Anecdotes

the mercury), were called tanks to avoid confusion with vacuum tubes, a term used by the Americans for thermionic valves.

The other main memory effort at that time was associated with electron tubes on to which digits could be stored as fluorescent images. Manchester University was one of the leading lights in this research. Indeed, Fred Williams, working at the Electro-Technics Department of the university, successfully proved the theory on June 21, 1948. His computing device was crude but sufficient to prove the electron tube principle. The device became known as the Williams Tube. The Manchester research eventually led to the famous Ferranti Atlas computer using other storage methods. IBM, however, used the Williams Tube in some of its early computers, the UK research into this technique having been more successful than the American.

Thompson, who had a brilliant mind, immediately realized the significance of this research. During his tour he heard that Cambridge University was among the leaders in this field and already embarked on a project. In November 1947, after he had returned from his American tour, a deputation visited Cambridge University and without too many preliminaries offered to donate £3,000 to the university if, in return, guidance could be given on how Lyons could develop its own electronic calculator (the term “computer” was not then in use for such a device). The university viewed this gesture with delight since their own work was beginning to slow for lack of funds. Shortly afterward, Lyons employed John Pinkerton to head up their project, and a small team of electronic/electrical engineers was assembled and work started on designing a calculator, based on the university’s experience, to specifically handle full clerical operations.

Earlier, Cambridge had decided that the mercury delay line method for storage (at this early stage, terminology had not properly evolved, and memory and storage were used to describe the same thing) had the best hope of success, even though it had the disadvantage of complicated circuitry and relatively slow speed. This decision had been made by Maurice Wilkes, influenced by a technician working in the Cavendish Laboratory who had practical knowledge of mercury delay tanks. The technician had gained this experience while working for the Admiralty Signals Establishment on radar research during the war. By contrast, the Williams electron tube had few “mechanical” parts and all digits could be accessed simultaneously. By grouping a number of Williams Tubes together, large storage systems could be assembled. However, Maurice Wilkes had made his decision for delay lines and thus started the EDSAC project.

Even before Cambridge had succeeded in the task of bringing its machine to operation, Lyons started the process of design and construction of its clerical machine, which was in many ways quite different from the EDSAC and the academic needs of the university. The project, of course, included the design of software and systems, and both hardware and software design proceeded in parallel and complemented each other. Many historians have neglected to mention this, although it was a most necessary and vital part to the whole project. Much meticulous work on the mechanization aspects was undertaken by John Simmons and his O&M team, and it is not well known that the name LEO (Lyons Electronic Office) was suggested by John Simmons.

Much of the construction work was carried out by Lyons’ own skilled tradespeople at Cadby Hall, the exception being some of the more specialized work associated with delay line tube manufacture and circuit wiring, which was subcontracted and done to Lyons’ specifications.

By September 1951, a working machine had been assembled and the first clerical task was run, albeit at a slow speed. However, there were still many problems associated with speed, input/output devices, and general reliability. It was not until Christmas Eve 1953 that the world’s first full-scale clerical operation was performed—that of payroll.

The job had taken five years, more than twice the time the Cambridge researchers had taken to build EDSAC. About 18 months of this time was spent designing, testing, and installing on site the various electronic components. The rest of the time was spent designing and testing input and output circuits—more difficult than at first thought—and in finding ways of making the machine thoroughly reliable. One of the most striking features of the LEO story is the small number of people who guided the project—quite different from today’s large teams. The initial budget for the project was £100,000, and it was exceeded by £50,000.

This period had seen the birth and establishment of commercial data processing when computers were considered only the concern of mathematicians. The few who had considered their relevance to industry had usually dismissed the thought. For a few brief years, therefore, Lyons alone had the vision to realize their potential and the courage to pursue it. At no time was the project threatened with cancellation, despite the many technical difficulties and setbacks. While other companies with the technical and marketing resources waited on events, Lyons, with a small but passionately dedicated team, demonstrated what could be achieved and helped lay the foundations of a worldwide industry that has caused a revolution in information processing.

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Biographies

ERIC A. WEISS, EDITOR

Obituaries

Rear Admiral Grace Brewster Murray Hopper, first lady of software and first mother-teacher of all computer programmers, died in her sleep in her Arlington, Va., home on January 1, 1992. She was 85.
Born in New York City on December 9, 1906, Hopper received a BA in mathematics and physics from Vassar College in 1928, where she was elected to Phi Beta Kappa. Her graduate studies in mathematics at Yale University earned her an MA in 1930 and a PhD in 1934. She returned to Vassar, where she taught mathematics from 1933 to 1943. In December of that year she joined the US Naval Reserve, attended Midshipmen’s School at Northampton, Mass., and on graduation, in July 1944, was commissioned a lieutenant, junior grade. She was at once assigned to the Bureau of Ordnance’s Computation Project at Harvard University, where she was greeted by Naval Reserve Lieutenant Commander Howard Hathaway Aiken with the words, “Where the hell have you been?”

He pointed to the Harvard Mark I, said it was a computing machine, and told Lieutenant Hopper to compute the coefficients of the arc tangent series by Thursday. Thus it was that she, who later said, “I had never met a digit and I wanted nothing to do with digits,” came into the computer business, becoming, in her words, “the third programmer on the world’s first large-scale digital computer.” (The two programmers — then called “coders” — who preceded her, were Ensigns Robert Campbell and Richard Bloch.)

In addition to using the Mark I for mathematical calculations, Hopper was assigned the task of drawing together all the mimeographed notes concerning the machine into a Manual of Operation for the Automatic Sequence Controlled Calculator. This became a 500-page volume that both explained how to set up the machine and outlined the operating principles of computing machines. It was published in the spring of 1946 as Volume 1 of the Annals of the Harvard Computation Laboratory and has since been reprinted by the Charles Babbage Institute as Volume 8 of its Reprint Series on the History of Computing. Although no title page credit is given, Hopper was both the editor and a major contributor to the volume, writing both the first chapter on history and the two chapters on machine description and electromechanical circuit operation. (Extracts from the manual were published in 1946 under the authorship of both Aiken and Hopper in the AIEE magazine, Electrical Engineering, Vol. 65, pp. 384-391, 449-454, 522-528, and are reprinted in The Origins of Digital Computers, Selected Papers, edited by Brian Randell, Springer-Verlag, 1973.)

In the summer of 1945, while Hopper was working with the Mark II, the successor to the Mark I, the incident called “the first bug” occurred. A large moth had caused a relay to fail. Hopper entered the moth with scotch tape in the log book with the note, “First actual case of bug being found.” (The log book and the moth are in the Naval Museum at the Naval Surface Warfare Center in Dahlgren, Va.) It is clear from her note that she did not believe she had invented the term, which has since been traced back to at least the time of Edison, but she was humorously pleased to have found a real bug that had caused a bug in the machine. (The story appears, with a photograph of the bug, in the Annals of the History of Computing, Vol. 10, No. 4, 1989, pp. 340-342. A letter in Vol. 13, No. 4, 1991, pp. 360-361, raises a question about the date of the event.)

At the end of World War II Hopper resigned from Vassar and was appointed to the Harvard faculty as a research fellow in the Computation Laboratory. In 1949 she joined, as senior mathematician, the newly formed Eckert-Mauchly Corp., where Binac and Univac were under construction, and stayed with that firm and its successors (Remington-Rand and Sperry-Rand) until her retirement in 1971. In these years she made her major contributions to programming. Inspired by John Mauchly’s “Short Order Code” of 1949 and Betty Holberton’s first Sort-Merge Generator of 1951, she developed the first compiler, A-0 (1952) and later modified it to produce A-2 (1953). This work and her view of what programming languages ought to be like led her to the development of the first English-language data processing compiler, B-0 (Flowmatic), completed in 1957.

Her views on programming and compiling were expressed in “The Education of a Computer,” first published in the Proceedings of the ACM Conference, May 1952, and reprinted, with an introduction by David Gries, in the Annals of the History of Computing, Vol. 9, No. 3, 1988, pp. 271-281. In this paper, Hopper expressed the hope that “the programmer may return to being a mathematician.” She anticipated artificial intelligence saying, “it is the current aim to replace, as far as possible, the human brain by an electronic digital computer.” She recognized that the software would turn out to be more expensive than the hardware and foresaw that there would be the same kinds of applications in commercial programming as there were then in mathematics. The paper includes glimmerings of many tools and techniques concerning compilers that are now commonplace, including subroutines, translation of a formula, relative addressing, the linking loader, and code optimization. In the paper she also anticipated symbolic manipulation.

In the opinion of some who were there at the time, had Remington-Rand supported Hopper’s efforts more vigorously and exploited her programming developments with the skill and force with which IBM was then exploiting Fortran, Hopper might have saved her employer from being overtaken by others in the industry.

Grace Hopper’s involvement with Cobol was indirect, through her subordinates who served on the committee that developed the Cobol specifications, and through Flowmatic. The influence of Flowmatic on Cobol was enormous because it was the only English-language business data processing language in use at the time that the Cobol effort started. As such, Flowmatic served as a model on which to build and augment with inputs from other sources.

Biographies

Hopper was an early member of the Association for Computing Machinery and served on its council. In 1957 she edited its first *Glossary of Computing Terms*, the discipline's first authoritative dictionary. For several decades she was the most requested speaker of all those on the ACM lecture circuit. Her talks, which were both educational and highly entertaining, are still remembered for the physical representations she would give to abstract concepts, such as the short piece of wire she would hold up to represent a nanosecond. In speaking of the future, she early expressed her hope that she would one day have a computer the size of a shoe box — this at a time when computers occupied several rooms.

Throughout her life Hopper was active in the US Naval Reserve. In 1946 she was put on inactive status only to be recalled to active duty in August 1967 to help the Navy with its manifold computing problems. She was promoted successively through the ranks and after the regular retirement age of 62 was given repeated year-to-year extensions to stay on active duty until her final retirement as rear admiral, the rank she received as a special presidential appointment on November 8, 1985. Her retirement ceremony took place aboard the USS Constitution, the oldest warship still in commission in the US Navy. At her retirement she was given the Distinguished Service Medal.

Hopper had honorary degrees from more than 40 colleges and universities. She received the first Computer Science "Man of the Year" award from the Data Processing Management Association (1969), the Harry Goode Memorial Award from AFIPS (1970), and the Wilbur Lucius Cross Medal from Yale (1972). In September 1991 she was awarded the National Medal of Technology "for her pioneering accomplishments in the development of computer programming languages that simplified computer technology and opened the door to a significantly larger universe of users." She was the first woman to receive the award as an individual.

She always wanted to help young people and she took great pride in the fact that in 1971 Sperry-Rand created the Grace Murray Hopper Award, which is presented annually by ACM to a distinguished young computer professional. She considered her best biography to be *Grace Hopper, Navy Admiral and Computer Pioneer*, by Charlene W. Billings (Enslow Publishers, 1989), which she hoped would encourage girls to look to careers in computing and in the Navy.

Her talent, vision, dedication, and persistence laid the foundation for computing as we know it and helped to guide it in its explosive growth. She was always a teacher, battling the entrenched attitudes of what she always called "the establishment." She could always give a humorous twist to the presentation of her ideas. For example, she hated the phrase, "but it's never been done that way," and, to remind visitors of this dictum, she kept a ship's clock on the office wall behind her desk — it ran backward.

At the time of her death she was employed as a senior consultant at Digital Equipment Corp., and until mid-1990 was actively representing the company at industry forums, making presentations that focused on government issues and participating in corporate educational programs.

Admiral Hopper was sometimes called "Amazing Grace" because she recorded successful careers in academia, business, and the US Navy while making history in the computer field. Just as Admiral Hyman Rickover is considered the father of the nuclear navy, Admiral Hopper was the mother of computerized data automation in the naval service.

Grace Hopper was buried at Arlington National Cemetery, Arlington, Va., on January 7, 1992, with full Navy ceremony. She is survived by her brother, Roger Murray II: a sister, Mary Murray Westcote; and numerous nephews and nieces.

Ida Rhodes (1900-1986), mathematician, pioneer programmer, and language-translation specialist, died of congestive heart failure and stroke February 1, 1986, in Rockville, Md. She was 85.

Rhodes was born Hadassah Izkowitz on May 15, 1900, in a Jewish village between Nemirov and Tulein in the Ukraine about 150 miles southwest of Kiev. Her stories of her youth were not those of the poverty described in *Fiddler on the Roof*. Instead she told of a Russian countess who owned, she said, about ninety-nine communities:

She [the countess] was a great naturalist and set up a school for the poor of the area. She was very kind and wanted to adopt me. I said that was impossible; that I already had a family. Nevertheless, she often had me as a house guest and arranged for the finest of kosher food for me. She took me riding and showed me plants and explained what I could expect of the plants' development by the next time we visited. There was an island we visited in one of her parks where the swans nested. The lady was careful to instruct me never to touch the swan eggs or the mother would disown them.

After Rhodes had left Russia, at the time of the Bolshevik Revolution, the communities sent a delegation to the local Soviet, urging good treatment for the countess and, for a while, she was spared.

Rhodes' parents, David and Bessie Sinkler Izkowitz, brought her to the United States in 1913, where she attended Cornell University (1919-1923). She was elected to Phi Beta Kappa in 1922 and received her BA in mathematics in February 1923 and her MA in September of the same year. She later studied at Columbia University (1930-1931).

One of the stories she told about these years involved Einstein. About 1936 she joined a group of mathematicians who each weekend piled into their cars to race to Princeton to spend weekends in informal seminars with Albert Einstein (she carefully pronounced it "Einstein"). When she entered with the others, Einstein looked at her a moment and said, "It must have been in 1922 that we first met at Cornell. Have you learned to talk since then?" At the earlier meeting Rhodes had been so impressed with Einstein's reputation that she had said practically nothing.
Rhodes held several positions involving mathematical computations before she joined the Mathematical Tables Project (MTP) in New York City in 1940. MTP was a particular effort of the New Deal within the Works Projects Administration to relieve unemployment among mathematicians by setting them to work creating mathematical tables using pencil, paper, and desk calculators. (See *Annals of the History of Computing*, Vol. 11, No. 1, pp. 52-52, 1988.) It was sponsored by the National Bureau of Standards and later supported by the Office of Scientific Research and Development. After the war, in 1946, MTP became the NBS Computation Laboratory.

In 1947 Rhodes' supervisor in New York told her to go to NBS in Washington and learn what she could about the new efforts by NBS to develop electronic computers. After a week there, she was so disappointed with her own incapacity, as she saw it, that she returned to New York and scolded her boss for having humiliated her. He told her to pack again, that the Washington people had been very much impressed and wanted her to work with them in the bureau’s development and procurement of automatic electronic digital computers.

The purpose and first five years of progress of this part of NBS, set up in July 1947 as the National Applied Mathematics Laboratories (NAML), are described in a contemporary paper (1953) by John H. Curtiss, its chief. The paper was long neglected in NBS and finally printed in the *Annals of the History of Computing*, Vol. 11, No. 2, 1989, pp. 69-98, with a curious explanation of the neglect—an explanation that tells much about the temper of the times.

In this paper, Curtiss specifically identifies Rhodes as one of those in the Machine Development Laboratory (MDL) of NAML who was most active in offering consulting and advisory service to the many government agencies (in this period Rhodes was moved from MDL to the administration of NAML as a consultant). In addition to this work, she was a pioneer in the analysis of systems of programming. She designed the C-10 language in the early 1950s for the Census Bureau Univac I and designed the original computer program used by the Social Security Administration. She was a pioneer in the application of computers to language translation, being one of the first to recognize the importance of parsing sentences and separating the roots of words from their prefixes and suffixes as initial steps in the process.

As mentioned by Curtiss, she gave orientation lectures on computers to government agencies and private firms, explaining how computers could enable them to do their work better, more easily, and faster. She taught computer coding techniques, including special classes for the physically handicapped, for example, deaf mutes and the totally blind. She also taught Russian within NBS, as she is shown doing in the accompanying photograph, and lectured widely on computers and their applications.

In 1949 the Department of Commerce awarded her an Exceptional Service Gold Medal for “significant pioneering leadership and outstanding contributions to the scientific progress of the nation in the functional design and application of electronic digital computing equipment.”

Rhodes formally retired from NBS in 1964 but continued to be active as a consultant in the Applied Mathematics Division until 1971. In retirement Rhodes maintained an immense worldwide correspondence.

In 1976 the Department of Commerce gave her a Certificate of Appreciation “on the occasion of the 25th anniversary of Univac I in recognition of your services to the Information Revolution.” At the 1981 ACM Computer Conference in Chicago she was cited as a Univac I pioneer.


Rhodes’ benevolences went beyond generous gifts to Hebrew charities to the extent of a 1977 gift to NBS for azaleas and rhododendrons to be planted near the Administration Building in honor of the three directors under whom she served, Lyman J. Briggs, Edward U. Condon, and Allen V. Astin.

A friend of Rhodes reported that Golda Meir (later prime minister of Israel), who used to live in Rhodes’ New York apartment house, had urged Rhodes to go to Israel. The friend remarked that if it had not been for Rhodes’ dedication in caring for her aging parents Rhodes might have done her main work in Israel.

As she aged, Rhodes’ heart condition required that she conserve her energy, so she cut back on phone calls and correspondence, finally moving to a nursing home. As reading became more tiring, she comforted herself with the comment that the dimming of her eyes had a compensatory benefit: She couldn’t see so many of the wrinkles on her face.

*Prepared from information furnished by Robert L. Birch, Israel Rotkin, and John Todd.*