IEEE History Center

ISSUE 122, June 2023

OUR SPECIAL ORAL HISTORY ISSUE

*Evolution of the IEEE History Center's physical media:
Top row: Oral history #001 on reel-to-reel tape,
oral history #112 on cassette tape;
bottom row: Oral history #472 on DV tape,
SD card used in current oral history camera*

SIGNALS FROM THE DIRECTOR

Dr. Michael Geselowitz
Senior Director, IEEE History Center

As you can see from the cover, we would like to focus this issue on our important oral history collection. If you were not already aware of this program and our archive of interviews, I hope that you will be impressed, and—if you are one of our supporters—gratified that your generosity makes possible this crucial activity to preserve and make known the history of our professions.

However, I would like to point out that, while we are emphasizing oral history in this issue, our other activities continue to have impact. In these pages you will also find exciting updates on IEEE REACH (see page 9), and—as promised in my last column—the new IEEE Global Museum initiative (see page 8).

Finally, if you will be attending IEEE Sections Congress in Ottawa, Canada, in August, look for a strong History Center presence. Definitely introduce yourself to us and say hello, so that we can thank you in person for all of your support.

WAYS YOU CAN HELP HISTORY

As you read this newsletter, you will see the many success stories of the IEEE History Center and the ways it nurtures the heritage of the profession. As successful as the Center is, it relies on the support and contributions—financial, intellectual, and time and effort—of many people. We ask you to help further our work by:

Proposing an IEEE Milestone—Milestones recognize significant achievements in technology **ieeemilestones.org**

Contributing a First-Hand History—Written and oral histories help us chronicle important innovators and innovations **http://ethw.org/create**

Authoring an article for the ETHW—The Engineering and Technology History Wiki (ETHW) is an authoritative collection of historical information about technology's contributions to society **ethw.org/create**

Supporting the History Center's mission with a donation.

However you can help, it is always deeply appreciated.

HOW CAN THE HISTORY CENTER HELP YOU?
A Handy Guide to Some of Our Programs and Contacts

Engineering & Technology History Wiki: **https://ethw.org/Main_Page**

List of dedicated IEEE Milestones: **https://ethw.org/Milestones:List_of_Milestones**

How to Propose an IEEE Milestone: **http://ieeemilestones.ethw.org/Milestone_Guidelines_and_How_to_Propose_a_Milestone**

Milestone proposals in process: **http://ieeemilestones.ethw.org/Milestones_Status_Report**

Oral History Collection: **https://ethw.org/Oral-History:List_of_all_Oral_Histories**

REACH Program (free online materials for teaching the history of technology): **https://reach.ieee.org/**

History Events Calendar: **https://www.ieee.org/about/history-center/events.html**

Support for scholars:

Fellowship in the History of Electrical and Computing Technologies:
https://www.ieee.org/about/history-center/fellowship.html

Pugh Young Scholar in Residence:
https://www.ieee.org/about/history-center/internship.html

Middleton History Prize (awarded to a book in the history of technology):
https://www.ieee.org/about/history-center/middleton-award.html

NEWSLETTER SUBMISSION BOX

The IEEE History Center Newsletter welcomes submissions of letters to the editor, as well as articles for its **Reminiscences** and **Relic Hunting** departments. "Reminiscences" are accounts of history of a technology from the point of view of someone who worked in the technical area or was closely connected to someone who did. They may be narrated either in the first person or third person. "Relic Hunting" are accounts of finding or tracking down tangible pieces of electrical history in interesting or unsuspected places (in situ and still operating is of particular interest). Length: 500–1210 words. Submit to **ieee-history@ieee.org**. Articles and letters to the editor may be edited for style or length.

WHO IS MAXWELL THE MAGPIE?

Many readers have noticed that Maxwell the Magpie has become part of the visual identity of the IEEE History Center, and several have asked how this came to be. The original photo of the Australian magpie pointing expressively to a page of the IEEE History Center newsletter was sent to us by David Burger, IEEE Senior Member and past Chair of the IEEE History Committee. A family of friendly magpies, "who will do anything for some mince meat," come to the Burgers' deck where they have posed with radio equipment, as well as IEEE transactions and journals.

The History Center staff ran the photo on the masthead page of the History Center Newsletter and began using the "Maxwell invites…" photo with a QR code in various presentations. People responded positively to the image, and Maxwell just sort of took off from there. Because Magpies are nature's museum curators (they frequently collect shiny or colorful objects and bring them back to their nests), Maxwell the Magpie also seemed a good visual ambassador for the Center's Global Museum Project.

Magpies are corvids (related to crows, ravens, and jays), and are extremely intelligent and playful. They have a melodious call, and their plumage in flight is visually striking. This video in particular shows off their playful side: https://www.youtube.com/watch?v=KqSbDcks_uA

As to the question of whether we adopted Maxwell as our visual mascot, or Maxwell adopted us, "it's complicated."

Maxwell the Magpie invites YOU to learn about the History Center

◆IEEE

HISTORY COMMITTEE ACTIVITIES

AARON GLUCK-THALER IS 2023-2024 IEEE LIFE MEMBERS' FELLOW IN THE HISTORY OF ELECTRICAL AND COMPUTING TECHNOLOGY

Aaron Gluck-Thaler is a PhD candidate in the Department of the History of Science at Harvard University and an affiliate of the Berkman Klein Center for Internet & Society. He studies the history of surveillance and its relationship to scientific practice.

Aaron's dissertation provides a history of pattern recognition in 20th century America. It considers how and why scientists in diverse fields–from anthropology to engineering–adopted practices of pattern recognition. The project focuses on how technical research in pattern recognition acted as an epistemic support for surveillance, changing how people could be identified and what their identity was thought to be composed of. Tracing how pattern recognition, computer vision, and other data classification techniques were embraced by intelligence agencies and corporations, Aaron's dissertation foregrounds the conditions that have made surveillance today possible. Aaron also works on early histories of cybersecurity and artificial intelligence.

Aaron holds a BEng in Mechanical Engineering from McGill University, a MSc in the Social Science of the Internet from the Oxford Internet Institute, and a MSc in the History of Science, Medicine, and Technology from the University of Oxford, where he was a Rhodes Scholar. Aaron's doctoral research has been supported by Harvard's Frank Knox Memorial Fellowship and the Social Sciences and Humanities Research Council of Canada's Doctoral Fellowship.

CENTER ACTIVITIES: ORAL HISTORIES

HIGHLIGHTS OF THE COLLECTION

The IEEE Oral History collection is one of the largest oral history collections of electrical engineers and related technologists in the world. Beginning the first oral history, conducted on July 1st, 1968, the IEEE Oral History Collection spans a wide range of historical developments in electrical engineering.

Computing history is one of the major highlights of the IEEE History Center's oral history collection, which contains interviews with computing pioneers that date back to the first generation of electronic digital computing. Included

The IEEE Oral History collection is one of the largest oral history collections of electrical engineers and related technologists in the world. Beginning the first oral history, conducted on July 1st, 1968, the IEEE Oral History Collection spans a wide range of historical developments in electrical engineering.
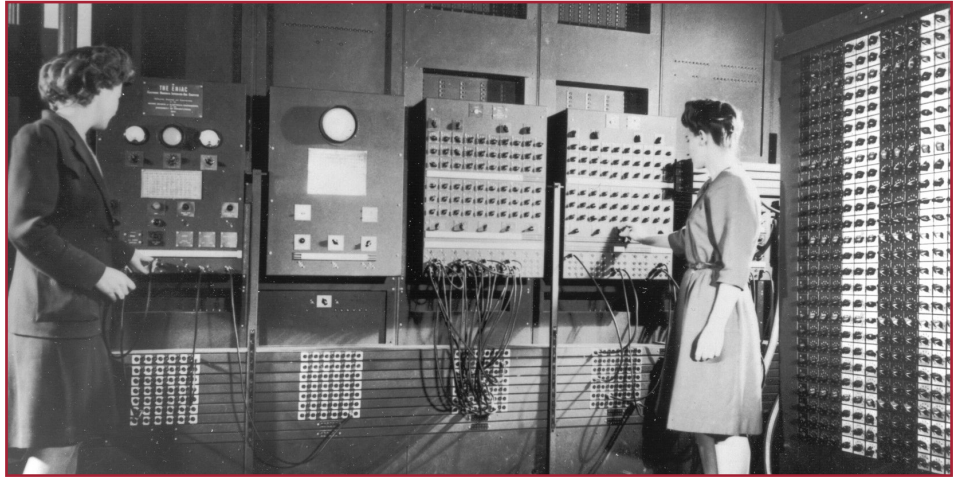
Jean Bartik (left) with ENIAC. Bartik's oral history is just one of hundreds of in our collection.

among these early pioneers are Konrad Zuse, who developed the electromechanical computer, the Z3, from 1938 to 1941, Jean Bartik, Elsie Shutt, and John Gregory, who worked on the ENIAC, one of the earliest electronic digital computers, built at the Moore School of Electrical Engineering at the University of Pennsylvania, and Eleanor Ireland, who was one of the operators of the Colossus computers, which was used at Bletchley Park for codebreaking during World War II. Many of these oral histories are part of the Women in Computing collection, conducted in 1996-1998 by Dr. Janet Abbate who served as a post-doctoral fellow at the IEEE History Center. Her chief focus during her fellowship was the completion of her book on the history of the internet, Inventing the Internet (MIT Press, 1999).

Later computing developments are represented in Thelma Estrin, who worked on the WEIZAC in the 1950s, Jacob Ziv, one of the co-creators of the Lempel-Ziv compression algorithm, Mary Lee Berners-Lee, who worked on the Ferranti Mark 1 computers, and her son, Tim Berners-Lee, who was the inventor of the World Wide Web, and Masatoshi Shima and Federico Faggin, two of the developers of the 4004 microprocessor. A number of pioneers related to the development of ARPANET and packet-switching are represented, precursors to the modern internet. These include Robert Kahn, Robert Lucky, Leonard Kleinrock, Leo Beranek, Vinton Cerf, Robert Metcalfe and Paul Baran.

In other technologies, the development of foundational electronic components are represented in the oral history collection, through Gordon Teal, who worked at Bell Labs and Texas Instruments where he made pioneering developments on the transistor, as well as the two inventors of the integrated circuit, Jack Kilby (Texas Instruments) and Robert Noyce (Intel), who developed the technology in parallel. These technologies enabled the consumer electronics, as did the work of Nobel Prize laureate George E. Smith, who invented an essential component in modern digital imaging, and Vladimir Zworykin, whose iconoscope was a major development in electronic television. Major developments in cellular phone and communications technologies are represented by the work of Amos Joel, Irwin Jacobs, John Pierce, Raymond Pickholtz, and Andrew Viterbi. Robotics pioneers include interviews with Ruzena Bajcsy, Ayanna Howard, and Lydia Kavraki.

The IEEE Oral History collection is also focused on the activities of IEEE itself, through a large collection of interviews with past IEEE Presidents, such as John Douglass Ryder (1955), Ernst Weber (1963), Arthur Stern (1975), Ivan Getting (1978), Emerson Pugh (1989), Martha Sloan (1993) and John Vig (2009).

To view the entire oral history collection, including various sub-collections, identified by technical area, please visit: **http://ethw.org/oh.**

MEETING THE WIZARD AND OTHER CONVERSATIONS WITH GREATNESS

Hurricanes…bombs through the sidewalk…a sampling of some favorite oral history moments.

"You're going to meet the wizard!?!?"
I had just learned that—thanks to lucky timing, high-speed trains, and the Friday before a holiday weekend—I would be conducting an oral history with Sir Tim Berners-Lee, the inventor of the World Wide Web. In addition to the technological fascination of meeting one of the most influential people of our age, it would also be the first time I had ever met

a real-life knight in person.

And yes, I admit to shamelessly name-dropping in the weeks before and after, telling friends and colleagues about my assignment, and watching the expressions on their faces.

The interview itself was fascinating and wide-ranging. Many of the topics were prescient and have ongoing implications in our increasingly interlinked society **https://ethw.org/Oral-History:Tim_Berners-Lee**. Sir Tim talked eagerly and passionately about the importance of trust, freedom, and originality in the functioning both of the World Wide Web as well as

in our face-to-face lives. He spoke of riding the wave, and how each development becomes a step for the next one. The oral history interview also touched on topics of plagiarism and being able to authenticate work, topics that have grown even more pertinent in the years since the interview was conducted.

Our oral histories consciously usually begin with open-ended questions about childhood influences and early education not only because those are often extremely formative, but also because some of the best stories come out in response. As a child, Dimitry Grabbe **https://ethw.org/Oral-History:Dimitry_Grabbe** gave proof both of his ability to tinker and his aptitude for small things (which he later put to good use as a major contributor to the semiconductor packaging and printed circuit board industries). During World War II, at the age of twelve in Yugoslavia he disassembled a U.S. bomb that had fallen, unexploded, on his street.

The story needs telling in his own words. *"A bomb came through the sidewalk, burrowed underground, and broached the brick wall in the cellar. It didn't go off, so most people ran out of there.*

I was curious. The bomb had pushed out the brick wall, so just with taking a few bricks out of the wall you could see the face of the bomb. It was a round affair with four notches. I didn't have wrenches of that size so I took a hammer and chisel, and tried to unscrew it. After a while I realized that it was a left-hand thread rather than a right-hand thread, so I tried it to the left. The bomb was about one meter long. I got the thing unscrewed, and it was very interesting. It was a detonating cartridge about two by six inches held with three spider legs of metal, and in back of that was a plastic bag with foaming liquid inside. It was acid eating on the wire which held the striker back. About four hours later, it went off, but by then I had it all apart."

That kid who took the bomb apart grew up to do crucial work on the computers for the Apollo missions.

In addition to the fascinating technical insights of these oral histories, I remember, with pleasure, the gracious hospitality many of the subjects have showed us over the years. Morris Tanenbaum, inventor of the silicon transistor, **https://ethw.org/Oral-History:Morris_Tanenbaum** baked cookies. We sat and ate them warm, fresh from the oven, as we talked and the wind rose in the trees outside. Hurricane Floyd had chosen that day to storm across New Jersey. Inside,
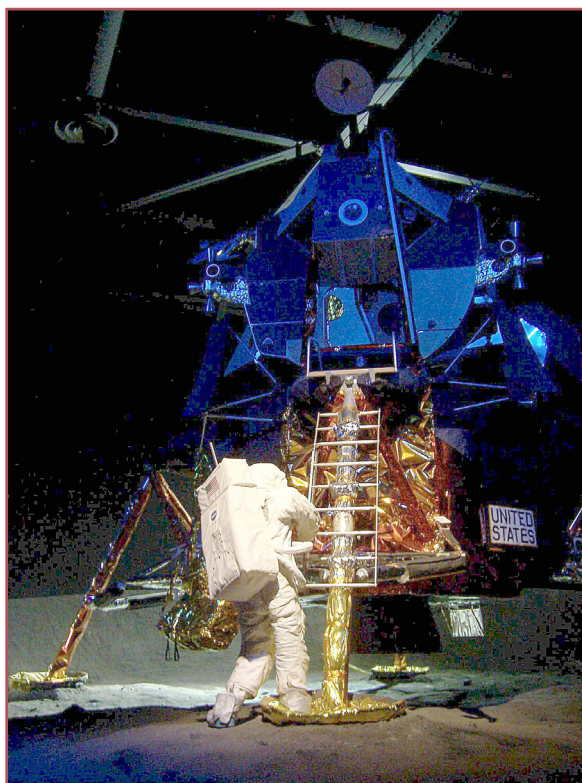
Dimitry Grabbe, who worked on Apollo project computers, talks in his oral history about taking apart a World War II bomb as a child.

we discussed the order of crystals and the methodical manufacturing processes that led to the silicon revolution. *"Disclosure was sort of the industry norm. I think people generally felt (and I think they were right) that, yes, it's nice to have patents, nice to collect royalties, but don't lean too heavily on them because others are always gaining on you. Better run fast yourselves for that's the only way to maintain a lead."*

I caught what turned out to be the last train running before New Jersey Transit shut down entirely. Fortunately, the final stop the train made was within two miles of my home, which was on a hill. Between station and home, there was some low ground where everything was flooded. I had to wade through waist-deep water, holding my backpack with the precious tape recorder (wrapped in a plastic bag) over my head. On the way, I assisted the police checking stranded half-submerged cars to make sure no one was in them.

And the interview was absolutely worth it. Years later, the *Wall Street Journal* quoted from it.

Similarly hospitable, Charles Kao **https://ethw.org/Oral-History:Charles_Kao** 2009 Nobel Laureate in Physics and the visionary who made fiber optics possible, brewed me wonderful green tea at his apartment on a cold February day, explaining the nuances of steeping the leaves in ways that preserved the most flavor and antioxidants. It was an additional insight into the thought processes—detailed, observant, appreciative of all the subtleties of the world around him—of my host and interview subject. He explained the reasons why using lasers to communicate through air was not ideal (instability of atmosphere, moisture, dust), the need for a waveguide, and the reasons for choosing glass. The tone of the oral history is modest, matter-of-fact. *"The material [glass] is very cheap, as I went to the most abundant material on Earth. Also the fiber itself has very, very good durability. So really it is an ideal thing. It is really the cheapest and strongest material that you can use."*

Considering the communications revolution that fiber optics made possible, and the vast amount of voice and data currently traveling over fiber, "an ideal thing" is perhaps an understatement.

All of the oral histories I and my colleagues have had the pleasure to conduct have been stimulating windows into the creativity and thought of fascinating people.

We look forward to our next ones.

MAKING A GREAT COLLECTION EVEN BETTER: NEW ORAL HISTORIES ON THE ETHW

The Engineering and Technology History Wiki (ETHW) is the IEEE History Center's main platform for publishing its oral histories. The ETHW is governed by a consortium of the major engineering societies, thus other ETHW partner societies, such as AIME and SWE also use the site for posting their oral histories. Below are some of the new oral histories that are available:

Dr. Maxine S. Cohen, IEEE Senior Member and IEEE Life Member, earned a B.A. in mathematics at the University of Vermont,1970, and an M.S. and Ph.D. in Advanced Technology and Computer Science at Binghamton University, in 1982 and 1991, respectively. She is an active IEEE volunteer, especially with the IEEE Life Members Committee and the IEEE History Committee. She is also a member of the Association for Computing Machinery and Upsilon Pi Epsilon, the Honor Society for computer science. For more than twenty years, she served on the faculty of the College of Engineering and Computing, teaching graduate courses (on campus and online) in Human-Computer Interaction, Interaction Design, and Social Media and advises doctoral students. In January 2017, Cohen retired from full-time work and was awarded the title Professor Emerita, but she continued working until 2019, when her last Ph.D. student completed their studies. Cohen's primary teaching focus has been Human-Computer Interaction (HCI), but she has taught other graduate courses.

Jose M. Rodríguez Ibabe has been Chair of CEIT (Centre for Technical Research) since 2017 and is an industrial engineer holding a Master of Metallurgy and a Ph.D. in Industrial Engineering from the ESII School of Industrial Engineering at the University of Navarre in San Sebastián. Following his Ph.D., he joined CEIT and also became a part-time professor in the School of Industrial Engineering in San Sebastián. Over time his work has become focused on the combination of properties, microstructure and process, and he has become a leading international figure on thermomechanical steel treatments. Together with his colleagues, Professor Rodríguez Ibabe received the Vanadium Award (2001) and the Charles Hatchett Award (2003) from the Institute of Materials (London). He has also received the Meritorious Award (2000) from the Iron and Steel Institute (USA), is a three-time winner of the Gilbert R. Speich Award (2012, 2013 and 2016) from AIST (Association for Iron and Steel Technology, USA), and won the Henri Meyers 2017 Award on Forming from ABM (Brazilian Metallurgy, Materials and Mining Association).

Dr. Jessica Elzea Kogel is the Associate Director for Mining and the Director of the Office of Mine Safety and Health Research at the National Institute for Occupational Safety and Health. At NIOSH she leads the institute's mining research program which focuses on improving mine worker health and safety through the development and implementation of innovative engineering controls, novel monitoring approaches, and improved work practices. Before joining NIOSH, Dr. Kogel spent twenty five years in the mining industry where she held positions in research and development and mining operations management for two global producers of industrial minerals. Dr. Kogel is a member of the National Academy of Engineering, Distinguished Member of SME, past President of SME, and past President of the Clay Minerals Society. She is a recipient of the Hal Williams Hardinge Award and the Joan Hodges Queneau Palladium Medal.

Dr. Donald H. Kraft (born 1943), is an IEEE Life Fellow, elevated to IEEE Fellow with the class of 2002 "for contributions to text retrieval via fuzzy set theory and genetic algorithms." He is a member of the IEEE Computational Intelligence Society and the IEEE Computer Society. Kraft is also a Fellow of the International Fuzzy Systems Association (2013) and the American Association for the Advancement of Science (2003) and a Distinguished Scientist (2008) in the Association for Computing Machinery. Kraft received his B.S. and M.S. degrees in industrial engineering and his Ph.D. in industrial engineering (operations research) from Purdue University in 1965, 1966, and 1971, respectively. Kraft served as chair of computer science and is now professor emeritus, at Louisiana State University, Division of Computer Science and Engineering where he spent much of his career from 1976 to 2008. Since the early 1970s, Kraft has had an extensive experience in the application of computer methods to library science.

Dr. Arogyaswami Paulraj's development of multiple input-multiple output antenna technology for wireless communications has revolutionized both local area and mobile broadband communications, enabling high-speed access to multimedia services. In 1998, Paulraj founded Iospan Wireless Inc. as the first company to incorporate MIMO technology in a commercial system. The lessons learned at Iospan gave the wireless industry confidence to incorporate MIMO into emerging wireless standards. Iospan's technology underpins today's 4G wireless systems. In 2003, Intel Corp. acquired part of Iospan to help launch its own push into wireless broadband, further establishing the importance of Paulraj's MIMO concept.

Dr. Syd S. Peng is Charles E. Lawall Chair of Mining Engineering emeritus, Department of Mining Engineering, West Virginia University, Morgantown, WV, U.S.A. Dr. Peng received his undergraduate diploma in mining engineering from National Taipei University of Technology in Taiwan. He went to the U.S. in 1965 for advanced study and received his Ph.D. in mining engineering from Stanford University in 1970. In 1978 he was appointed as chairman of the Mining Engineering Department, a position he held until September 2006.

Louis L. Scharf received the Ph.D. degree from University of Washington, Seattle, WA, U.S.A., in 1969. He is currently Research Professor of Mathematics and Emeritus Professor of Electrical and Computer Engineering at Colorado State University, Fort Collins, CO, U.S.A. His research interests include statistical signal processing and machine learning as they apply to space-time adaptive processing for radar, sonar, and communication, modal analysis for electric power system monitoring, spectrum analysis for nonstationary times series modeling, hyperspectral imaging, and image processing for group-invariant classification and registration. Prof. Scharf was the recipient of several awards

for his contributions to statistical signal processing, including the Technical Achievement and Society Awards from the IEEE Signal Processing Society, Donald W. Tufts Award for Underwater Acoustic Signal Processing, Diamond Award from the University of Washington, and 2016 IEEE Jack S. Kilby Medal for Signal Processing. In 2021, he received the Education Award from the IEEE Signal Processing Society.

Michael Strelbisky is a Fellow of the AIST, Professional Engineer and graduated from the University of Waterloo in 1985 with a degree in Mechanical Engineering and a minor in Metallurgical Engineering. Mr. Strelbisky's career spans more than 30 years with Tallman Technologies Inc. Mr. Strelbisky currently holds eight patents in the field of oxygen steelmaking and electric arc steelmaking. His inventions help steel plants reduce CO_2 emissions, increase safety and increase productivity. Mr. Strelbisky has been the Chair of the John F. Elliott Lectureship Award Committee for the last five years, is an active member of the AIST European Chapter Steel Forum planning committee, is an active member of the Electric and Oxygen Steelmaking Technical Committees, is past chair of the AIST Oxygen Steelmaking Technical Committee and is a former Member of the Board of the AIST.

To read these, and other oral histories, visit **http://ethw.org/oh**

New First-Hand Histories
In addition to a repository for oral histories, the ETHW also allows the submission and posting of first-hand memoirs. Two new First-Hand histories include:

Joan Travis (neé Kaye) was a computer pioneer who, in her chosen role of, as she put it, 'Engineers' Mate,' had worked with computer hardware at its lowest level and written low-level test programs and applications software for a variety of machines. She made four visits to Shell's Amsterdam Laboratories in the period 1955 to 1958, mostly each of about a week but one of thirty eight days' duration. The purpose was to attempt to connect a novel 35mm magnetic tape deck and then a half-inch magnetic tape deck and a Bull lineprinter to Shell's Ferranti Mark I computer. In a similar exercise, Joan made one visit to Rome in 1956 of seventeen days to connect new equipment to the Instituto Nazionale per le Applicazioni Calcolo (INAC)'s Ferranti Mark I computer.

Gunther Karger was born on 16 March 1933 in Schmieheim, Germany. In 1939, his parents sent him on a transport of children to Sweden to escape from Nazi Germany. He was the only member of his family to survive the Holocaust. After World War II, he was sent to the United States. Upon graduating high school as valedictorian, he enlisted in the United States Air Force, where he worked on radar systems. After leaving the Air Force, he enrolled in Louisiana State University, where he graduated in 1958. Karger held positions at Boeing, Bell Labs, and Eastern Airlines, and was involved with IEEE in several volunteer positions, including editor for the IEEE Communications Society Newsletter, member of the Executive Committee of the IEEE North Jersey Section, and chair of the IEEE Canaveral Section.

To read these and other First-Hand histories, or to submit your own, visit **http://ethw.org/fhh.**

DOCUMENTARIES, JOURNALISTS, BOOKS, SCHOLARS: THE ORAL HISTORY COLLECTION HAS WORLDWIDE IMPACT

The IEEE History Center's oral history collection has enormous public and professional impact throughout the world because it is used and quoted by scholarly journal authors, books, documentary film producers, journalists, professors, IEEE volunteers preparing IEEE events, and — on one notable occasion — the French embassy.

One of the broadest methods of bringing public visibility to IEEE's fields of interest is via documentaries and television and radio programs. Some of the most respected organizations in the field have drawn on the IEEE History Center's oral history collection for content. Among the all-star lineup are National Geographic, Lionsgate, BBC, London Weekend Television, PBS, and German National Public Radio. In addition, the German public television station Der Erste used a video clip for its quiz show, "Wer Weiss den sowas?"

The oral history collection supports IEEE's mission of informing the public and government policy makers by serving as a resource for journalists. The *Wall Street Journal, Minneapolis Star Tribune, Washington Post,* and *New York Times* have quoted from the collection.

At least thirty-one books on subjects as wide-ranging as

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semiconductors, materials sciences, history of Silicon Valley, The Chinese Computer, history and applications of artificial intelligence, loudspeakers, Alfred Hitchcock, exploring the solar system's distant horizons, and women scientists. Most notably, Nathalia Holt's critically acclaimed best-seller *The Rise of the Rocket Girls* drew on the oral history of Lois Haibt. The publishers of these books are a roll call of some of the most respected presses in the world: Cambridge University Press, Yale University Press, MIT Press, Penguin, Springer, Thames & Hudson, McGraw-Hill, Stanford University Press, and Johns Hopkins University Press.

Learned societies as well as corporations and consultants rely on the oral histories as primary sources. The National Academy of Engineering and the National Academy of Sciences have consulted us multiple times. In addition, we have supplied material to the Consortium for Computing Sciences in Colleges, the Anaesthesiology Society, the National Inventors Hall of Fame, the American Electric Power Engineering Organization, the International Union of Radio Science, the Center for Innovation Management Studies, and the French Society for Industrial and

Applied Math. We also support the scholarship in IEEE's fields of interest by answering requests from Ph.D. candidates who make use of oral histories in their theses.

Most of these requests arrive at the History Center via email, and most of the users have found us via the Engineering & Technology History Wiki. Once the Center receives a request to re-use intellectual property, there is a rapid and simple process for granting the permission.

Perhaps most satisfying on a personal level, the History Center has been able to fulfill requests from family members for video or audio recordings of deceased loved ones, thus preserving their voice and presence. In some cases, grandchildren who might have been too young at the time to appreciate their grandparent's work are able to reconnect to, and treasure, it.

If you have enjoyed our coverage of oral history, and wish to support the collection, please consider making a donation to the IEEE History Center either with your dues renewal, or via
https://www.ieeefoundation.org/impact/illuminate/ieee-history-center/

IEEE HISTORY CENTER HOWARD ARMSTRONG EXHIBIT MAKES ITS DEBUT

'How Far Can You Go' is the pilot exhibit of the Global Museum program. It will travel to technology museums throughout the United States, beginning with the San Antonio Museum of Science and Technology (SAMSAT) in Texas.

Armstrong exhibit at IEEE Board Series. L to R on the pedestals: Klitzen Model 525 Regenerative Receiver (1922) with Ackerman Dodge-tone Loudspeaker (1922) and Yale Electric/Franco Radio "B" Battery (c.1923); Radiola 24 Portable Super-Heterodyne (1925); Stromberg-Carlson FM Receiver (1941)

Our traveling exhibit, "How Far Can You Go? Edwin Howard Armstrong and the Birth of Our Wireless World," **https://vimeo.com/800959766/e637e3e3f5** made its debut at the IEEE Board Series held at the Sheraton Hotel Times Square in New York City in February, in conjunction with the IEEE Foundation's 50th anniversary reception. A joint project by Senior Historian Daniel Jon Mitchell and Outreach Historian Alex Magoun funded by an anonymous bequest, the exhibit told the story of the electrical engineer Edwin Howard Armstrong, one of the greatest contributors to the field of radio-electronics.

Armstrong was unique in making key contributions to solving three crucial problems in wireless communication. His invention of a *regenerative circuit* opened up the possibility of continuous-wave radio, or the transmission of voice and music—an achievement that earned him the first IRE Medal of Honor in 1917. Armstrong developed a *superheterodyne circuit* through his work in World War I as a member of the U.S. Army Signal Corps in France. It dramatically expanded the electromagnetic spectrum used for communications and made radio receivers more sensitive and selective. It is still used today in practically all radios, televisions, and even some cell phones. In the 1930s, Armstrong developed *wideband frequency modulatio*n (FM) that eliminated static caused by electric motors, power lines, appliances, and radio stations sharing the same airwaves. He then built the world's first FM radio station: W2XMN in Alpine, NJ, and networked it wirelessly with other, new FM stations. In 1942, the AIEE recognized these breakthroughs by awarding Armstrong its Edison medal.

Thanks to generous loans from radio collectors, the exhibit included some of the earliest radios that incorporated these technologies as well as remarkable cultural artifacts from our new Martha and Jerry Simkin collection. During the explosion of radio broadcasting during the 1920s triggered by Armstrong's regenerative receiver, entrepreneurs seized upon radio's symbolism of modernity to sell all kinds of consumer products to men, women, and children, from cosmetics to kitchen tools. As other engineers improved circuits and lowered production costs, listeners could swap their headphones for loudspeakers. This turned radio broadcasts into a nightly family activity, spawning an industry of radio-themed products for children, including books, toys, and games as well as celebrity entertainment and news reporting.

When the Board Series ended, we moved the artifacts and posters to IEEE corporate headquarters at 3 Park Avenue in New York City where they can be seen by staff and visitors. The exhibit will remain there as we develop its contents further, at which point it will travel to technology museums throughout the United States, beginning with the San Antonio Museum of Science and Technology (SAMSAT) in Texas. "How Far Can You Go" is the pilot exhibit of the Global Museum program. The program is intended to promote an understanding of electrotechnology and its impact upon society by bringing museum-quality exhibits to IEEE members and the public. We are establishing collaborations with local and national museums, private collectors, universities, corporations, and other organizations to curate traveling exhibits, from a single treasured artifact to a full collection, and install them at technology museums or IEEE conferences, facilities, and events around the world. For more information contact Daniel at **daniel.mitchell@ieee.org**.

Maxwell's Ether: From Wave Optics to the Electromagnetic Theory of Light
4 October 2023

**Save the Date
4 October 2023**

Please mark your calendar for 4 October 2023, at 1:00 pm Eastern time, and join us for a virtual presentation! We invite you to celebrate IEEE Day with the IEEE Foundation and IEEE History Center by exploring James Clerk Maxwell's revolutionary unification of light, electricity, and magnetism. The keynote speaker, Daniel Jon Mitchell DPhil., Senior Historian of the IEEE History Center will walk you through the remarkable history of how Maxwell adapted the concept of an all-pervading ether to develop and ground his electromagnetic theory of light. We shall see how, in Maxwell's hands, the ether became a powerful theoretical tool to substantiate the electromagnetic field— through which he ultimately brought about a profound conceptual transformation of physical reality.

The IEEE Foundation is excited to have you join us as we present a rich historical picture of Maxwell's greatest work. Please register here: **https://webinars.on24.com/ieeedigital/ieeeday** For additional information, contact Laura Bessey, Donor Relations, at **donate@ieee.org** or **+1 732-465-7817.**

IEEE REACH AT THE UNITED NATIONS' SCIENCE, TECHNOLOGY, AND INNOVATION FORUM

Kelly McKenna, Sr. REACH Program Manager, IEEE, (second from the left) highlights the IEEE/UNESCO MOU and IEEE REACH pilot program that was implemented in Uganda, Africa during the United Nations STI Forum's side event, Uncovering gender disparities in STEM and higher education in Southern Africa

On 4, May, as part of the United Nations' Science, Technology, and Innovation Forum for the Sustainable Development Goals, a side event organized by the UNESCO Regional Office for Southern Africa, Harare was held. Titled "Uncovering gender disparities in STEM and higher education in Southern Africa: evidence from nine countries," it highlighted the preliminary results of a joint research project of UNESCO International Institute for Higher Education in Latin America and the Caribbean (IESALC) and UNESCO in Harare that assessed women's participation and representation in higher education in Southern Africa and identified areas with gender imbalances. Kelly McKenna, IEEE REACH Senior Program Manager, was invited to participate in this event as one of the panelists.

Although the event predominately focused on the inclusion of women in higher education institutions and their sustainable participation in STEM in South Africa, Kelly McKenna was asked to highlight the IEEE/UNESCO REACH pilot program that was implemented in Uganda. An initial pilot program that engaged young women at the pre-university level in STEM through the use of the IEEE REACH resources and hands-on activities. McKenna explained that local NGOs, Silver Bolt and Smart Girls Foundation, adapted the REACH resources to meet Uganda's National Curriculum Development Centre's standards, and that the program was carried out both in the classroom and by way of a traveling education trailer, which reached underserved communities. She explained that the REACH resources were delivered to students based on their language, education levels, and the communities where they lived, and all pedagogy used the history of science, engineering, and innovation to spark creativity, and to boost critical thinking, collaboration, teamwork, and communication. She highlighted that this was an informal education program and attendance for the female students was optional. However, Maryanne Karamagi, CEO of Silver Bolt and REACH implementation partner for the IEEE/UNESCO REACH pilot, described that many students who attended on the first day returned to the program on the second and third day with their friends. This showed that the students were not only engaged by what they were learning, but they were interested in learning more! A testimonial from Maryanne Karamagi about the IEEE/UNESCO REACH Pilot can be viewed here: **https://vimeo.com/ieeereach/testimonial.**

9

When used in the classroom and on the road, REACH's resources and format allowed for high levels of contextualization and relevance while maintaining historical accuracy. Upon completion of the initial pilot, more than seventy teachers and approximately 1,000 students were impacted. Due to this success, the program was expanded to STEM teacher workshops that were hosted by the UNESCO National Commission for Uganda. A representative from the Uganda Ministry of Education was in attendance during one of the workshops and became interested in the program's format and the resources it provides. The Uganda Ministry of Education is now using the REACH program in an effort to scale up STEM teacher engagement.

Also highlighted was additional interest in REACH from key stakeholders in South Africa and other African countries that was a direct result from the IEEE REACH exhibit booth at the World Science Forum, which was held in South Africa in December 2022. The STI Forum presentation concluded by noting that IEEE REACH provides an opportunity to improve technological literacy skills and advance female interest in STEM, and that UNESCO seeks to expand the program to Southern Africa, including to rural areas. The panel discussion as a whole, and its REACH component, was very well received.

This engagement was a direct result of the IEEE/UNESCO memorandum of understanding, and assistance from the IEEE Africa Council, the IEEE Uganda Section, Vincent Kaabunga, Past Chair of the IEEE Africa Council and lead volunteer for the IEEE/UNESCO MOU, Maryanne Karamagi, CEO, Silver Bolt, and the Smart Girls Foundation where the pilot took place. In addition, the IEEE REACH Program is grateful for Kathleen Weeks' assistance with the IEEE REACH/UNESCO partnership, to UNESCO and Rovani Sigamoney, Regional Programme Specialist at UNESCO, and to the REACH donors as REACH would not be possible without their support.

The REACH team welcomes opportunities to further this work with other IEEE volunteers and members. Please contact Kelly McKenna for information about how to get involved. She may be reached at **k.mckenna@ieee.org**.

HISTORY VOLUNTEERS IN ACTION

COMPUTER GRAPHICS HONORED AS AN IEEE MILESTONE

By Brian Berg, IEEE History Committee

On March 24, I was pleased to be the MC for the dedication of the Utah Section's first IEEE Milestone. Titled "Development of Computer Graphics and Visualization Techniques, 1965-1978," a bronze plaque honoring the fundamental rendering and visualization techniques described in the dissertations of early University of Utah CS graduates from this time period was unveiled as part of a 2-day celebration on the school's campus. IEEE Senior Member Dan Donahoe originated the idea of this Milestone, I served as its History Committee Advocate, Region 6 Director Kathy Hayashi represented IEEE, and the University pulled out all the stops for a successful event. See **www.UtahMilestone.com** for videos and extensive background information.

In the early 1960s, the concept of "computer graphics" (CG) was still in its infancy. Ivan Sutherland gave many their first glimpse of what the technology might offer with his Sketchpad program as described in his 1963 MIT PhD thesis. To advance this area, funding for a Center of Excellence for CG research was granted to the University of Utah by the Advanced Research Projects Agency (ARPA). *The Economist* has called ARPA (now DARPA) the agency "that shaped the modern world" by way of its support for efforts that have led to a myriad of advances in computers, biotechnology, and many other areas including ARPANET – which became today's Internet. David Evans had been invited to Utah to lead the effort for this ARPA project, and he invited Sutherland to join him in 1968. Within weeks they founded Evans & Sutherland (E&S), the world's first company building CG hardware, and whose offices were in the university's research park.

The dedication program told the story of how Utah doctoral students created the technological foundation of the rendering and visualization revolution that is now part of everyday life.

The dedication program told the story of how Utah doctoral students created the technological foundation of the rendering and visualization revolution that is now part of everyday life. These key techniques are named after the students who created them: (1) the Warnock Algorithm for hidden surface removal, (2) Gouraud shading to enable continuous lighting on rendered objects, (3) the Catmull-Rom spline for smooth interpolated motion, (4) the Catmull-Clark surface patch for rendering curved surfaces, and (5) the Blinn-Phong reflection model for accurate shading.

The dedication included a talk by Alan Kay '69, and celebrated the companies founded by Utah graduates: Atari in 1972 (Nolan Bushnell '69), Silicon Graphics in 1982 (Jim Clark '74), Adobe in 1982 (John Warnock '69), Pixar in 1986 (Ed Catmull '74), and Netscape in 1994 (Jim Clark '74). Warnock and Clark became E&S employees for a period following their graduation from Utah.

For the first time ever, each of these Utah alumni along with Ivan Sutherland were gathered together in one location, and I had the honor of helping to craft a program that allowed each of them to talk about the role they played in these nascent days of CG. John Warnock's keynote described how his work at E&S led to the creation of the PostScript page description language, and his co-founding Adobe Systems in 1982. He noted that over 10 trillion PDF files have been created since the introduction of Acrobat in 1993.

Ed Catmull's closing keynote paralleled much of his recent Turing Award talk, and he described his work at Lucasfilm, his co-founding of Pixar with Alvy Ray Smith, and his discussions with Steve Jobs who eventually provided vital funding for Pixar.

Critical in this odyssey were Catmull's discussions with Roy Disney, Jr., who had a desire to reinvigorate Disney Animation in order to bring the magic back after Walt Disney's passing. Roy knew that his Uncle Walt had always implemented new technologies as they became available since "change was in Walt's DNA," since change "gave energy to the creative process," and since change was essential to the future of Disney.

An underlying theme throughout the program was the critical role played by Moore's Law in the maturation of CG from the time of Utah's ARPA funding in 1965, the same year that Gordon Moore made his famous observation. Catmull described 1991 as a watershed year as Disney awarded Pixar a contract for a feature-length, fully computer-generated film, and this led to the 1995 release of *Toy Story*. After its release, Catmull and Pixar were overjoyed because the reviews highlighted the movie's story and not the computers that rendered it.

I worked closely with Alvy Ray Smith on this dedication event, and he led discussions with eight of the dedication participants which also included Ivan Sutherland, Bob Schumacker, Henri Gouraud, Henry Fuchs, Martin Newell, and Jim Blinn. Alvy is sometimes jokingly referred to as "the only Univ. of Utah graduate who never actually attended Utah" since he worked professionally with so many of the key CG engineers over the years. The role that Utah played in this process is weaved into Alvy's recent book *A Biography of the Pixel*. During an afternoon event, Martin Newell gave a replica of his famous "Utah Teapot," which was signed by himself and Jim Blinn, to the John and Marcia Price College of Engineering's Richard Brown and Mary Hall.
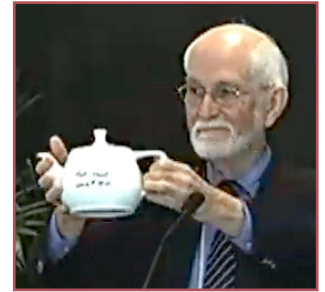
Ed Catmull's keynote also discussed how fellow Utah alum and Silicon Graphics founder Jim Clark encouraged Pixar to introduce the RenderMan interface to the industry, how this hardware API quickly received broad industry support, and how it played an important role in the maturation of CG throughout the industry. I was the Advocate for a RenderMan Milestone, which Pixar will dedicate at its headquarters in the near future.

TECH HISTORY ON THE WEB

SURFING THE WEB FOR JULY 2023

The Electronic Music Education and Preservation Project (EMAPP) **https://emeapp.org/**. EMAPP's expansive ambit includes "all things that use electricity to create, modify, record, store and reproduce musical sound." Based outside of Philadelphia, Pennsylvania, U.S.A., this group of musicians, engineers, and scholars collects, restores, and documents the development of all genres of electrically generated music with a focus on keyboards and synthesizers for "the musician, technician, and historian." The activities making use of their extraordinary collection of instruments include workshops, performances, publications, and an artist in residence. The EMEAPP Institute "is an academic-level division that undertakes …rigorous analysis of circuitry and sonic characteristics, listening tests, extensive interactions with designers and users, and historical research in its work." Free membership enables access to more of the group's research and online resources.

The LEO Computers Society and the Centre for Computing History, supported by the AIT Trust, have revised and greatly expanded their book, *LEO Remembered - by the People who Worked on the World's First Business Computers* (2022). Featuring more than eighty accounts by participants—engineers, programmers, entrepreneurs, and consumers—in J. Lyons & Co.'s pioneering innovation in business computing, the 244-page book is available from **www.computinghistory.org.uk/ det/69347/LEO-Remembered-Book-2nd-edition**.

The Media History Digital Library, led by Eric Hoyt and the Wisconsin Center for Film and Theater Research, offers, for free, millions of pages of books and magazines from the histories of film, broadcasting, and recorded sound: **https://mediahistoryproject.org/**.

For more than twenty years, Geoff Fors WB6NVH has been building his collection of mobile police radios, their documentation, and an accompanying website with his histories and thoughtful commentary. Part of an international network, he provides links to similar pages in New Zealand, Russia, Sweden, and the United Kingdom. A section on post-1949 Chinese military radios is "coming eventually": **www.wb6nvh.com/index.htm**.

Was *The War of the Worlds* broadcast of 1938 overblown as a panic, as some historians have argued? Not according to the AT&T operators who responded to the phone calls of nervous listeners across the United States. Some of their interviews, recorded fifty years later, have been digitized and posted by AT&T: **https://techchannel.att.com/play-video.cfm/2012/10/24/ AT&T-Archives-War-of-the-Worlds-Operators-Interviewed**.

Al Klase N3FRQ used Google Earth to develop a N*ew Jersey Area Historic Radio Map*, a technology tour of the sites relevant to the history of radio and other applications of electromagnetic radiation in the Garden State of the U.S.: **www.ar88.net/radio_ map/**. If driving to each site in a day proves impractical, the map provides historic photos or informative documents in PDF for a virtual tour.

Collectors in many countries are developing increasingly sophisticated websites. Here's one from the Czech Republic that covers radios, loudspeakers, vacuum tubes, and more: **www. historicka-radia.cz/**. Oof Oud of the Netherlands has built and written a spectacular *Digital Museum of Plugs and Sockets* to complement and share his international collection of electrical connectors: **www.plugsocketmuseum.nl/index.html**. Perhaps Mr. Ood's site will stimulate new scholarship on this aspect of electrical networking last addressed in 1986 by Fred Schroeder in "More 'Small Things Forgotten': Domestic Electrical Plugs and Receptacles, 1881-1931."

IN MEMORIAM: EIJU MATSUMOTO/松本栄寿, 1935-2023

The IEEE History Center learned of Eiju Matsumoto's passing as this *Newsletter* was going to press. Dr. Matsumoto died on 23 May at the age of 88. He is the translator of Heather Ewing's *The Lost World of James Smithson* and, with his companion Kiyoko KOHAMA, David Nye's *When the Lights Went Out: A History of Blackouts in America*, among other books. Eiju had a keen interest in the improvement of measurement, especially through Weston meters; the New Jersey Institute of Technology invited him to attend its IEEE Milestone dedication for the Weston Meter in 2016. Dr. Matsumoto grew up in a working-class family and earned his B.S. in electronics from Shizuoka University in 1957. He then joined Yokogawa Electric Corporation where he became a research engineer in its Electric Process Control Instruments Department in 1989. Receiving his doctorate in engineering from Tamagawa University in 2001, Eiju was the general manager and curator of Yokugawa's Museum of Measurement; a visiting scholar at the Smithsonian Institution's National Museum of American History in 1994 and 2004; and a two-time member of the IEEE History Committee. He directed the Society of Historical Metrology from 2002 into the 2010s, and was a member of IEEE, ISA, SHOT, ICOHTEC, IEEJ, and SICE.

Eiju Matsumoto continued his work up until almost his death

Along with his colleague Eiichi Ohno on the IEEJ Council and IEEE History Committee, Eiju was a vital link between Japan's and western countries' electrical histories and scholarship. Besides his translations, Eiju published articles in English on Edward Weston and 19th century metrology along with other topics and reviews. He acted as translator for Bill Aspray's interviews with Yokogawa engineers who became executives. Eiju participated regularly in Histelcon and other scholarly meetings; hosted western historians for research and IEEE Milestone dedications, introducing at least one to the delights of Osaka's okonomiyaki and Asahi beer; and in 2012 he and Dr. Ohno organized the IEEE Life Members tour of Japanese technology and science locations for more than fifty visitors. The IEEJ Electrical Engineering History Technical Committee honored his efforts with its Achievement Award in 2016; the Japan University of Economics in Tokyo recognized him a year later for his cross-cultural contributions to the growth of research on the history of electrical technologies.

A generous donor to the IEEE History Center, Eiju Matsumoto was a dynamic, thoughtful, and knowledgeable multinational member of the world's invisible college of electrical scholars. We will miss him.

INTERESTING READS

# 2013 IEEE LIFE MEMBERS' FELLOW GABOURY WINS BEN SHNEIDERMAN AWARD

Jacob Gaboury, IEEE Life Members' Fellow in Electrical History in 2013, recently received the Charles Babbage Institute's Ben Shneiderman Award in Human-Computer Interaction History for his book, *Image Objects: An Archeology of Computer Graphics* (MIT Press: 2021). Based on the dissertation research supported by his IEEE fellowship, *Image Objects* offers the first comprehensive history of the University of Utah's pioneering human-computing interaction research, from the 1960s to the 1980s, that gave rise to the field of computer graphics. Using conceptual and theoretical insights that invite readers to revise their thinking about history, communications, and media studies, Gaboury organized his book as a journey through five objects: an algorithm, an interface, an object standard, a programming paradigm, and a hardware platform. The narrative and analysis of the work of Ivan Sutherland, Dave Evans, and others at Utah and elsewhere shows how the people developing digital graphics in turn made computing interactive. Gaboury's book provides a prehistory to the professional field of HCI, and to the design tools, graphical processors, and virtual reality technologies that are changing our collective and individual worlds. It is a happy coincidence that Gaboury, now an associate professor at the University of California, Berkeley, received the Shneiderman Award just two months after the IEEE Utah Section and the University of Utah dedicated an IEEE Milestone to the accomplishments of the period covered in his book (See p. 10 for more on the Milestone).

The IEEE Life Member History Fellowship supports a year of full-time graduate or post-doctoral scholarship for a historian in any area covered by an IEEE Society. The fellowship is administered by electrical engineers and historians on the IEEE History Committee and has contributed to the steady publication of peer-reviewed histories on IEEE technologies and techniques by its recipients. The CBI Ben Shneiderman Award in Human-Computer Interaction History recognizes excellence in advancing the history or social study (over time) of HCI.

BOOKS FROM THE
IEEE HISTORY CENTER PRESS
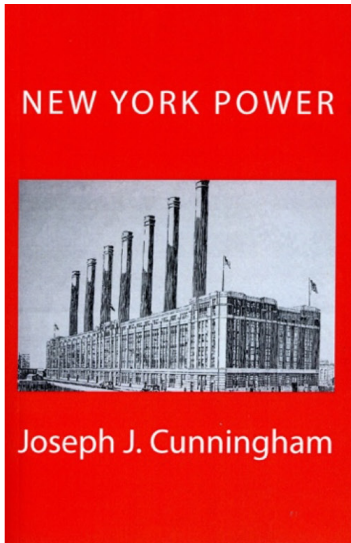
NEW YORK POWER
by Joseph J. Cunningham
tells the story of the electrification of one of the densest electrical load areas in the world. Electrification began during the 1880s, but many innovations were required to supply urban service at a cost that would make possible large-scale consumption.
https://www.amazon.com/New-York-Power-Joseph-Cunningham/dp/1484826515
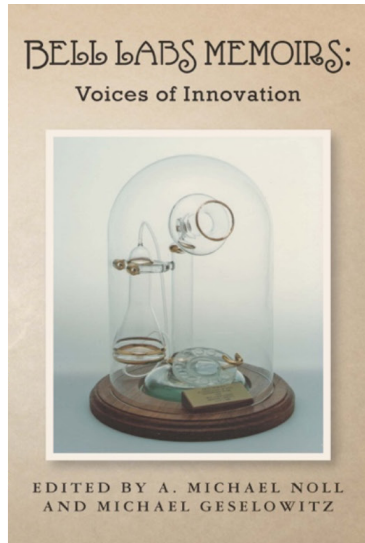
BELL LABS MEMOIRS:
VOICES OF INNOVATION
The innovative spirit and creative energy of Bell Labs during the directorship of William Baker are described by twelve people who worked there. Through their eyes and words, the culture of Bell Labs comes alive.
https://www.amazon.com/Bell-Labs-Memoirs-Voices-Innovation/dp/1463677979
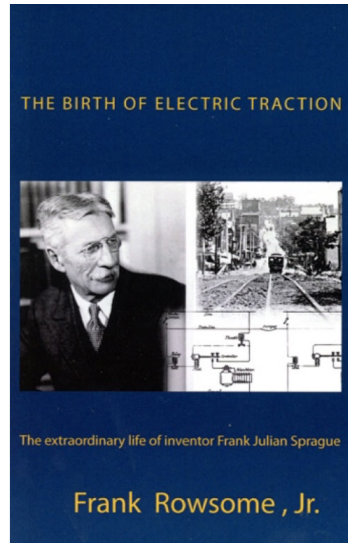
THE BIRTH OF ELECTRIC TRACTION:
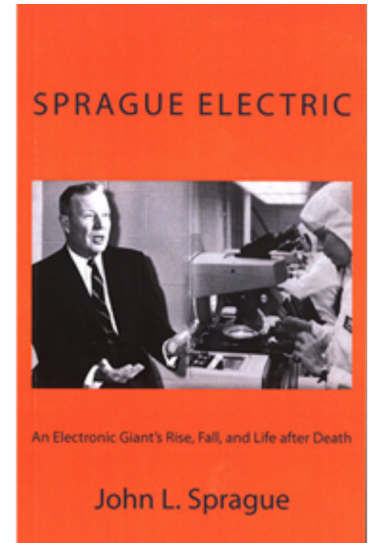## THE EXTRAORDINARY LIFE OF INVENTOR
FRANK J. SPRAGUE
Sprague made enormous contributions in the areas of electric traction, control and safety, especially automatic signaling and brake control for railroads. He was active in the planning and construction of New York City's subway system, and in the electrification of Grand Central Terminal.
https://www.amazon.com/Birth-Electric-Traction-extraordinary-inventor/dp/1490955348
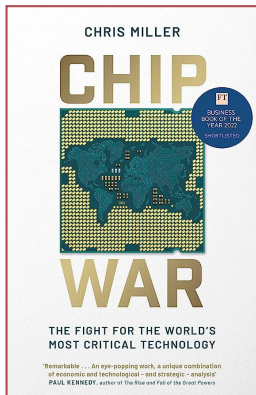
SPRAGUE ELECTRIC
Sprague Electric Company's rise from a high-tech kitchen-table startup is representative of much of the U.S. electronics industry. Begun in 1926, it became a thriving manufacturer of components. More than 50,000 Sprague components rode aboard every *Apollo* mission, and more than 25,000 aboard every Space Shuttle. *Sprague Electric* provides a valuable business and technological history, a story of corporate success… and a cautionary tale of what to avoid.
https://www.amazon.com/Sprague-Electric-Electronics-Giants-after/dp/150338781X

IEEE History Center Press books are available from Amazon.com in hard copy and on Kindle

MILLER, CHRIS *Chip War*
Simon and Schuster, 2022 | ISBN 978-1-3985-0409-7

by Peter Grant LFIEEE

This excellent book provides a very comprehensive description of the development of semiconductor chips following the invention of the integrated circuit in 1958 by Jack Kilby and Bob Noyce. It focusses on the many key individuals such as Gordon Moore, Morris Chang, Jerry Saunders, etc, who were responsible for the worldwide development of the semiconductor business over seven decades. It carefully explains the decisions, made by these individuals, which were responsible for the worldwide evolution of semiconductor chip design and production.

It starts by showing how the first chips with very modest transistor count, as produced by Fairchild Semiconductor and Texas Instruments, were predominantly developed for the NASA lunar programme and deployed by the U.S. military to improve the accuracy of their weapon delivery systems. These early chips were manually designed on graph paper, before the computer era, with the required patterns for the semiconductor production masks first cut in rubylith then photographically reduced down to the size required to produce the individual component transistors and resistors.

Early chips were often designed predominantly to replace bulky magnetic core storage systems with electronic storage in flash memories. *Chip War* explains Moore's Law in simple language and shows how the ever reducing feature size of the component transistors drives the increasing chip complexity providing such spectacular year on year increases in computational power or capability in these miniature devices. As chip complexity increases, with ever more individual transistors on each chip, the cost of developing and running the semiconductor foundries spirals, resulting inevitably in consolidation into a smaller number of foundry units.

The author explains how these semiconductor chips enabled the PC revolution with the x86 microprocessor architecture continuously evolving into new generations. This then led on to the rise of the smartphone or pocket computer and the consolidation of the infrastructure for the mobile cellphone internet on a very small number of companies such as Huawei, Ericsson and Nokia.

Further it explains how the requirements for ever smaller feature sizes in the embedded component transistors invokes the necessity to move from optical to much more expensive ultra violet photo lithography for the production of the component parts. This inevitably focussed the fabrication industry onto a very small number of operators and, for such advanced photolithography, Miller shows how the Dutch company ASML became a key supplier of this technology but it is still dependent on worldwide sourcing of the required component parts. Chip manufacturers had to decide whether to combine design with fabrication or to concentrate on designing locally the ever more complex chips and offshore the fabrication to low labour cost countries, the so called fabless revolution. Although initially semiconductor design and fabrication started in the USA today 90% of all memory chips, 75% of all processor chips and 80% of all silicon wafers are now produced in East Asia.

The book concludes by discussing first the attempts by Russia to catch up and design up to date fabrication plants, then the more recent desire for China to design and fabricate advanced chips and it documents these clashes with the West. Even though, in some cases espionage, has been used to secure the plans for a fabrication plant, without the extensive knowledge and experience of the operating staff it is impossible for another country to catch up and build a state of the art fabrication facility. Further, today's fabrication plants in Taiwan and Korea are under constant upgrade to maximise their yield.

In addition to a full index the book has fifty five pages of notes detailing the references which were used and the discussions that were conducted during Miller's research into writing this comprehensive history. This is a must read for history buffs and an essential addition to the personal library held by all electronics engineers.

GIVING & SUPPORT FOR IEEE HISTORY CENTER PROGRAMS

DONOR PROFILE: MARTHA SLOAN

Martha Sloan was elected an IEEE Fellow in 1971 and attained Life Fellow status in 2011, and as a trailblazer in the engineering world, she was the only woman among 600 engineering graduates at Stanford University. While at Stanford she graduated Phi Beta Kappa in 1961 and would go on to earn her master's degree in electrical engineering and Ph.D. Later, she would become the first female faculty member in the electrical engineering department at Michigan Technological University.

Martha also blazed trails at IEEE. She was appointed to the Board of Governors of the IEEE Computer Society in the late 1970s. She ran as a petition candidate for president of the society and won the election becoming the 1984-1985 IEEE Computer Society President. A decade later, she was a petition candidate once again – but for the role of president of IEEE. She won that election, becoming the first female president of IEEE in 1993.

Among Martha's other contributions she has been committed to generously supporting the IEEE History Center throughout the years. Martha credits the IEEE History Center with her desire to go back to school during retirement and earn her master's degree in history. She hopes by sharing her story, and through her donations, she can inspire the next generation of female trailblazers.

The women in Martha's life gave her a blueprint for her success, helping her realize women could achieve major accomplishments in traditionally male fields. She credits her great-aunt Lucia Goodwin, a high school mathematics teacher, for demonstrating the power of excellent teaching and driving her to achieve high performance. Her grandmother, Celia Goodwin, modeled female leadership in the 1920s and 1930s as the director of the Red Cross in Montana, and then as assistant secretary-treasurer of Copley Press in Illinois.

Martha remembers a particular IEEE inspiration, Irene Carswell Peden, "who was a graduate student in electrical engineering at Stanford when I was an undergraduate. She became the first woman on the IEEE executive committee, paving the way for others like me."

Learn more about Martha and her trailblazing activities for women and the profession by reading her oral history on the Engineering & Technology History wiki – **ethw.org**.

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We invite you to find out more about the Center and its programs at **https://www.ieee.org/about/history-center/index.html** and more about the Engineering & Technology History Wiki (**www.ethw.org**)

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