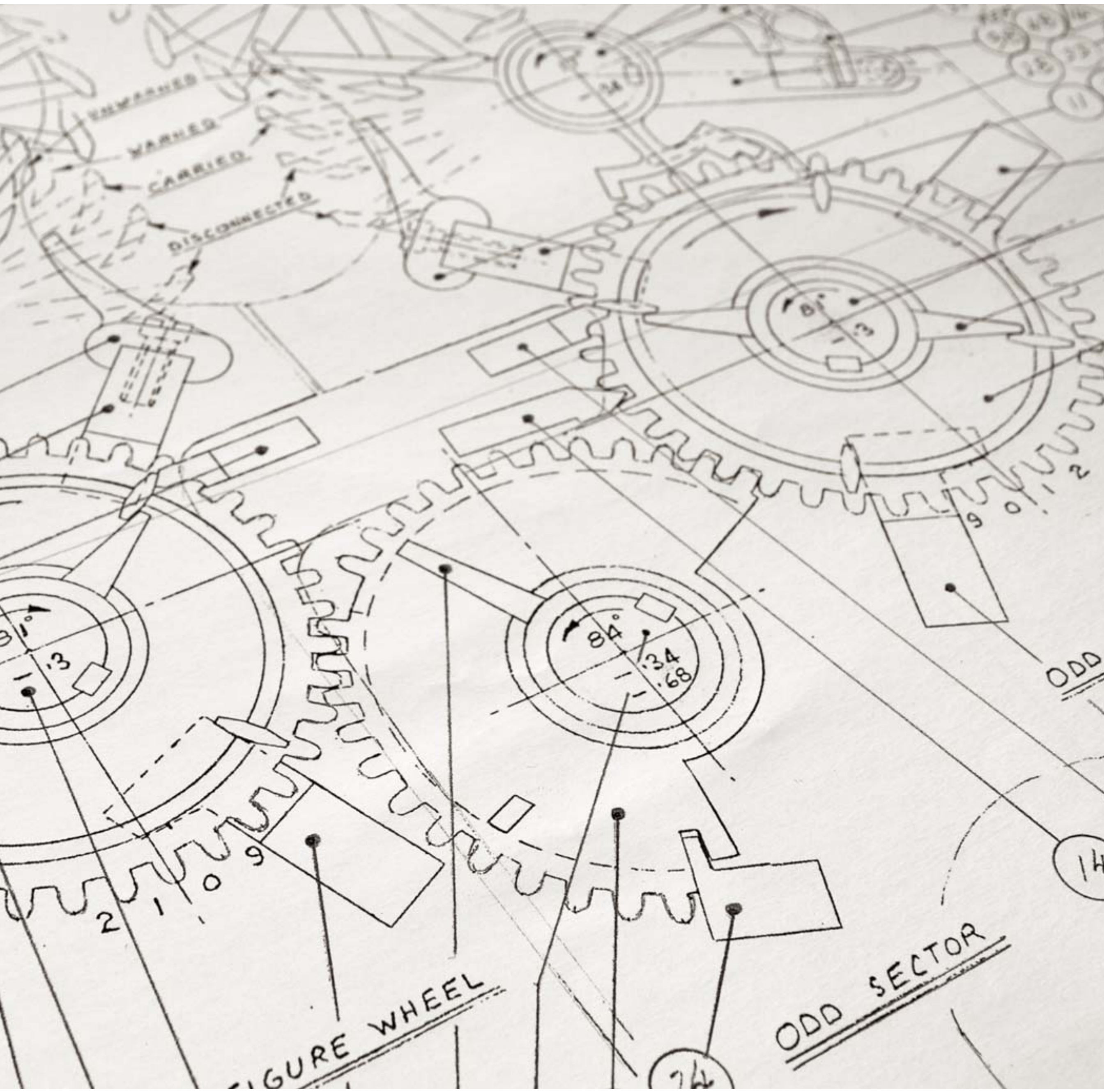

SCIENCE MUSEUM LONDON

Portrait of Charles Babbage (1791–1871) aged 68. The last known portrait of Babbage. Taken in London, 1860.

A detail from one of over 150 modern engineering drawings created by the London Science Museum. This one shows the essence of the calculating mechanism.

In 1991, the bicentennial year of Babbage's birth, the cover of *New Scientist* declared Babbage the "architect of modern computing."[1] Two years later *Scientific American* carried a feature article in which the advertising abstract stated that "Charles Babbage's plans for mechanical calculators and computers paved the way for the modern computer revolution."[2] The perception of a direct debt to Babbage was reinforced when the Royal Mail launched, in 1991, special-issue postage stamps commemorating British scientific achievement. Babbage shared philatelic honours with Michael Faraday, Frank Whittle, and Robert Watson-Watt for their pioneering work on electricity, the jet engine, and radar respectively. The implication is clear—that Babbage contributed as much to modern computing as his compatriots did to their fields. Babbage's elevation from dismal failure to national hero was now official. But in the quartet of pioneers, Babbage is arguably the odd man out.

While the Royal Mail was minting a stamp in Babbage's honour, computer scientist and historian, Allan Bromley, who had studied Babbage's designs more closely than anyone, wrote that "Babbage had effectively no influence on the design of the modern digital computer."[3]



Maurice Wilkes, distinguished pioneer of post-WWII electronic computing at Cambridge, had come to the same conclusion. In 1971, the centenary of Babbage's death, Wilkes wrote that Babbage "however brilliant and original, was without influence on the modern development of computers."[4] Wilkes and Bromley are not alone. J. G. Brainerd, Director of the Moore School, wrote in 1965 that "Babbage's influence [on ENIAC] was nil."

It gets worse. In the same publication, Wilkes, who elsewhere describes Babbage as possessing "vision verging on genius," accuses Babbage not of pioneering the modern computer age, but of actually delaying it. Wilkes argues that Babbage's projected image became one of failure and that this discouraged others from thinking along similar lines.[5]

Wilkes...accuses Babbage not of pioneering the modern computer age, but of actually delaying it.

At first sight the allegation is shocking. But new evidence has come to light of at least one instance in which Wilkes's allegation, however originally intended, is specifically and historically vindicated.

Thomas Fowler, an impoverished self-taught Devonshire printer and bookseller, devised an original digital computing device based on ternary arithmetic. The machine, which was demonstrated in the 1840s, calculated logarithms to thirteen places "in a singularly beautiful and concise manner."[6] The calculator was a scientific novelty, and luminaries, Babbage included, flocked to view it. Fowler's son wrote, with unmistakeable bitterness, that the British government refused to fund Fowler's work on the grounds that it had already spent vast sums of public money on Babbage, with no obvious result. In retrospect, Fowler's machine was, in many respects, more promising than Babbage's. Fowler's work was not explored by his contemporaries, and this appears to have been directly a result of Babbage's failures.

Others in the 19th-century attempted automatic calculating engines—George and Edvard Scheutz, and later Martin Wiberg in Sweden, Alfred Deacon in London, and Barnard Grant in the United States. But these were isolated splutterings that failed to ignite a movement. There was a febrile twitch in the early 20th century. Percy Ludgate, an Irish auditor, designed an "analytical machine" in the first decade of the century. The design is original and Ludgate attests that he had no prior knowledge of Babbage's work.[7] The machine was a developmental *cul de sac*, with no discernable influence on what followed.

It seems then that there is no unbroken line of development from Babbage to the electronic era. But the gulf between the two is far from total. After Babbage, no one doubted that automatic machine computation was possible, and analysis, based on citation frequency from 1889 to 1948, shows that there are no large time gaps in awareness of Babbage amongst the

1 Swade, Doron. "Building Babbage's Dream Machine." *New Scientist* 1775.29 June (1991): 37-39.

2 Swade, Doron. "Redeeming Charles Babbage's Mechanical Computer." *Scientific American.* February (1993): 86-91.

3 Bromley, Allan G. *The Babbage Papers in the Science Museum: A Cross-Referenced List.* London: Science Museum, 1991, p. 9.

4 Wilkes, Maurice V. *Babbage as a Computer Pioneer*: British Computer Society and the Royal Statistical Society, 1971, p. 1. L.J Comrie, an acknowledged authority on the calculation and production of mathematical tables, is reported to have remarked that "this dark age in computing machinery, that lasted 100 years, was due to the colossal failure of Charles Babbage." See Cohen, I. B. "Babbage and Aiken." *Annals of the History of Computing* 10.3 (1988), p. 180.

5 Wilkes, 1971.

6 See Swade, Doron. *The Cogwheel Brain: Charles Babbage and the Quest to Build the First Computer.* London: Little, Brown, 2000, pp. 310-312. For an account of the reconstruction of Fowler's calculator see Glusker, Mark, David M Hogan, and Pamela Vass. "The Ternary Calculating Machine of Thomas Fowler." *IEEE Annals of the History of Computing* 27.3 (2005): 4-22.

7 For details of Ludgate's machine see Randell, B. "Ludgate's Analytical Machine of 1909." *Computer Journal* 14.3 (1971): 317-26. Also Randell, Brian. "From Analytical Engine to Electronic Digital Computer: The Contributions of Ludgate, Torres, and Bush." *Annals of the History of Computing* 4.4 October (1982): 327-41.

Small demonstration piece of Difference Engine No. 1. A similar piece was presented to Harvard in 1886 by Babbage's son and seen by Howard Aiken.

Modern recreation of Thomas Fowler's ternary calculating machine.

TOP: SCIENCE MUSEUM, LONDON / BOTTOM: BILL LEUNG, MATRIX PHOTOGRAPHY

coteries of pioneers who carried the flag.[8] Some of the pioneers of the electrical and electronic eras were aware of Babbage. Others were not. But almost without exception all claim, with credible conviction, that their own efforts were uninfluenced by any detailed knowledge of Babbage's work.

One exception is Howard Aiken, one of two main bridging figures between Babbage and the modern age.[9] Aiken, who championed the construction of the Harvard Mark 1, completed in January 1943, claimed explicitly that he was directly influenced by Babbage's work. In the late 1930s Aiken came across a small demonstration piece that Babbage's son, Henry, had sent to Harvard to advertise his father's work. Aiken later claimed that he "felt that Babbage was addressing him personally from the past" and that "if Babbage had lived seventy five years later, I would have been out of a job."[10] Aiken repeatedly emphasised his indebtedness to Babbage, and his frequent tributes publicised Babbage's work in the post-war years.

Aiken styled himself as Babbage's modern-day heir. It is curious that the historian, I. B. Cohen, went out of his way to demonstrate not only that Aiken was largely ignorant of the detail of Babbage's work but that some of his perceptions were in fact wrong. Cohen in effect accuses Aiken of band-wagon fame—of attempting to stake a claim to his own place in history through a public affiliation with Babbage. It is an irony that the one pioneer to lay a strong claim to direct influence is accused of immodest self-promotion. History, it seems, is determined that Babbage shall have no intellectual heirs.

Babbage published practically nothing in the way of technical description of his engines, and his drawings, which remain largely unpublished in a manuscript archive, were not studied in any significant detail until the 1970s, notably by Allan Bromley. It is fairly conclusive therefore that Babbage's designs were not the blueprint for the modern computer and that the pioneers of the electronic age reinvented many of the principles explored by Babbage in almost complete ignorance of the detail of his work.

Such continuity as there is not in the technology nor in the designs, but in the legend. Babbage and his efforts were an inseparable part of the folklore shared by the small communities of scientists, mathematicians and engineers who throughout remained involved in calculation, tabulation and computation. Babbage's failures were failures of practical accomplishment, not of principle, and the legend of his extraordinary engines was the vehicle not only for the vision but also for the unquestioned trust that a universal automatic machine was possible. ○

Doron Swade is a world-renowned expert on Charles Babbage and his Engines. Swade was Director of CHM's Babbage Project and curated the Museum's Babbage Engine Exhibit.

8 Metropolis, N., and J. Worlton. "A Trilogy of Errors in the History of Computing." *Annals of the History of Computing* 2.1 (1980): 49-59.

9 The other main bridging figure is Babbage's son, Henry Prevost, to whom Babbage bequeathed his workshop and drawings. Henry continued his father's work after Babbage's death, but without any startling outcome.

10 See Cohen, I. B. "Babbage and Aiken." *Annals of the History of Computing* 10.3 (1988): 171-91, and Cohen, I B. *Howard Aiken: Portrait of a Computer Pioneer*. Cambridge (Mass): MIT Press, 1999.

EXTRAORDINARY IMAGES

THE BABBAGE ENGINE

PHOTOGRAPHS BY MARCIN WICHARY

Charles Babbage's Difference Engine No. 2 is one of the earliest designs for an automatic computing engine. Weighing five tons, with 8,000 parts of bronze, cast iron and steel, the Engine is a stunning display of Victorian mechanics.

This modern construction was led by Doron Swade (see the previous article on Babbage by Swade). It measures 11 feet long and 7 feet high, and automatically calculates and prints tables of polynomial functions to 31 decimal places.

The Engine's construction was commissioned by Nathan Myhrvold, CEO of Intellectual Ventures and former Chief Technology Officer of Microsoft. The CHM Babbage Engine exhibit was also made possible through the generosity of the following benefactors: Andreas Bechtolsheim, Bell Family Trust, Donna Dubinsky & Len Shustek, Judy Estrin, Fry's Electronics-Kathryn Kolder, Dorrit & F. Grant Saviers, Marva & John Warnock, and with special thanks to Science Museum, London.

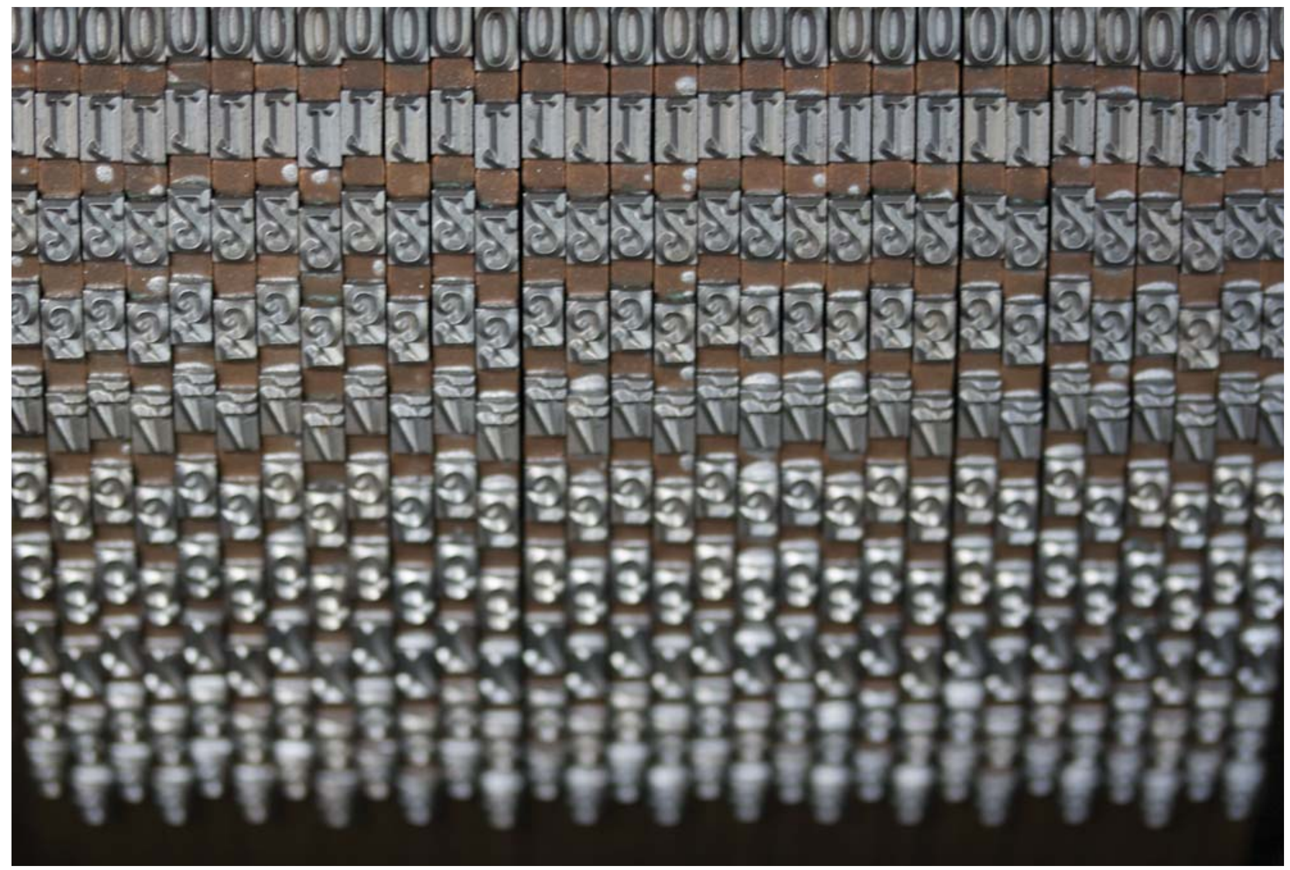
The Difference Engine No. 2 will be on display at the Computer History Museum until Spring 2009. ○

Note the thin line at the bottom - a catgut thread disconnects the main drive at the end of a page.

One of the 248 bronze figure wheels.

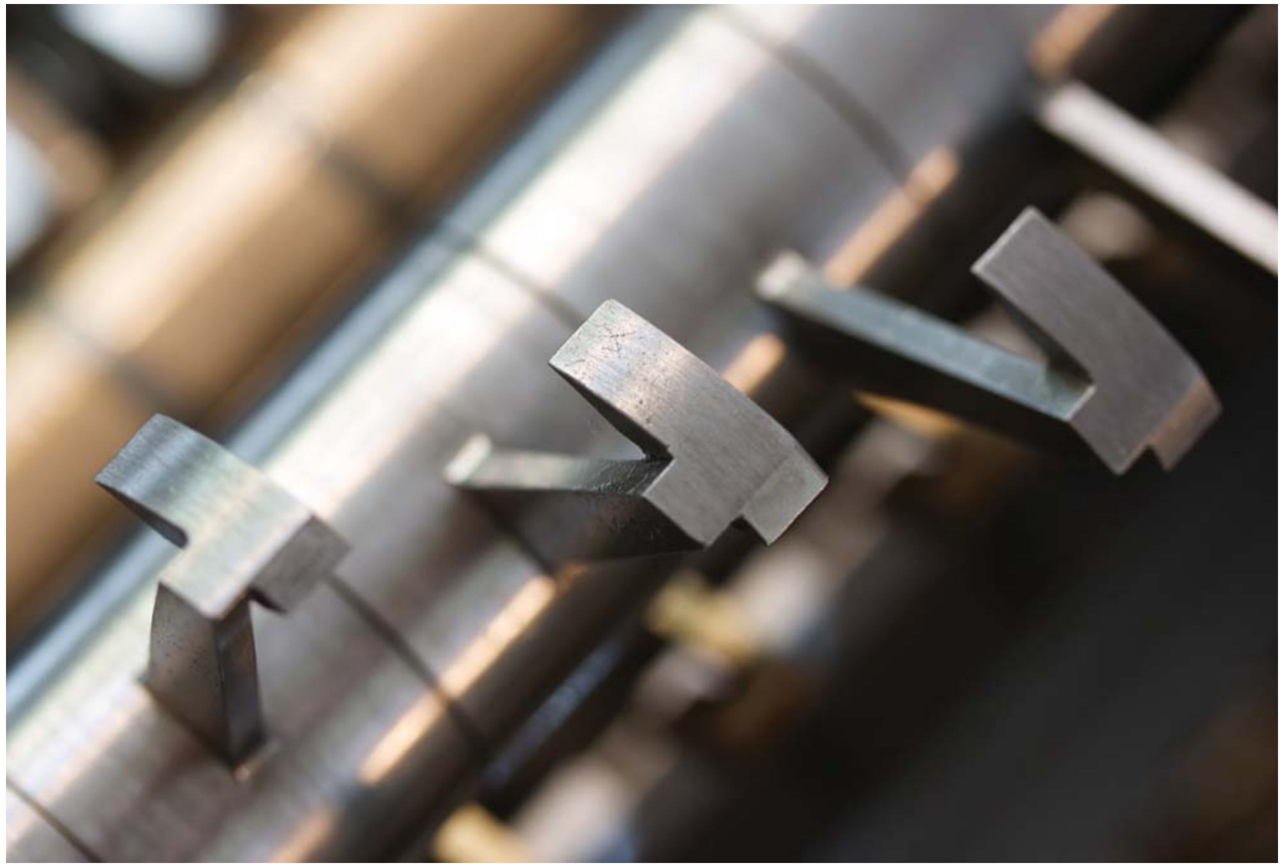
Figure wheels engaged with adjacent sector wheels during addition.

A page from Babbage's celebrated 1827 *Table of Logarithms.*

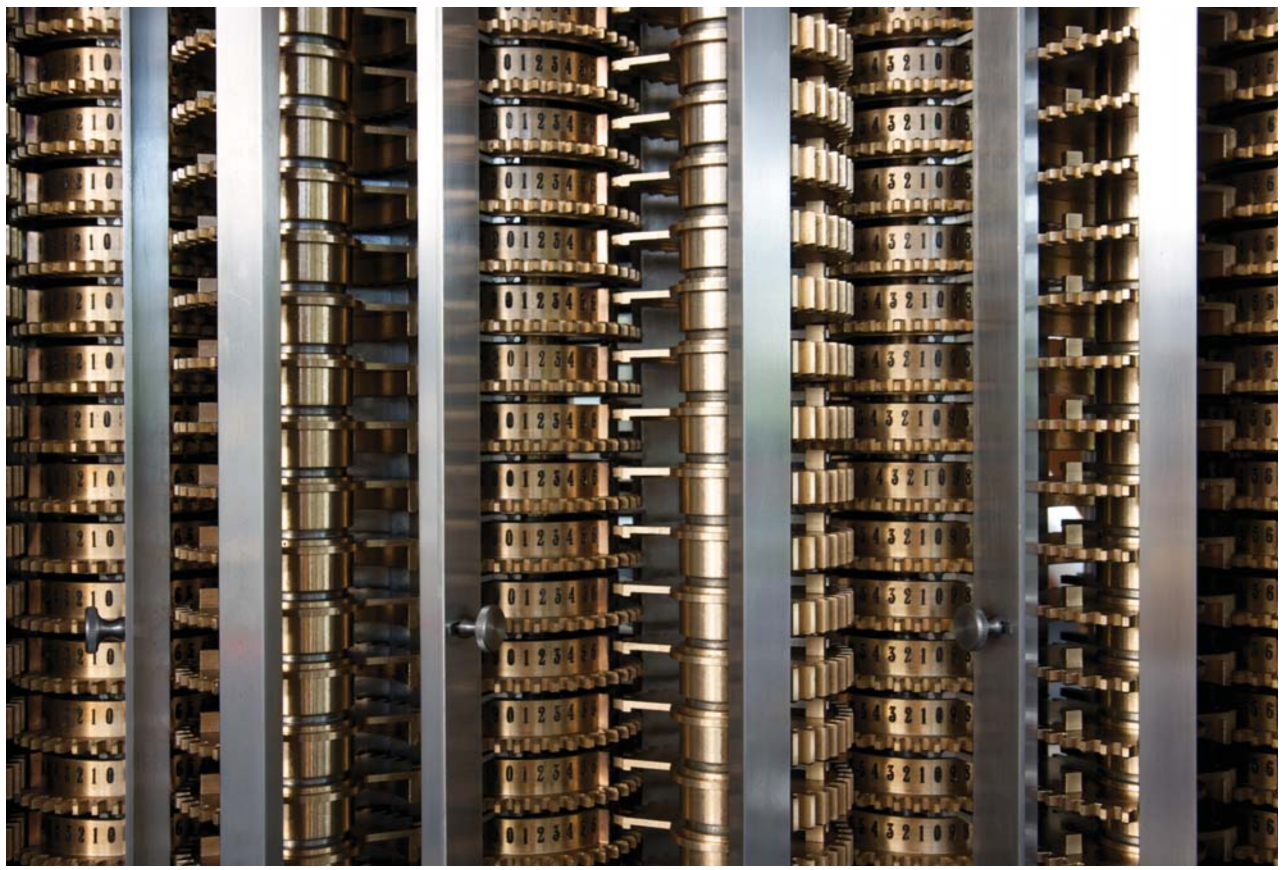


Closeup of type wheels in the printing section.

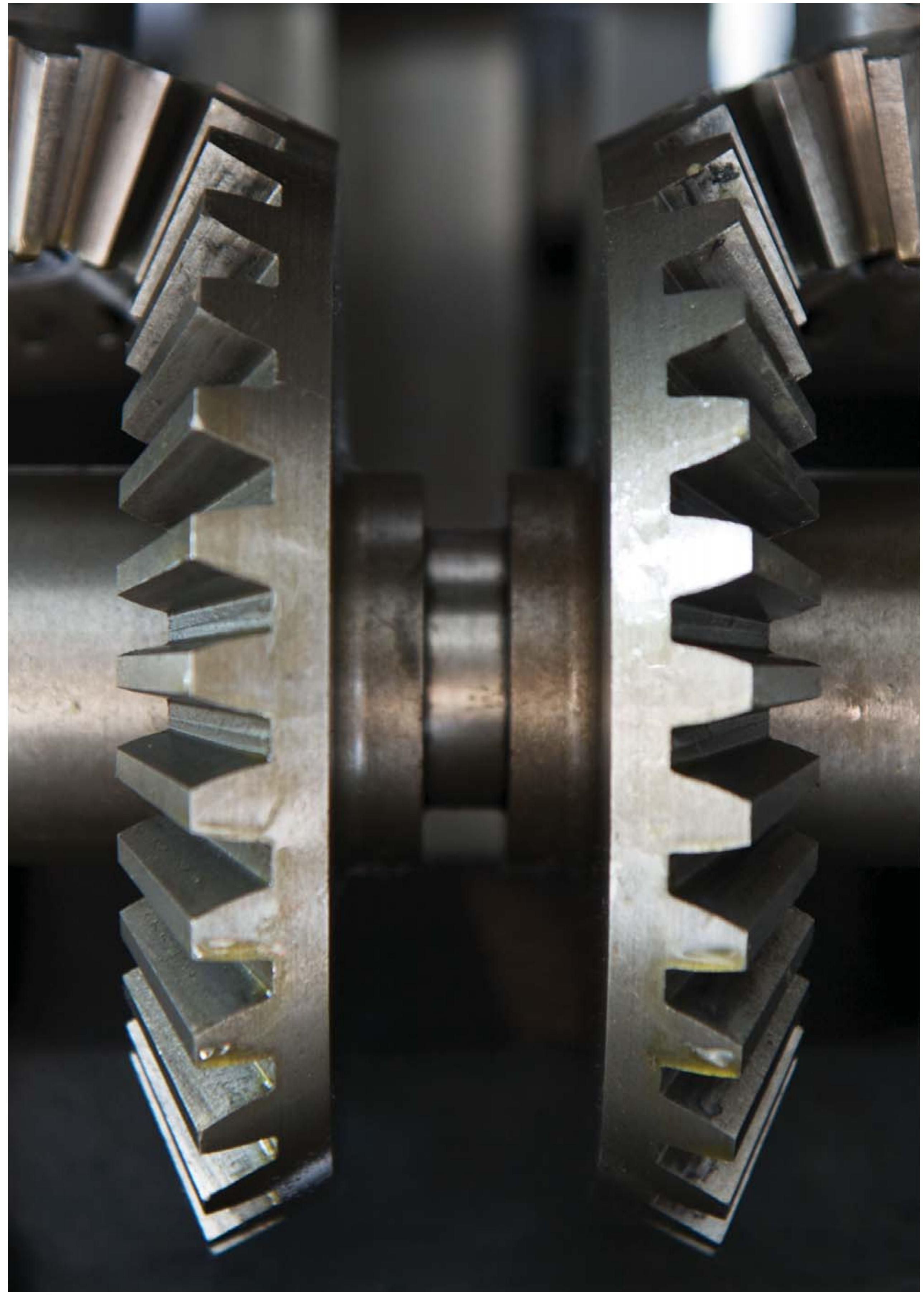
The subtle profiles of these cams encode the Engine's microprogram.



Helically arranged carry arms. As these columns rotate, carries are propagated sequentially from low to high digits.



Vertical columns of figure wheels store 31-digit decimal numbers.



Bevel gears drive a pair of vertical carry axes.

VALLEY OF DEATH

EXCERPT

Andrew S. Grove, born September 2, 1936, has been with Intel since the company was founded in 1968. Currently, his role is Senior Advisor to Intel's executive management.

MICHAEL PRINCE PHOTOGRAPHY

Excerpt of Richard S. Tedlow's *Andy Grove: The Life and Times of an American*—Chapter 10

Gordon Moore has a small wooden plaque that had etched on it: "This is a profit-making organization. That's the way we intended it... And that's the way it is!"

It certainly did not look that way in 1986 with the loss of $173 million. With the benefit of hindsight, we know that Intel pulled out of this dive dramatically in 1987. Sales soared 51 percent to $1.9 billion. The profit picture was equally exciting, hitting a record $248 million. Market capitalization increased by almost $2 billion to $3.328 billion. In 1987, Intel placed 200 on the Fortune 500, higher than ever before. We know today that Intel reached the precipice in 1986 but was able to leap it and continue its climb the following year. No one was arguing with Moore's sign displayed in 1987.

Life, however, is not lived in hindsight. What if the collapse of 1986 had continued into 1987? If the company experienced another 7.3 percent decline in sales, they would have dropped to $1.172 billion, well below the level of 1984. If the company's losses had continued at the 1986 rate, it would have been close to $350 million in the red, losing almost a million dollars a day. Its market capitalization would have fallen to $1.767 billion. Intel's situation would have been dire.

Grove has cautioned against drawing sharp distinctions between "management" and "leadership." One hears arguments in the academic world about management being "transactional." Management concerns itself with the myriad activities that, when undertaken effectively, keep the corporation running and increasing its profitability.

Leadership, one can argue, is "transformational." The leader drives the company in a whole new direction. The leader is charismatic and inspirational. His or her impact helps people exceed their own expectations of themselves.

The problem with these definitions is that, in Grove's words, "there is an implicit value judgment that suggests that leadership is better than management. In reality, you need both capabilities." Grove believes that "the same person should be able to do transactional jobs when those are needed and transformational jobs when those are needed... A tennis player has both a forehand and a backhand. Not all tennis players are equally good at both, but we don't talk about backhand players and forehand players."

True. Indeed, if anything, Grove's career indicates a bias toward management and a skepticism that borders on the acute when it comes to leadership, especially charismatic leadership. He and others in the company were proud when *Dun's Review* named Intel one of the "five best-managed" companies in the United States. There is no similar survey on the "five best-led" American companies.

Grove's efforts, more than anyone else's, put Intel deservedly on that list. John Doerr said that Grove made Intel the best-managed technology company in the world. The semiconductor industry had historically been plagued by poor management. Grove was determined to see Intel break that mold. Remember that Grove's first full-time experience in a corporation was at Fairchild Semiconductor from 1963 to 1968. If ever a company was "over-led" and "under-managed," it was Fairchild. Grove blamed Noyce, the perfect example of a charismatic leader, for that state of affairs.

If people were going to say nasty things about him because of his Late List and other such devices to instill discipline at Intel, Grove could not have cared less. He did not need the affection of Intel's workforce. What he needed, what he demanded, was that Intel's employees manage their work lives rigorously.

Grove's first book not on a technical topic, *High Output Management*, is all about management, not leadership. The book makes reference to "leadership" only in passing. The words, "charisma," "transformation," and even "strategy" do not appear in the index. The first two chapters concern themselves with running a restaurant called "Andy's Better Breakfasts." The chapter titles are "The Basics of Production: Delivering a Breakfast (or a College Graduate, or a Compiler, or a Convicted Criminal…)" and "Managing the Breakfast Factory." He did not have a chapter on "Leading the Breakfast Factory" or "Transforming Andy's Better Breakfasts into Chez Panisse."

Even conceding these points, the fact is that in 1986, Grove acted as a "leader," if that word has any meaning. What did Grove do? To make a long story short, he presided over the creation of a new product line for Intel. Under his leadership—his management also, but preeminently his leadership—Intel exited the memory business and became a microprocessor company. Or, as he put it, "The most significant thing was the transformation of the company from a broadly positioned, across-the-board semiconductor supplier that did OK to a highly focused, highly tuned producer of microprocessors, which did better than OK."

"There is an implicit value judgment that suggests that leadership is better than management. In reality, you need both capabilities."

Two beliefs that Grove said were "as strong as religious dogmas" made it more difficult than it otherwise would have been to get out of a product [memory] that any objective outsider could see was a loser for Intel. One of these "dogmas" was that memory was Intel's "technology driver." Because memory devices were easier to test than other Intel products, they were traditionally the products that were debugged first. The lessons learned could then be applied to other products. Intel's identity was rooted in its excellence in technology. In its industry, technology and testosterone were linked. Real men live on the technological edge.

The second dogma dealt with marketing. Intel owed it to its customers and therefore its salesforce to field a full line of products. The customers demanded one-stop shopping, and if Intel could not provide that service, its customers might defect to someone else who would.

At one point in mid-1985, after a year of "aimless wandering," Grove said to Moore, "If we got kicked out and the board brought in a new CEO, what do you think he would do?" Moore immediately replied, "He would get us out of memories." "I stared at him, numb, then said, 'Why shouldn't you and I walk out the door, come back, and do it ourselves?'"

This was a real moment of truth in the history of Intel, and it should be part of every management course at our business schools. Grove was able, by self-creating new management, to adopt a different frame for his decision making. He was no longer the actor. Now he was the audience. The audience was so displeased with the actor that it would give him the "hook" if it could. He was no longer the subject. He was the object. He got outside himself and looked at the situation as a fantasized, rational actor would.

This was a cognitive tour de force. It was made possible by Grove's capacity to frame issues differently from the way others do.

Grove said that even after this moment of clarity, effective action was inhibited by the intensity of emotion around this product and around the thought that Intel had been beaten at its own game. When he started talking about jettisoning memories, "I had a hard time getting the words out of my mouth without equivocation."

How do you get something like this done? Once you know that you have got to get rid of a product, how do you implement the decision? When I started teaching at the Harvard Business School more than a quarter of a century ago, a businessman said to me that if you are going to cut off a dog's tail, it is best to cut it right at the torso rather than half an inch at a time. The observation struck me as quite uncalled-for and even sadistic. We were talking about business, not mutilation of animals. The point he was dramatically making was that if you have a tough decision, you should implement it cleanly, completely, and without hesitation. The pain will only be greater if you move in stages.

Intel moved in stages, as if its executives were working their way through a trance. At one point, Grove, to his own amazement, allowed another executive to persuade him "to continue to do R&D for a [memory] product that he and I both knew we had no plans to sell."

At last, at long last, Intel got out of the memory business. It had taken three years. A decade later, Grove recalled that the mechanics of getting out of that business were "very hard." It was a "year-and-a-half-long process of shutting down factories, letting people go, telling customers we are no longer in the business, and facing the employees who all grew up in the memory business, who all prided themselves on their skills and those skills were no longer appropriate for the direction that we were going to take with microprocessors." The wounds remained always fresh for Grove. No matter what success Intel achieved, he never ceased to believe that what had happened before could happen again.

Lessons learned? For Grove, the whole memory episode reinforced in his mind the importance of middle management. "While [top] management was kept from responding by beliefs that were shaped by our earlier success, our production planners and financial analysts dealt with allocations and numbers in an objective world." So it was simply vital to have the ranks of middle management populated by top-flight executives and then to pay careful heed to what they say and do.

Second, in Grove's words, "It is always easier to start something than to kill something." Therefore, you better be careful about what you start. That is, however, another example of a lesson that may have been learned too well. With the triumphant exception of microprocessors in personal computers, Intel has not set the world on fire introducing new products into new markets.

Third, when your failure has been of the noble variety rather than the result of stupid mistakes, you as the top manager have to figure out a way to keep the talent that was involved in that unavoidable failure in the company. The DRAM technology development group was unquestionably highly talented. "The DRAM TD group led the company in linewidth reduction. They were already developing a 1-micron process while the logic group was still developing a 1.5-micron process. Sunlin Chou and his group were widely regarded as Intel's best resource for process development." Grove had hired Sunlin Chou at Fairchild in 1964 and always held him in particularly high regard.

What is called for in situations like this can legitimately be denominated as something more than management. What is called for is leadership. "So I went up to Oregon," Grove tells us. Oregon was the headquarters of the DRAM team. The team was worried about its future, not without reason.

Grove gathered them into an auditorium and delivered a speech whose theme was "Welcome to the mainstream." Intel was making the transition from a memory company to a microprocessor company. In fact, the transition had already been made for Intel by marketplace realities. Although this group had not been involved in microprocessors, there was plenty of room for them, and the company would do what it could to help them make the contribution Grove knew they could.

The speech "actually went a lot better than I had expected." Grove's audience, knowledgeable people below the ranks of top management, had seen the handwriting on the wall and wanted some resolution of the situation. Thus Grove narrates this story as one in which "the CEO is the last to know" what others inside and outside the company had already figured out. Perhaps. However, that would not be the case as Intel moved self-consciously forward as a microprocessor company. ○

In Intel's beginning, Gordon Moore and Robert Noyce used the name NM Electronics before deciding on the name Integrated Electronics or "Intel" for short.

For Andy Grove's other valuable lessons learned, please refer to Richard S. Tedlow's book *Andy Grove: The Life and Times of an American.*

Richard S. Tedlow is a member of CHM's Board of Trustees and the Class of 1949 Professor at Harvard Business School, where he is a specialist in the history of business.

REMARKABLE PEOPLE

AN INTELLECTUAL BUSINESS LEADER

Gene Amdahl's thoughts on leadership

BY FIONA TANG

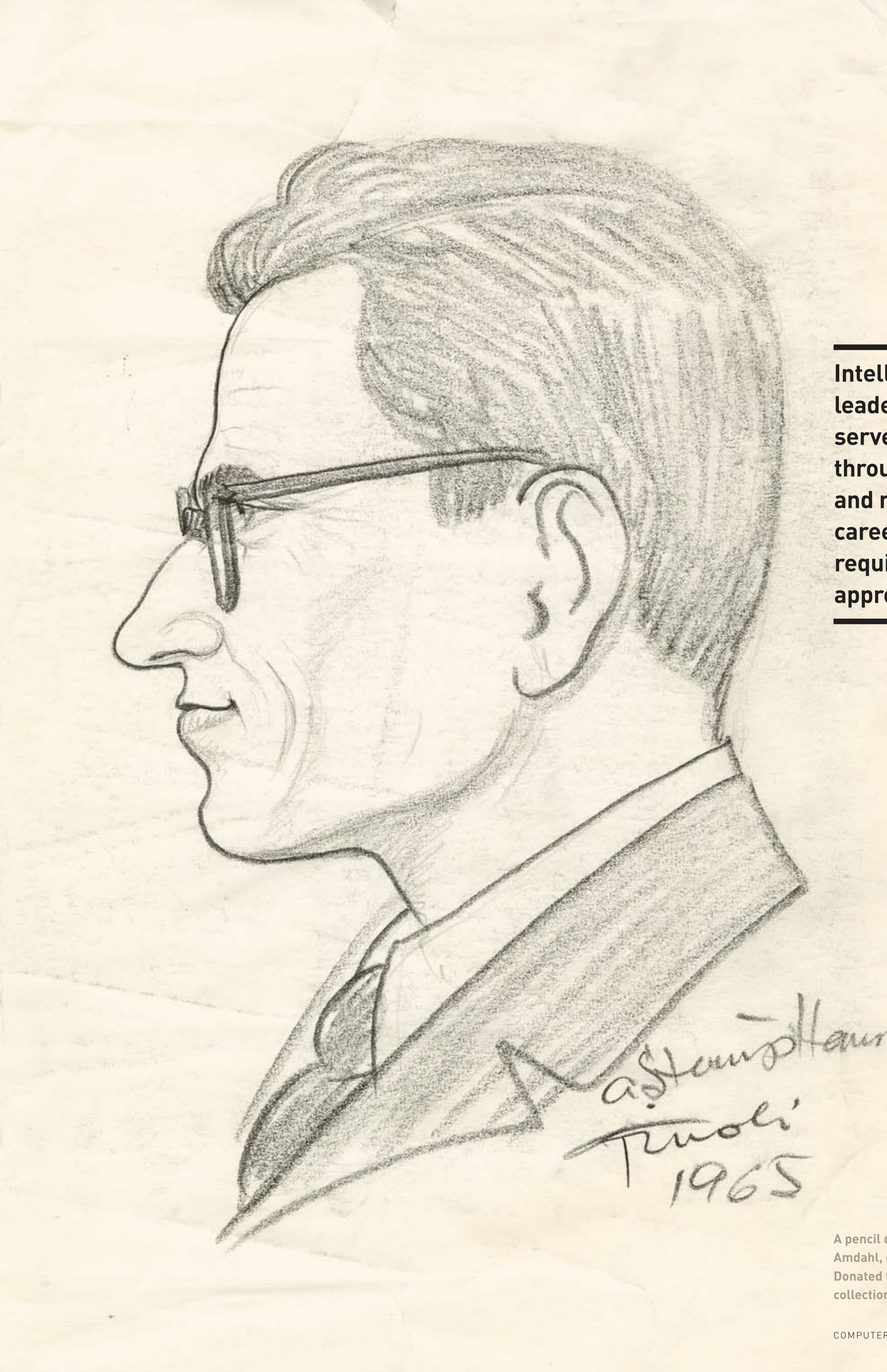
When asked to describe his success as an entrepreneur and business leader, Gene Myron Amdahl declared, "I did not view myself as a manager. I liked to work with things, not manage people. But I appreciate people and they knew that. So they would do their part because they were contributing to something valuable." This approach—one he calls intellectual leadership—served him well through a long and remarkable career but it required a subtle approach.

Amdahl, born November 16, 1922, is indeed a remarkable person. He received numerous prestigious awards within the technology industry, most notably the CHM 1998 Fellow Award, Harry H. Goode Memorial Award by the IEEE Computer Society, and the SIGDA Pioneering Achievement Award. He is an IBM Fellow, a member of the National Academy of Engineering and a Distinguished Centennial Alumnus of South Dakota State University.

Amdahl's career was highlighted by many years of project leadership within IBM and decades of entrepreneurship including the founding of Amdahl Corporation, Trilogy Systems, Andor International, and Commercial Data Servers.

Does he have advice for today's startups? Amdahl doesn't say people are doing things wrong but he notes a fundamental change in the business plan of today's startups: they don't often take a direct path toward a public offering these days and those that do take a long time to do it because the process is risky. "Today's new companies work on getting bought by bigger companies," he observes.

While Amdahl admits this may be the best way to attain financial success, he also advises that entrepreneurs pay attention to the design integrity of their technologies—hard though that may be. Given Amdahl's notable success as an intellectual business leader, professional project manager and entrepreneur, this advice is worth heeding.



Intellectual leadership—served him well through a long and remarkable career but it required a subtle approach.

A pencil drawing of Gene Amdahl, created in 1965. Donated to the Museum's collection by Amdahl.

MOVING IN

COLLECTION

The Museum's collection settles into a new home

BY KAREN KROSLOWITZ

Anyone looking at the beige building that has become the Computer History Museum's new collections storage from the outside would never suspect that a world-class collection resides in such a non-descript industrial Bay Area neighborhood. Often, visitors and contractors who have toured the CHM's new building proclaim with surprise that it is "the cleanest warehouse" they've ever been in. In one sense, I deny that the Museum even has a warehouse because, as a collections management professional, I prefer to emphasize its status as a "museum artifact storage facility."

In need of space for the highly-anticipated "Computer History: The First 2,000 Years" exhibition, the Museum purchased and then relocated its collection just a few miles away from our Mountain View campus. Maintaining a separate and distinct building for collections storage offered numerous advantages. We gained the markedly improved ability to sustain consistent temperature and humidity levels; we can now more closely monitor collections-related activities and facilities issues, including heightening security and minimizing possible pest infestations.

So, in 2007, a never-before-occupied steel shell was converted into a modern artifact vault. Hired contractors wallpapered the walls and ceiling with insulation, boarded up the windows to reduce damaging UV rays, and installed enormous air-conditioning units to keep temperatures constant. All of these measures not only contribute to a longer life span for the artifacts the CHM will house there, but they save energy too.

> **"Boxes only come in two sizes—too big or too small."**

The move project was planned to occur over four phases. Phase 1 commenced in September 2007 when seven cargo container loads of the SAP-funded collection from Germany arrived at the new facility (Read "Rescued Treasures," *Core*, Spring/Summer 2007, pages 4–9). The curators, feverish with rediscovery, hastily opened crates and were followed by the registrars and archivists, who inspected the contents to assess condition and identify any unwanted pests. Volunteers arrived soon after to begin inventorying, cleaning, numbering and photographing the materials. Phase 2 followed a few months later with the transfer of objects from the aged storehouse at Moffett Federal Air Field. Spring 2008 brought the start of Phase 3: the relocation of all physical objects and about half the text collection from the Museum's main storage areas. Since the project began, CHM has relocated roughly 25,000 physical objects and 1,800 linear feet of text. We still have more to go with Phase 4, the temporary shift of 3-D objects currently on display in the Visible Storage exhibit, which will conclude the move project in the very near future.

For any museum or archive, a collection move is the right time to ensure its collections inventory is complete. For CHM, the move has been serendipitous. In August 2007, the Museum received a two-year cataloging grant to further document its physical objects (See "Documenting a World-class Collection" in this issue, page 8). With a collection estimated at about 100,000 artifacts, the Museum relies on an accurate database to locate exactly which artifacts researchers want to see and identify the ones the curators plan to exhibit in "Computer History: The First 2,000 Years." This move has also been the perfect time to procure specialty conservation supplies and time to assert extra effort in carefully packaging many artifacts into acid-free boxes for long-term storage.

Boxing and protecting the physical objects during the move has been challenging. As my predecessor, former Registrar Allison Akbay noted, "Boxes only come in two sizes—too big or too small." Our expert team of move specialists consists of museum professionals and computer industry retirees, whose expertise has been invaluable. They've pooled their collective knowledge and creativity when packing scores of circuit boards; a potentially explosive Stromberg-Carlson Charactron tube; commemorative champagne bottles; and the most fragile of core memory boards.

And what about all those big machines? It turns out pallet racks aren't useful solely to big lot wholesalers. Mainframe units, operator consoles, punched card sorters and more have been strapped to pallets and set aloft using a specialized forklift, whose forks can swivel 180 degrees and whose driver can ride with the pallet upwards to 20 feet. A scissor lift helps collections staff access the upper levels of 11-foot high shelving, where box after box of systems manuals, magnetic tapes, calculating machines, keyboards, and conference keepsakes now reside.

Exceptional organization and cleanliness are clear indicators of first-rate conservation practices in all museums and archives. So, when I hear the "cleanest warehouse" compliment, I feel quite proud because the praise truly belongs to the dozens of people who have contributed to cataloging the collection, to reorganizing the text archives, and to this move project overall. Our visitors' observations are evidence that we're managing our artifacts with care. During an open house event, long-time volunteer Dave Babcock exclaimed, "It's so wonderful to see all the artifacts being stored properly and getting the care they deserve. This new facility is like a dream come true!"

I couldn't agree more.

Karen Kroslowitz, the Museum's Registrar, has extensive experience in managing museum collections within institutions such as the William K. Vanderbilt Museum & Planetarium on Long Island and the Wing Luke Asian Museum, Seattle, WA.

The smallest of physical objects are securely nestled in a sea of white archival boxes.

EXPLORE THE COLLECTION

AMSLER INTEGRATOR MODEL 4282 & ASSOCIATED GUIDE RAIL

BY JIM MCCLURE

CHM#: B1506.01 and 102630325, respectively
DATE: c.1900
DONOR: Gwen and Gordon Bell

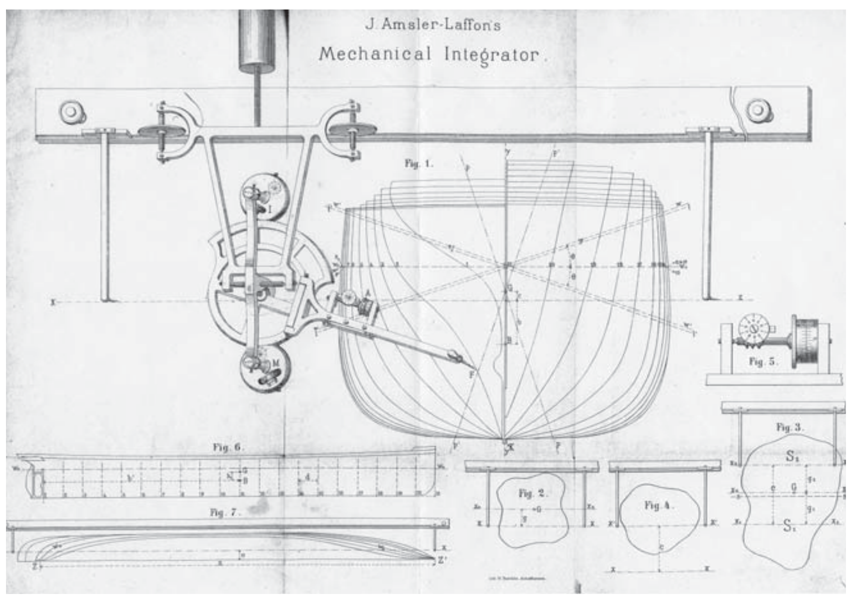
Ship stability was a great concern to shipbuilders in the 1870s and 1880s. Ships frequently capsized during initial sea trials or even upon an initial launch. This happened often with loss of life and goods, so Lloyd's of London insisted new ships be launched and rolled to see if they capsized before it would insure them.

In the 1700s, scientists such as Pierre Bouguer, Daniel Bernoulli and Leonhard Euler, began studying principles of stability—specifically ship stability—and publishing their research. But the calculations needed to assess stability were so complex that they could take years.

It wasn't until 1855 that Jakob Amsler, a Swiss mathematician, conceived of a device—the Amsler Integrator—that would solve exactly this sort of calculation. It looked deceptively simple yet Amsler worked for years to produce a commercial version of it in 1878.

The Integrator's popularity quickly grew. In 1880, shipbuilder William White declared, "This is a thing for which we have been longing for years because it will save us an immense amount of mere routine work."

The Integrator could determine the area, center of gravity, and static and inertial moments around any axes of the cross section of any ship almost as quickly as the Integrator's operator could trace its outline. A stability analysis that once took a year could now be performed in hours.

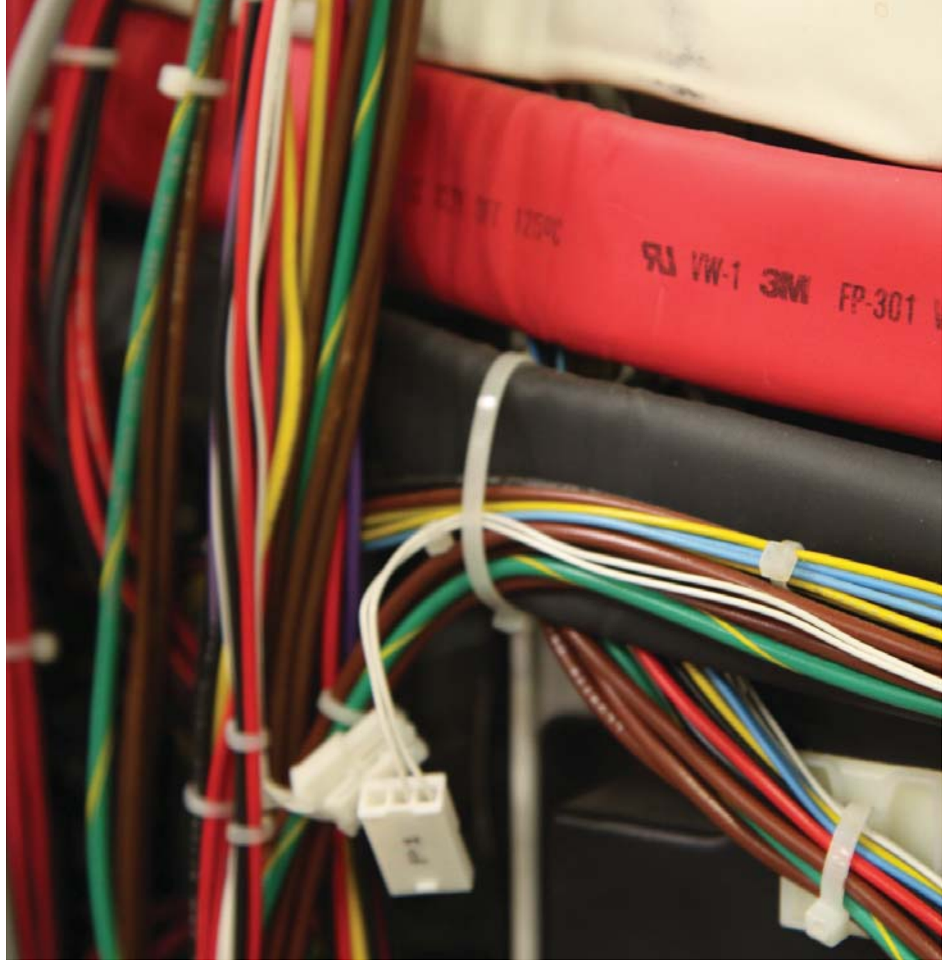


This training drawing illustrates the measurement of stiffness, displacement, and stability of a complex ship's hull design. A few measurements replaced weeks of hand calculations.

The Integrator quickly calculates the bending properties of any railroad rail design placed under it. The user need only trace the outline. This complex mechanism calculates static and inertial moments as a drawing is traced.

ASCI RED: THE WORLD'S FIRST TERAFLOP COMPUTER

BY DAG SPICER



CHM#: X4603.2008
DATE: 1997–2006
DONOR: Sandia National Laboratories

In the time it took you to read this sentence, ASCI Red could breeze through five trillion calculations. This pioneer of supercomputers may be retired—with portions resting in the Computer History Museum's permanent collection—but the breakthroughs it made will long be felt.

At ASCI Red's decommissioning ceremony, supercomputing pioneer Justin Rattner observed, "When Chuck Yeager cracked the sound barrier or Armstrong landed on the moon, I wonder if they had the same feeling. It is with great fondness that we say goodbye to ASCI Red. It's been a great run and we'll never forget it."

ASCI Red owes its creation—in December 1996—to a 1992 Federal policy directive to discontinue live nuclear weapons testing. In order to obey this directive, Intel and Sandia National Laboratories created ASCI Red to simulate those tests. While pursuing this goal, it became the first computer in the world to reach one trillion calculations per second (1 Teraflop or TF). A later CPU upgrade pushed ASCI Red's speed to a stunning 3TF. For much of its amazing run—between the years of 1997 and 2000—ASCI Red was the fastest computer in the world.

Remarkably, ASCI Red's service life was nearly 10 years, unheard of in the field of rapidly-obsolescent supercomputers. It owed both its speed and longevity to a "massively-parallel" processing system, using over 9,000 standard Intel CPUs (Pentium Pro). This allowed it to break large calculations down into smaller ones for each CPU to work on—resulting in enormous speed. ○

The ASCI Red supercomputer required 1,600 sq. ft. and was comprised of 85 cabinets, of which CHM has five in its permanent collection.

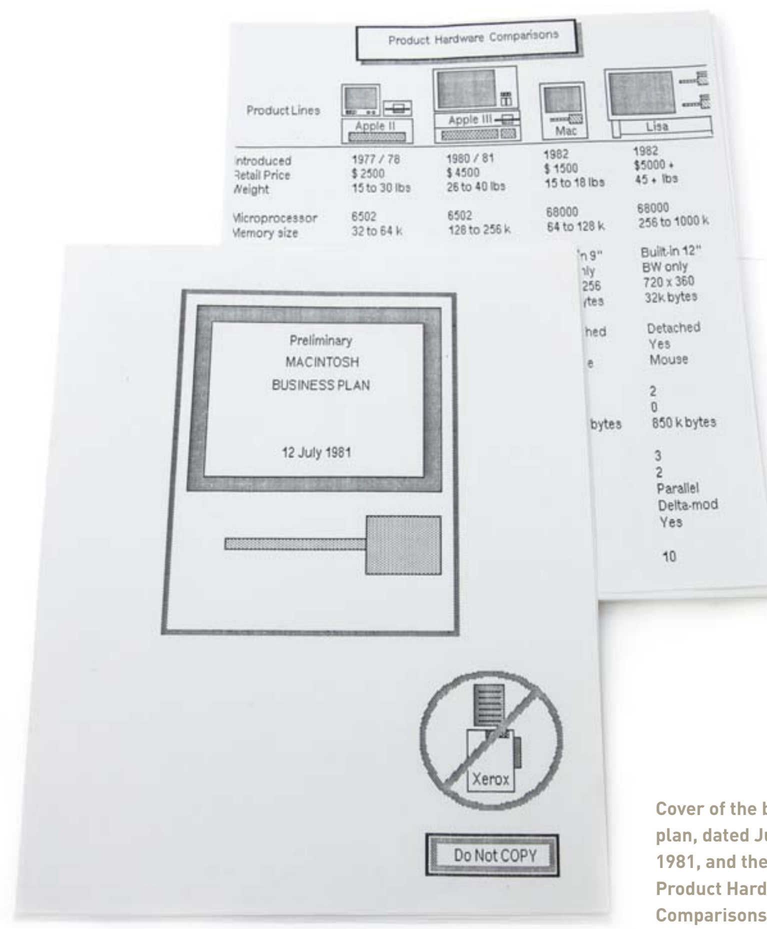
PRELIMINARY MACINTOSH BUSINESS PLAN

BY PAULA JABLONER

CHM#: X4554.2008
DATE: July 12, 1981
DONOR: Mike Markkula

Super Bowl XVIII was a turning point in the history of personal computers. During that game, the mass-marketing of personal computers kicked off with the phrase, "On January 24, Apple Computer will introduce Macintosh. And you'll see why 1984 won't be like *1984*." Not only was this Ridley Scott directed television ad ground-breaking, the Mac it promoted was itself revolutionary. The Mac offered a graphical user interface and mouse at a price that made the personal computer accessible to the novice computer user.

In July 1981, an internal Apple document outlined the Preliminary Macintosh Business Plan: "Jobs' Product Timeline" stated that Apple aimed to produce the Mac by mid-1982 at a price of $1,000 to $1,500 with no mouse. Eighteen months later, for $2,500, the Mac—with a mouse—launched. The strategy was to offer a computer to an audience of hobbyists (Band 1) who were already using Vic and TRS color computers and small businesses (Band 3) who had been buying the HP-85 or Xerox 820. Apple identified a market where no one else saw one and developed this computer to reach it: "… The job of Macintosh and VLC is to migrate the remaining Band 3 customers down to Band 2, leaving Band 3 manufacturers out in the cold!!" ○



Cover of the business plan, dated July 12, 1981, and the Product Hardware Comparisons page.

RECENT ARTIFACT DONATIONS

BY DAG SPICER

COLLECTION

IBM THINKPAD 701CS LAPTOP COMPUTER ("BUTTERFLY")

CHM#: 102707367
DATE: 1995
DONOR: Gregory Joseph Badros

IBM's ThinkPad 701CS was cutting edge in its day. It featured a large color display and keyboard packed into a "sub notebook" size that would still appeal today. It weighed only 4.5 lbs, ran for six hours on its battery, and had 16 MB of RAM and a 720-MB hard drive. A clever split keyboard expanded to a standard 85-key layout when you opened the lid. Because of the keyboard, the 701CS was dubbed the "Butterfly."

The 701 is also in the permanent collection of the Museum of Modern Art and was featured in the movies *Golden Eye*, *Mission Impossible*, and *Batman Forever*. ○

LIONS' COMMENTARY ON UNIX 6TH EDITION, 2 VOLS., WITH SOURCE CODE

CHM#: 102707366
DATE: 1976
DONOR: John Mashey

John Lions, professor of computer science at the University of New South Wales, wrote these two books as course notes on the UNIX operating system for his students in May of 1976.

When AT&T announced UNIX Version 7 in June 1979, its new academic and research license no longer permitted classroom use. Despite this, thousands of students made photocopies—and photocopies of those photocopies. Because of this, the popularity of the book spread quickly and widely.

In fact, for many years, the Lions' Book was the only UNIX kernel documentation available outside of Bell Labs. It is considered one of the classic works in computer science. ○

THE AMAZING DR. NIM BOARD GAME E.S.R. INC., U.S.A., CA.

CHM#: 102688881
DATE: 1965
DONOR: Warren Yogi

This deceptively simple plastic board game actually teaches binary arithmetic. It is a strategy game where one player (human versus Dr. Nim) takes turns removing marbles from a row. On each turn, this player must remove one, two, or three marbles. The player who gets stuck with the last marble loses.

The game's easy-to-read and entertaining manual includes philosophical speculations about whether computers can think. ○

SILICON RUN – 7 DVD SET

CHM#: 102707368 / X5022.2009
DATE: 1985–2004
DONOR: Ruth Carranza

Acclaimed as one of the world's best documentaries on the semiconductor manufacturing process, *Silicon Run* began in 1998 as an introduction to the design and assembly of Integrated Circuits (ICs). This newly-issued, 7-part series includes two introductory-level DVDs and four specialized programs on Etching, Lithography, Implantation, and Deposition—four key stages in how chips are made.

In time, even these advanced manufacturing techniques will appear dated. At which time, these DVDs will become a useful historical record of late 20th-century chip making. ○

ROCKET E-BOOK

CHM#: 102691369
DATE: 1998
DONOR: Donna Dubinsky

The Rocket e-Book was an early hand-held book reader. It held about 4,000 pages of words and images—equal to about 10 novels—and weighed just 22 ounces. Users could connect to web-based retailers by connecting it to a PC. The battery lasted an average of 20 hours.

Several other companies also made (and still make) electronic book readers but none have sold all that well. Whether this technology will acquire mass appeal remains an open question. ○

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The Computer History Museum is dedicated to the preservation and celebration of the computing revolution and its worldwide impact on the human experience. It is home to the largest international collection of computer artifacts in the world, encompassing computer hardware, software, documentation, ephemera, photographs and moving images.

CHM brings computer history to life through an acclaimed speaker series, dynamic website, onsite tours, as well as physical and online exhibits. We have a wide variety of programs and participation opportunities.

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"Men and women who innovate, who invent, who engineer and succeed—they're the heroes of our age. The Museum is a tribute to those innovators, and to their spirit."

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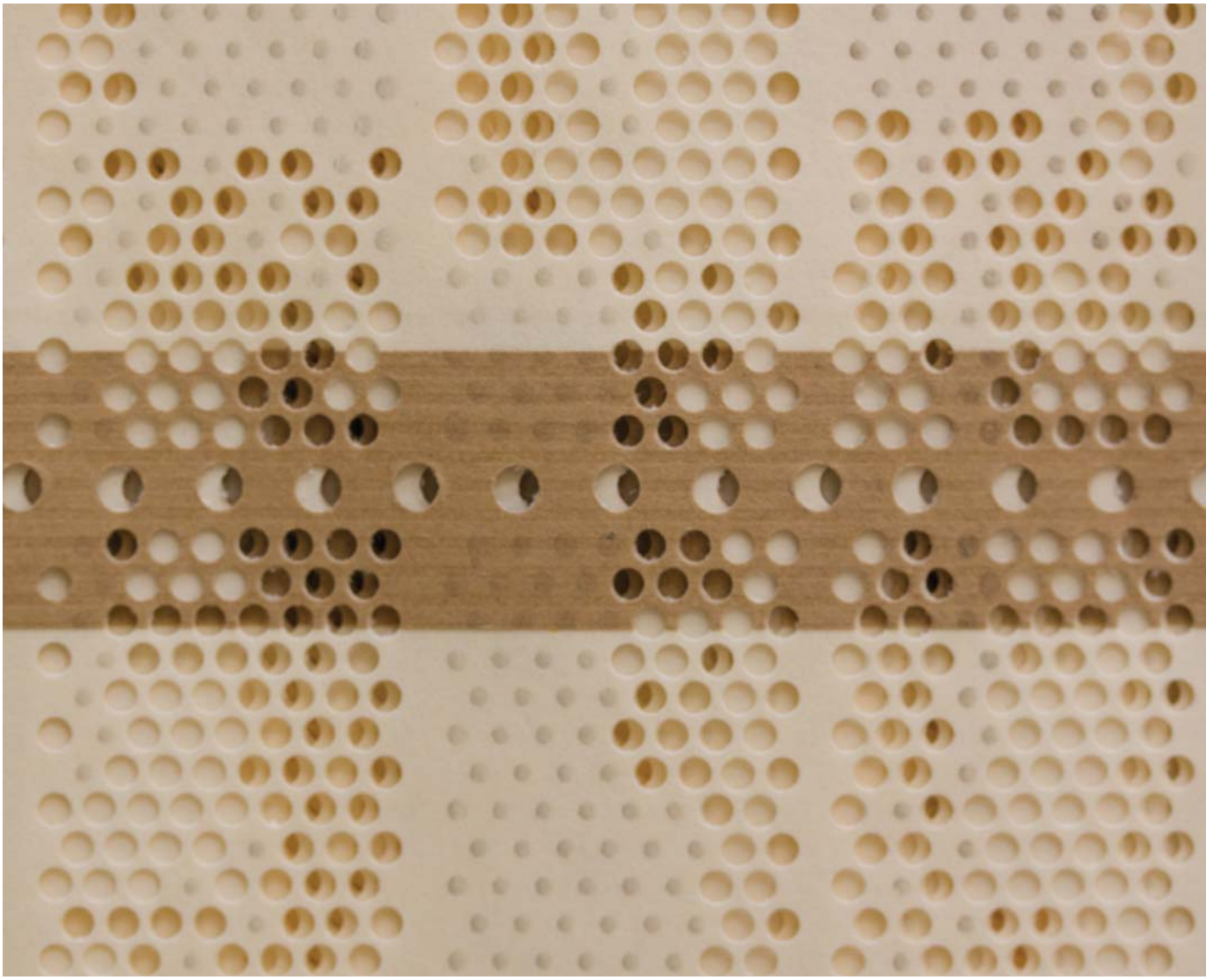
MYSTERY ITEM

WHAT'S THIS?

Take your best guess! The first two *Core* readers who submit the correct answers by March 1, 2009, will receive a free copy of *Core Memory: A Visual Survey of Vintage Computers*. Email your guess to: editor@computerhistory.org. Good luck!



Previous *Core* Mystery Item Description

This is a black and white image of ENIAC co-designer Presper Eckert with guests of ABC's "Nightlife" television program. The episode aired March 24, 1965. From left to right: William Williams, Presper Eckert, Angie Dickinson, Pat Boone and Mort Sahl. The computer is a Univac 422, a medium-scale mainframe system that was sold to colleges and universities for educational purposes.

REGENCY PICTORIALS, INC.