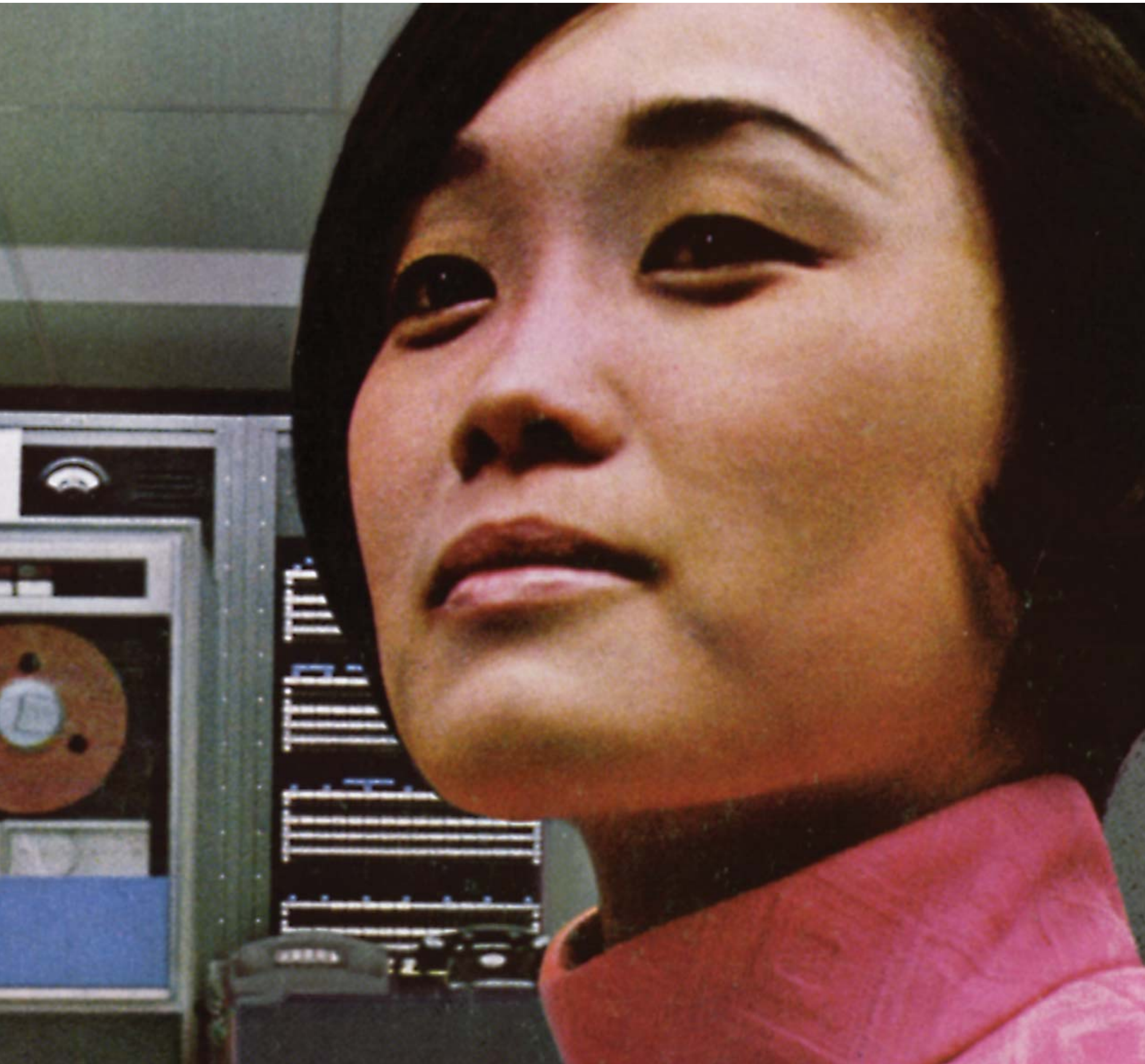
2016

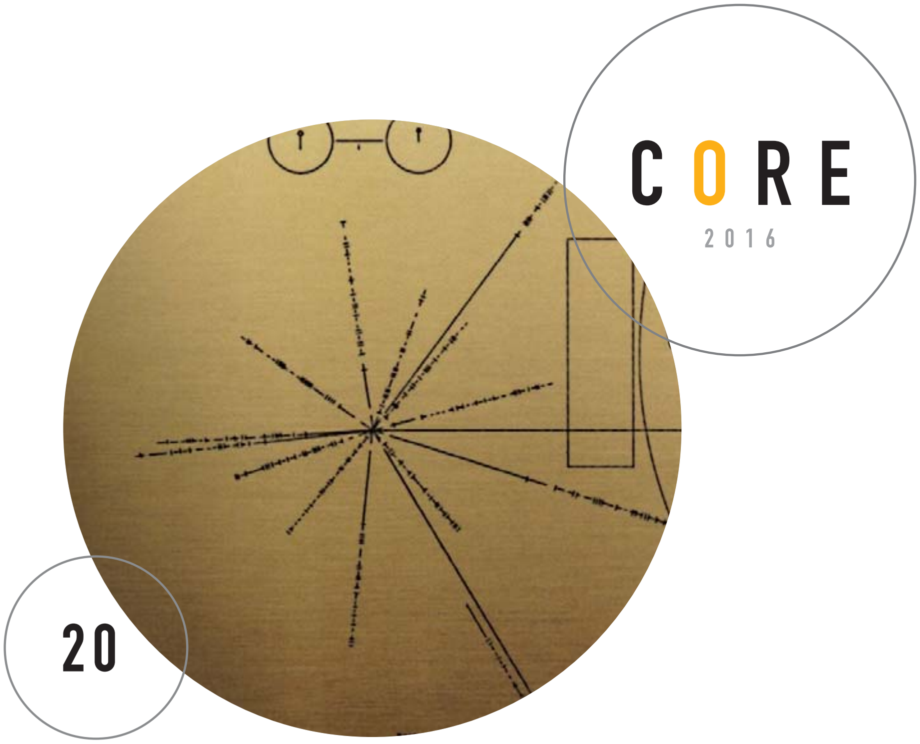
CORE

A Publication of
the Computer
History Museum

Women in Computing
Connecting Silicon Valley to History
Empowering Educators with Raspberry Pi



Cover: "Carol Ching," *Datamation*, January 1970. This page: Detail of Sandy Lerner's Custom IPO Dress, February 16, 1990. © Studio Dizon Opposite: Cisco "Pioneer ad," 1992. © Cisco Systems Inc. Image courtesy of the Cisco Archive



WOMEN IN COMPUTING

CONTRIBUTORS

MARIE HICKS

ASSISTANT PROFESSOR OF HISTORY, ILLINOIS INSTITUTE OF TECHNOLOGY

Marie Hicks is an assistant professor of history at Illinois Institute of Technology in Chicago and a former UNIX systems administrator. She works on integrating gender and sexuality into the history of computing to show how technologies develop around categories of social difference. She is currently finishing a book on computerization in Britain, exploring how gender played a role in Britain's technological fortunes.

MICHAEL HORN

ASSISTANT PROFESSOR OF LEARNING SCIENCES & COMPUTER SCIENCE, NORTHWESTERN UNIVERSITY

Michael Horn is an assistant professor at Northwestern University where he directs the Tangible Interaction Design and Learning (TIDAL) Lab. Michael has a joint appointment in Computer Science and the Learning Sciences, and his research explores the use of interactive technology in the design of innovative learning experiences. His work can be seen at the California Academy of Sciences, the Field Museum, and the Museum of Science, Boston.

CHUCK HOUSE

FOUNDER & EXECUTIVE DIRECTOR, INNOVASCAPES INSTITUTE

Chuck House, a longtime Computer History Museum trustee, is the director of the Cisco Heritage project; he has a long Silicon Valley history with HP, Intel, and several other companies. Co-author of *The HP Phenomenon* and author of *Permission Denied*, his new book is entitled *Preserving Your Digital Revolution Heritage: If Not You, Who—If Not Now, When?* House is founder and executive director of InnovaScapes Institute.

URSULA MARTIN

PROFESSOR OF MATHEMATICS & COMPUTER SCIENCE, UNIVERSITY OF OXFORD

Ursula Martin CBE is a professor of mathematics and computer science at the University of Oxford. After degrees in mathematics at the Universities of Cambridge and Warwick, she has held positions at the Universities of Illinois, Manchester, St Andrews, and London. In 2012 she was appointed Commander of the Order of the British Empire for services to computer science. Her recent work on the Ada Lovelace archives combines her passion for mathematics and computing.

Computer History Museum

Editor-in-Chief
John C. Hollar

Executive Editors
Jennifer De La Cruz
Carina Sweet
Kirsten Tashev

Contributors
Caroline Evans
Chris Garcia
Marguerite Gong Hancock
Marie Hicks
John C. Hollar
Michael Horn
Charles House
Paula Jabloner
Karen Kroslowitz
Maya Makker
Ursula Martin
Kate McGregor
Megan Merritt
Amanda Reilly
Dag Spicer
Kirsten Tashev
Marc Weber

Design
Studio1500

CEO'S LETTER

CELEBRATING WOMEN IN TECH

The history of computing is at least as old as the Antikythera mechanism and as contemporary as the code in a self-driving car. Certain periods stand out in that sweeping arc of history, however. The Victorian era is one of them.

From that period emerged some of the most intriguing and forward-thinking minds of the time. Charles Babbage dreamed of a giant steam-powered calculator that could wipe out human error from complex computation. George Boole pondered whether his mathematical approach to logic could prove the existence of God. Mary Somerville connected the dots between the sciences in a bold, published attempt to "simplify the laws of nature" through mathematical principles. And an intrepid and intellectually tireless young woman named Ada Byron—later, Ada, Countess of Lovelace—learned mathematics through correspondence by mail and dreamed of a universal, programmable "thinking machine."

Boole and Babbage, of course, enjoy great renown in the history of computing. Until recently, Ada Lovelace has been little more than a footnote. Thankfully, the recent public unveiling of the Lovelace papers at Oxford University's Bodleian Libraries has allowed historians and scholars to shine a fascinating light on her contributions to computational thinking, her storied intellectual partnership with Babbage, and her writing down of what is now widely regarded as the earliest published form of an algorithm.

The year spanning December 2015 to December 2016 marks the 200th anniversary of Ada Lovelace's birthday. The Museum and many of our sister institutions around the world are marking the occasion by hosting year-long festivities, with special educational programming and live events that celebrate Lovelace and her work. In December 2015, CHM opened a beautiful temporary exhibit on Lovelace's life, *Thinking Big: Ada, Countess of Lovelace*. We are grateful to have formed a 12-month partnership with the Bodleian and its wonderful staff to bring the contents of many of Lovelace's papers for display at CHM—the only such display in North America.

But we are also ranging far beyond a commemoration of the "Countess of Code," as some have described her. Here, in the pages of this issue of *Core*, you will see that CHM is using the Lovelace anniversary to contemplate and highlight the role of creative, driven women in many recent areas of computing. This issue examines those roles through the lenses of business, technology, the economy, philanthropy, and social impact. As the world contemplates the slow growth of women in the computing field and wonders what to do, we believe such a celebration is both fitting and insightful.

I hope you enjoy this issue of *Core*, and thank you for your interest in and support of our ongoing work.

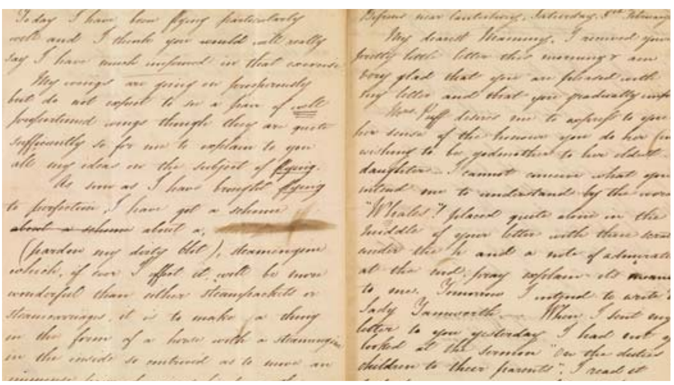
Yours sincerely,

JOHN C. HOLLAR
PRESIDENT & CHIEF EXECUTIVE OFFICER

EXHIBITS

THE MAKING OF *THINKING BIG: ADA, COUNTESS OF LOVELACE*

BY KIRSTEN TASHEV
VICE PRESIDENT OF
COLLECTIONS & EXHIBITIONS



Dated April 7, 1828, this letter from Lovelace to her mother imagines a flying machine powered by a steam engine.

As the 200th birthday anniversary of the British computer pioneer Ada Lovelace approached (December 10, 2015), CHM began discussing celebration ideas. Then in November 2014, an amazing opportunity presented itself. Professor of Mathematics and Computer Science Ursula Martin, Oxford University, shared news of Oxford's Bodleian Libraries' plans to make an exhibit of a compelling archival collection related to Ada Lovelace.

While the Lovelace papers have been on deposit for research at the Bodleian for many years, they have never been on public display. Part of what makes the papers so fascinating is the story behind them. Lovelace's mother, Annabella Milbanke (Lady Byron), amassed the collection over the course of her and her daughter's life. The papers include early documentation from Lovelace's childhood, including her governess' notes about Lovelace's daily routine ("music, French reclining, arithmetic, etc."), childhood workbooks, diary entries, and letters from Lovelace to her mother; later correspondence comprise letters from Lovelace to her tutors, including Augustus De Morgan, a brilliant mathematician, and other well-known Victorian thinkers. The papers also include Lovelace's letters to computer pioneer Charles Babbage about their work together on the Analytical Engine.

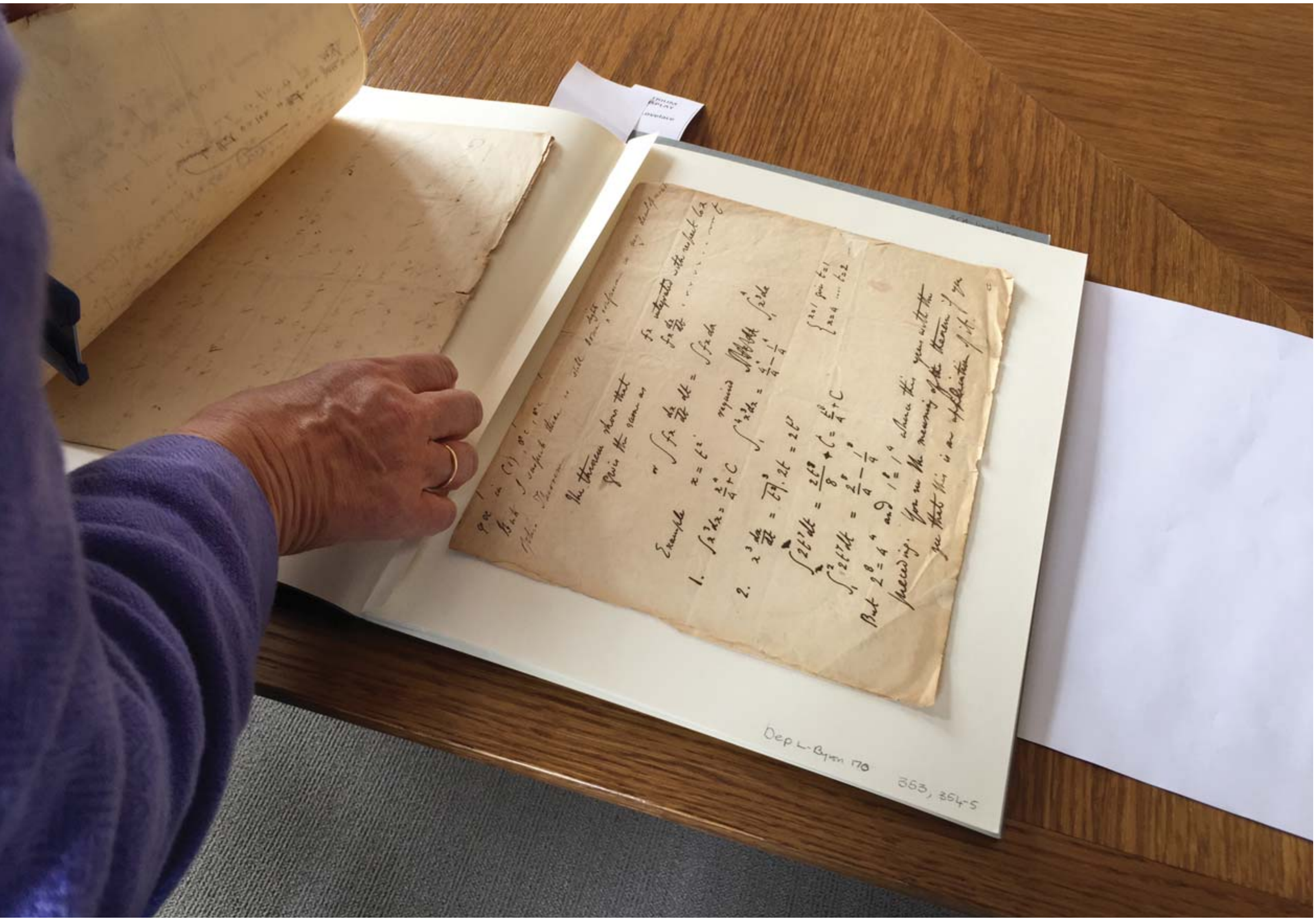
When CHM heard about this display, we wondered if it might be possible to work together and host a subsidiary exhibit at the Museum. The exhibit would feature high-quality reproductions of Lovelace's papers as the originals could not travel out-

Thinking Big: Ada, Countess of Lovelace **opened at CHM on December 10, 2015.**

side the United Kingdom for preservation reasons. The Bodleian team felt the Museum was the perfect home for such an exhibit because of CHM's broad audience, deep connection to Charles Babbage and Ada Lovelace, and archival sensibilities. The Bodleian was also very interested in extending access to the papers to an international audience as part of an overall outreach strategy.

For me, as a history major and museologist, digging deeper into the history of computing through Victorian archival materials was a dream come true. In fact, the era in which Lovelace lived, is one of the most fascinating periods of history for Britain, as this period of peace and prosperity led to unprecedented creativity in science, art, literature, and industry. To get a better sense of the Bodleian's plans, collection, and people involved in the project, a team from the Museum travelled to Oxford in June 2015.

Anyone who has been to Oxford knows how special it is. As one of the oldest universities, it is steeped in history: cobblestone paths, beautiful architecture, famous alumni, little pubs, and students in gowns. It's the real Hogwarts from *Harry Potter.*



Top: CHM staff traveled to Oxford's Bodleian Libraries to see the Lovelace papers firsthand. Bottom: Interior of Duke Humphrey's Library at the Bodleian Library, University of Oxford.

And as a bonus for a museum nerd like me, it is home to the Ashmolean Museum, considered the first university museum, built between 1678 and 1683.

Our first stop was the Bodleian, where we met Ursula Martin and the Bodleian team. We looked at the display case in the main lobby of the Weston Library (formerly known as the "New Bodleian"), where their Lovelace exhibit would be staged. (The display case contained an exhibit with two Magna Carta originals, celebrating the 800th anniversary of its sealing.) We then went upstairs to a large conference room overlooking Broad Street and the beautiful Clarendon Building and Sheldonian Theater. The archival team brought up the papers for us to view. It was amazing to see the papers first hand. There is nothing to prepare you for the strong sense of history in seeing original handwriting and drawings.

The collection also includes Lovelace's many letters to her mother and her passion for flying, both her desire to fly and to design flying machines. You really get a sense for her creativity and wild curiosity for everything. We also enjoyed looking at her correspondence with Charles Babbage. It gave us a greater sense of the intensity of their working relationship. Finally, we discussed logistics of the project, how we would work together, exhibit layout, content, and overall schedule. I was impressed with the generosity of the Bodleian team, as well as their desire to collaborate and learn from each other.

After our meetings at the Bodleian, Head of Exhibitions Madeline Slaven gave us an amazing behind-the-scenes tour of the Weston Library, including the rooftop view. She then took us through the beautiful Divinity School square to the "Old Bodleian," which includes the breathtaking Duke Humfrey's Library, the oldest reading room at the Bodleian Library.

We then headed over to the Museum of the History of Science (MHS) to meet Dr. Sophie Waring, Nick Wicker, and Adrian Rice to see papers in the MHS collection related to Charles Babbage. We were thrilled to see what was considered Babbage's first description of an "Engine for table of differences" from 1820. The multipage document included many notes and what seemed to be a flurry of drawings done in one sitting by Babbage. I also very much enjoyed seeing Babbage's table of contents for a memoir he never finished, as far as I know. Here are some of the more interesting chapter headings: "My Experience by Water," "Experience by Fire," "Picking Locks and Deciphering," "Hints for Travelling," and "Waistcoats and Miracles."

Finally, we visited MHS's galleries, the original location of the Ashmolean Museum. It now houses a beautiful collection of scientific instruments from the Middle Ages to the 19th century, including Einstein's blackboard that was used in a 1931 lecture at Oxford, an early radio receiver by Guglielmo Marconi, and parts from Charles Babbage's first difference engine project.

I have visited Oxford before, but as a tourist. Visiting again with this special mission brought the history of Oxford and Lovelace to life for me. What impresses me about Lovelace is that as privileged as she was, she broke her assigned mold, focused on her ideas, threw herself into important work, and had deep intellectual relationships with the men and women who surrounded her. Lovelace's ability to make connections and see potential for machines and their role for mankind went way beyond her contemporaries. This is what makes her remarkable.

CHM's Ada Lovelace exhibit, *Thinking Big: Ada, Countess of Lovelace*, is located in the main lobby. The exhibit celebrates the magic of Lovelace's thinking through carefully selected high-resolution facsimiles from the Bodleian Libraries as well as many photographs and rare daguerreotypes of Lovelace, her family members, and mentors. Audio clips with modern readings of four key papers transport visitors back in time, allowing them to connect more deeply with this exceptional person. The exhibit opened on December 10, 2015, Lovelace's 200th birthday, with a special private event featuring CEO of YouTube Susan Wojcicki as a guest speaker. The exhibit will remain open to the public for one year, until December 11, 2016.

This exhibit is made possible through the generosity of ACM and Google.org.

ABOUT THE BODLEIAN LIBRARIES

The Bodleian Libraries of the University of Oxford form the largest university library system in the United Kingdom. They include the principal university library—the Bodleian Library—which has been a library of legal deposit for 400 years; major research libraries; and libraries attached to faculties, departments, and other institutions of the university. The combined library collections number more than 12 million printed items, in addition to 80,000+ e-journals and vast quantities of materials in other formats.

October 13–December 23, 2015
Ada, Countess of Lovelace: Computer Pioneer
Blackwell Hall, Weston Library, Broad Street, Oxford OX1 3BG
This display celebrates Byron's daughter Ada, Countess of Lovelace (1815–1852), who wrote with remarkable foresight about the potential of Charles Babbage's calculating machine, including what is often called "the first computer programme." It is based on collections held in the Bodleian Library and the Oxford Museum of the History of Science. See Ada Lovelace's childhood letters, correspondence with Charles Babbage, and newly discovered mathematical notes and images.

BY MICHAEL HORN
ASSISTANT PROFESSOR
OF LEARNING SCIENCES &
COMPUTER SCIENCE,
NORTHWESTERN UNIVERSITY

PROGRAMMING IN THE POND

A COMPUTER PROGRAMMING INTERACTIVE

The history of computation is a history of powerful ideas. Innovations in hardware and software have had a defining impact on society for the last 60 years or more. One of the most powerful ideas, popularized in large part by Seymour Papert in the early 1980s, was that children can be programmers and that programming can radically transform learning and education. The Logo programming language put this vision in action, and, like many kids of my generation, Logo was one of the first computer languages I encountered. This spirit has been kept alive with a second wave of programming environments designed to engage young people in computational thinking. Some of my favorites are NetLogo, developed by Northwestern's Center for Connected Learning and Computer-Based Modeling (CCL); Scratch, developed by the Lifelong Kindergarten Group at the MIT Media Lab; and Kibo, developed by KinderLab Robotics.

I'm now an assistant professor at Northwestern University, and my own research explores ways to engage kids and families in playful computational experiences in museums and other informal learning settings. In 2008 I developed a "tangible" programming exhibit with the Museum of Science, Boston in which visitors could build working computer programs by connecting physical wooden blocks shaped like jigsaw puzzle pieces. These blocks controlled the action of a robot that roamed around on a platform. In evaluating this exhibit, we found that the wooden blocks interface was a great way to attract and engage a diverse range of visitors in programming activities.

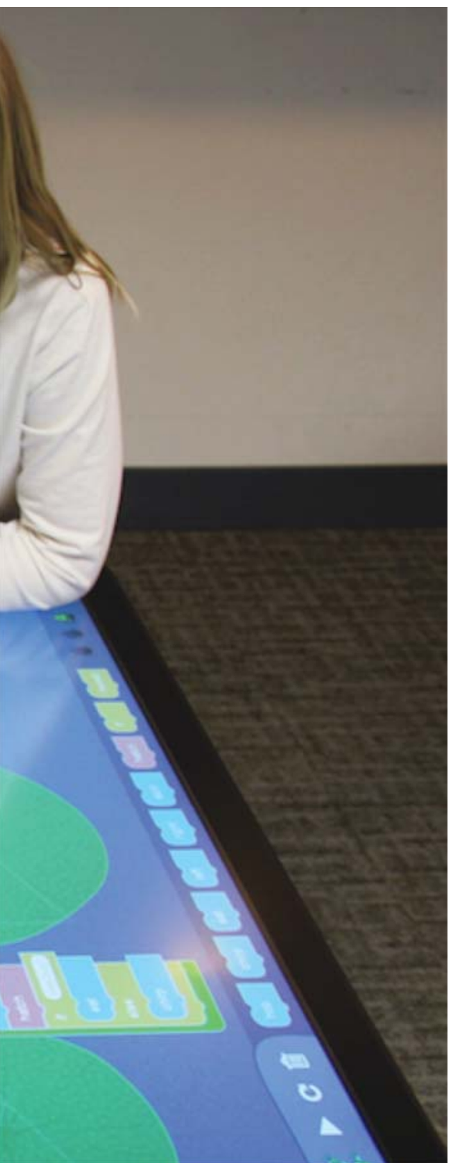
More recently I've been working with CHM to develop an interactive for their upcoming exhibition *Make Software: Change the World!*, designed to give visitors a unique and playful experience with computer programming. The "Coding Pond" uses an interactive tabletop display showing a lily pond environment. Visitors construct simple blocks-based programs to control the actions of colorful frogs that hop around the pond and eat bugs. The environment introduces several programming concepts including sequential actions, loops, and conditional logic. One of the blocks, called "hatch," even allows visitors to create multiple frogs all running the same code. We developed the interactive using the Dart language running in a web browser and an Ideum Platform 46 tabletop.

Our design process was guided by several high-level goals. The first was to provide an engaging and fun experience with computer programming for visitors from a variety of backgrounds and experience levels. Central to this goal is that visitors should be able to create programs that are simple but that still result in interesting and complex outcomes. To accomplish this, we were inspired by NetLogo, an agent-based modeling environment derived from Logo. With Logo, kids control the actions of a "turtle" that can, among other things, draw geometric shapes on the screen through sequences of simple commands, like `forward 1` and `left 1`. One of the key innovations of NetLogo is rather than writing code to control a single turtle, you can instead write programs to control many hundreds or thousands of turtles that can all interact with one another. In this way, simple programs can result in dazzlingly complex and unexpected outcomes.
In our case, visitors can hatch new frogs that interact with one another in parallel.

Second, we wanted to make sure it was easy for people to learn how to use the interactive even if they have never programmed before. We worked hard to make it intuitive and fast for people to create and run working computer programs using simple touch gestures.

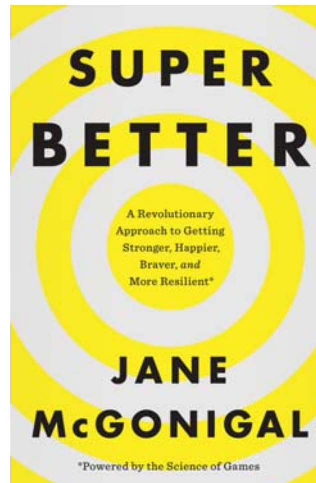
Third, we wanted to support social and collaborative engagement with the interactive rather than a single user in front of a screen. To do this we used a large tabletop display that supports multiuser interaction. We also included two programming workspaces, one on either end of the table to support collaborative, side-by-side programming or more competitive head-to-head programming.

Finally, we wanted the Coding Pond to be consistent with the overall mission of the Museum and the goals of *Make Software: Change the World!* This meant that it should be clear to visitors using the Coding Pond that what they are doing is computer programming, and the experience should encourage exploration of programming in other contexts. The exhibition's target audience is the general public (with no technical expertise), ages 8 to adult. The interactives are intended to be usable by younger visitors as well as with help from an adult or older sibling.



The Coding Pond, a freshly imagined interactive by Michael Horn, introduces users of all ages to the basics of computer programming.

Jane McGonigal's newest book *SuperBetter* explores how games can do more than just entertain. They can transform.



BY JOHN C. HOLLAR
PRESIDENT & CEO

LECTURES

SUPERBETTER AUTHOR JANE MCGONIGAL TALKS SOCIAL TRANSFORMATION AND GAMES

Jane McGonigal has become the public face of social transformation through gaming and game theory. That happened for very personal reasons.

While game theory was the subject of her PhD, she found herself the subject of her own scholarship in 2009 when she suffered a major concussion. Plagued by anxiety and depression due to an impossibly slow recovery, she designed a game to help her re-engage with life. That game is now known as "SuperBetter," played by more than half a million people worldwide, and is also the title of her new book about how games can do more than just entertain—they can transform.

On September 22, 2015, CHM welcomed McGonigal back to its stage, as part of the *Revolutionaries* speaker series. The occasion was the release of her latest book, *SuperBetter: A Revolutionary Approach to Getting Stronger, Happier, Braver and More Resilient, Powered by the Science of Games*.

Laura Sydell, NPR's digital culture correspondent and frequent moderator of *Revolutionaries*, led the conversation with McGonigal, discussing how we can harness the power of games to improve our lives.

Sydell: If you [could] talk a little bit about that experience that led you to realize what making certain things in life more game-like would do . . .

McGonigal: Well, it was 2009. I was in the middle of writing my first book, which was all about the psychology of games. And I happened to hit my head. I sort of slammed it on an open cabinet door, got a concussion. It didn't heal quickly.

I was essentially concussed for a year. And in addition to all of the cognitive symptoms —I couldn't think clearly, I couldn't concentrate, I was forgetting people's names—and the headaches and the nausea and all those things, I also had a lot of depression and anxiety. Which at the time I thought, oh, I'm just depressed and anxious because I'm afraid I'll never work again. Or, I am depressed because I can't get out of bed. But it turns out that when you have a concussion, it actually changes the neurochemistry of the brain as it's trying to heal, and it's very common for people to be severely depressed.

One in three people will actually go on to have suicidal thoughts, which happened to me at my lowest point. A few weeks afterwards, I started feeling suicidal for the first time in my life. And I don't know if anyone else would have had this reaction to that, but after about a week of feeling suicidal and realizing that it felt dangerous and a bad place to be, I thought, I'm in the middle of writing a book about how playing games helps us tackle tough obstacles with more optimism and curiosity and motivation. We're more likely to reach out to others for help. And surely I should be able to use that same psychology to restart my brain. And so that's what I did.

I wound up making a really—it seemed silly at the time—game called "Jane the Concussion Slayer," inspired by *Buffy the Vampire Slayer*. And as you said, I just tried to do things in my recovery, the things you would do in a game—like adopting a persona, this heroic persona; collecting power-ups; battling bad guys; or creating allies. It really did

McGonigal discusses a "gameful mindset" with NPR's Laura Sydell.

© DOUGLAS FAIRBAIRN PHOTOGRAPHY

help me bring all of those positive psychological resources to what was the hardest experience I'd ever been through.

Sydell: This [*SuperBetter*] is the second book. Last book, you laid the foundation. You talked about your own experience, then talked about history and the importance of games. I began to wonder, actually, what got you so into games. Your PhD is in performance studies from Berkeley.

McGonigal: The secret truth is I started my PhD program at Berkeley intending to study physicists and how they collaborate and how they communicate science with the public. So I was always interested in the public communication of science.

But it was in my first year of graduate school that actually—I started graduate school in September of 2001; 9/11 happened right after. I just left New York to come to graduate school. And a number of online gamers, their first reaction to that event was to try to come together online and collaborate and use their collective intelligence and use their crowd sourcing abilities to try to help, to try to investigate, to try to be a force for good at a time when so many people were feeling powerless and hopeless and anxious.

All these online gamers were really saying we have unique

McGonigal signs copies of ***SuperBetter*** **for audience members after the show.**

strengths. We want to help. And that experience right after I showed up to graduate school got me thinking, do lots of gamers feel this way? Do lots of gamers want to use their strengths that they've developed in games to solve real problems?

And it turned out when I started writing papers about this, people were a lot more interested in hearing about the gamers trying to save the real world than they were about physicists' collaboration methods.

Sydell: *Reading question from audience member:* "What observations can you make about how a 'gameful mindset' impacts human relationships?"

McGonigal: Well, lots of ways. [. . .] One thing that we found really interesting from setting the SuperBetter method is that people who were invited to play and come online and create accounts as allies for someone else's challenge actually logged in more often than the people who had the challenge and completed three times as many actions per day as the person with the challenge.

It was almost like this untapped pent-up desire to truly be helpful—I want to be there for you. But maybe I didn't know how because I didn't understand your challenge in the way that this game infrastructure allows me. I see what your bad guys are. I know what goals you're trying to go for. I understand how you want to see yourself through the secret identity. The friends and family were much more able to help. And when we did the clinical trial, we found that not only were the patients with traumatic brain injuries less depressed and anxious, the caregivers were as well.

Their parents, their loved ones who were taking care of them through the recovery, after joining this gameful structure, they felt more optimistic and more empowered to help. So there is something about the way that games let us understand a common goal, share a common obstacle that I think allows people to be there for each other in much more concrete and explicit ways.

Sydell: *Reading question from audience member:* "In video games, one often has many second chances or additional lives. However, in real life, there aren't always second chances."

McGonigal: There are certain questions that I hear a lot, and this is, I would say, the number one.

Sydell: How does this reconcile with a gameful mindset?

McGonigal: Yes. Because obviously in real life, you can fail and there are consequences. Therefore it would be ruinous to approach it with the kind of frivolousness of a game. So I think we can actually think about in real life, most things that create stress or anxiety are not actually ruinous if we fail or don't achieve it the first time.

© DOUGLAS FAIRBAIRN PHOTOGRAPHY

In most real life situations, it is important to be able to deal with the emotional experience of failure, the frustration of not achieving your goal, and being willing to try again. And when there is permanent failure, it's often because of how we've designed society. And it doesn't necessarily reflect a reality that has to be that way.

I think about school as a great example. A lot of schools now, looking at the gamer generation, are changing the way they do exams; and you are allowed in these schools to take a test as many times as you want until you get the grade that you want.

If you got a B and you want an A, try again. If you failed it, try again. And you decide when you get the score that you want, just like when you play a video game. You might be happy with one star. Maybe you want three stars.

And it takes away that completely unnecessary performance anxiety. Because in real life, we're not walking around taking tests and then being told well, you're not good at this because you failed one test. [. . .] In real life, you actually have many opportunities to improve and get better.

Sydell: You should've heard my first story on NPR. Because in real life, I got the chance to keep working at getting better at it.

McGonigal: Yes. And to have the mindset that you can try things that are going to be difficult for you and to always be thinking about how you can learn from that more effectively. That's the mindset that actually correlates with success.

So most people are held back by anxiety, by worrying about being embarrassed. They're not comfortable with the feeling of loss or failure. But it's an emotional resistance. It's not that you're going to be fired right away or that you're going to be denied some important opportunity in your life just because you didn't succeed the first time you played.

So I hear that question a lot. But I think there are very few circumstances where you don't actually have an opportunity to keep getting better and trying. And where there are those road blocks, we should re-design our institutions the way that many schools are changing now. Not enough schools, but more schools are trying to say, wait. The gameful mindset is actually more conducive to learning than this high-stakes, performance anxiety-inducing system.

Funding for *Revolutionaries* was made possible in part by the Carsten-Ellis Foundation.

DOCENT PROFILE: WYNNE DOBYNS

Museum volunteers help bring computer history to life. One such volunteer is Wynne Dobyns, who has been with the Museum for eight years in a variety of capacities.

Dobyns became interested in technology while working at the San José Public Library in their section dedicated to Silicon Valley information and resources. It was through her role as a librarian that she eventually met CHM staff and began volunteering at the Museum.

From her time working with the Museum's archives, collections, and Education Department, Dobyns has almost seen it all at. One of her favorite things to do at the Museum is give tours. She especially loves working with elementary and middle school students because of their eagerness to learn and be involved.

Though she loves talking about the history of computing, the future of technology in the medical and healthcare fields also excites her. For Dobyns, the endless possibilities of technology are thrilling.

The Museum's future also has Dobyns excited. She is looking forward to seeing more of the Museum's archives made available for research as well as the opening of the Museum's new exhibition *Make Software: Change the World!* so that more stories about women in technology can be shared.

Dobyns' passion for the Museum and its mission helps bring computer history to life for visitors. As a volunteer she is a great resource and offers much appreciated support to Museum staff.

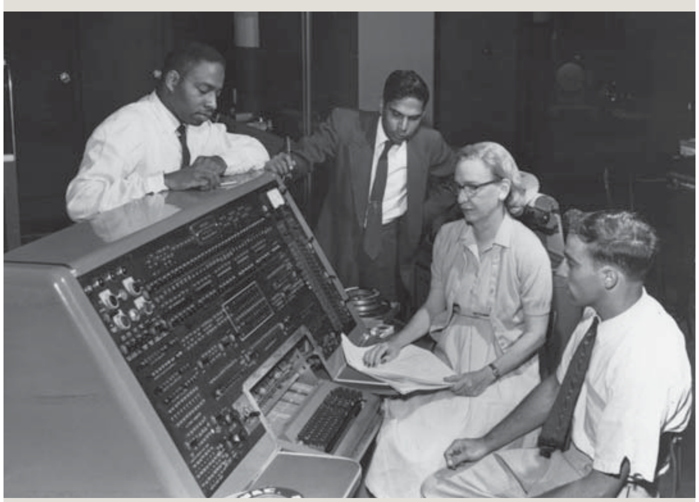
WOMEN IN TECHNOLOGY TOUR

BY CAROLINE EVANS
EVENT COORDINATOR

The Museum has recently revamped its popular "Women in Computing" tour and trained a new corps of docents to act as facilitators. The tour takes visitors through *Revolution: The First 2000 Years of Computing*, highlighting the important roles and inspiring stories of extraordinary women who have shaped computer history.

In the 1800s, it was Ada Lovelace who glimpsed into the future and realized computers could be used for more than just calculating numbers; they offered infinite possibilities—like composing music. During World War II, it was a team of six women who programmed the ENIAC and demonstrated the power of wartime computers. Grace Hopper's and Frances Allen's work optimized the performance of computers and helped humans and machines communicate. Adele Goldberg, Ginny Strazisar, and many others helped usher in the modern computing age. And these are just a few of the inspiring women the tour highlights.

The Museum is excited that more docents have been trained to give this fascinating tour, allowing for more thoughtful discussions about the integral role of women in computer history. This will ensure that these remarkable stories continue to inspire Museum visitors for years to come.



Grace Hopper at UNIVAC-I console, 1957.

IMAGE COURTESY OF HAGLEY MUSEUM AND LIBRARY; REPRODUCED COURTESY OF UNISYS CORPORATION

SHOULD AULD ACQUAINTANCE BE REDISCOVERED?

COLLECTION

BY KAREN KROSLOWITZ
DIRECTOR OF COLLECTIONS

The folk song "Auld Lang Syne" was written in 1788 by poet Robert Burns, who added his distinct poetic style to lyrics and common catch phrases he'd collected over time. Burns noted to James Johnson at the Scots Musical Museum, a printer of traditional Scottish folk songs, that "The following song, an old song, of the olden times, and which has never been in print, nor even in manuscript until I took it down from an old man."[1]

"Auld Lang Syne" is traditionally sung at the turning of each new calendar year, a common set point for tracking time, a tool by which we mark our collective and personal histories. Perhaps it is not too surprising then that a song compiled from other collected works, expressing a desire to not forget old acquaintances, to toast their good health and to warmly reunite in the future frequently meandered into my thoughts over the last two years as I led a team of CHM collections specialists and volunteers to reacquaint ourselves with our own artifacts.

Prior to the database revolution of the 1960s, "collection keepers" had few options outside dedicating to memory and to ledgers the contents and locations of the thousands of relics, specimens, and artworks in their care. Given that staff turnover and the resulting loss of knowledge were inevitable, things were often "lost in the archives." Thankfully, repositories worldwide have been using customized collections-centric databases for the last several decades to diligently record and photograph every last item in their care. Through several cataloging projects in recent years, CHM has endeavored to bring to light its artifacts with an eye toward also increasing access through staff and docent knowledge, the Museum's online catalog search, the Shustek Center, new exhibitions, and interpretive programs.

Of note is the recently concluded, two-year Collections Cataloging and Reconciliation Project (CCARP) to process all backlogged hardware and ephemera. Funded through a federal grant from the Institute

IBM 7030 "Stretch" data processing system.

COURTESY IBM CORPORATION

for Museum and Library Services, staff curators, registrars, archivists, and two professional catalogers worked in tandem with a corps of volunteers to identify, describe, and photograph the objects. The Museum collects strategically to build a comprehensive collection; thus, after the curators culled nearly 1,200 duplicative items (such as blank circuit cards and blown vacuum tubes), the CCARP2 team updated or created more than 9,941 object records and added nearly 33,000 new images to the database. Including the nearly 39,000 pieces of hardware and ephemera now processed, CHM's catalog currently totals more than 100,000 records.[2] While numbers are impressive, the crowning achievements are that the Museum's backlog of hardware and ephemera waiting to be cataloged no longer exists and everything is available for public access.

The final phase of CCARP2 included review of many artifacts assembled during the Museum's earliest days as The Computer Museum (TCM) in Boston, when storage space was cramped, physical access was challenging, and the early collections database was primitive. The same conditions existed when the collection was temporarily housed at Moffett Field in Mountain View. Now at the Museum's East Bay artifact resource center, the cataloging team was able to retrieve and reunite with old acquaintances to add content to hundreds of existing records. Among the old friends were the ECHO IV Home Computer and IBM 7030.

In "A Computer in the Basement?," writer Glenn Infield accurately predicted that James F. Sutherland's Electronic Computing Home Operator (ECHO IV) would become a prototype to today's smart home technologies.[3] A systems design engineer for Westinghouse Electric, Sutherland scrounged second-hand parts to build ECHO IV (CHM Lot X509.84). His homemaker wife, Ruth, flowcharted its functions, which were used by the family to control thermostats, set binary-coded decimal clocks, pay bills and assist with income tax accounting, update calendar tasks and reminders, inventory the kitchen pantry, and entertain with logic games. Akin to today's parental controls, it quizzed his children before powering on the TV.

IBM's 7030, also known as "Stretch," was the computer giant's first transistorized supercomputer. Though you may remember the operator's console and engineering consoles previously on display in *Visible Storage* and now in *Revolution: The First 2000 Years of Computing*, you may not know that in 2002 the Museum acquired a separate 38-unit "Stretch" system from Lowell Wood of Lawrence Livermore National Laboratories (CHM Lot X2462.2002) that had been crated and auctioned by the federal General Services Administration in 1971. The CCARP2 team uncrated and cataloged all twenty 7101 CPU cabinets, three 7612 disk synchronizers, three 7619 exchangers, a console, and much more.

CCARP2 is an achievement and a pivotal point in CHM's history and heralds the Museum's newfound ability to sustain a timely processing rate for new hardware acquisi-

CCARP2 Team. Top (left to right): Dave Cortesi, Chris Garcia, Aurora Tucker, Don Hanson, Allen Baum, Don Williamson, and Toni Harvey. Bottom (left to right): Dennis Coad, Sarah Schafer, Gretta Stimson, Karen Kroslowitz, Anna van Raaphorst, and Dick Johnson.

Not pictured: Jim Allen, Fred Bockmann, Jay McCauley, Sue Mickel, Lita Midmore, Pat Yoshihiro, and Dag Spicer.

tions. With a goal of making its entire collection accessible, the Museum also recently implemented an archives-centric project. Using the same collaborative staff-volunteer model as CCARP2, the two-year CHM Archives Processing Project (CHM APP), funded by the Council on Library and Information Resources, will process half the backlog of text, plus hundreds of images, and will publish finding aids to the Online Archives of California (OAC) and to the Museum's website by May 2017.[4] Future projects will address the remaining backlog of these collections, as will the new Software Center's focus on digitization. *Auld lang syne*. The time has indeed gone by, and we welcome back our old friends. ○

For more information on the artifacts mentioned, search the Museum's online catalog (computerhistory.org/collections/search/) by using the lot numbers cited in this article.

---

1 Maurice Lindsay, *The Burns Encyclopedia* (London: Robert Hale Ltd.,1995).

2 This article refers to the Museum's second Collections Cataloging and Reconciliation Project and is designated as CCARP2 to distinguish it from a previous grant. CCARP1 took place from 2007 to 2009.

3 Glenn Infield, "A Computer in the Basement?" *Popular Mechanics* (April 1968): 77–79, 209, 229.

4 For more information about CHM APP, please see the @CHM blog post "Maxing Out the Minimal: CHM's Archives Processing Project Is Underway," by Senior Archivist Sara Lott.

CHM RESEARCH INFORMS NEW PUBLICATIONS

BY DAG SPICER
SENIOR CURATOR

CHM has been home to researchers from around the world for over 20 years. With the newly purchased Shustek Center (named after Museum founder and chairman Len Shustek), researchers will soon have even better facilities for exploring CHM's archival holdings, reviewing research results, and collaborating with Museum staff and other researchers. Research represents the leading edge in the contemporary historical understanding of our common past and informs the Museum's exhibits and education programs, while also contributing to the larger global historical community in the form of research papers and books.

Researchers come to CHM for its unique content, well-organized facilities, and comprehensive archives. The following books have been published recently by authors who conducted their research at CHM. ○

Ross Bassett, *The Technological Indian* (Cambridge, MA: Harvard University Press, 2016).

Raiford Guins, *Game After: A Cultural Study of Video Game Afterlife* (Cambridge, MA: MIT Press, 2014).

Walter Isaacson, *The Innovators: How a Group of Hackers, Geniuses, and Geeks Created the Digital Revolution* (New York: Simon & Schuster, 2014).

Barry Katz, *Make It New: The History of Silicon Valley Design* (Cambridge, MA: MIT Press, 2015).

Christophe Lécuyer and David C. Brock, *Makers of the Microchip: A Documentary History of Fairchild Semiconductor* (Cambridge, MA: MIT Press, 2010).

Steven Malcic, *Encyclopedia of Social Media and Politics* (Thousand Oaks, CA: SAGE Publications, 2013).

Joseph November, *Biomedical Computing: Digitizing Life in the United States* (Baltimore: Johns Hopkins University Press, 2012).

Arnold Thackray, David C. Brock, and Rachel Jones, *Moore's Law: The Life of Gordon Moore, Silicon Valley's Quiet Revolutionary* (New York: Basic Books, 2015}.

© DOUGLAS FAIRBAIRN PHOTOGRAPHY

BY KATE MCGREGOR
MANAGER OF FAMILY &
COMMUNITY PROGRAMS

EMPOWERING EDUCATORS WITH RASPBERRY PI

EDUCATION

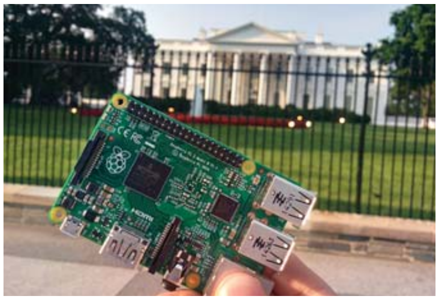
PICADEMY USA LAUNCHES AT CHM IN 2016

An inexpensive, credit card– sized computer will be the centerpiece of an exciting new program to launch at CHM in February 2016. The Raspberry Pi computer consists of a single circuit board, with simple inputs and outputs. In the hands of an enthusiastic and well-trained teacher, this revolutionary little computer can provide students with endless opportunities for problem solving and exploration.

CHM and the United Kingdom–based Raspberry Pi Foundation are partnering to bring Picademy, Raspberry Pi Foundation's teacher education program, to the United States for the first time. Each two-day workshop will engage classroom and community educators in hands-on learning and exploration, highlighting innovative ways in which Raspberry Pi computers can be integrated into educational programming and emphasizing tinkering, coding, and project-based learning. Beyond the clear connections to STEM (science, technology, engineering, and math) curricula, Raspberry Pi offers an incredible medium for exploring diverse fields and topics in new and interesting ways. Reflecting on computer history will help connect elements of past, present, and future and will create an important framework for understanding technological innovations and developments and their relevance and impact on our world.

Throughout the 2016 pilot year, four Picademy USA workshops will offer free, in-person professional development opportunities to 40 K–12 educators. The first two programs will launch at CHM; two additional program weekends will be held in central and eastern states. Workshops will be led by certified Picademy instructors and CHM educators. Every educator who completes the Picademy USA program will become a Raspberry Pi Certified Educator within a dedicated network of like-minded teachers from around the world.

As a partner in Picademy, CHM will be able to highlight meaningful aspects of computer history and connect the Museum's collection with Raspberry Pi's dynamic computer hardware and software technology. "Here at Raspberry Pi, we're great admirers of the Computer History Museum's educational outreach activities. We're looking forward to bringing our flagship teacher training program, Picademy, enhanced with material from the Museum's collection, to the USA in 2016," says Eben Upton, CEO of Raspberry Pi Trading.



CHM's Kate McGregor and Raspberry Pi's Matt Richardson traveled to Washington, DC, for the White House's official announcement of Picademy USA.

BOTTOM: COURTESY OF MATT RICHARDSON

Interested educators should sign up at raspberrypi.org/picademy/usa/ to stay informed and receive updates as the application process opens and additional dates and locations are announced.

Picademy USA #1:
Saturday, February 28 and Sunday, February 29, 2016 at CHM

Picademy USA #2:
Saturday, April 30 and Sunday, May 1, 2016 at CHM

Picademy USA #3:
Dates and Location TBD

Picademy USA #4:
Dates and Location TBD

Carrie Anne Philbin, who leads the education mission on behalf of the Raspberry Pi Foundation, including global oversight and development of Picademy content, says that "training teachers has been part of the Raspberry Pi Foundation's mission to see more young people get hands-on with computer science. The Raspberry Pi Academy for Teachers, or 'Picademy' as we call it, inspires teachers and shows them ways of bringing 'making' into their classrooms. The Pi team and I are really looking forward to hacking with educators across the pond!"

The Museum and the Raspberry Pi Foundation aren't the only ones excited about this new program! On Friday, June 12, 2015, in response to US President Barack Obama's call to action, and to kick off the National Week of Making, the White House announced our launch of Picademy USA. Raspberry Pi's Matt Richardson and I were there to participate in the event and celebrate this exciting new program and partnership.

John Hollar, CHM president and CEO, explains, "The Raspberry Pi puts the awesome power of modern computing into the hands of every learner. Through this partnership we can now help hundreds of teachers each year learn how to tap into that power and inspire their students for the future."

CHM TEEN TAKEOVER: 2015 SUMMER INTERNSHIP

BY MAYA MAKKER
EDUCATOR, COMMUNITY PROGRAMS

© DOUGLAS FAIRBAIRN PHOTOGRAPHY

In summer 2015, the Education Department launched CHM'S first high school internship program, which gave 16 local students the opportunity to explore computing history and serve as Museum ambassadors. Throughout the summer, the interns researched artifacts in *Revolution* and our hands-on teaching collection. They worked in teams to uncover the stories of computing pioneers and learned how to communicate their knowledge with Museum visitors. They led discussions in the galleries and managed the Exploration Station, an interactive activity table in the lobby. Each day they were onsite, our interns interacted with at least 200 visitors, sharing their passion and excitement for computer history with audiences of all ages.

The interns also had the opportunity to develop relationships with Museum volunteers and grew to see the volunteers as sources of incredible guidance. One intern shared: "Working with docents was absolutely amazing; hearing what they had to say was great since they knew so much about the artifacts you researched. Overall, working with them taught me a lot more than I would've known otherwise." The Museum greatly appreciates all the time the interns spent onsite this summer and looks forward to welcoming more high school students in the years to come.

LETTERS TO LOVELACE COMPETITION

BY MEGAN MERRITT
EDUCTION PROGRAMS COORDINATOR

The year 2015 marked Ada Lovelace's 200th birthday, and in honor of her mathematical and artistic achievements, CHM began a year-long celebration to commemorate her legacy with exciting Museum-wide events. Among them was our Letters to Lovelace competition, which asked girls across the United States to share their creative responses to the question: What do you think would interest Ada Lovelace about 21st century technology? In partnership with The National Museum of Computing in Bletchley, England; the University of Oxford; Queen Mary University of London; and the Heinz Nixdorf Forum in Germany, CHM welcomed girls ages 18 and under to submit responses to be judged on the quality of their research, creativity, and their message to Lovelace.

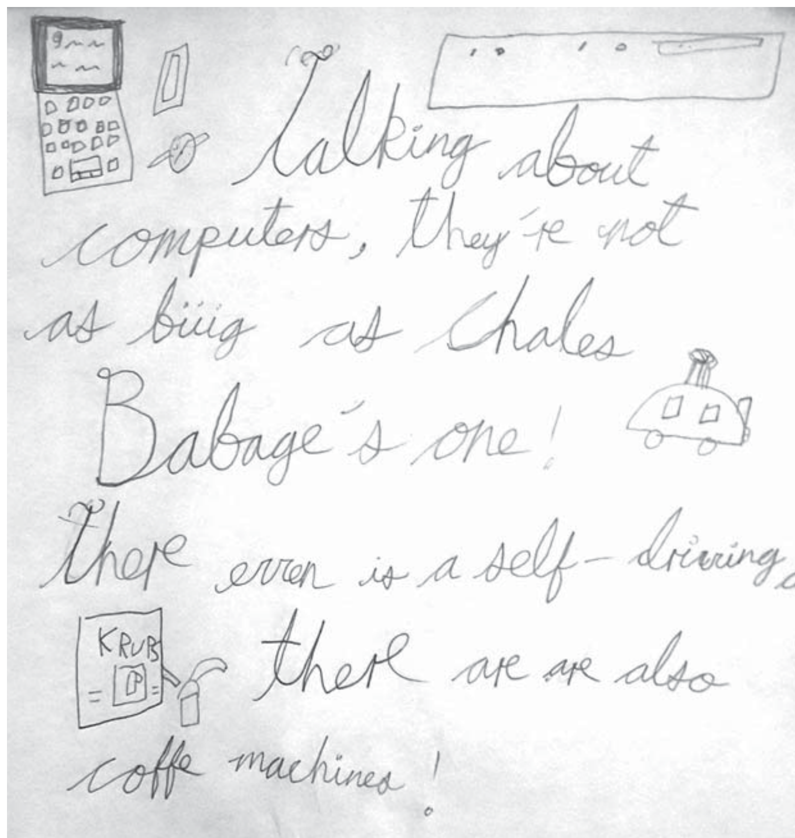
After receiving numerous letters and drawings describing modern technologies to Lovelace, it was difficult to narrow down the entries to just a few. Many contestants used Charles Babbage's Analytical Engine as a starting point, explaining that complex calculations could now be done on smartphones that not only compute, but also help us communicate with people around the world. Myriad applicants paid homage to Lovelace, explaining that her remarkable vision as a mathematician and computational thinker has inspired girls around the world, like themselves, to learn more about STEM topics. We were honored to highlight Lovelace's story at CHM and to partner with other organizations to help encourage young girls to think creatively about how history has shaped the present. ○

First-Prize Winners by Age Category

Under 13: Emilia D., age 6 / Kate W., age 10 (Tie)
Ages 13–15: Emily M., age 15
Ages 16–18: Caroline C., age 16

© DOUGLAS FAIRBAIRN PHOTOGRAPHY

Excerpt from 6-year-old Emilia D.'s winning letter to Ada Lovelace.

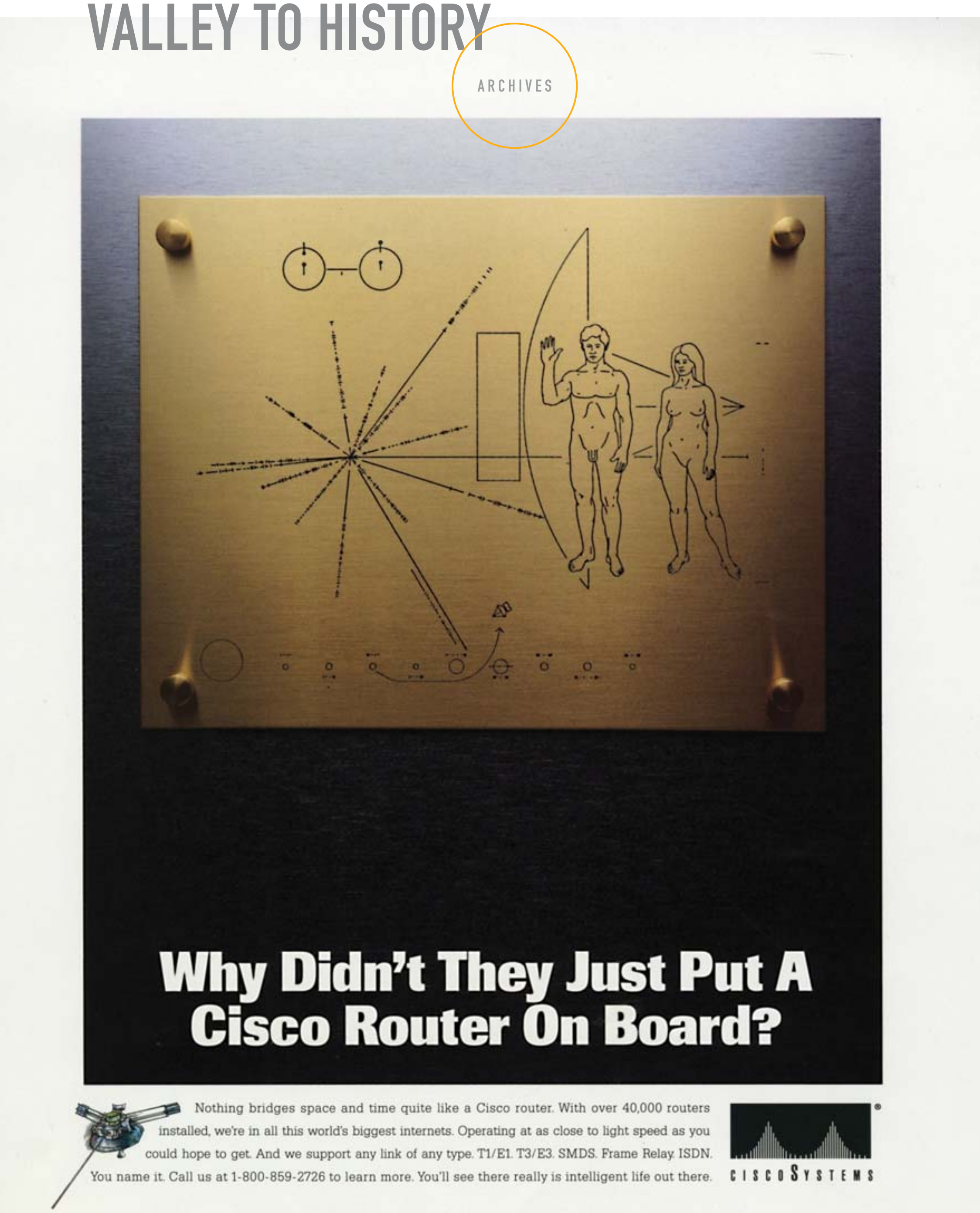


Talking about computers, they're not as biig as Chales Babage's one! There even is a self-driving c there are are also coffe machines!

BY PAULA JABLONER
DIRECTOR, CISCO ARCHIVE

CONNECTING SILICON VALLEY TO HISTORY

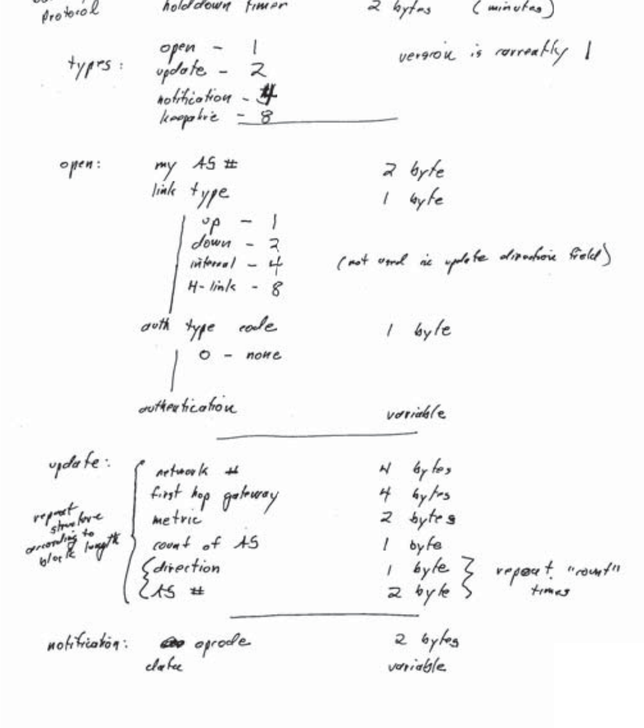
ARCHIVES



The "Pioneer ad," from Cisco's 1992 marketing campaign, is one of many artifacts preserved in the Cisco Archive and accessible via its online catalog.

CHM is in its third year of an innovative and groundbreaking collaboration with Cisco Systems Inc., preserving Cisco's three-decade history. The Cisco Archive documents, preserves, and reveals Cisco's significant role in shaping the Internet and becoming the worldwide leader in networking. Our first two years proved remarkably successful. During that time, we created an online Cisco history gallery, collected fascinating artifacts and stories, built impressive interest among and received support from Cisco employees, and garnered notable media attention.

The collaboration between CHM and Cisco is truly exceptional; we are unaware of another example of a jointly created corporate archive of this nature. Much of this significance is rooted in the authority that comes with partnering with CHM. As a result of the Museum's professional management, individuals affiliated with Cisco are eager to donate artifacts and tell their stories because they know the archive will be sustained. Moreover, the Museum is able to communicate and make Cisco's rich history relevant in engaging ways. One of the Cisco Archive's biggest successes is telling the story of Border Gateway Protocol (BGP), a routing protocol that has been described as the technology that "literally makes the Internet work." It was originally written by two engineers, Kirk Lougheed of Cisco and Yakov Rekhter of IBM, on two napkins in classic Silicon Valley style. Having undergone many revisions, the protocol is still as


Protocol holddown timer 2 bytes (minutes)
types: open - 1
update - 2
notification - 4
keepalive - 8
version is currently 1
open: my AS # 2 byte
link type 1 byte
up - 1
down - 2
internal - 4
H-link - 8
(not used in update direction field)
auth type code 1 byte
0 - none
authentication variable
update: network # N bytes
first hop gateway 4 bytes
metric 2 bytes
count of AS 1 byte
direction 1 byte
AS # 2 byte
repeat "count" times
repeat structure according to block length
notification: opcode 2 bytes
data variable

Photocopies of the Border Gateway Protocol (BGP), written on two napkins by Cisco's Kirk Lougheed and IBM's Yakov Rekhter, are housed in the Cisco Archive—a significant donation as the original napkins have been lost.

relevant today as in 1989 when it was first written. News of the BGP story and photocopies of the original napkins were shared on Cisco's employee home page and generated the most views of any piece that week. Comments included "A lunch that changed routing forever!" "Fantastic," "awesome," and "What an inspiring story!" The post continues to reverberate months later, deployed as part of a company-wide video segment with protocol co-author and Cisco Engineering Fellow in Engineering Kirk Lougheed for Cisco's "Innovate Everywhere!" challenge.

Preservation alone is not enough, people have to know what you have, or the archive becomes a time capsule to be discovered decades later. Why collect if no one knows you have this cool stuff! Hence we created an online presence for the Cisco Archive. What do dolphins, radio telescopes, a punk rocker, and flying saucers have in common? Communicating across the divide! All were featured in Cisco's first print ad campaign, along with pithy copy such as *Why Didn't They Just Put A Cisco Router on Board?* For archivist Stephanie Waslohn and me, our favorite project was sharing and making available this first ad campaign, along with many other gems at www.ciscoarchive.lunaimaging.com.

Our unexpected finds continued with two videos containing footage and outtakes from Cisco's first product line promotion, filmed on October 17, 1989, the day of the infamous Loma Prieta earthquake. (For once, dating a donation was not a problem.) One outtake records Cisco founders Sandy Lerner and Len Bosack performing a "duck and cover"as the earthquake struck. Now, over 50 early Cisco videos are available online, including "Nerd Lunches," marketing campaigns, and community events.

The first Networkers conference (now Cisco Live) also began in 1989. Almost as an afterthought, all attendees were given a railroad engineer cap for attending. The hat was such a success that every year since, all conference attendees received a wacky hat. Highly coveted, a complete collection of Networkers silly hats (Elvis wig knock-off, sequined fedoras, cowboy hats, jester caps, Robin Hood caps) was donated by Cisco's events department. The Cisco Archive embraced this tradition at CHM's Cisco community weekend. Over 1,200 Cisco employees and friends visited the Museum for free—a thank you for Cisco's generosity—and the Cisco Archive put its extra wacky hats to good use. Entire families, from small children to grandparents, snapped pictures in an array of silly headgear.

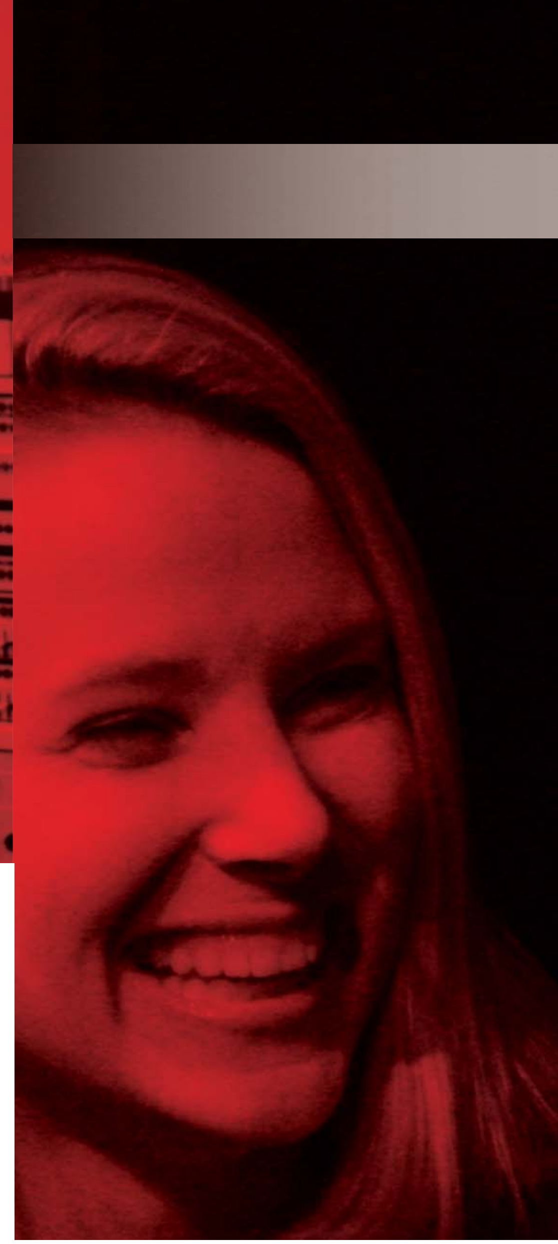
When people visit the Cisco Archive and see the first piece of hardware they worked on or their favorite ad from years ago or a powerful story that they'd forgotten, they're often overcome with emotion, which translates into company pride and customer loyalty. Many of the artifacts at the archive are magnets for selfies during visits. The connections made at the Cisco Archive can't be replicated anywhere else.

The Cisco Archive shines a spotlight on entrepreneurship, innovation, leadership, social responsibility, product development, open standards, and customer advocacy over Cisco's 30-year history. The insights learned in preserving Cisco's history will inform the Museum's endeavors as we engage in the unique work of collecting and interpreting Silicon Valley history. The project is so much more than networking equipment. The uniqueness of the project and the importance of collecting Silicon Valley history really hit me when this article—"How Cisco is Preserving its History and Why Other Tech Companies Should, Too"—was published about the Cisco Archive on Medium.com. The title of the article says it all.

Thanks goes to Cisco for being so forward thinking in its own archive. These artifacts and stories of Silicon Valley culture would otherwise be lost to Cisco and future historians. The stories provide unusual insight into a particular time and place. The archivists are excited about the new activities, stories, and treasures that lie ahead in year three! The essential part of the partnership is that history is being preserved *now* while it is happening. I'm hoping other companies follow in Cisco's footsteps. The Valley has changed the world; the more we preserve, the better we understand the phenomenon that is Silicon Valley. ○

Kirk Lougheed visits the Cisco Archive Open House in October 2015.

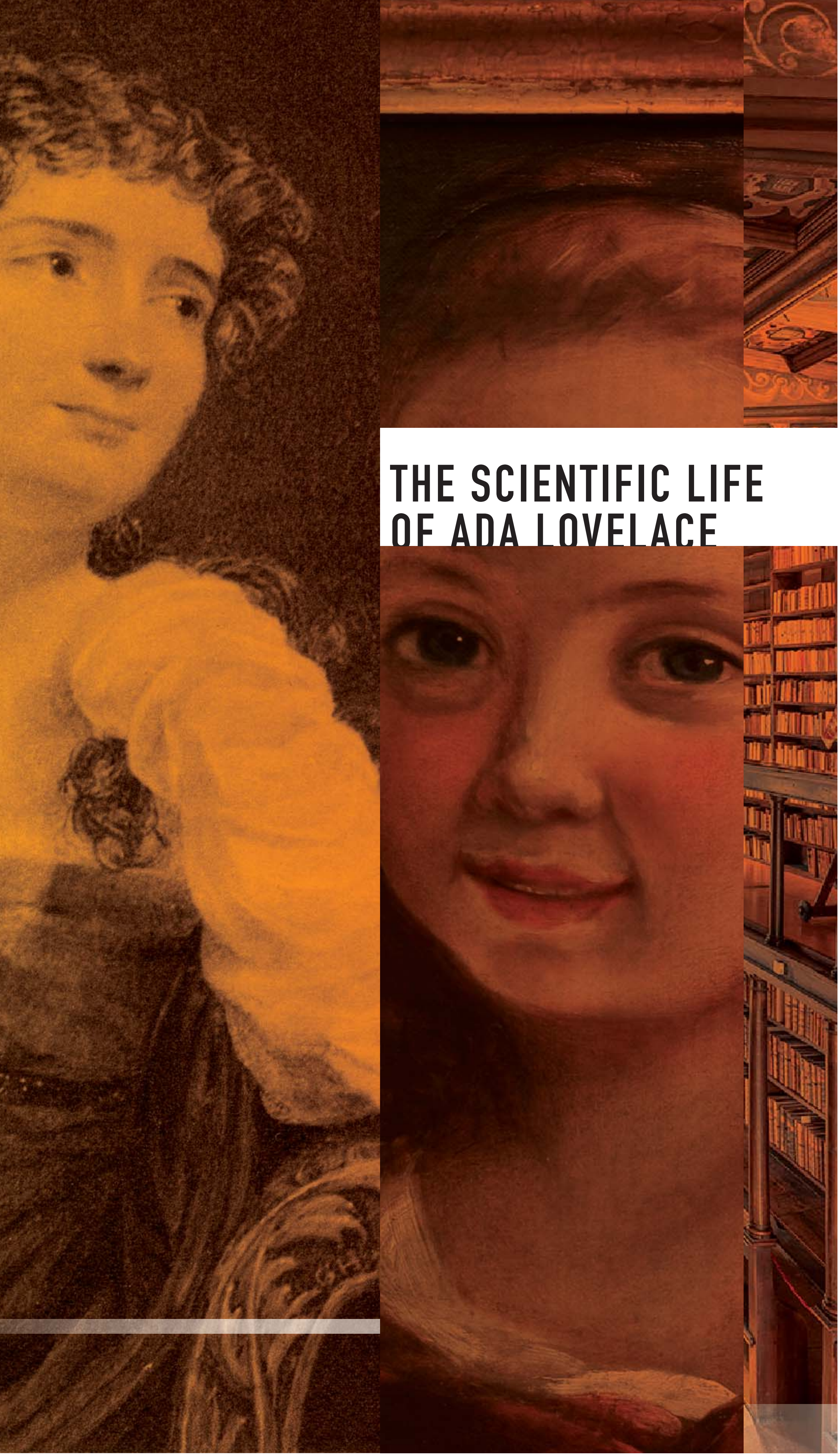

WOMEN IN COMPUTING



In 1843 a woman contributed what many consider to be the earliest published form of an algorithm. During the Second World War, six women programmed the first general-purpose electronic computer—ENIAC—to calculate ballistics tables for the US Army. It was a woman who invented one of the first computer compilers and laid much of the groundwork for the popular programming language COBOL. In 1984 a woman co-founded one of the world's largest and most successful networking companies—Cisco. In 2014 a woman was appointed CEO of YouTube, but not before she excelled as Google's first marketing manager. Can you name these women?

Women have played key roles throughout computer history and continue to shape the industry today. Yet many of their contributions remain undefined, unacknowledged, or both in a field that touts the importance of meritocracy. The following articles take a critical look at the significance and changing roles of women throughout computer history.

Ursula Martin, professor at Oxford University, offers new insight into the life and accomplishments of 19th-century mathematician Ada Lovelace. Marie Hicks, assistant professor at the Illinois Institute of Technology, demystifies meritocracy in post-World War II Britain and present-day Silicon Valley. Dag Spicer, senior curator at CHM, examines the perception and status of women in the computing industry in parallel with imagery from the professional computer journal *Datamation*. Finally, Marguerite Gong Hancock, executive director of CHM's Center for Entrepreneurship and Innovation, chronicles the history of women entrepreneurs in Silicon Valley and the diversity challenges still prevalent in the field today.



THE SCIENTIFIC LIFE OF ADA LOVELACE

BY URSULA MARTIN
PROFESSOR OF MATHEMATICS & COMPUTER SCIENCE, UNIVERSITY OF OXFORD

Ada, Countess of Lovelace, was born Ada Byron on December 10, 1815, and died, after a long and painful illness, in 1852. The daughter of the infamous poet Lord Byron and his wife Annabella (née Milbanke), Lovelace married William King in 1833, who was created Earl of Lovelace in 1838.

Ada Lovelace is famous for a paper published in 1843, which translated and considerably extended a work by Luigi Menabrea about a general-purpose computer designed by Charles Babbage, his unbuilt Analytical Engine. The substantial appendices written by Ada Lovelace contain an account of the principles of the machine and a table displaying how it might compute the Bernoulli numbers, often described as "the first computer programme."

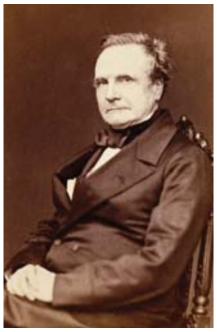
From an early age Lovelace showed a passion and a talent for mathematics and science. Her mother was a noted educational reformer and organized childhood visits to factories. These visits would later help Lovelace grasp the principles of Babbage's calculating machines, which she first encountered in her teens.

Charles Babbage said he conceived of the idea of computing tables of numbers "by steam" while he and the astronomer John Herschel were engaged in the tedious task of checking the values of a table computed by hand. Nineteenth century science and business relied on a huge variety of such printed tables for matters such as navigation or interest calculations.

Babbage raised substantial government funds to build his "difference engine," a mechanical device to compute and print successive values of functions using the method of finite differences. Lovelace and her mother were frequent visitors to Babbage's regular soirees where he demonstrated working models of these devices. It was not until the 1990s that two complete difference engines were constructed to Babbage's designs—one is in the London Science Museum and one in the Computer History Museum in Silicon Valley.

After her marriage, and the birth of three children, Lovelace went back to mathematics and studied with one of the United Kingdom's pre-eminent mathematicians, Augustus De Morgan. In a remarkable two-year correspondence course, preserved in Oxford's Bodleian Library, we see her working through the same material as De Morgan's students at University College London—limits, series, functions, differential equations, and the like.

This rare daguerreotype, from the early to mid-1840s, was taken when Lovelace was about 30 years old.



Top: Lovelace was unhappy about her short hairstyle in this 1835 portrait by Margaret Carpenter. Lovelace thought the hairstyle made her look "like a crop eared dog" and showed too much of her "capacious jaw bone."Bottom: Charles Babbage, shown here at the fourth International Statistical Congress of 1860, exchanged many letters with Lovelace about calculations for his analytical engine.

This background served Lovelace in good stead when she came to translate and extend Menabrea's article. While he prepared many notes and drawings, Babbage never published an account of his Analytical Engine; the first account was published (in French) by Luigi Menabrea in 1842, based on lectures that Babbage gave in Turin, Italy.

Unlike the Difference Engine, Babbage's "analytical engine" was, in modern terms, a general-purpose computer, programmed with punched cards, similar to the Jacquard cards used at the time to control looms. In principle it could calculate any function. Remarkably, Lovelace's paper presents it, not in terms of ironmongery, but as what we could now call an "abstract machine," describing the functions of memory, CPU, registers, loops, and so on.

The paper contains a table illustrating the workings of the machine through the computation of the seventh Bernoulli number. This is often described as "the first computer programme." However Lovelace wrote, more accurately, that it "presents a complete simultaneous view of all the successive changes" in the components of the machine, as the calculation progresses. The "programme,"[1] had the notion existed at the time, would have been the stack of punched cards that caused the machine to make those successive changes, though Babbage's designs were rather unclear about aspects of how the cards would be manipulated, making it hard to reconstruct an explicit program.

This table from Lovelace's 1843 paper presents the calculation of the seventh Bernoulli number.

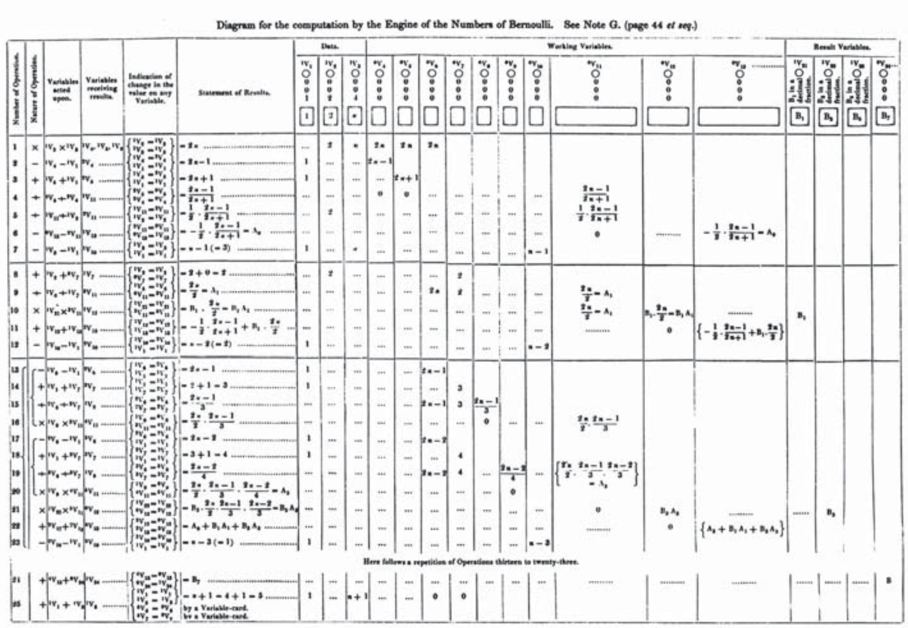


Diagram for the computation by the Engine of the Numbers of Bernoulli. See Note G. (page 44 *et seq.*)

Here follows a repetition of Operations thirteen to twenty-three.

What is truly remarkable to the modern computer scientist reading the paper, and the correspondence between Lovelace and Babbage preserved in the British Library, is Lovelace's high-level view and how her speculation on the capabilities and potential of the machine mirror present-day concerns. Lovelace and Babbage's collaboration by letter, as they exchanged successive versions of the table for Bernoulli's numbers, echoes the frustrations of collaborators over the ages—"Where is it gone?" writes Babbage in a moment of frustration as they lose track of Note G.

She understands the complexity of programming

> *There are frequently several distinct sets of effects going on simultaneously; all in a manner independent of each other, and yet to a greater or less degree exercising a mutual influence.*

the difficulty of verification

> *To adjust each to every other, and indeed even to perceive and trace them out with perfect correctness and success, entails difficulties whose nature partakes to a certain extent of those involved in every question where conditions are very numerous and inter-complicated.*

and the need for program optimization.

> *One essential object is to choose that arrangement which shall tend to reduce to a minimum the time necessary for completing the calculation.*[2]

MUSEUM OF THE HISTORY OF SCIENCE, MS. BUXTON 4, TABLE BETWEEN PP. 40–41

She reflects on the power of abstraction, explaining how the machine provides a link "between the operations of matter and the abstract mental processes of the *most abstract* branch of mathematical science." She also explores the role of the machine in supporting creativity: "We might even invent laws for series or formulæ in an arbitrary manner, and set the engine to work upon them, and thus deduce numerical results which we might not otherwise have thought of obtaining."

Most famously, the paper is also remarkable for Lovelace's reflections on the potential of the machine. In what Alan Turing later described as "Lady Lovelace's objection" to whether machines can think, Lovelace observed that "The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we *know how to order it* to perform." She reflected on how the machine might do algebra, as well as compute with numbers, how it "*weaves algebraical patterns* just as the Jacquard-loom weaves flowers and leaves," and how if music could be represented algebraically "the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent."

In later life Lovelace continued to pursue her mathematical interests. Although she did no further work on Babbage's engines, Babbage and the Lovelaces remained friends. In one letter she asks whether peg solitaire could be modeled algebraically, and another charming document includes the Bridges of Königsberg, a discussion of Pythagoras's theorem and even a magic square. She contributed to her husband's writings on crops and husbandry, proposing a quadratic, rather than a linear, model to relate growth of plants to quantity of sunlight. She became interested in mesmerism and reflected on whether there might be mathematical laws underlying the operations of the brain, a "calculus of the nervous system."

Lovelace's name lives on through the Ada programming language and initiatives for women in science, including the annual "Ada Lovelace Day" in mid-October. In her 200th birthday year, we can celebrate an extraordinary individual, who defied the constraints of her time and gave a remarkable and farseeing account of the principles, potential, and challenges of Babbage's analytical engine and the many machines that have come after it.

The Analytical Engine has no pretensions whatever to originate anything. It can do whatever *we know how to order it* to perform. —ADA LOVELACE

Further Reading

Thomas Haigh and Mark Priestley, "Innovators Assemble: Ada Lovelace, Walter Isaacson, and the Superheroines of Computing," *Communications of the ACM*, vol. 58 no. 9, Pages 20–27. cacm.acm.org/magazines/2015/9/191176-innovators-assemble/fulltext

Richard Holmes, "Computer science: Enchantress of Abstraction," Nature 525, 30–32 (September 3, 2015). nature.com/nature/journal/v525/n7567/full/525030a.html.

A full list of biographies and other information about Ada Lovelace can be found at blogs.bodleian.ox.ac.uk/adalovelace/.

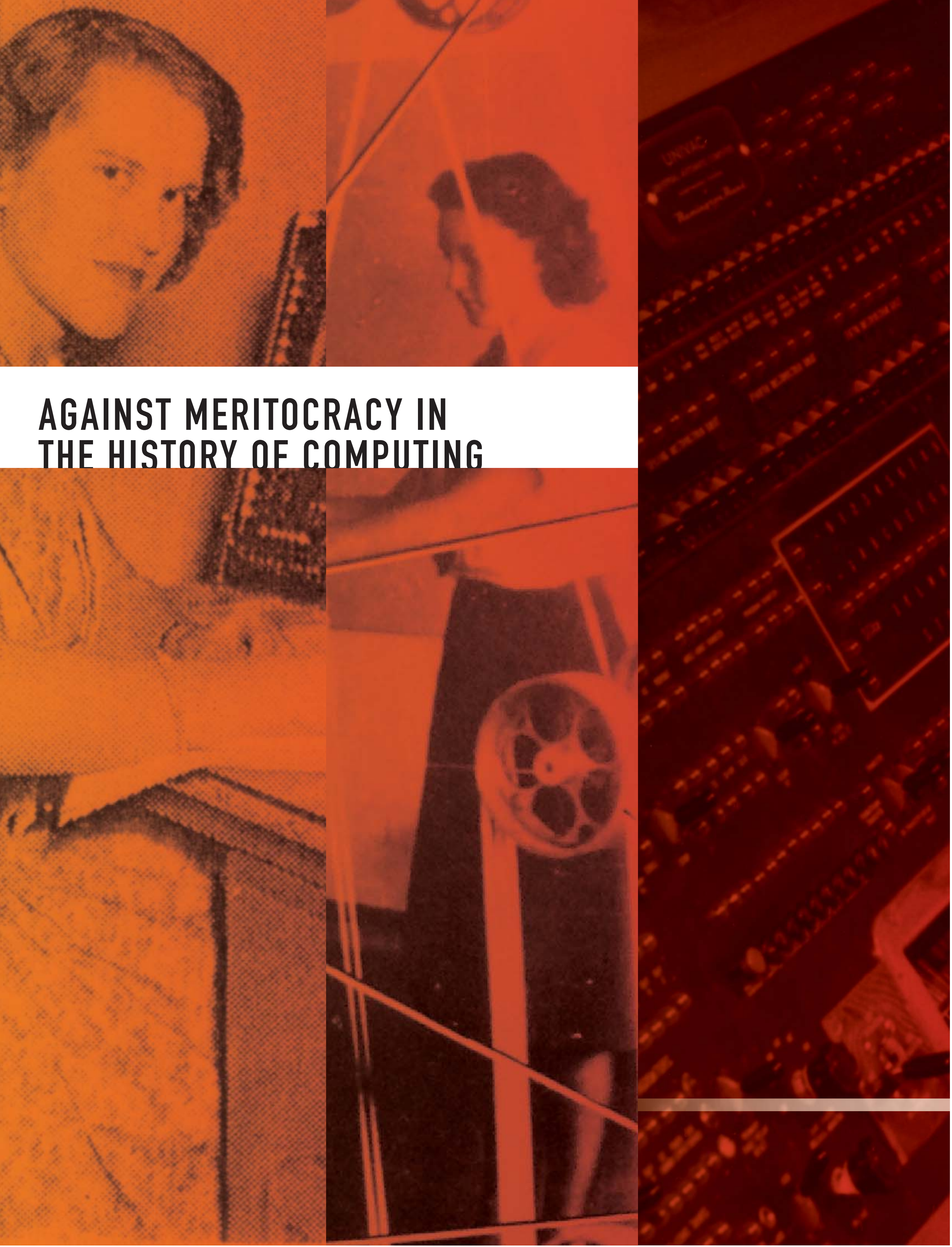
Images and transcriptions of the mathematical writings of Ada Lovelace were released online at claymath.org in December 2015, thanks to the generosity of the Clay Mathematics Institute and the descendants of Ada Lovelace.

[1] Museum of History of Science, MS. Buxton 4, table between pp. 40–41.

[2] Dep. Lovelace Byron 168, fols. 45v-6r.

This portion of Babbage's Difference Engine No. 1 was assembled in 1832 by his engineer, Joseph Clement, as a test. It consists of 2,000 parts and represents one-seventh of the complete engine.

AGAINST MERITOCRACY IN THE HISTORY OF COMPUTING



BY MARIE HICKS
ASSISTANT PROFESSOR OF HISTORY, ILLINOIS INSTITUTE OF TECHNOLOGY

Perhaps the most important fiction in the history of computing is the concept of meritocracy. Within the fast moving world of high technology, sheer talent seems to trump differences that lead certain people to ascend to the top while others sink to the bottom. Computing seems to hold the promise of the American Dream: a field where cleverness can trump credentials and success is dictated by ingenuity and hard work. Scores of current initiatives aimed at getting women and minorities into computing careers turn on the idea that computing is, at base, a meritocracy. But history tells a different story.

Technology as an equalizing force in society is not a new idea, nor a distinctly American one. Decades ago, at the beginning of the electronic age, a similar ethos took hold in the United Kingdom, our close historical cousin. During World War II, Britain had secretly invented the first digital, electronic, programmable computer for codebreaking, which ensured Allied forces knew where to land on D-Day and significantly shortened the war. Little wonder then that Britain had a thriving computing industry early on, rivaling—and often leading—American technological developments.

By the 1960s, Britain was gripped by the idea that success in building and using computers could save its shrinking empire. Current promises that Silicon Valley will "disrupt" the struggling postindustrial economy of the US echo the hopes and fears of Britain in the 1960s, when high technology became seen as the be-all, end-all of economic growth and global political power. Prime Minister Harold Wilson declared an era of "white hot" technological revolution that would "burn up" differences of class at home while launching Britain back into the role of a technological superpower. Having risen to the highest levels of government from a working class background, Wilson was captivated by the idea that, with the right technological tools and training, the entire nation could become a meritocracy.

The government already modeled itself on the ideal of meritocracy. Its Civil Service, which employed nearly a million workers, required examinations for promotion in order to privilege talent over connections. It had long been known as a "fair field with no favor," and those who moved to the top held enormous power—having the ability to shape the destiny of the nation. The huge public sector, which included not only the Civil Service but also workers in the nationalized industries and the National Health Service, generated massive amounts of data and required a huge amount of computing power. Providing the labor and know-how for this gigantic data processing machine were thousands of women workers.

In 1958, British Tabulating Machines—the same company that had built the codebreaking Bombes for the government during World War II—sent a young computer operator named Andrina Wood around the world to "demonstrate" BTM's new general-purpose electronic computers. Wood wrote and tested all of the programs she showed to customers, yet her role was described as an "operator."[1] Wood was not unique: in industry most computer companies employed all-women "demonstration teams" through the early 1970s, in what we might today call sales engineer positions. Within government, many "machine operators" not only operated computers but, like Miss Wood, programmed them. These "Machine Grade" job classes in the Civil Service were also known as the "Women's Grades." "You are a women's grade, and we are a women's association with your interests at heart," pointed out a women's union at the time.[2] Despite the Civil Service's meritocratic underpinnings, these workers received substantially lower pay than their male peers.

When the government gave its workers equal pay in 1954, the Machine Grades were renamed the "Excluded Grades."[3] Computing was so feminized, the government declared, that it made no sense to raise the wages of women machine operators to the rarely used men's pay rates. The government reasoned that the "fair market rate" for computer work was the artificially low rate given to women.[4] Ironically, the vast majority of women working within this "fair field with no favor" did not receive equal pay as a result. After depressing their wages through unequal pay, the government made that the standard value of their work. At the time, few saw this as undercutting the Civil Service's meritocracy.

As computing grew in importance and prestige, one might have expected these women to gradually rise in status as well. Yet for the most part they remained stuck at the bottom of the labor pyramid. Hiring and promotion began to privilege nontechnical skills. Management ability and career potential, rather than actual technical experience, started to become the qualities that helped people get computing jobs. Computers, it was now thought, should be able to not only manage data, but also people. As such, they were a tool of management, and not a something to be controlled by lower-level workers, especially women, who could not be trusted to wield authority.

As such, the gulf between women in computing and their superiors widened. One woman, described by her supervisors as having "a good brain and a special flair" for programming, was demoted after training her two new management-level male co-workers how to program.[5] Despite her technical skills, she did not benefit from the rising prestige of computing. Her case serves as a potent reminder that skills often do not equate to leadership opportunities, and the most talented workers are often not the ones promoted to positions of authority.

In industry, where women's cheap labor was useful, thousands were employed in technical work. Where it was inconvenient, they were not. The British company that invented the world's first dedicated electronic business computer, LEO computers, refused to hire women operators because


★ *YOU* are a women's grade . . . .

★ *WE* are a women's association with your interests at heart . . . .

So Join the

N.A.W.C.S.

Without Delay!

All about Machine Operators

The Machine operating class contains three grades:—

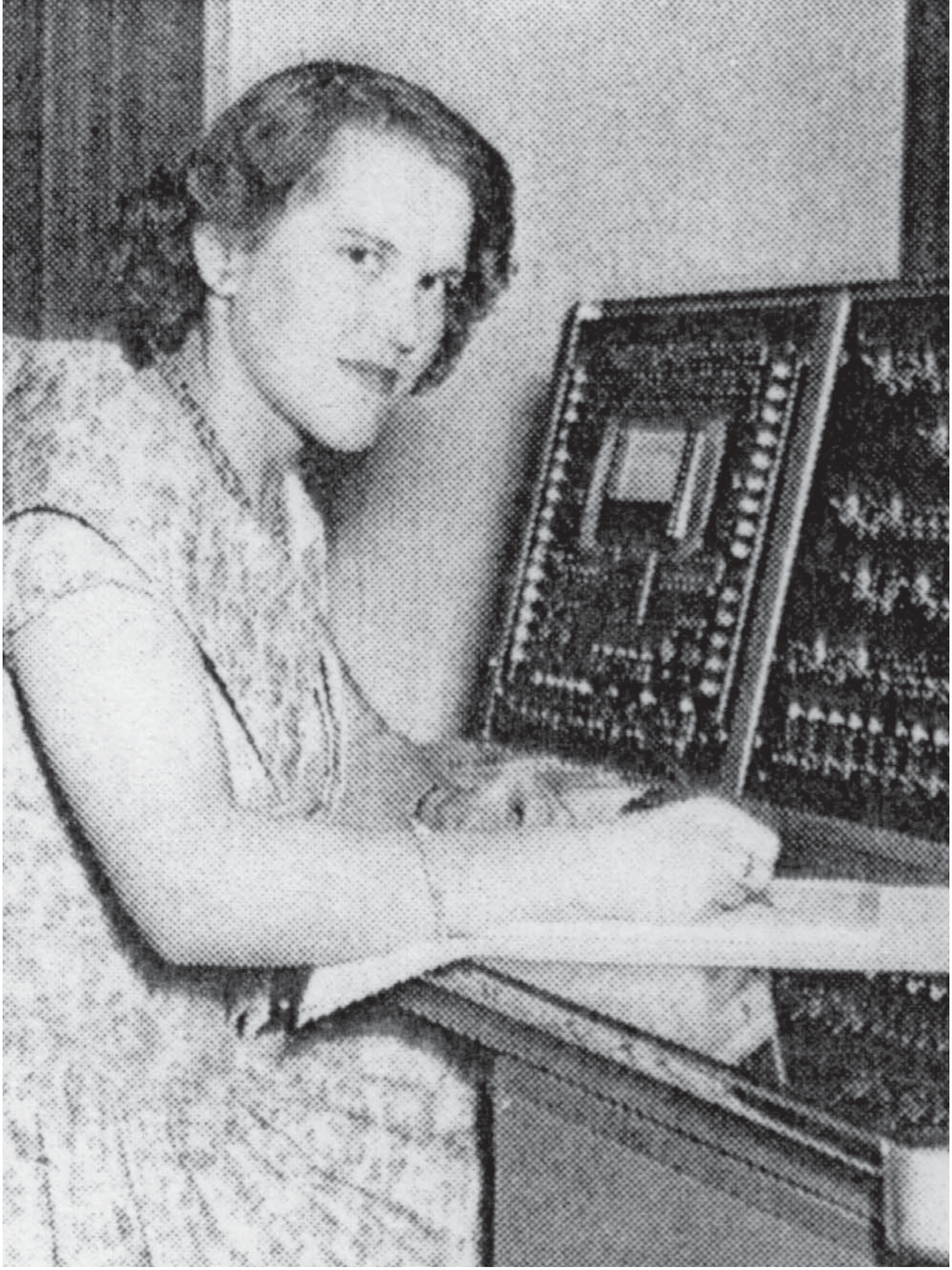
MACHINE ASSISTANT, the basic or entry grade;

MACHINE OPERATOR, to which Assistants may be promoted; and

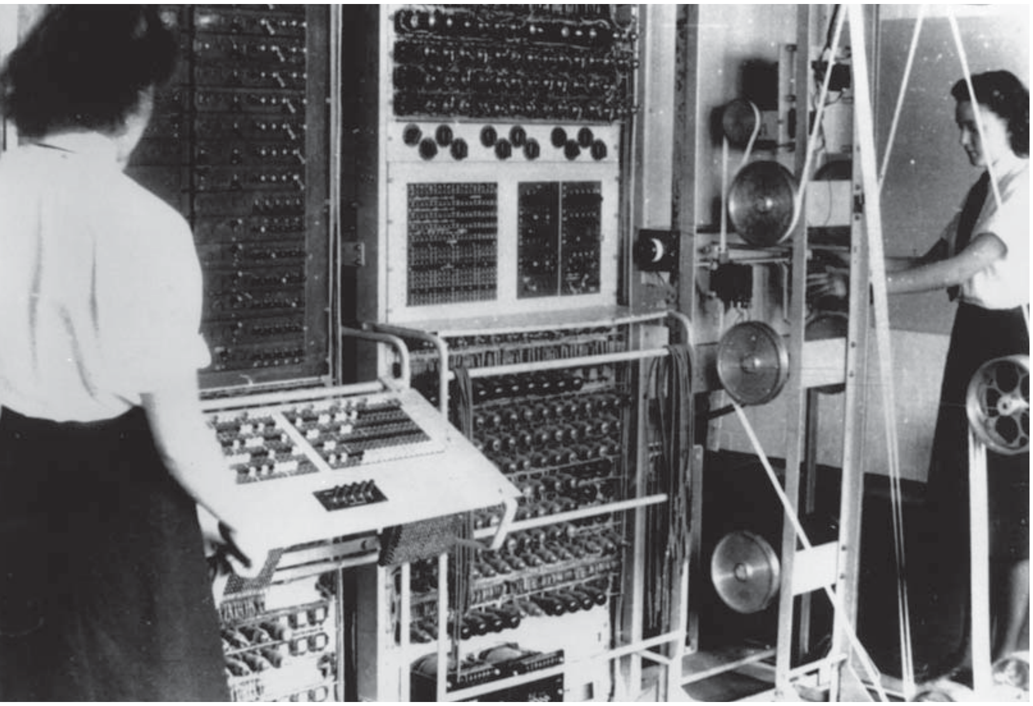
SENIOR MACHINE OPERATOR, the grade which

A recruiting pamphlet aimed at machine operators from the main women's labor association for civil servants. National Association of Women Civil Servants, "Pamphlet for Machine Operators," 1950.

WOMEN'S LIBRARY, LONDON SCHOOL OF ECONOMICS



Andrina Wood is shown here working at the console of a general-purpose electronic computer. Wood graduated from Girton College at Cambridge University with a history degree before going to work as computer operator/ programmer and becoming the first "computer officer" to be sent overseas to train BTM customers. ***Tabacus: The Magazine of the British Tabulating Company***, August 1958, p.8.



Dorothy Du Boisson and Elsie Booker operating a Colossus during WWII at Bletchley Park. Though men like Alan Turing and Max Newman are most associated with the triumphs at Bletchley, thousands of educated women worked there during the war, and British military intelligence was built on their labor.

they did not want to hire a "women's officer" (a type of HR supervisor) to oversee them.[6] "The worst places," to apply for a job in the 1960s said one computer operator, "were the computer firms. They didn't want women because they thought they couldn't work at night."[7] A fear of sexual impropriety blocked many women from the better jobs available at computer companies. Meanwhile, young men with no technical skills could work their way up from the bottom. Yet these same ideas about the need to protect women's chastity failed to prevent their persistent objectification and harassment in the industry.

The initiatives to change computing's status, though not its content, meant more and more men became computer "experts." Even within the government's supposedly meritocratic Civil Service, men with fewer skills rose to supervise or replace women with more skills. By the 1960s only those already working in managerial posts were allowed to compete for new computing jobs, cutting the vast majority of women out of the running. These top down initiatives to get more of the "right sort" of people into computer jobs became standard policy, upset only in times of severe computer labor shortage. In the mid-1960s labor shortages for programmers drew both more men and women into computing, blunting the effect of hiring policies intended to masculinize the work. But by the 1970s, computing had acquired a distinctly male image, shaped by the presumption that more men than women had the nontechnical abilities to rise to positions of power and responsibility in this newly important field.

In recent years, historical studies of women in computing have proliferated, uncovering women's contributions and adding them back into the historical record. Most focus on computer programmers, since programming has become seen as important, lucrative, and foundational to what computing is. Many zero in on the few women who have a claim to greatness or whose activities put them at the center of major historical events. Unfortunately, it is possible to interpret these accounts as supporting the idea of meritocracy in early computing, with some women rising to the top given their sheer talent. In reality, arbitrary circumstances made certain women visible while many others remain hidden. Before programming was a separate profession it was done by thousands of women who were known simply as "operators." They have largely disappeared from the historical record—not because they were unusual but because they were so common. Our unconscious desire to project meritocratic ideals onto the past ensures their contributions are assumed to be unimportant and their skill levels low.

When considering how the history of computing relates to women's roles today, it is important to remember that technical skills were not the main reason that women lost out. For a long time, technical skill was seen as being the opposite of intellectual ability. Women working in electronic computing early on were dismissed precisely because they had technical skills, not because they lacked them. As those skills became more highly valued, women were often forced out of the field instead of being promoted, even in the context of an explicit meritocracy like the British Civil Service. In addition to hurting individual workers, this caused perpetual labor crises and ultimately harmed the British computing industry and Britain's economy as a whole.

It has been said that history "doesn't repeat itself, but it rhymes." If so, focusing on "re-skilling" women and minorities today might not be the best approach. Instead of assuming—or asserting—a fictive meritocracy and enacting solutions that invite women to start at the bottom and work their way up, we should look at the larger cultural and historical reasons why so many more women than men, and so many more black women than white women, have to start from the very bottom and often get stuck there. The problem of women in computing does not turn so much on lack of skill as it does on perception. Meritocracy is a worthy goal, but when merely asserted in the face of existing power imbalances it does little good. History shows that every meritocratic system is circumscribed in particular ways that allow only certain people to truly compete equally.

A prescient cartoon, by an anonymous computer company worker, describes the gender change underway in the field. "Yearning Miss" Cartoon from *Tabacus: The Magazine of the British Tabulating Company*, 1957.

Today, many people are beginning to realize that while technical skills may be valuable, teaching girls to code is not going to create gender parity at the highest levels of power in industry.[8] It may simply allow women to fill a new set of worker-bee jobs, much as they did back in the mid-20th century. Though these jobs are currently lucrative, history shows that an influx of workers into a field—particularly women workers—depresses wages and contributes to a loss of status and prestige.[9] As such, the problem of women in computing is one that can only be fixed with knowledge of where we've been, as much as hopes about where we are heading: a big part of the solution turns on the difficult task of confronting the fiction of meritocracy head on. ○

---

1 "First Computer Officer Overseas," *Tabacus: The Magazine of the British Tabulating Company*, (1958): 8.

2 National Association of Women Civil Servants, "Pamphlet for Machine Operators," 1950, 6/NCS Box 282 Pamphlets Folder, Women's Library, London.

3 Women in the British private sector did not gain equal pay until well into the 1970s, when Britain sought to join the European Economic Community (EEC). Even then, the laws designed to enact equal pay in the UK were judged inadequate by the EEC.

4 See Marie Hicks, "Meritocracy and Feminization in Conflict: Computerization in the British Government," in Gender Codes: *Why Women Are Leaving Computing*, ed. Thomas J. Misa (Wiley-IEEE Computer Society, 2010).

5 Minutes, April 20, 1959, STAT 14/2320 Accounts Division: Combined Tabulating Installation Staff Inspection Report 1958–1959, The National Archives of the United Kingdom.

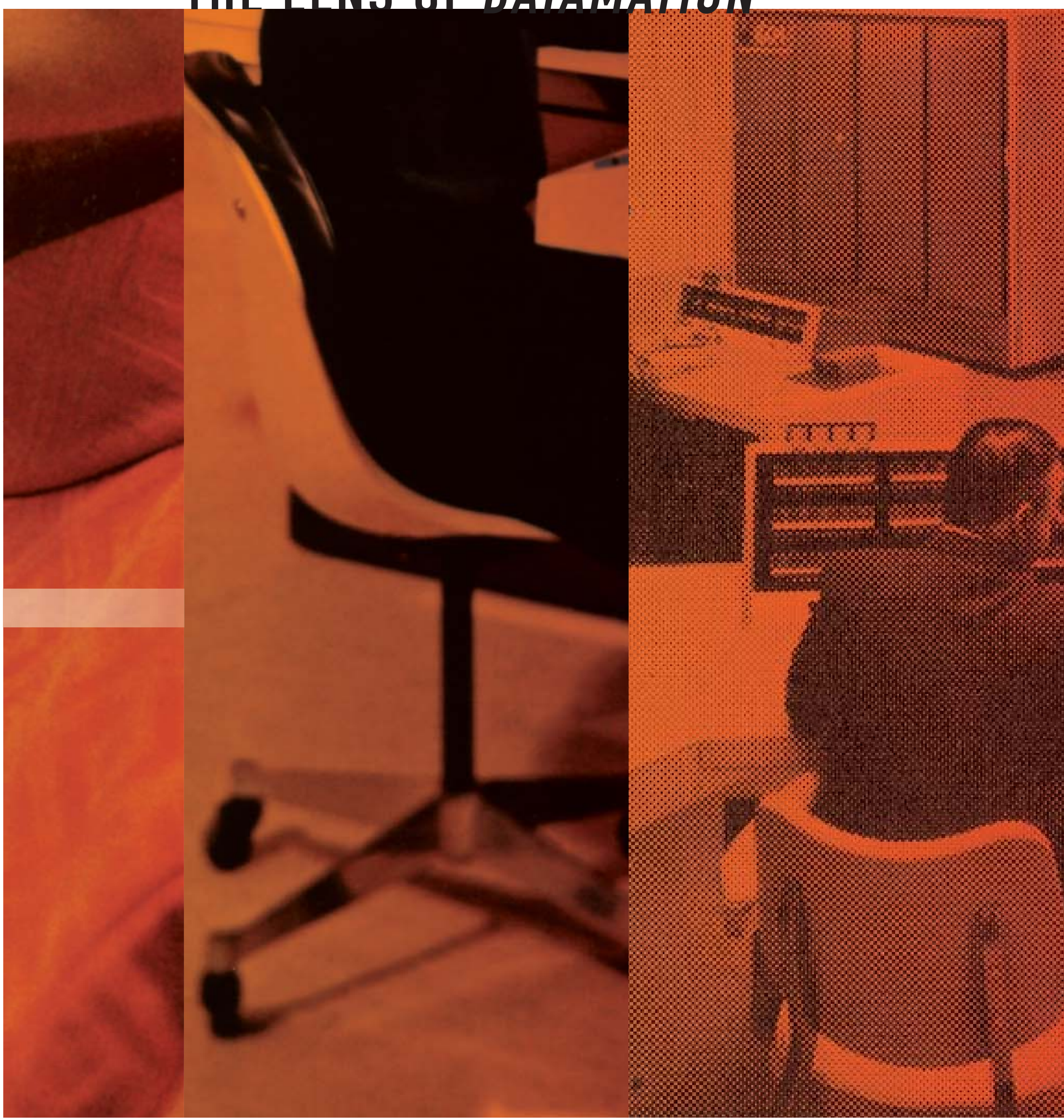
6 Colin Hobson (Employee of LEO Computers), e-mail interview by the author, December 18, 2005, London, UK.

7 Ann Sayce (Government Computer Operator), interview by the author, January 5, 2006, London, UK.

8 Elizabeth Scharpf, "Why Teaching Girls to Code Is Not the (Only) Answer," *Pacific Standard Magazine*, October 16, 2015, psmag.com/business-economics/why-teaching-girls-to-code-is-not-the-only-answer.

9 See Barbara Reskin and Patricia Roos, eds. *Job Queues, Gender Queues: Explaining Women's Inroads into Male Occupations* (Philadelphia: Temple University Press, 1990) for examples.

WOMEN IN COMPUTING THROUGH THE LENS OF *DATAMATION*



BY DAG SPICER
SENIOR CURATOR

As computers moved out of the laboratory and into the marketplace in the early 1950s, computer companies began producing marketing materials to inform and convince potential customers of the features and benefits of commercial computer systems. Like many businesses, they used advertising to supplement their sales approach.[1]

Advertisements can be revealing and useful historical primary sources as they encapsulate information relating to a company's perception of who their potential customers might be, whether the appeal is fact-based or emotional, perceived gender roles in the workplace, status relations (professional or clerical), or class.

Viewing these advertisements over time reveals long-term patterns as well as the shifting conceptions of users and, of course, of computers. This article examines the computer industry's changing perceptions of women from the 1960s to 1980s in parallel with how they are portrayed in advertisements from the professional journal *Datamation*.

Of a Technical Nature

Datamation was among the first professional trade journals for buyers and users of computers. From *Datamation*'s first issue in 1957 until the early 1960s, many advertisements were highly technical, aimed at engineers, and included not only complete computer systems but also electronic devices and components used to build computers, like magnetic cores and teleprinters. It was an era in which there were many new entrants to the marketplace, low barriers to entry, and a popular notion that computer automation was going to usher in a golden age of high-performance management and productivity. In fact, competing journal *Computers and Automation*, founded by actuary and computer entrepreneur Edmund Berkeley, made clear this connection between computers and a new age of productivity. Marie Hicks has written about a similar cultural and political drive to automation in the United Kingdom during this same period.[2]

For the most part, the technical content found in these early advertisements appealed to engineers or scientists, who companies considered their primary customers and decision-makers. Many of these ads listed "speeds and feeds"—the industry term for the various performance characteristics of the computer or component being sold. How much memory did a system have? How quickly could it access information from magnetic tape? How many punched cards could the computer's peripherals process at a given time? Some advertisements were little more than tables of specifications.

Buying a computer is a serious decision. No women allowed. *Datamation* July/August 1960.

Decisions For a Man

As more companies began making computers in the mid-1950s, brochures remained technical, but advertisements began portraying people (users). The early advertisements in *Datamation* reflect the era's perception of potential buyers and decision-makers: men.

With useful software slowly emerging by the mid-1950s, companies considering computers expended great energy in understanding how these new automated methods would integrate into their existing hierarchies and organizational structures. Planners and decision-makers were the first generation of managers to adapt organizations to these new automated methods. Several ads, for example, show very serious-looking businessmen around a table pondering the complexities of how computers might fit into their companies. This reflects both the high cost of large computer systems at the time and that such a purchase was a group decision, not to be taken lightly, while underscoring the gendered (all-male) managerial layer in these early companies.

It is also important to note that machine specifications, performance expectations, and users are portrayed differently in advertisements depending on the industry sector a computer is intended to serve—that is, the commercial versus the scientific sector. In the commercial sector, there is more emphasis on the "business case" for deploying computers. What is the return on investment? How will this new system affect labor costs? In the scientific community, the emphasis is on performance and technical capabilities, with cost often a secondary consideration. There is also a division between large and small-scale systems. In the commercial sector, the larger and more expensive a system is, the more likely men will be shown in command of the computer, with women relegated to a clerical role, such as picking up the output from a printer or changing magnetic tapes in the background. Conversely, scientific and technical computer systems appear to show both men and women equally. These systems are often single-user computers, such as the Librascope LGP-30 or Bendix G15, and typically show the system in use by a man or a woman seated in front of the main console.

Garnering Respect, or "Garnishing" Machines?

By the end of the 1960s, some significant changes have taken place in computer advertisements. While there remain advertisements showing women using a piece of computing equipment in a clerical context, advertisements are also beginning to portray women as technically competent in their own right, not merely support workers for the men who do the "real" work. At the same time, as women are increasingly shown as equal technical partners, there is a parallel type of advertisement that shows women in the role of "human parsley," that is, as objects of desire for a (presumably) male audience of engineers and decision-makers.

This bifurcation reflects the larger social trends of the era, one of sexual liberation, increasing opportunities for women, and the mounting importance of computing in the world. One should, however, be careful interpreting this change. As French historian of computing Pierre Mounier-Kuhn has observed, "A hypothesis would be that . . . sexist computer ads were less motivated by the real interests of computer makers or clients, than by trends within the advertisement industry."[3] Kuhn continues by observing that many computer companies in the 1960s and 1970s, being new to the marketplace, had little idea of how to promote their systems and so deferred to advertising agencies to portray them publically. The creation of "sexy" ads for computers—and consumer products, in general—was widespread at this time though not all ad agencies followed this trend. As advertising legend David Ogilvie famously remarked about showing proper respect for women in advertising: "The consumer isn't a moron. She is your wife." It is a quote that manages to simultaneously defend and patronize women, but the idea being expressed is that using women as "garnish" to a consumer product is unacceptable.[4] Ogilvie also believed that decision-makers wanted information not titillation, and he ran his advertising campaigns accordingly.

A hypothesis would be that . . . sexist computer ads were less motivated by the real interests of computer makers or clients, than by trends within the advertisement industry. —PIERRE MOUNIER-KUHN

Role Reversal

Interestingly and in contrast to small computer manufacturers, the largest computer makers during the mid-1960s to mid-1970s, such as IBM, reversed the expected gender hierarchy in their advertisements of mainframe systems. The man is often shown at the printer or changing tapes while the woman is seated at the CPU console, the highest-status position. Is this meant to signify ease of use in the implicit assumption that women are less sophisticated technically? Advertisements for punched card equipment from British firm Powers-Samas featured a character known as the "Powers Girl." A Powers-Samas manager claimed that while their systems "are so complex," nonetheless "a girl can be taught how to work them in only ten minutes."[5] Since low-status female employees—"girls"—could be taught to use computers, unspoken is the fact that this would allow for easier and less costly staffing than if a man were required.

Or are IBM's advertisements a genuine expression of gender equality? As historian Julie Wosk notes, "Depictions of women as timid and fearful creatures baffled by machinery have alternated with images of them as being fully capable of technological mastery and control—and of lending sex appeal to machines as products."[6]

The 1960s was the era of BMC's Austin Mini, the miniskirt, and the minicomputer. "The Maximum Mini," *Datamation*, September 1969, p.108.

By 1970, women were increasingly shown as technically competent. "Carol Ching," *Datamation*, January 1970, p. 89

Perhaps IBM's use of women thus encodes both the instrumental need for low-cost labor as well as a more subtle, but nonetheless still sexist, appeal to male computer users and buyers, one appealing to male fantasies of a woman in control. As Goffman has observed, people in advertisements portrayed as being in positions of authority (typically men) are depicted as larger and situated in the foreground, precisely the position the woman plays in the IBM advertisements.[7]

A Disappearing Act

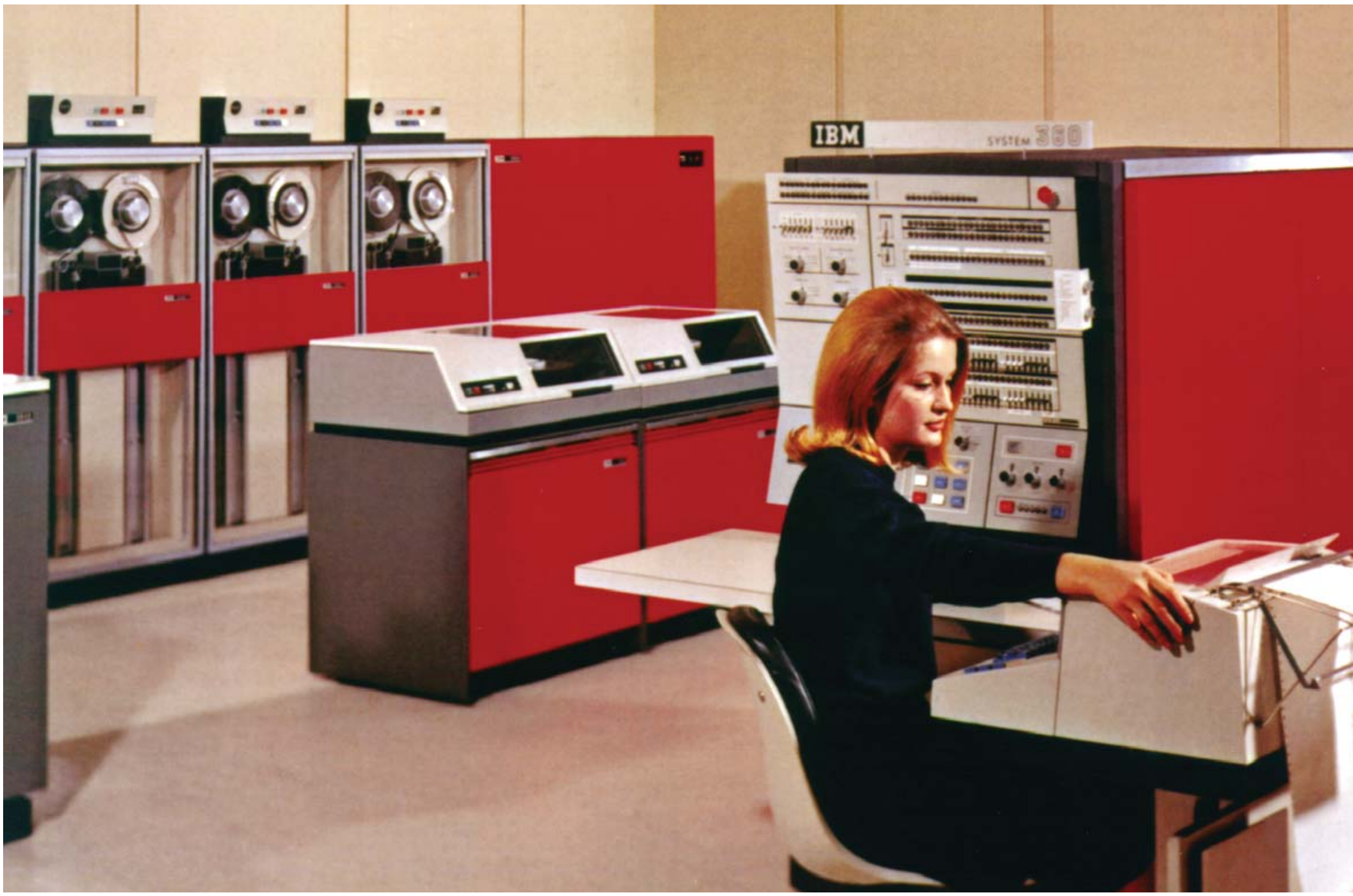
By the 1980s advertisements in *Datamation* rarely showed people—let alone women—at all. While women tended to be portrayed as equal partners in computing by the 1970s, the personal computer era of the 1980s and beyond largely excluded women. Products, which now included a great deal of PC-based software, typically showed a screen display of the program in operation accompanied by extensive text. The ads were purely informational with few appeals to emotion.

Advertisements that did show users, like the Commodore 64, appealed largely to boys and young men (actually, their parents) with an aim of attracting future employees to a booming, new computer industry. At least one author has noted how this parallels declining participation by women in computing.[8]

Conclusion

Decoding these advertisements over time cannot, of course, be done in a vacuum. Against the background of the changing role of women in advertisements is the computer industry itself, which evolved through three technical epochs in the period covered, from mainframes to minicomputers to personal computers.

From this brief survey, we have seen how the changing perceptions of women's roles in computing have been reflected in the pages of a leading computer industry journal. As computing itself broadened to include minicomputers and personal computers, advertisements became more inclusive of women in senior or technical roles. In this sense, the use of "sexy" ads for selling computers by some companies is an anomaly and, as Mounier-Kuhn has suggested, probably more indicative of trends in the advertising industry than conscious choices by the manufacturers. Advertising, after all, is not meant to inculcate social values but, as Mee-Eun Kang has noted, "to naturalize people and things in such a way as to maximize demand by defining social relations in terms of the consumption of goods and services."[9] Women in computer advertising, in other words, exist to reinforce the decision-maker's world view about the role of women in their organization and how purchasing a computer fits in with this existing organizational structure and corporate norms.[10]



COURTESY IBM CORPORATION

IBM often reversed traditional gender roles in its mainframe advertisements, like this one showing an IBM System/360.

[1] The two earliest commercial systems—the Lyons LEO I (UK) and the Univac-1 (US)—both began operations within a few months of each other and produced brochures showing full systems, making these the earliest advertisements for commercially available computer systems.

[2] Marie Hicks, "Only the Clothes Changed: Women Operators in British Computing and Advertising, 1950–1970," *Annals of the History of Computing*, vol. 32, no. 4 (2010): 5–17.

[3] Pierre Mounier-Kuhn, email message to author, October 29, 2015.

[4] David Ogilvie, *Confessions of Advertising Man* (London: Southbank Publishing Company, 2012).

[5] Hicks, 7.

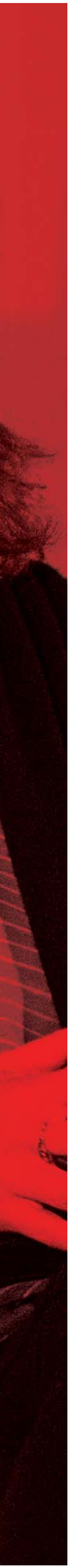
[6] Julie Wosk, *Women and the Machine: Representations from the Spinning Wheel to the Electronic Age* (Baltimore: John Hopkins University Press, 2003).

[7] Erving Goffman, *Gender Advertisements* (New York: Harper Collophon Books, 1973), passim.

[8] Natalie Shoemaker, "Advertising Contributed to Women's Decline in Computer Science," Bigthink, bigthink.com/ideafeed/advertising-contributed-womens-decline-in-computer-science.

[9] Mee-Eun Kang, "The Portrayal of Women's Images in Magazine Advertisements: Goffman's Gender Analysis Revisited," *Sex Roles: A Journal of Research*, vol. 37, no. 11/12, (1997).

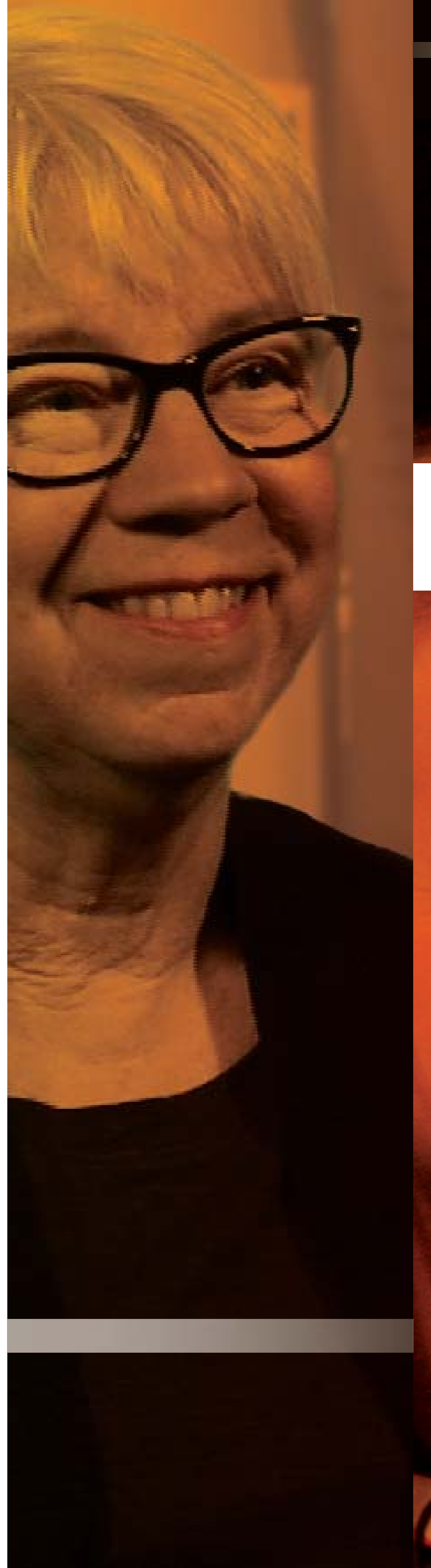
[10] *Selling the Computer Revolution*, a Computer History Museum online exhibit about computer brochures, was a frequently referenced source for this article: computerhistory.org/brochures/index.php.



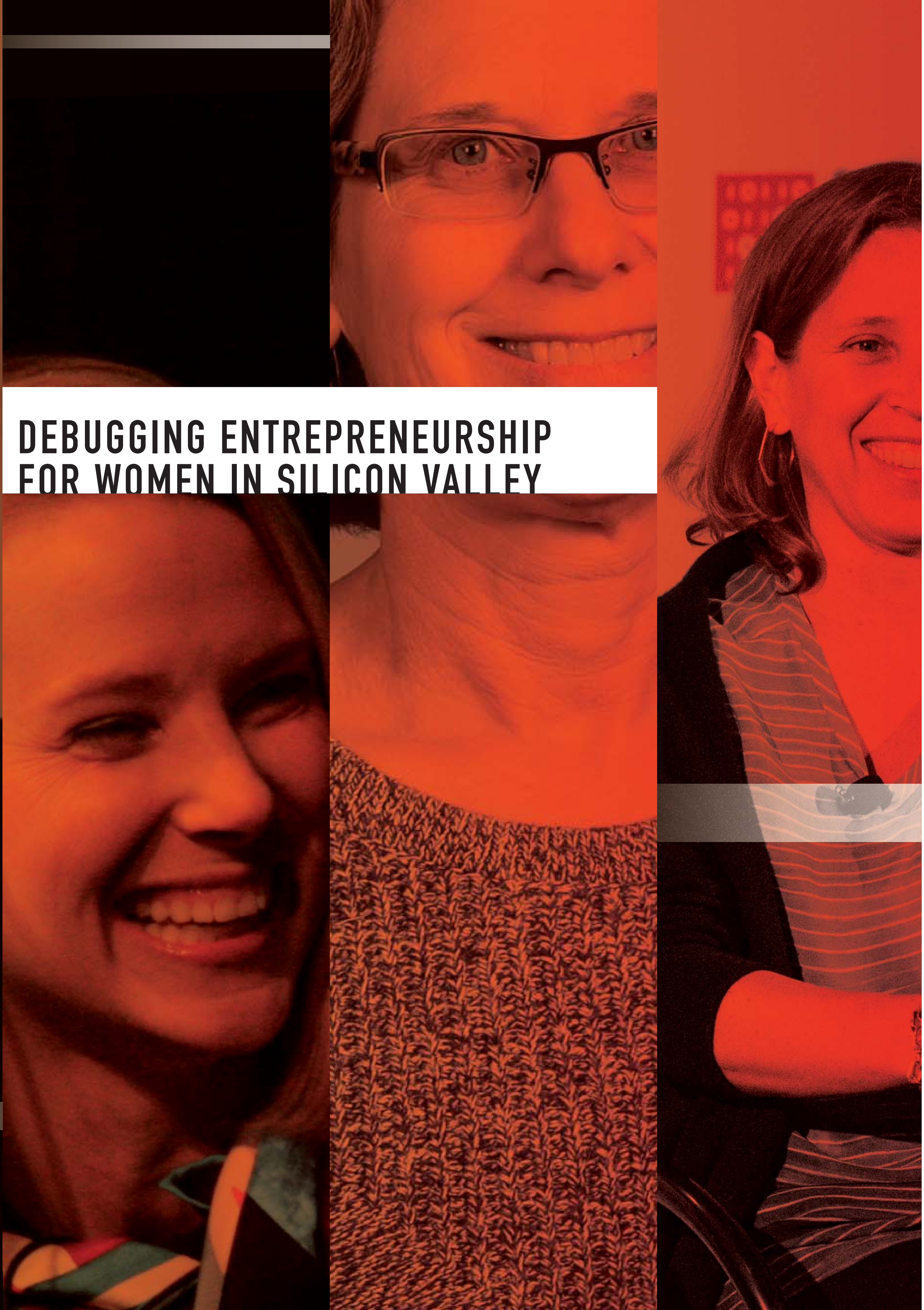
BY MARGUERITE GONG HANCOCK
EXECUTIVE DIRECTOR, CENTER FOR ENTREPRENEURSHIP & INNOVATION

In 1972 big things were brewing in the newly christened Silicon Valley. Intel introduced the 8008, an 8-bit central processing unit that paved the way for generations of later microprocessors. Nolan Bushnell founded Atari with hit game Pong and launched the video game industry. Two firms opened that evolved to define Silicon Valley–style venture capital. Kleiner Perkins subsequently invested in Amazon, Genentech, Google, Intuit, and more than 500 other ventures; Sequoia provided venture finance for Apple, Oracle, Cisco, Google, Instagram, and hundreds of other firms which now have an aggregate public market value of over $1.4 trillion.

Less well known, 1972 also marked Sandra Kurtzig's founding of ASK Group, a software firm that eventually achieved $400 million in annual sales. A math major from UCLA with a master's degree in aeronautical engineering from Stanford, Kurtzig used $2,000 in savings to finance her foray into the uncharted waters of entrepreneurship. She later recalled that in that era "a woman starting her own company was considered a pariah, a piranha, or both." In 1981, ASK completed its initial public offering (IPO), making Kurtzig the first woman to take a Silicon Valley technology company public. Unfortunately, Kurtzig's actions did not trigger a spate of women as entrepreneurs to move center stage.



DEBUGGING ENTREPRENEURSHIP FOR WOMEN IN SILICON VALLEY



Tandem NonStop Systems advertisement.

Male executives in Tandem Incredible Hulk Contest.

For decades, men persisted as the poster boys for tech. Stories in Silicon Valley revolve around iconic men, starting in the formative years with Bob Noyce, Bill Hewlett, David Packard, and Gordon Moore. The early, commonly held script featured men as the principal stars and women as supporting cast. This has been a topic of ongoing—often heated—debate.

For example, when eccentric Texan Jimmy Treybig founded Tandem Computers in 1975, the firm catapulted to become the dominant manufacturer of fault-tolerant computer systems for banks, ATM networks, and stock exchanges. At the same time, Tandem deliberately built a forward-thinking corporate culture with annual stock options for every employee and weekly gatherings where executives mingled informally with employees. Yet, despite Tandem's innovations in technology and corporate culture, attitudes toward women lagged.

A print ad for Tandem's NonStop Systems featured two shapely blonde women dressed in revealing shorts while riding a tandem bicycle. Women in the company's marketing department were appalled. To protest, they staged a Tandem Incredible Hulk Contest: male executives shed their shirts and donned equally short shorts, so they could be rated by women in the company.

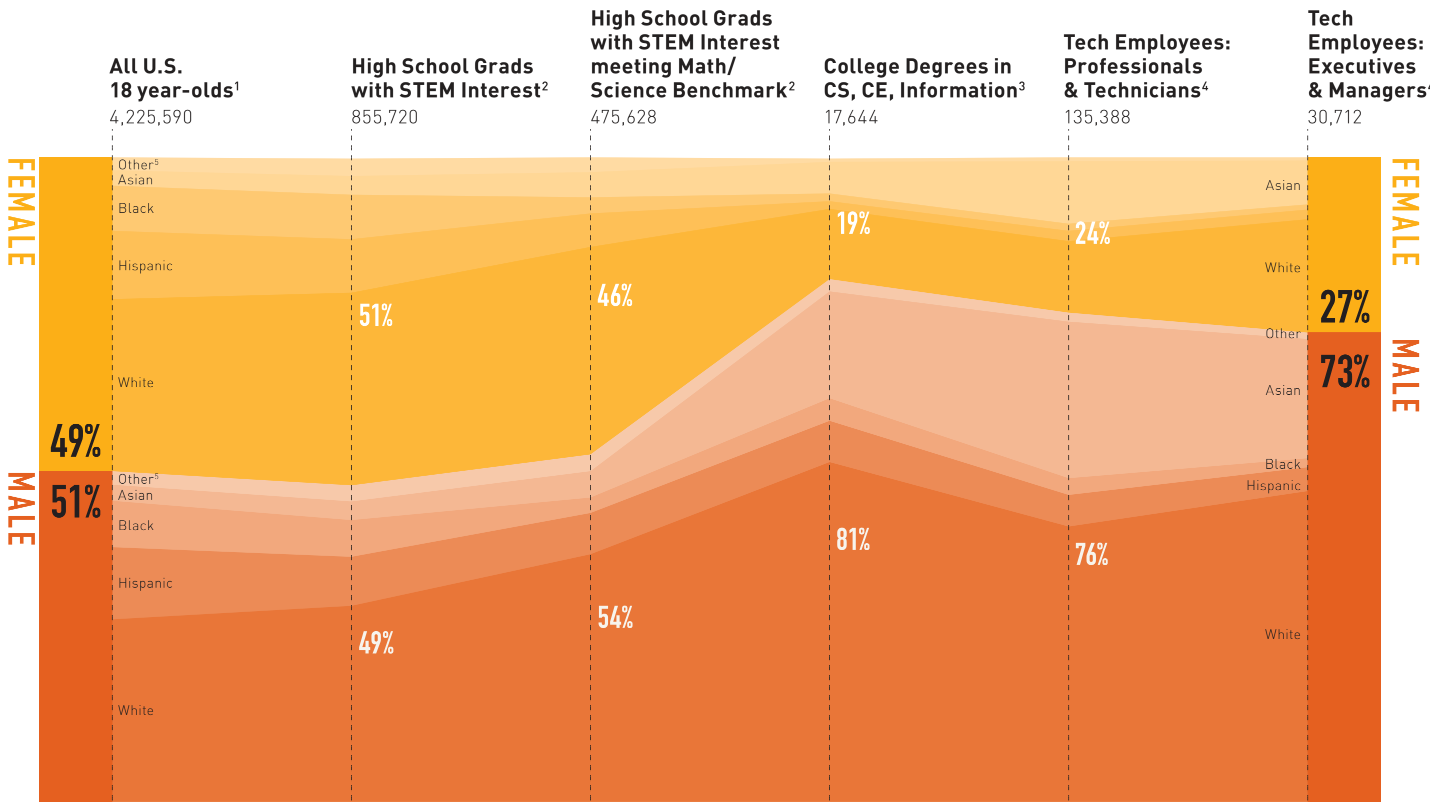
During subsequent decades, many women in Silicon Valley faced roadblocks on their path to become entrepreneurs. In 1984, Sandy Lerner and Len Bosack started Cisco Systems. Pitching unsuccessfully to more than 70 venture capitalists, Lerner recounted that "a number of them said, you're never going to get funding with [you as a woman] in the mix as a founder." Commenting on the cultural milieu of the Valley in the mid-1990s, Anita Borg, a senior researcher at Digital Equipment Corporation in Palo Alto, cited the "invisible-woman syndrome," where women's ideas were discounted or ignored. "It's like water torture. It wears you down."

Many women entrepreneurs faced an uphill battle in how they were portrayed and evaluated. For example, self-described "girl geek" Kim Polese followed a successful stint at Sun Microsystems by founding Marimba, an Internet-based software management firm. Attracting media coverage, such as *Time* magazine's "25 Most Influential Americans" in 1997, she wrestled with the focus on her as a femme fatale instead of on her company, which she considered a double standard in judging women leaders.

Consider the business school case of Heidi Roizen, co-founder and CEO of T/Maker, an early personal computer software company. Frank Flynn, Stanford business school professor, tested MBA student attitudes toward gender with a simple exercise. One class section received a case study about "Howard" Roizen; the other received the identical case, with female pronouns for "Heidi" Roizen. When students rated the protagonists, they gave "Heidi" high marks for competence and leadership effectiveness. Whereas they gave "Howard" positive scores for being assertive, the more aggressive they perceived Heidi, the more they didn't like her, they wouldn't hire her, and they didn't want to work with her.

Despite serious challenges, these and other women in Silicon Valley succeeded as founders and tilled new ground as executives. In 1981, Judith Estrin co-founded Bridge Communications—a network communications firm that went public in 1985 then merged with 3Com in a deal worth more than $200 million. Estrin went on as

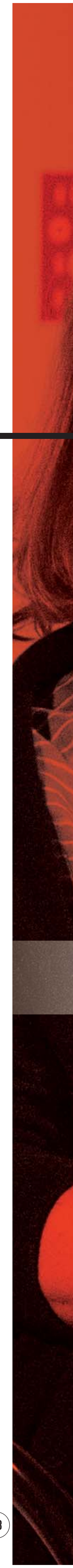
THE TECH WORKFORCE PIPELINE



Sources: [1]American Community Survey - July 2014, [2]ACT, Inc. "The Condition of STEM 2014", [3]CRA 2014 Taulbee Survey (does not include non-resident aliens),
[4]EEO-1 Reports from 2014 for Apple, Cisco, Facebook, Google, Intel, LinkedIn, Twitter, Yahoo, and Yelp – note that EEO-1 reports include foreign nationals working in the U.S.
[5]Other includes American Indian, Alaska Native, Native Hawaiian, Other Pacific Islander, and Two or More Races.
Research & Design: Threestory Studio - threestory.com

COURTESY OF ERIK JACOBSEN OF THREESTORY STUDIO

Current diversity data from nine Silicon Valley titans (Apple, Cisco, Facebook, Google, Intel, LinkedIn, Twitter, Yelp, and Yahoo) reveal that women are still significantly underrepresented in tech jobs, totaling 27 percent of executives and managers.



Google Doodle in honor of the 197th birthday of Ada Lovelace (December 10, 2012).

serial entrepreneur to co-found eight technology companies. In 1992, Carol Bartz was named chief executive of Autodesk Inc. and subsequently recruited to lead Yahoo. Donna Dubinsky joined Palm Computing as CEO just after its founding in 1992 and then was co-founder and CEO of Handspring starting in 1998. Both companies played leadership roles in the emergence of the handheld computing and smartphone industries.

By the 1990s, some of the most experienced leaders and team members in operational roles in technical companies were women. Helen Bradley, vice president of engineering at NetApp from 1995 to 1999 recalled: “NetApp actually had a lot of senior women in the company—Carol Bartz was a board member, the executive engineering team was 40 percent women, and if you looked at every functional organization, there were senior women in it.” This talented cluster of women rose within NetApp or moved to help grow other companies, including Cisco, Citrix, Dell, Hitachi, Ironport, Parascale, VMware, and others.

Bradley emphasized the importance of a strong pipeline of women with STEM education. The percentage of all computer-science degrees that went to women rose from less than 5 percent in 1970 to nearly 40 percent in the early to mid-1980s, though it has sunk below 20 percent in recent years. Recent data shows the vulnerability of losing girls along the pipeline, from high school through college to the tech work force. It is not surprising that current diversity data from nine Silicon Valley titans (Apple, Cisco, Facebook, Google, Intel, LinkedIn, Twitter, Yelp, and Yahoo) show that women are still significantly underrepresented in tech jobs, totaling 27 percent of executives and managers.

Lagging diversity is far more than a STEM pipeline issue. Silicon Valley likes to portray itself as the embodiment of meritocracy. But studies show that it is harder for the existing pool of qualified female than male entrepreneurs to gain funding, mentors, and networks of connections. Less than 5 percent of venture funds go to women founders. And the current tally of executives is highly imbalanced: for 2014, the S&P 100 has 16 percent women executives, while the Valley counts only 11 percent female executives within the Silicon Valley 150, the Bay Area’s top tech companies.

Another contributing factor is gender bias, albeit often unconscious. Consider Google’s home page. People from around the globe visit the site every day; it serves as a kind of virtual town square. In honor of the 197th birthday of Ada Lovelace on December 10, 2012, the Google Doodle featured Ada as computer pioneer, engaged in calculations on paper that looped to connect generations of computing machines down to the modern laptop.

However, for years the presence of women in Google Doodles was literally nonexistent. Analysis revealed that between 2000 and 2007, 100 percent of the Google Doodles featured men. And until 2014 the majority of Google Doodles echoed the demographics of Silicon Valley tech companies: male and white. Between 2010 and 2013, of the 445 people honored by special Google logos world-wide, 82.7 percent were men and 62 percent were white men. By 2013, the presence of women in Google Doodles rose to 23 percent. And in 2014, Google Doodles used their world stage to highlight women's contributions with 50 percent women: 56 men and 56 women. Changes like these may seem small but are emblematic of significant progress in deep attitudes and constructive behavior.

Silicon Valley's tech arena has come a long way from the days of Tandem's bicycle ad. The Valley's high-profile women executives include Marissa Mayer at Yahoo, Safra Catz at Oracle, Meg Whitman at eBay and now HP Enterprise, Susan Wojcicki at YouTube, and Sheryl Sandberg at Facebook. Generations of women entrepreneurs are building companies side by side, from Weili Dai, co-founder and president of Marvell, a $4 billion fabless semiconductor firm, to Diane Greene, co-founder and former CEO of VMware, now senior vice president for Google's cloud business. For rising star companies, Julia Hartz (Eventbrite), Sarah Leary (Nextdoor), Holly Liu (Kabam), Amy Pressman (Medallia), Adi Tatarko (Houzz), Anne Wojcicki (23 & Me), Michelle Zatlyn (CloudFlare), and others (co-)founders have earned their place in the exclusive unicorn club of private valuations above $1 billion.

From 1972 and Kurtzig to today's unicorn founders, Silicon Valley's women entrepreneurs have also impacted the way people work, live, and play. Yet frequently they have been unheralded. There is still much work to do. Individuals and organizations are committing resources, mindshare, and energy to continue progress. On this front, Megan Smith, former Google vice president and now chief technology officer of the United States, identified a pressing need and issued a challenge: "Women, especially those in science, technology, and mathematics, and entrepreneurship are often missing from history's major canons. Even if you didn't create the problem, once you become aware of it you can debug it and solve it. You can become part of the solution." ○

Silicon Valley likes to portray itself as the embodiment of meritocracy. But studies show that it is harder for the existing pool of qualified female than male entrepreneurs to gain funding, mentors, and networks of connections.

Helen Bradley, vice president of engineering, NetApp, 1995–1999.


OF AMERICA
B68945675A
WASHINGTON, D.C.
FEDERAL
THIS NOTE IS LEGAL TENDER FOR ALL DEBTS, PUBLIC AND PRIVATE
100

BY CHARLES HOUSE

FOUNDER & EXECUTIVE DIRECTOR,
INNOVASCAPES INSTITUTE

REMARKABLE PEOPLE

EARLY ENTREPRENEUR

SANDY LERNER

COURTESY OF EVELYN BEREZIN

Cisco co-founder Sandy Lerner wore this dress to her company's IPO party on February 16, 1990. Lerner made the dress herself using $100 bills as a pattern.

Sandy Lerner, 1984 co-founder of Cisco Systems, holds two high-tech distinctions. Cisco Systems is the only high-tech Fortune 500 company founded by a woman, and Lerner and ex-husband Len Bosack have also been honored as America's most generous high-tech philanthropists. Even so, Lerner is virtually unknown within the tech sector. Why?

The answer in part is the character of the industry. Products are celebrated. iPhones and Teslas are quickly recognized. Facebook, Twitter, and Instagram are successive fads. And some personalities—for example, Jobs, Ellison, and Zuckerberg—loom large.

Cisco's first products were Internet "plumbing." Akin to building roads while car marquees got noticed, Cisco built routers and switches that made a functional Internet, while search engines—Yahoo and Google—and content providers—Facebook and YouTube—got the attention and brand awareness. No Cisco names come up as Internet inventors.

Cisco became the most valuable company on the planet at the acme of the dot-com boom—March 2001—but the founders were long gone. Venture capitalist Don Valentine fired Lerner six months after Cisco's successful February 1990 IPO, when CEO John Morgridge's executive team threatened to resign en masse if she stayed.

How important was Lerner for the Cisco story?

Both Lerner and Bosack were information technology directors at Stanford—she at the business school and Bosack in the computer science department. Bosack's team built a networking accessory—a router—that connected the computers of the two departments. The router, with multiple protocol interfaces, eventually connected Stanford's 5,000 disparate computers.

Other universities heard about the router and sought to buy them. Stanford, though, elected not to supply the router to other universities and, in addition, denied the couple rights to sell the router themselves.

Bosack was passionate about technology—not management; but Lerner aggressively thought: Let's form a company to sell the router ourselves.

It was a slow start. The company persevered for 19 months before Bosack left Stanford, under a cloud that included a now-settled lawsuit over issues of who invented what and significant enmity.

Meanwhile, Lerner quit Stanford, joining Schlumberger to get a higher income to fund the new company. Persuading friends to work for stock and deferred pay, Bosack and Lerner installed a used mainframe in their garage and maxed out their credit cards. Lerner provided a vivid image: "We spent our own money. We mortgaged our house. Our parents crawled around the floor making cable."[1]

Kirk Lougheed, one of the first to join, described the Atherton, California, home where Cisco started:

> *One bedroom was the office and I took over another bedroom as the lab. We put together the first 12 or 15 chassis boxes . . . on the living room floor. Sandy had recently put in this white wool carpet—to protect that, I had a bunch of avocado green sheets that I had used in college as bed sheets, and we laid those out over her carpet.*[2]

Cisco hired and empowered strong women. Cate Muther, marketing vice president at Bridge Networks and then 3Com, was recruited to Cisco. No one in the world understood network marketing better. Muther, long retired, is clear:

> *Sandy Lerner was fiercely customer-loyal and fiercely customer-oriented. That was an important core value—Sandy's major contribution to the culture and success of Cisco.*

Bosack was passionate about technology—not management; but Lerner aggressively thought: Let's form a company to sell the router ourselves.

Lerner in 1988 product brochure, featuring Cisco's AGS router.

Muther brought Tae Yoo, Cisco's corporate social responsibility (CSR) executive vice president, from Bridge. Tae is emphatic:

> *Sandy was the catalyst for Cisco. [The product inventors] and founder Len Bosack were very focused on technological innovation—what kinds of problems are we trying to solve? Sandy was interested in all of that, but specifically wanted us relevant and meaningful to the customer base. She coined the phrase "customer advocacy"—it was "Be my advocate. What keeps me up at night should keep you up at night."*

Joe Pinto, Cisco's customer support vice president, said:

> *The beauty with Sandy was that there was incredible focus on the customer. Back then, state of the art for high tech wasn't to focus on the customer, nor worry about customer intimacy. Fortunately, Sandy and Len said "No, we're going to go a different way."*

Joel Bion worked with Bosack and Lerner beginning in 1980 at Stanford. Shortly after joining Cisco in 1987, Bion had an epiphany about Lerner's customer advocacy view:

> *I realized how dependent these customers were on our products working. They had literally bet the farm; they'd spent their entire IT budget building the network.*
>
> *Back then, the idea was risky—breaking from vendor-specific equipment, from IBM SNA, DECnet, or Novell NetWare—going to a third-party vendor like Cisco violated the design principles given to you by those companies.*
>
> *I became very appreciative of the courage that our early customers had to show.*
>
> *Cisco was able to solve very specific problems they were having, such as broadcast storms. Networks would be down for a full day. The culture that formed at Cisco was "We will make it work no matter what."*

Lerner and Bosack in Cisco's 1994 annual report.

Thus, customer advocacy generated a culture that evolved from deep interactions with customers and from mutual trust that resulted from solving big problems together.

There was a darker side. Lerner could be acerbic, demanding, and unyielding. The pace was incredible, the pressure immense. Greg Satz, one of the original five employees, recalls:

> *The standard that was set was "How hard can you work." I don't remember a lot of fun. . . . It was crazy for a decade, complete chaos. Lots of strong personalities . . . [and] lots of moving parts. To say that Cisco was dominated by conflict would put the focus on the conflict and not on the outcomes. But we didn't have a good social lubricant to manage conflict in a healthy way [which] built up a lot of negative energy.*

Joanna Holmes, an early employee, wryly commented:

> *This was a quirky, nutty group of people. . . . What kept me there day after day was that these people were so darn intelligent. They obviously had strong technology background, but each of them was a renaissance person.*

Lerner brought in a CEO, Bill Graves, her supervisor at Schlumberger. Although Cisco was quickly profitable, Lerner decided that they needed venture capital to grow faster. Graves helped garner venture support but found the pace intolerable. Unfortunately for Lerner, Valentine's deal with the couple included the right to select CEOs. His interim pick, Chuck Sutcliffe, was soon replaced by plain-spoken Midwesterner John Morgridge.

Satz summed up the reaction to Morgridge:

> *We were just doing everything we could—it was hard not to see these new people as just getting in the way of what we were doing and one more voice to tell us what to do. Sometimes that voice had real value but it was hard to parse out with all the different inputs and demands —it was like a cacophony.*

The Packet, Winter '92

Cisco Systems Users Newsletter

IBM, cont'd from page 1

Another mixed-media environment that Cisco can internetwork as of Release 9.0 is SDLC to LLC2 translations (SDLLC). This feature allows users who are connected via serial SDLC lines to access Token Ring attached hosts. The Cisco implementation supports locally terminated SDLC and LLC2 sessions, eliminating timeouts over extended wide-area backbones.

Cisco's IBM Connectivity Commitment

Cisco recognizes the importance of providing internetworking solutions that complement IBM's data communications environments. From hardware to software to network management solutions, Cisco's IBM internetworking solutions are, and will continue to be, tailored to the requirements of evolving and growing networks. Cisco's support of IBM internetworking and plans for new capabilities focus on providing a flexible infrastructure that facilitates building interoperable enterprise networks that are more efficient and manageable.

Cisco's 5-Phase IBM Plan

During the past two years, Cisco has developed a plan for extending its internetworking expertise to IBM-oriented environments. This plan, as illustrated in the diagram on page 1, addresses three basic technology elements: LAN support, integrated WAN interconnection, and flexible network management.

- Phase I consists of Cisco's current and ongoing implementations of Token Ring products within multiprotocol routers, including support for IBM's source-route bridging (SRB) and remote source-route bridging (RSRB) environments. SRB and RSRB are used to transport Systems Network Architecture (SNA) and other IBM protocols.
- Phase II adds transport of SNA data via the Synchronous Data Link Control (SDLC) data link protocol. An SNMP-NetView interface is provided via NetCentral.
- Phase III adds support for mixed-media environments via the proposed source-route transparent (SRT) bridging standard, translational bridging and SDLC/Token Ring translations. IBM's LAN Network Manager (formerly LAN Manager) is also supported in this phase.
- Phase IV extends support for SNA PU4 Properties
- Phase V delivers SNA peer-based internetworking support and OSI network management services.

Customer Advocacy:
Customer Engineering Improves Problem-Handling

As a leader in the internetworking industry, Cisco Systems is as serious about its service and support as it is about its products. Customer Engineering (CE), the dynamic group on the receiving end of calls from users, undergoes continuous development in order to keep pace with the increasing complexity of Cisco customers' networks. Recent changes to the group's Problem Management Procedure have improved responsiveness and quality.

When You Need Help…

To request technical assistance, support and warranty customers can phone, fax, or send electronic mail to the Technical Assistance Center (TAC). When a user contacts the TAC, a service coordinator verifies warranty and service information and records a general problem description. A case number is assigned for tracking, and a case priority is established to reflect the impact of a problem on the customers' business operations. The case is then routed to a CE with appropriate expertise.

The assigned CE begins work on the problem by verifying the user's equipment and network configurations. Diagnosing some problems requires users to provide data traces of network activity during occurrence of the problem. At appropriate times during the resolution process, the CE might request assistance from senior CEs or managers. Upon resolution of a case, the CE requests confirmation from the user for case closure.

To ensure consistent service, cases exceeding established target resolution times generate automatic alerts to the assigned CE and management. Should a user feel that a problem is not receiving sufficient resources or attention from the TAC, he or she may request escalation to management.

Users can request escalation by contacting the TAC, providing their case number, and requesting the duty manager. With help from the caller, the duty manager determines the appropriate level of escalation. The receiving manager assesses the current status of problem resolution and contacts the user with a proposed plan of action. This manager retains ownership of the problem and provides the user with periodic feedback on progress.

Additional details of the Problem Management Procedure are described in an addendum to Cisco's *Customer Service Product Guide*. Cisco users may obtain this document by calling the Customer Services Marketing group, 1-415-326-1941.

To reach the TAC:
Tel. 1-800-553-2447, or 1-415-688-8209,
Fax 1-415-688-7878
or send e-mail to: tac@cisco.com

fifteen

Cisco continued its focus on customer advocacy well after Lerner's departure, as seen in this 1992 user newsletter.

Holmes reacted also:

> *When Morgridge first arrived at Cisco, we weren't really sure what his skill set was or why he was here. He didn't seem to understand us. He didn't fit with the culture. But it didn't take long for him to win our hearts because, aside from being an amazing businessman, underneath this gruff exterior he had a really warm side.*

Lerner missed "the really warm side." She and Morgridge immediately clashed over customer advocacy issues, in addition to policies, approach, and direction. Times weren't easy even with a successful company IPO in February 1990. Heavy competitive challenges, radical growth rates, internecine warfare, and an involved venture capitalist, newly enriched by the Cisco IPO, combined to present myriad challenges.

Bosack had already conceded day-to-day management; Lerner was increasingly marginalized, which she did not take lightly. *Au contraire*, Lerner became even more outspoken, irascible, and, on occasion, confrontational in front of the group she cherished most—the customer. The management team, by now a combination of folk hired by Lerner and Morgridge, grew weary. Collectively, they went to Morgridge, demanding that he remove Lerner. Their ultimatum—all seven would leave if she remained.

Morgridge passed the ball to Valentine, who recalled the historic Traitorous Eight palace coup at Shockley Semiconductor. Valentine wasn't about to let his whole team walk; he axed Lerner August 28, 1990. Len followed her out the door. They each sold their stock in pique shortly after leaving Cisco.

Lerner was apoplectic. "Len and I underestimated our skills," she said in a 1992 *Forbes* interview. "I certainly could have run that business. I had my hands on the reins."[3] Twenty years later she was more reflective: "I was not a very smart organizational player. [. . .] I made my own life harder to hoe; I made myself an easy target."[4]

Regardless, the founders were gone, and with that, their impact on Cisco diminished. And the company did little for years to ennoble their cultural legacy. History is written by the winners, and Lerner was no longer part of the story. ○

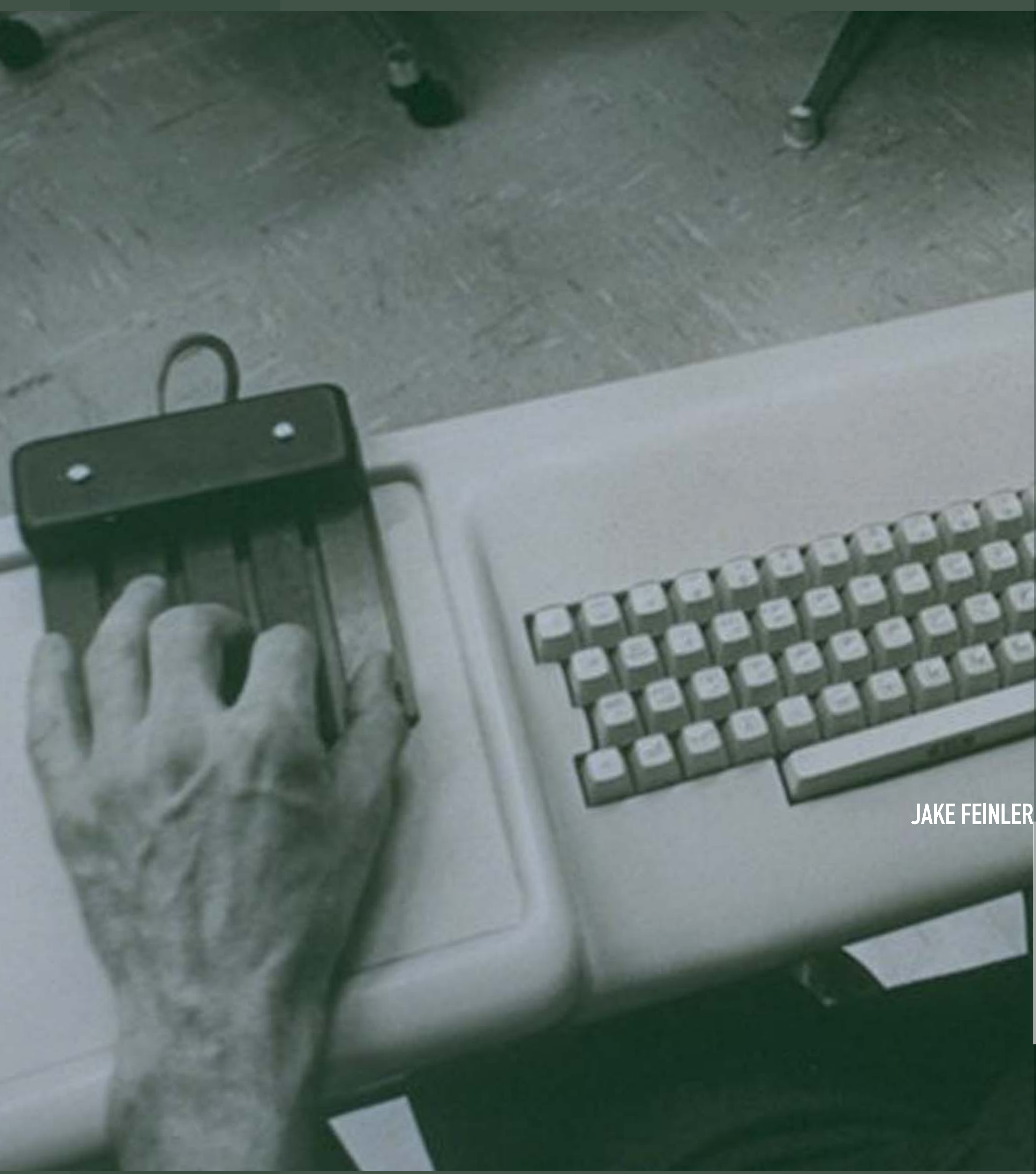
---

[1] Sandy Lerner, interviewed by Seema Mody, Women 2.0 PITCH NYC 2012 Conference and Competition, November 14, 2012

[2] CHM has been privileged to work with Cisco leaders and alumni over the past three years, collecting artifacts and interviewing many from Cisco's first dozen years, to gain deeper understanding of the extant culture. The quotes herein, unless otherwise cited, are from the Cisco Heritage project, directed by Charles House in conjunction with CHM's Cisco Archive project.

[3] See Julia Pitta, "Long Distance Relationship," *Forbes*, vol. 149, no. 6 (1992): 136.

[4] Lerner and Mody interview, 2012.



JAKE FEINLER

B

NLS mouse and keyset, ca. 1968. Users of NLS, including Feinler, could do many tasks with their hands resting on the mouse and keyset. The keyboard was only needed for extended text entry.

BEHIND THE CURTAIN OF THE INTERNET

ORAL HISTORIES

INTERVIEW AND EXCERPT BY MARC WEBER
CURATORIAL DIRECTOR, INTERNET HISTORY PROGRAM

What if the early Internet was run from some secret center that not only tracked each computer but compiled all kinds of information about the net, from mailing lists for developers to bits of fun trivia and instructions for beginning users? The closest real-world equivalent would be the Network Information Center (NIC) at the Stanford Research Institute (SRI). Here, the top-level domain names (.com, .org, etc.) got invented, and calm, reassuring administrators cooled the 1970s flame wars over email spam. NIC-published directories of users united a growing community by discreetly omitting titles (for example, military generals could correspond amiably with long-haired antiwar activists and officers in rival services alike).

Elizabeth “Jake” Feinler headed the NIC for nearly 25 years. It began as one of the three service centers that ran the ARPANET, a pioneering early computer network. When the ARPANET joined with other networks to form the seedling Internet in 1983, the NIC came with it. By the time Jake left to head another NIC at NASA in the early 1990s, the original NIC had a staff of more than 40 and was the nerve center of the ballooning Internet—that once-obscure research net poised (with more than a little help from Al Gore) to take over the online world.

Feinler, a core advisor to CHM’s Internet History Program, single-handedly saved the massive NIC archives from being thrown out by SRI in the late 1990s, storing them for a number of years in her own garage. Those archives are now one of the founding pillars of CHM’s networking history collection, over 300 boxes worth of documents plus many computer tapes.[1]

The first time I sat down, somebody came and yelled at me and said, "Secretaries aren't supposed to be using the machines," and I said, "Well, I'm not a secretary."—JAKE FEINLER

Those archives also reach back to the NIC's origins and into its other life as an ambitious project within one of the more outrageously utopian efforts of the 1960s—Douglas Engelbart's Augmentation Research Center (ARC). ARC's goal was nothing less than to augment human intellect with better tools for navigating and recombining knowledge, and thus helping to solve the world's great problems. As parts of his oNLine System (NLS), Engelbart invented hypertext links, the mouse, and a good chunk of what we do both online and on personal computers today.

When his ARC lab was asked to be part of the ARPANET, Engelbart readily agreed to host a NIC at SRI as an ideal way to spread his tools to a far wider group of users. Feinler joined the NIC soon after its launch and considered Doug her mentor.

Feinler is a member of the Internet Hall of Fame and a 2013 recipient of the prestigious Jonathan B. Postel Service Award from the Internet Engineering Task Force (IETF). The following excerpts are from my 2009 oral history with Feinler.

Going to Work for Engelbart's ARC Lab

[I grew up in Wheeling, West Virginia, and I was the first person in my family to go to college. So it was all a brave, new world for me.] I should describe myself first—back-combed hair, high-heel shoes, business suit because I was always meeting the public and clients and that sort of thing. I walked into this group with their hair out to here <gestures> and their beards down to here <gestures> [wearing] Birkenstocks and looking kind of like unmade beds, all sitting [around, some on the floor], staring at television sets. Sometimes I would say, "What am I getting myself into?" I'm sure they thought I came from some outer planet, but it was kind of fun.

How the NIC Worked Day to Day

We were kind of a hub. We didn't always try to answer questions so much as get the person to the right person that could answer the question. I mean, we did not try to be experts on everything that was going on, but just try to know who was the expert and pass that person on. Especially in the working groups.

Using Engelbart's oNLine System (NLS) with a Mouse and Chord Keyset

I found that was pretty easy, [it] was very nice. You had the keyset [on the left on], which you could type any letter or character. [On the right] was a three-mouse button [on which] you could do uppercase, lower case, [and shift to] numbers, [and] characters. What was nice about [this arrangement was that,] if you were editing, which I did a lot of because we were putting out a book about three-inches thick, you didn't have to take your hands [off the mouse and keyset to] go back to the keyboard. You could just sit there and make your edits with your hands on the keyset and the mouse. Why that didn't carry over, I don't know, but I thought it was very nice. I still would like to have that setup.

PREVIOUS: COURTESY OF SRI INTERNATIONAL

. . . [NLS] had a programming language, it had email, it had document tracking, and everything was under one umbrella and it was a very nice system to work on. I said I started out with the best and it's been downhill ever since.

. . . The first time I sat down, somebody came and yelled at me and said, "Secretaries aren't supposed to be using the machines," and I said, "Well, I'm not a secretary." . . . That wasn't so much sexist as it was because of the jobs that needed to get done, so secretaries were kind of at the end of the food chain.

People just didn't interact with computers then. They didn't touch them, so [it] was very interesting [to interact directly with one.] We found it was harder to get higher-ups to touch them—because they were afraid they would look foolish—than it was to get secretaries or people that were used to typing, or didn't care. So that was kind of interesting.

Women in the Net Community

There were a lot of women on the net, but they seem to have been forgotten. MIT, there were quite a few there. When I first went to MIT—Radia Perlman was busy freeing the johns because the women had to go down a couple of [floors] to go to the john and the men's john was on the same floor [as the computers]. So she was "freeing the johns." I thought that was [an] interesting concept, liberating the johns. At ISI [Institute Sciences Institute], there were a number of women. There were a number of women at BBN, MIT. Most of the sites had some women. I've got a list of them somewhere. As I think of them, I'm writing them down, but when you ask me, I blank on people's names. There was a woman, Ellen Golden, at MIT. She ran some of the information stuff at MIT and they had several machines, so she was kind of the center of things there. And there were a lot of lonely graduate students out there in those days, so we kidded around [that] she got to be Abby and I got to be Ann, Ann Landers and Abby [Van Buren].

Culture Clashes

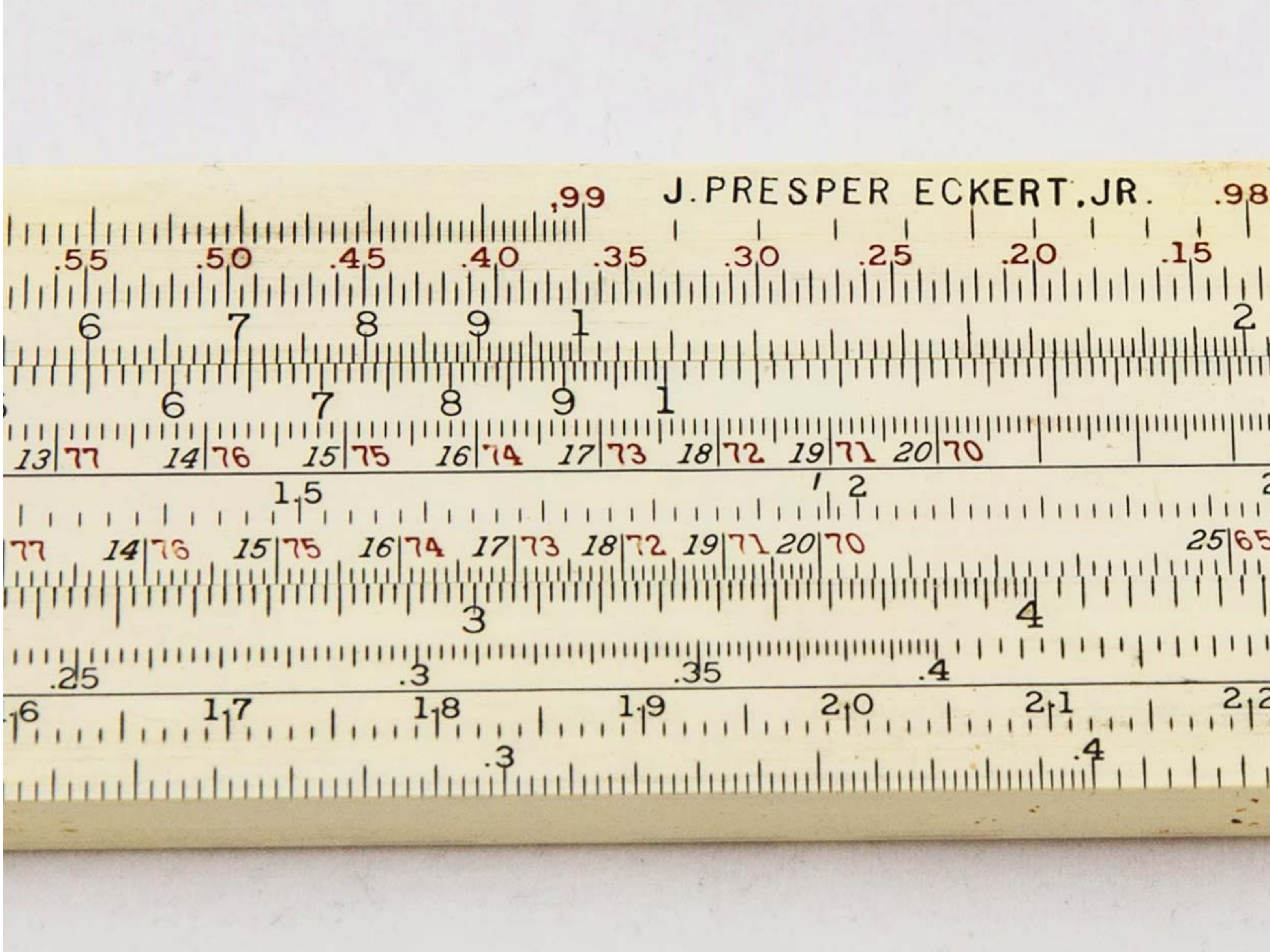
And Jon [Postel], for those that don't know him, was one of the stalwarts of the network and he was a very unassuming, nice, quiet researchy kind of guy. And he had a beard, long beard. And he always wore flip-flops, but they were Indian shoes that he got at Cost Plus . . . and when he was dressed up he wore his hiking boots. And so the fellows came out from DCA (Defense Communications Agency) and they were all dressed in natty suits and were all spit and polish, well, you know, polyester suits in those days and polished shoes and what not. And they said they wanted to talk to the head technical guy. So I go and get Jon, and Jon comes and he's got his—it was cold then so he had his lumberjack jacket on, big black and red checks, and his hiking boots; he was dressed for the day. And so they talked to Jon a little bit and one of the guys motioned me to go out in the hall. So I went out in the hall and he said, "I want to talk to the head technical guy." And I said, "That's him, Jon Postel." He wouldn't believe me. But anyway, finally he got it through his head that Jon was the head technical guy. At the same time I had a secretary named Adrian. Adrian was a black guy and in those days afros were in, so he had an afro and he always wore bib overalls, which was fine for Engelbart's group, but it didn't sit too well with DCA. And they asked me, "Who is this person?" And I said, he was my secretary, and they said, "Well, does he always dress like that?" And I says, "Yes." And I said, "I didn't notice that how one dressed had anything to do with how much work they got done." Adrian was really a good worker. That ended that conversation.

Working for Doug Engelbart

He was an interesting guy to work for. He always had in his head, a vision of where he wanted to go. There were certain people to whom he was really good at communicating his ideas, and other people to whom he just couldn't get through, he just couldn't make them understand where he wanted to go or what was in his head. I always found him to be a very interesting guy. Of course he was my mentor. I wouldn't have had a career without him and Don Nielson. So they are people who are very special to me. But I found that if you went to Doug with an idea, he was pretty receptive. If you went to him with a demand, forget it; he just closed up like a turtle. He was a research guy. When the institute was leaning on him to shape the NLS system up and sell it, that didn't fit well. His whole world was figuring out how people and machines interact with each other and contemplating the long-term impact. He definitely saw things the rest of us didn't at the time.

[1] For more information about these documents, please see the @CHM blog post "SRI ARC Journal: A Record of Engelbart and His Team," by Senior Archivist Sara Lott, and the guide to the SRI ARC/NIC records, computerhistory.org/collections/catalog/102706170.

Elizabeth "Jake" Feinler was inducted into the Internet Hall of Fame in 2012.



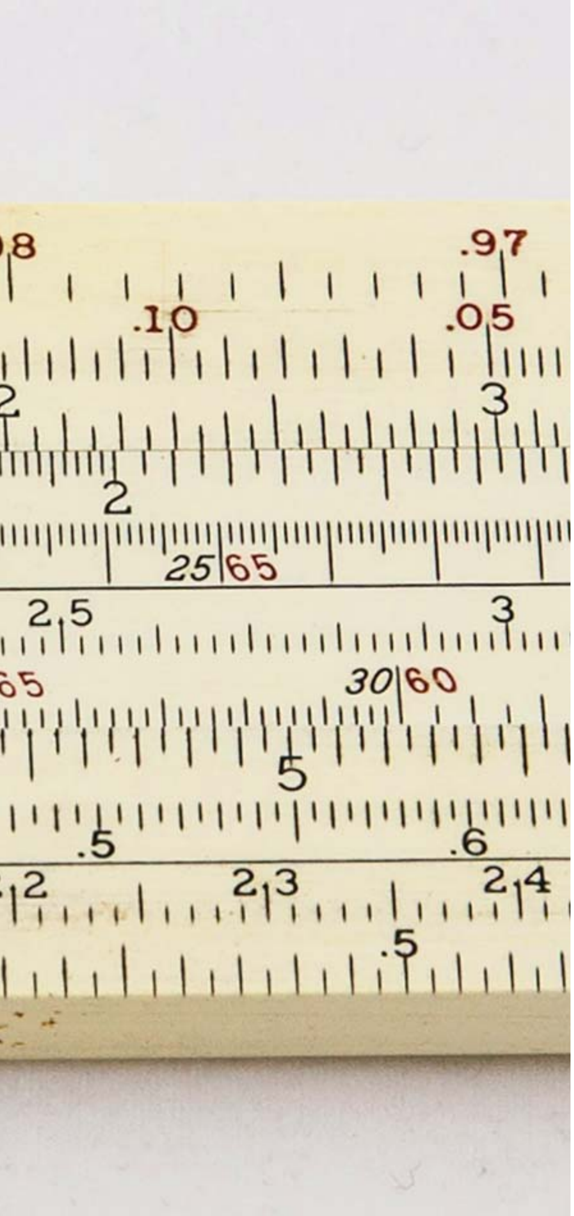
J. PRESPER ECKERT'S KEUFFEL & ESSER SLIDE RULE

CHM #: X7569.2016
Date: ca. 1940
Donor: Gift of Wayne Holder

J. Presper Eckert is one of the seminal figures in the history of computing. Born into a wealthy Philadelphia, Pennsylvania, family in 1919, Eckert was interested in science and engineering from an early age and spent many afternoons in his youth in the laboratory of Philo T. Farnsworth, one of the inventors of television. At the University of Pennsylvania, he participated in radar research and made improvements to the school's differential analyzer, a mechanical computer made of disks, shafts, and gears. When colleague John Mauchly's proposal to build the ENIAC electronic computer for the US Army was approved, Eckert was named chief engineer and made many brilliant technical contributions. The team of Eckert and Mauchly left the Moore School following a disagreement with the university about the rights to their invention and founded the Electronic Computer Corporation. This was soon renamed the Eckert Mauchly Computer Corporation (EMCC). At EMCC they designed and built the UNIVAC I computer—the first commercial electronic stored-program computer in the United States.

Eckert's slide rule is a Keuffel & Esser Log-Log Duplex Vector slide rule, introduced in 1939. The mahogany body is covered with a celluloid front with machine-made markings. The scale was specially created for use in vector mathematics.

BY CHRIS GARCIA
CURATOR



COLLECTION

RECENT ARTIFACT DONATIONS

ADVANCED VOTING SOLUTIONS, WINVOTE VOTING MACHINE, US

CHM #: X7593.2016
Date: 2002
Donor: Gift of Jeremy Epstein

© DOUGLAS FAIRBAIRN PHOTOGRAPHY

The vote-counting debacle of the 2000 US presidential election between George W. Bush and Al Gore led to calls for computerized voting solutions to replace paper and punched card ballots. The AVS WINvote system was a direct recording electronic system—an automated device that recorded votes electronically and also printed a copy of the voter's ballot choices for verification. The device was basically a laptop with a touchscreen running the Windows XP Embedded operating system.

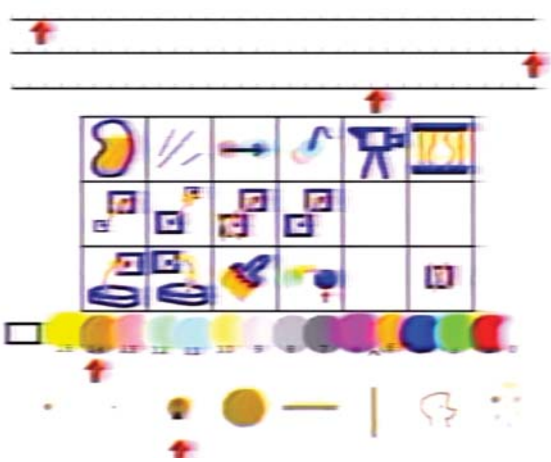
WINvote was widely criticized for being insecure due to its use of unencrypted wireless technologies, poor training, and lax security policies, as well as the inclusion of publically accessible USB ports on the device itself. While several high-profile lawsuits were launched to contest election results tabulated by the WINvote system, it is still in use by some counties. The donor, who works at Princeton University's Center for Information Technology Policy, describes it as "The worst voting machine in the US."

RICHARD SHOUP, SUPERPAINT DEMO VIDEO, US

CHM #: X7611.2016
Date: 1977
Donor: Gift of Richard Shoup

Designed between 1972 and 1973 by Xerox PARC engineer Richard Shoup, SuperPaint was the earliest computer-based digital paint system and consisted of a Data General Nova computer, an 8-bit video digitizer, and an early form of frame buffer created using 16 shift registers. Shoup designed most of the hardware and software, with Patrick Baudelaire and Bob Flegal, while Alvy Ray Smith provided additional software routines and other assistance. The system was revolutionary in the use of a pixel-based frame buffer, as well as being one of the first to use an anti-aliasing program (which Shoup referred to as "jaggie removal.") SuperPaint had a graphical toolbox menu that allowed users to create images, define custom paint-brushes, and even create simple animations using a graphic tablet for input. SuperPaint was used to create custom graphics for KQED television's *Over Easy*, and later for NASA's Pioneer Venus project, where it was used to create demonstration graphics for the space mission. Shoup was awarded an Emmy Award for his work in 1983 and shared a technical Academy Award with Smith and fellow researcher Tommy Porter in 1998.

Narrated by Alvy Ray Smith, this video demonstrates the capabilities of SuperPaint, starting with Shoup using the paint system to create images using the toolkit. Shoup's images also include some of the earliest color computer animations. ○



BLOOMBERG TERMINAL WITH "B-UNIT," US

CHM #: X7552.2016
Date: 2014
Donor: Gift of Bloomberg, LP

Up-to-the-minute information is invaluable for traders on the world's major stock markets. Having news even a minute before a competitor can mean the difference between making and losing millions of dollars. In 1981 stockbroker Michael Bloomberg received a $10 million severance package from investment bank Salomon Brothers. He used these funds to found Bloomberg LP, whose mission was to deliver timely market information to traders and investors. The Bloomberg terminal resulted and has been a regular feature of stockbrokers' desks for over three decades. The terminal allows traders to monitor multiple asset classes on markets around the world in real-time and also allow traders to message one another and to execute trades. The Bloomberg system is very popular with traders in the US and Europe, with more than 300,000 subscriptions to the service at an average rental price of $20,000 a year. Its keyboard has single-key shortcuts for many of the most used functions and also incorporates a biometric fingerprint scanner, ensuring that only authorized users have access to the system. A portable version of the biometric scanner, called the "B-unit" allows users to access their account from any PC or mobile device.

Robert L. Severns established the Severns Family Foundation in 1988 to help solve the nation's literacy crisis.

DONOR PROFILE

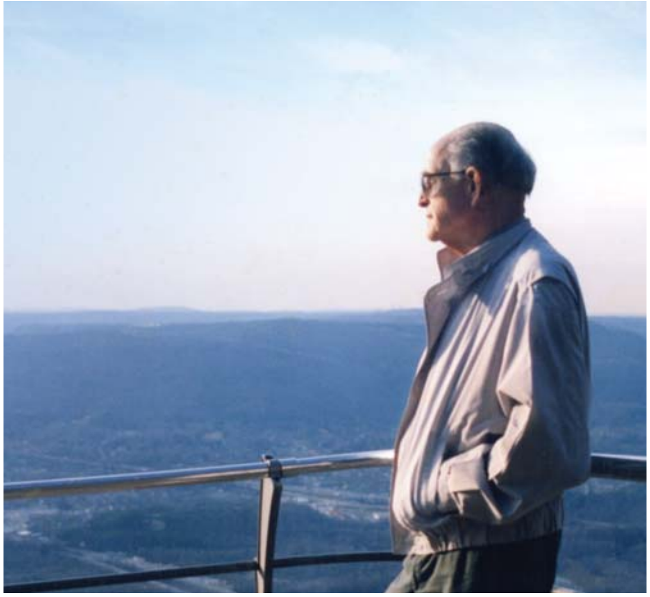
SEVERNS FAMILY FOUNDATION SUPPORTS MUSEUM EDUCATION PROGRAMS

BY AMANDA REILLY
DIRECTOR OF FOUNDATION & GOVERNMENT RELATIONS

The year 2016 marks the five-year anniversary of the opening of *Revolution: The First 2000 Years of Computing*. During those five years, the Museum's education programs have expanded dramatically thanks largely to early support from the Severns Family Foundation. Since the first Severns Family Foundation grant in 2009, the number of youth visiting the Museum has increased from 900 to more than 11,000.

David W. Severns, who spent most of his career at Applied Materials, was president of the Severns Family Foundation from 2003 to 2011. Dave and his sister and fellow board member Nancy Severns first visited the Museum in 2008 and were impressed by the Museum's capacity to enliven computer history through its vast collection. They enthusiastically supported the Museum's efforts to leverage the collection and stimulate excitement in the STEM learning community. With funding provided by the foundation, the Museum was able to create programs such as school group visits, interactive student workshops, and teacher professional development opportunities. The foundation's initial funding also helped establish an education department at the Museum.

Nancy Severns leads the foundation as it focuses its philanthropic activities in the areas of education and environmental awareness, resulting from the family's interest in these issues. The foundation was founded in 1988 by the late Robert L. Severns, David and Nancy's father, in an effort to help solve the nation's literacy crisis. "My father believed that early literacy was one of the critical building blocks of any education. As an engineer himself [Robert], STEM literacy was the corresponding essential element, and Dave and I believed that the Museum's education programs were and continue to be an important resource for youth and educators," says Nancy.



COURTESY OF NANCY SEVERNS

CHM is grateful for the foundation's support. Its contributions have been instrumental to the Museum's growth. "The Severns Family Foundation provided the important seed funding that enabled the Museum to begin building the core elements of our education programs. This was a very generous and visionary gift, which the foundation then followed with ongoing education support. We are thankful to Nancy and the Severns family for all they have made possible for the Museum and for the community," says Museum CEO and President John Hollar.

The Museum's education programs are founded on the principle that all students must develop critical 21st century knowledge and skills to succeed in school and professional life. With innovation and cutting-edge technology driving the national and global economy, the Museum is equipping both students and teachers with the STEM tools to master work-related personal competencies and further preparing students for postsecondary education and careers. The Severns Family Foundation, along with other institutional partners, is enabling the Museum to engage students in science, technology, engineering, and math through problem-solving and innovation.

MUSEUM DONORS

SUPPORT

Museum Campaign
(Through January 2011)

EXA / $10M+

Donna Dubinsky and Leonard Shustek

Bill and Melinda Gates Foundation

Elaine and Eric Hahn

Gardner Hendrie and Karen Johansen

PETA / $5M–$9.99M

L. John Doerr and Ann Doerr

Jeff Hawkins and Janet Strauss

House Family Foundation

Intel Corporation

Intuit, in honor of founder Scott Cook

TERA / $1M–$4.99M

Anonymous

Gwen and C. Gordon Bell

Michael and Kristina Homer

Burgess and Elizabeth Jamieson

Gloria Miner

Max and Jodie Palevsky

John and Sheree Shoch

Charles Simonyi Fund for Arts & Sciences

GIGA / $500K–$999K

Bill Campbell

Lawrence and Janice Finch

Fry's Electronics

Sheldon Laube and Nancy Laube, MD

Gordon and Betty Moore Foundation

Grant and Dorrit Saviers

Edward and Pamela Taft

Pierluigi Zappacosta and Enrica D'Ettorre

MEGA / $100K–$499K

Applied Materials

Steve Blank and Alison Elliott

Campbell Fund

Patricia and Gene Carter

David R. Cheriton

Yogen and Peggy Dalal

Dunlevie Family

Fairchild Semiconductor

Robert Garner and Robin Beresford

Harvey Family

John and Andrea Hennessy

Hitz Foundation

Mark Horowitz and Jody Buckley

The Joan and Irwin Jacobs Fund of the Jewish Community Foundation

The Dirk and Charlene Kabcenell Foundation

John Mashey and Angela Hey

Burton and Deedee McMurtry

Ike and Ronee Nassi

National Semiconductor

The David and Lucille Packard Foundation

Bernard L. Peuto and Ann Bertaud-Peuto

The Harry and Carol Saal Family Foundation

Daniel and Charmaine Warmenhoven

KILO / $10K–$100K

Sally M. Abel and Mogens Lauritzen

David and Robin Anderson

David Babcock

Peggy Burke and Dennis Boyle

Jack and Casey Carsten

Lori Kulvin Crawford

Andrea Cunningham and Rand Siegfried

David Emerson

Carol and Chris Espinosa

Judy Estrin

Samuel H. Fuller

Terry and Dotty Hayes

Peter Hirshberg

Jennifer and Chuck House

Christine Hughes and Abe Ostrovsky

Pitch and Cathie Johnson

Peter and Beth Karpas

Steven and Michele Kirsch Foundation

KLA-Tencor

Lam Research

Linear Technology

Pierre and Pam Omidyar

Stephen Squires and Ann Marmor-Squires

Karen and Mark Tucker

Xilinx

Peter and Cindy Ziebelman

Individual Annual Donors
(2014-2015)

BENEFACTORS CIRCLE ($65,536+)

Bell Family Foundation*

William K. Bowes, Jr. Foundation

James H. Clark Charitable Foundation

Vinod (Vin) and Dolly Dham

Ann and John Doerr

Donna Dubinsky and Leonard Shustek*

Jeff Hawkins and Janet Strauss

Gardner Hendrie* and Karen Johansen

John and Andrea Hennessy

House Family Foundation*

The Dirk and Charlene Kabcenell Foundation

Mark and Debra Leslie

Jim and Stephanie Nisbet

Bernard L. Peuto* and Ann Bertaud-Peuto

The Harry and Carol Saal Family Foundation

Grant* and Dorrit Saviers

John* and Sheree Shoch

Carrie and Robert Zeidman

FOUNDERS CIRCLE ($25,000–$65,535)

Forest Baskett

Steve Blank and Alison Elliott

Jack C. and Casey E. Carsten

George Cogan and Fannie Allen

Lawrence and Janice Finch

Geschke Foundation

Burton Grad and Carol Anne Ances

Elaine and Eric* Hahn

The Joan and Irwin Jacobs Fund of the Jewish Community Foundation

Pitch and Cathie Johnson

The McMurtry Family Foundation

David Rossetti* and Jan Avent

Ray and Meredith Rothrock

Eric and Wendy Schmidt

Laurence L. Spitters

PIONEERS CIRCLE ($16,384–$24,999)

Ron and Penny Blake

Bill and Phyllis Draper

Terry and Dotty Hayes*

Urs Hoelzle and Geeske Joel

Ronee and Ike Nassi*

Paul and Antje Newhagen

Stephen S. Smith* and Paula K. Smith Family Foundation

Richard Yonash

VISIONARIES CIRCLE ($8,192–$16,383)

Eric and Sue Baelen

John and Sheila Banning

Andreas V. Bechtolsheim

Peggy Burke* and Dennis Boyle

William Carrico

Vinton and Sigrid Cerf

David N. Cutler

Judy Estrin

Edward H. Frank and Sarah G. Ratchye

Thomas Friel*

James and Mary Lynn Gibbons

Brian and Carolyn Halla

William* and Margo Harding

Angela Hey and John Mashey*

Hitz Foundation

John C. and Mindy W. Hollar

Herbert and Lee Kanner

James and Paula Kaval

Gordon and Betty Moore

Individual Donors list reflects donations from July 1, 2014–June 30, 2015.

*Computer History Museum Board of Trustees

Donald R. Proctor*

JP* and Shane Rangaswami

Rich* and Susan Redelfs

Arthur and Toni Rembe Rock

Diane Greene and Mendel Rosenblum

Bennett Smith

The Vadasz Family Fund

Susan Wojcicki* and Dennis Troper

Laurie Yoler*and Ben Lenail

INVESTORS CIRCLE ($4,096–$8,191)

Al and Katie Alcorn

Arthur and Jeanne Astrin

Sue Baelen and Phil King

Melanie and Gregory Bafitis

Paul Baran

Craig and Barbara Barrett

Ralph and Leah Bernstein

Judy* and Michael Bruner

Robert E. Davoli and Eileen L. McDonagh Charitable Foundation

Caroline Donahue*

Stephen Donaldson

Alfred Dubinsky

Martin Duursma*

Gregory C. Gretsch

Eli and Britt Harari

Burge and Libby Jamieson

Rudi and Jeff Katz

Sofia and Jan Laskowski

Sheldon Laube and Nancy Laube, M.D.

The Long Family Foundation

The Chris*& Melody Malachowsky Family Foundation

James and Patricia Markevitch

Linda and Mike Markkula

Philip McKinney*

Ken and Kris Moore

James and Rebecca Morgan

Stanley and Joan Myers

Gregory Papadopoulos* and Laurie Cantley

William Pollock

William and Joan Pratt

Jean E. Sammet

Rob Shaw

John and Donna Shoemaker

Peter Solvik

John Squires

Raymie Stata* and Kimberly Sweidy

John and Sandra Thompson

Wade and Brenda Woodson

L. Curtis Widdoes Jr.*

INNOVATORS CIRCLE ($2,048–$4,095)

Dave Anderson*

Mary Anne Nyburg Baker and G. Leonard Baker Jr.

Allen Baum and Donya White

Robin Beresford and Robert Garner

Evelyn Berezin

Brian Berg and Joyce Avery

Barry and Sharla Boehm

Charles E. Branscomb

Steve and Beth Crocker

Yogen and Peggy Dalal

William and Sonja Davidow

Aart de Geus and Esther John

Dave Emerson*

Irwin and Concepcion Federman

Edward Feigenbaum* and Penny Nii

Michael and Judith Gaulke

David and Deanna Gustavson

Allison Hale

Marcian and Judith Hoff

Charles* and Jennifer House

Mike Johnson

Peter* and Beth Karpas

Lucio L. Lanza

David and Jean Laws

Loewenstern Foundation

David* and Roben Martin

Craig J. Mathias

Katherine and Robert Maxfield

The McElwee Family

Debby Meredith* and Curtis Cole

Donald and Helen Nielson

Niemasik Kaufman Family Fund

Duane Northcutt and Monica Lam

Paul Pierce

Jordan Plofsky

Morris Ringer's Family

Jean Shuler

Richard Sites and Lucey Bowen

Robert and Lee Sproull

Kirsten and Todor Tashev

Charles and Karen Thacker

Jan* and Sylvia Uddenfeldt

Peter and Deborah Wexler

Paul Winalski

Susan and Anthony Wood

PARTNERS CIRCLE ($1,024–$2,047)

Anonymous-4

Gil Amelio

The Amidon and Menon Family

Dennis and Janet Austin Fund

Charles W. Bachman

Michele Baelen

Molly and Rick Bahr

Christopher and Janet Bajorek

Paul and Debbie Baker

Abbi Ball and Michael Dickey

Diosdado and Maria Banatao

John and Maggie Best

Dileep Bhandarkar

Lyle Bickley

Nancy Blachman and David desJardins

Erich Bloch

Janie Boone

Nathan Brookwood and Patricia Brookwood

Leonid Brookhis

Jack* and Patty Busch

Jarred and Amy Capellman

Gene and Patricia Carter

Tu Chen

Harry Chesley & Suzana Seban

Marshall G. Cox

John and Norma Crawford

Peter Cunningham

Enrica D'Ettorre and Pierluigi Zappacosta

Lloyd and Eleanor Dickman

John and Wynne Dobyns

Ray Duncan

Eric Dunn

L.J. Durham

Lester D. Earnest

David and Sarah Epstein

Jim, Kenna, and Celeste Fenton

William Ferry

Norman Fogelsong

Bob Frankston

Dov Frohman

Samuel H. and Carol W. Fuller

Diana Go and Stephen Smith

Bernard Goldstein

Frances Gordon

John Gustafson

Jan Half

Daniel Hannaby

Andy Hertzfeld and Joyce McClure

Leonard G. Hill III

Cynthia Holladay and Christopher Loosley

Matthew and Connie Ives Family Fund

George and Emily Jaquette

Philippe and Sonia Lee Kahn

Robert Kahn and Patrice Lyons

Ray and Laurel Kaleda

Kenyon Family Fund

Jerry and Judy Klein

Dr. and Mrs. Leonard Kleinrock

Tom Kopec and Leah Carneiro

Donald and Jill Knuth

Larry and Marian Krummel

Thomas E. Kurtz

Sandra L. Kurtzig

Bernard LaCroute

Cathy Lego

Roy Levin and Jan Thomson

Joyce Currie Little
J.P. London Fund
Robert E. Lorenzini
John and Marion Lowrance
Anne E. Massard
Mario and Luciana Mazzola
Kirk McKusick and Eric Allman
Mendelsohn Family Fund
The Bill and Dianne Mensch Foundation
Avram Miller
Pamela Gesme Miller
Mooring Family Foundation
Dean O. Morton
Jane and Malachy Moynihan
Jami and Stephen Nachtsheim
Jeremy Norman
Frank and Denise Quattrone Foundation
Jin and Chong Park
Lorna and Donn Parker
James L. Pelkey
Randall and Cynthia Pond
Raikes Foundation
Bruce Ray and Miriam Ungar
Walden "Wally" C. Rhines
Henry and Jean Richards
Tim and Lisa Robinson
Mark Roos and Catherine Rossi-Roos

Peter and Valerie Samson
John and Christine Sangui-netti
Gene Sinclair
Elizabeth and Roger Sippl
Roger V. Smith
Jerry Snyder
Mark and Mary Stevens
Charles and Nan Strauch
Bob Supnik
Edward and Pamela Taft
Ed Tecot
David and Carol Thompson
Fritz and Nomi Trapnell
Jeanie Nieri Treichel
Venture Capital Roundtable
Wilbur Vincent and Georgia Paulo
Lorna and Duane Wadsworth
Al Whaley
Donald Whittemore
Bruce Wonnacott
Steve and Catherine Zelencik

Institutional Partners

SUSTAINING $100K+

Association for Computing Machinery
Adobe
Broadcom Foundation
Cisco
Council on Library and Information Resources
Bill & Melinda Gates Foundation
Google
Institute of Museum and Library Services
Intel
Intuit
KLA-Tencor Foundation
Toshiba

FOUNDING LEVEL $50K+

Accenture
Applied Materials
Citrix
Google.org
Micron
Severns Family Foundation

INVESTING LEVEL $25K+

1185
Aerohive Networks
Autodesk
Bloomberg Philanthropies
First Tech Federal Credit Union
Gunderson Dettmer
IEEE
KQED
LinkedIn
Oracle
SanDisk Cares
Symantec
Upright Marketing

SUPPORTING $10K+

Bank of America
Ericsson
Fry's Electronics
IBM
KPCB
Microsoft
NSF
Qualcomm
SRI International
studio1500
Sutter Health Palo Alto Medical Foundation
TidalScale

Institutional Partners list reflects donations from July 1, 2014–December 31, 2015.

ABOUT THE MUSEUM

BACKGROUND

Inside Back Cover: Writing Exercise, Ada Lovelace, April 1822. Courtesy of the Bodleian Libraries, Oxford University

The Computer History Museum (CHM) is the world's leading institution exploring the history of computing and its ongoing impact on society. CHM is dedicated to the preservation and celebration of computer history and is home to the largest international collection of computing artifacts in the world, encompassing computer hardware, software, documentation, ephemera, photographs, oral histories, and moving images.

HOURS

Wed, Thurs, Sat & Sun
10 a.m. to 5 p.m.

Friday
10 a.m. to 9 p.m.

CONTACT

Computer History Museum
1401 N. Shoreline Blvd.
Mountain View, CA 94043
info@computerhistory.org
650.810.1010

facebook.com/computerhistory

Follow us on Twitter @computerhistory

Follow us on YouTube.com/computerhistory

Follow us on Instagram @computerhistory

Follow us on Tumblr @computerhistory

Follow our blog computerhistory.org/atchm/

SUPPORT

Generous contributions from individuals like you support our work in collections, exhibit development, and educational programming. We strive to foster greater understanding of the computing revolution's worldwide impact on the human experience. Please help us tell the fascinating stories of the Information Age by making a gift today. Go to computerhistory.org/contribute/.

My garden is like
a garden. My cold is
better. Good bye, Your
loving child. Ada Byron.

24th April GBH

Music	X	10
French reclining		1/4 11
Arithmetic	XX	1/2 11
Work	X	1/2 1
Music	X	1/4 3
French Exercise	X	1/2 4

25. April E. 2nd

French by heart	X
Music	X
French	X
French Exercise	X

Computer
History
Museum

1401 N. Shoreline Blvd.
Mountain View, CA 94043
650.810.1010
computerhistory.org