Publisher's Note

Computer Technology Innovators profiles the most innovative and influential individuals in the development of computer technology and the evolution of the Internet, many who have never been covered in any Salem Press set before. From the genesis of the World Wide Web in 1989 as a way to organize and manage data to the founding of the world's largest Internet retailer, Amazon.com, in 1994, to the first documented tweet in 2006, the history of the Internet is immeasurably rich, with milestones that have revolutionized our society. This new title examines those individuals most responsible for the technology and strategies behind the Internet today, from the pioneering community of engineers and intellectuals who worked to realize a vision of shared networks and research, to the dot-com founders and leaders driving business and commerce today.

Scope of Coverage

Computer Technology Innovators features more than 120 biographies of individuals who have had a significant influence on the development of computer technology, culminating with the advent of the Internet and beyond, with an emphasis on early pioneers such as inventors and engineers and influential founders and executives of computer companies. Each essay has been written specifically for this set; biographies represent a strong, global, cross-gender focus, with accompanying sidebars describing the company, organization, online service, or website with which that individual is most often associated. Among the editors' criteria for inclusion in the set was an individual's historical significance, whether through their respective company's influence in the Internet world or their role in the development and evolution of the Internet itself; his or her relevance to academic curriculum; and his or her appeal to high school and undergraduate students and general readers.

Essay Length and Format

Each essay is approximately 2,000 words in length and displays standard reference top matter offering easy access to the following biographical information:

- The name by which the subject is best known.
- A succinct description of each individual's nationality and occupation.
- The most complete birth and death dates, followed by the most precise locations of those events available.
- The areas of achievement, including primary field and specialty, with which the subject is often most closely identified. This latter is an all-encompassing categorical list and includes: mathematics and logic; physics and engineering; computer software; computer hardware; computer programming; security; Internet; management, executives, and investors; marketing; commerce; social media; content and data; applications; news and entertainment; and ethics and policy.
- The primary company or organization with which the individual has been associated in a meaningful way.
- A synopsis of the individual's historical importance in relation to computer technology and the evolution of the Internet, indicating why the person is or should be studied today.

Each essay concludes with a byline for the contributing writer. The bodies of the essays are divided into the following parts:

- Early Life provides facts about the individual's upbringing. Where little is known about the person's early life, historical context is provided.
- Life's Work, the heart of the article, consists of a straightforward, generally chronological account of how the individual gained recognition in his or her chosen primary field (applied science; computer science; business and commerce; and Internet), emphasizing the most significant endeavors and achievements—and failures—of the figure's life and career.
- Personal Information provides closing remarks on the person, including post–achievement activities or positions, family life, and topics of general interest.

Each essay also includes an annotated Further Reading section that provides a starting point for additional research.

Special Features

Several features distinguish this series as a whole from other biographical reference works. The back

matter includes the following aids, appendices, and indexes:

- Timeline: presents a comprehensive time line of milestone events that represent a concise history of the Internet, both theoretical and commercial in scope.
- General Bibliography: offers an extensive list of resources relevant to the study of the history of computer technology and the Internet.
- Biographical Directory: an annotated and concise listing of those individuals featured in the volume.
- Category Index: profiles figures by area of primary field or specialty.
- Company Index: lists the individuals associated or affiliated with a company or organization, in many capacities.
- Index: provides a comprehensive index including personages, scientific and computer-related concepts and discoveries, technologies, terms, principles, and other topics of discussion.

Other features include:

- Sidebars: A highlight of this publication and key feature of every essay, the sidebars describe the company, organization, online service, or website for which each profiled person is best known. Sidebars also describe why the organization or company was influential within a particular field.
- Images: More than eighty illustrations appear with the essays.

CONTRIBUTORS

Salem Press would like to extend its appreciation to all involved in the development and production of this work. The essays have been written and signed by writers and scholars of history, the sciences, and other disciplines related to the essays' topics.

A

Howard H. Aiken

Designer of the Harvard Mark I computer

Born: March 8, 1900; Hoboken, New Jersey
Died: March 14, 1973; Palo Alto, California
Primary Field: Computer science
Specialty: Computer hardware
Primary Company/Organization: IBM

Introduction

In the late 1930s, college professor Howard H. Aiken sold International Business Machines (IBM) on developing the digital computer he had designed. Although other claimants exist, Aiken, according to historians, has the strongest claim of any of the contenders to the title of inventor of the digital computer. His Automatic Sequence Controlled Calculator was the progenitor if not the prototype of the modern computer.

Early Life

Born in Hoboken, New Jersey, to Daniel and Margaret Emily Mierisch Aiken, Howard Hathaway Aiken grew up in Indianapolis, Indiana. To help support his family he took a night job as a switchboard operator for the local utility. The school superintendent, Milo Stewart, hearing that Aiken was working the twelve-hour-shift night job as well as attending school, allowed Aiken to test out of classes to cover a shortage of credits and graduate early. He graduated from Arsenal Tech's first graduating class. Stewart also wrote recommendations to every public utility in the university town of Madison, Wisconsin, where Aiken found a job as a telephone operator. He moved there with his mother, establishing her in her own apartment while he roomed with two or three others. In 1919, Aiken began attending the University of Wisconsin, graduating in electrical engineering in 1923. After graduation, he took a job at an electric plant and worked in Madison, Chicago, and Detroit until 1932. Graduate work at the University of Chicago and Harvard University came later; Aiken received an A.M. from Harvard in 1937 and his Harvard doctorate in physics in 1939. His mother traveled to Cambridge with him and remained there while Aiken was on the faculty, even after his postwar marriage. She prepared a

Howard H. Aiken.

hot lunch for him every day. Aiken said it was a good way to guarantee that she had at least one meal a day. Aiken became assistant professor and naval lieutenant commander in 1941.

Life's Work

In graduate school, Aiken became aggravated by the time it took to do the computations involved in differential equations integral to his electronics studies. Thinking that he and other scientists could better spend their time on real problems than on simple arithmetic, Aiken decided to invent a machine to handle the simple tasks. It was a bit harder than merely collecting parts and putting them together, however.

Aiken read the work of Charles Babbage and used it as the basis for his design. Aiken began working on the machine in 1935, when he joined the Harvard staff as instructor in physics and communications engineering. The machine required two years of theoretical work and six years of construction. Aiken was a naval reserve officer on leave to Harvard for the project.

In 1937, he developed a way to identify numbers in binary code using the on/off characteristic of electrical relays. Beginning work in 1939, Aiken made his machine as simple as he could while getting it to use positive and negative numbers, sines and other mathematical functions, and common mathematical sequences. Operation had to be automatic in what IBM labeled the Automatic Sequence Controlled Calculator, more familiarly the Mark I.

Aiken's colleagues thought the calculator would be far too expensive to build and directed him to IBM, a major manufacturer of accounting machines, tabulators, calculators, and other office machines. IBM used punch card technology, accumulated data, and transferred data across devices as accounting tools. IBM was the only company in the world that had the expertise and components that Aiken needed. Later machines—for instance ENIAC (the Electronic Numerical Integrator and Computer)—would be created through custom parts, but Aiken took IBM's experience and parts and used them for his new device.

Aiken met with James Bryce, holder of more than 500 patents, and the two broached the idea of the ASCC to IBM president Thomas Watson. IBM agreed to fund two-thirds of the bill, and the government financed the other third of the half-million-dollar project. IBM took on a project well beyond anything it had attempted before. It required new engineering and design, not just assembly from off-the-shelf parts. Aiken was more attuned to broader concepts, and he had no particular interest in the nuts and bolts.

There were few mechanical calculators in existence in 1943, when, as a Harvard professor, Aiken contacted IBM. His Automatic Sequence Controlled Calculator (ASCC) had no keyboard or screen. It was powered by electricity and used punch cards to give commands and magnetic switches to perform the computations at speeds impossible for humans. The ASCC debuted in 1943. Called the Mark I, it added, subtracted, divided, and multiplied to 23 decimal places and referred back to its earlier results. It gave access to multiple users simultaneously (at least two). It weighed 35 tons, stood 8 feet tall, and required 500 miles of wire and most of the space in a laboratory at Harvard. It had 750,000 parts, was 5 inches thick, and had 3,000 relays that clicked noticeably, making the Mark I in operation sound like a knitter's convention. Operations entailed working with 1,400 switches and running four punched paper tapes, but the machine could add or subtract 23-digit numbers in 0.3 second, multiply in 4 seconds, and divide in 12 seconds. Aiken and several IBM employees shared the patent.

Although journalists called it an electronic brain, the Mark I had no electronics but was instead an electromechanical device. Slow by modern standards, the Mark I nevertheless began the modern computing industry and made the United States its world leader.

Later designs—the Mark II, III, and IV computers—were more streamlined. The Mark series enabled the U.S. Navy to calculate trajectories for bombs and missiles during and after World War II. It appeared to be a mechanical brain, a threat to humanity, but it did relieve human beings of massive amounts of drudge work.

The Mark II's data relay switch failed because of a dead moth between two contacts. After that, any correction to a computer was referred to as "debugging."

Bryce was the only person at IBM whom Aiken respected and for whom he had no harsh words. Watson had a deep respect for the Ivy League and a strong commitment to using his company for the betterment of humanity. However, as head of IBM, a major business, Watson was not inclined to bend to Aiken, who also was not inclined to compromise. According to Ralph Niemann, who worked with Aiken in Dahlgren, Virginia, Aiken was "fiercely independent and dynamic." Working at IBM's labs in Endicott, New York, he encountered friction: Aiken and IBM each regarded the other as taking too much credit for the machine.

Aiken was also practical, however, asking interviewee mathematicians if they knew how to handle a

Affiliation: IBM

IBM is commonly defined as the brainchild of Thomas J. Watson, Sr., in 1914, but arguably its roots go back to the 1870s, when Herman Hollerith found a solution to the long-standing problem of counting census data. Hollerith's punch card equipment debuted in the 1890 census. By 1911 Hollerith was ready to sell his company, and the firm merged with two others to form IBM, with Watson coming on as head of the new business in 1914. Watson took a small entrepreneurial company and made it into a vertically integrated behemoth dominating business machines through aggressive research and development in business areas through the Depression and World War II. After the war, computing shifted to from electromechanical to electronic technologies, and IBM found itself struggling until Thomas Watson Jr., brought out the company's first electronic machine, with the System 360 dominating from the 1960s through the 1980s. Complacency and difficulties turning the *Queen Mary* of computing companies led IBM to struggle in the 1980s and later as small and innovative start-ups moved faster into new technologies.

screwdriver. He was available night and day for workers who encountered problems and understood the importance of what he was doing in pioneering large-scale computers. He considered himself not only a designer but also a teacher and molder of people. He initially believed that the computer would be suited only for mathematical uses, but he came to recognize that it had business applications as well. Aiken's Mark II, known as the Aiken Relay Computer, was developed for the Naval Surface Weapons Center in Dahlgren. The Mark II and Mark III were built at a combined cost of $2 million. When designing computers Aiken sought to balance the speed of the calculator with the capacity of the input-output devices.

When Harvard opened a new computer facility, later named for Aiken, Aiken was its first director. He was also instrumental in establishing university-level computer science. Courses in computer science began at Columbia in 1946–47, the year before they did at Harvard. In 1947, Aiken established the first master's program focusing on computing machines, a precursor to the computer science program. Many of Aiken's students went on to become key figures in the development of computing.

The ASCC was known in Nazi Germany, and in the 1950s preparers of lineages and family trees of computing commonly gave the ASCC a prominent position as the first, with Aiken as the inventor. When he received the initial Harry Goode Memorial Award for Outstanding Achievement in the Field of Computing, it recognized his major impact on the field, as did the 1965 renaming of the Harvard center for him.

Personal Life

Aiken's personality clash with Watson led him to deny Watson's involvement in the development of the ASCC. When he retired, he moved to Fort Lauderdale, where he received a distinguished professorship from the University of Miami. He developed the university's computer center and computer science program. He became a consultant, founding Howard Aiken Industries Incorporated, and specialized in taking over and reviving struggling businesses and then selling them. He also consulted for Lockheed Missiles and Monsanto. He developed a method of encrypting data for information security.

Aiken had married Lousie Mancill in 1939. After they divorced in 1942, he married Agnes Montgomery, a Latin teacher. He divorced Agnes and married his final wife, Mary McFarland. He had two children: Rachel Ann by his first wife and Elizabeth (Betsy) by his second.

Aiken was 6 feet, 4 inches tall with a large head and an intimidating presence. He had a quick temper and could be difficult to work with. Isaac Auerbach tells the story of how, while taking a course at Harvard with Aiken, he sought summer employment with J. Presper Eckert and John Mauchly's Electronic Control Company in Philadelphia. Aiken had a with-us-or-with-the-enemy attitude and apparently a jealousy of Eckert and Mauchly because their ENIAC was competing successfully with his Mark I. From that point Auerbach was a pariah, shunned by Aiken on contact, until finally Auerbach moved to Burroughs, at which point Aiken renewed his friendship with Auerbach.

Aiken also had a soft side, however, and was regarded by many as affable, sociable, and generous. When John Harr was a graduate student in mathematics, Aiken initially turned him down for a job as a programmer because he preferred not to work with graduate students and others who could not commit to programming full time. Aiken relented after Harr returned and, not mentioning graduate school, said he needed work and would study as time permitted. Harr

got the job and the degree and worked for Aiken for eight years.

While on a business trip to St. Louis, Aiken died on March 14, 1973. He was seventy-three years old.

John H. Barnhill

Further Reading

Bonasia, J. "Aiken, the Computer Master." *Investor's Business Daily* 18 July 2008: n. pag. *Business Source Complete*. Web. 30 Apr. 2012. A brief overview of Aiken's invention of the Automatic Sequence Controlled Calculator.

Cohen, I. Bernard. *Howard Aiken: Portrait of a Computer Pioneer*. Boston: MIT, 2000. Print. Biography of Aiken by a colleague at Harvard acknowledges Aiken's contributions but also indicates that the development of the digital computer was more than a one-person effort.

Cohen, I. Bernard, Gregory W. Welch, and Robert V. D. Campbell, eds. *Makin' Numbers: Howard Aiken and the Computer*. Boston: MIT, 1999. Print. Full of Aiken's work, including the technical element.

Esmenger, Nathan L. "*Howard Aiken/Makin' Numbers*." *Business History Review* 73.4 (1999): 761. Print. Reviews Cohen's biography as well as the companion piece, Cohen's coedited collection of essays *Makin' Numbers*. The focus is on technical development of the ASCC, the Harvard Mark I, and Aiken's role in developing computer science as a discipline.

Karwatka, Dennis. "Howard Hathaway Aiken." *Tech Directions* 55.9 (1996): 12. *Business Source Complete*. Web. 27 Apr. 2012. Profiles Aiken's career.

Pugh, Emerson. *Building IBM: Shaping an Industry and Its Technology*. Boston: MIT, 1995. Print. Traces the history of the company through the 1990s.

Frances E. Allen

First woman to win the A. M. Turing Award

Born: August 4, 1932; Peru, New York
Died: -
Primary Field: Computer science
Specialty: Computer programming
Primary Company/Organization: IBM

Introduction

Frances E. Allen, an American computer research scientist and pioneer in computing, spent nearly half a century working on compilers and high-performance computing systems. Her work led to technologies that formed the foundation for the theory of program optimization and contributed to the use of high-performance computers in weather forecasting, DNA matching, and national security-code breaking. Allen was among the first women recognized for her role in the technical aspect of computing. Her many awards include being named an IBM Fellow and winning the A. M. Turing Award; she was the first woman to be so honored with both titles.

Frances E. Allen.

Early Life

Frances Elizabeth "Fran" Allen was born August 4, 1932, in Peru, New York, a few miles south of the Canadian border. The oldest of six children, four boys and

Timeline

These milestone events below represent a concise history of the Internet, both theoretical and commercial in scope.

Date	Milestone
1957	After the Soviet Union launches Sputnik 1, the United States forms the Advanced Research Projects Agency (ARPA) to create a communications network that links the country in the event that a military strike renders conventional communication useless.
1961	"Information Flow in Large Communications Nets," a paper by computer science professor Len Kleinrock, is published; it outlines packet switching, which groups together transmitted data into suitably-sized blocks.
1965	At the federally-funded MIT Lincoln Laboratory, a research center dedicated to the application of advanced technology, the first network experiment for ARPA is conducted. During the experiment, two computers interacted with each other using packet switching technology.
1969	The Advanced Research Projects Agency Network (ARPANET), considered the predecessor of the Internet, is commissioned by the Department of Defense for research into networking. To many, this marks the official "birth of the Internet."
1969	The first APRANET message—"Lo"—is sent in an attempt to spell log-in, but the system crashed.
1972	Electronic mail is introduced by Ray Tomlinson, a computer engineer from Cambridge, Massachusetts. He used the @ sign to distinguish between the sender's name and the name of the network.
1973	The term "Internet" first came into modern usage.
1973	The first international connections to the APRANET are established to the University College of London and the Norwegian Seismic Array, or NORSAR (Norway).
1974	The first Internet Service Provider (ISP) is created with the introduction of a commercial version of APRENET called Telenet.
1975	The first all-inclusive email program is introduced, providing replying, forwarding, and filing functionalities and options.
1975	Often attributed as the first personal computer (PC), the Altair 8800 is introduced and is surprisingly sold in high quantities. Because of the computer's surprising sales and because it used Microsoft's first product (Altair BASIC), the introduction of the microcomputer becomes an important milestone in the personal computer revolution.

Biographical Directory

The following list briefly summarizes the achievements of the innovators covered in this publication.

A

Howard H. Aiken: In the late 1930s, college professor Howard H. Aiken sold International Business Machines (IBM) on developing the digital computer he had designed. Although other claimants exist, Aiken, according to historians, has the strongest claim of any of the contenders to the title of inventor of the digital computer. His Automatic Sequence Controlled Calculator was the progenitor if not the prototype of the modern computer.

Frances E. Allen: Frances E. Allen, an American computer research scientist and pioneer in computing, spent nearly half a century working on compilers and high-performance computing systems. Her work led to technologies that formed the foundation for the theory of program optimization and contributed to the use of high-performance computers in weather forecasting, DNA matching, and national security-code breaking. Allen was among the first women recognized for her role in the technical aspect of computing. Her many awards include being named an IBM Fellow and winning the A. M. Turing Award; she was the first woman to be so honored with both titles.

Paul Allen: Known by the public as a cofounder of the software giant Microsoft, Paul Allen played an active role in the company until 1983, when his role ended for health reasons. Since that time, he has become a major player in a number of venues by investing in computer technologies, medical research, space and oceanic exploration, entertainment, and sports. Allen and his sister Jody founded the Paul G. Allen Family Fund to promote community projects in the Pacific Northwest. He also built the Paul G. Allen School for Global Animal Health at Washington State University. Allen owns the Seattle Seahawks football team and the Portland Trail Blazers basketball team and is part owner of the Seattle Sounders soccer team. He also owns a yacht, the Octopus which he sails annually to the Cannes Film Festival, where he hosts lavish parties for celebrities.

John Vincent Atanasoff: One of the fathers of the computer, John Vincent Atanasoff was an Iowa State College professor whose work in the 1930s and 1940s culminated in the first electronic digital computer: the Atanasoff-Berry Computer (ABC), designed with his student Clifford E. Berry. The ABC included numerous features that would become synonymous with computing, although it lacked a central processing unit (CPU). ABC's significance was not immediately recognized; it was only through a later patent case, showing that the patent sought actually derived from Atanasoff's work, that Atanasoff's seniority in the burgeoning field was established. Atanasoff was later placed in charge of designing a large-scale computer for the Naval Ordnance Laboratory and designed systems for the Navy's Operation Crossroads, a series of atomic bomb tests at Bikini Atoll.

B

Charles Babbage: Charles Babbage was the inventor of the difference and analytical engines, which became the forerunners of the modern computer. The difference engine employed the first example of computer language on record. Babbage was considered a major voice in the school of thought that sought to apply scientific methods to commerce during the Industrial Revolution, and his ideas were implemented in the development of tools and in manufacturing and engineering techniques. Although Babbage was recognized as a mathematical genius during his lifetime, his work failed to win him widespread fame. He often suffered ridicule at the hands of his contemporaries because he was so far ahead of his time. It was not until the computer age, during the last quarter of the twentieth century and nearly a century after his death, that Babbage was finally given his due as the creator of the first mechanical computer. As a result, he is now alternately known as the father, the grandfather, and the godfather of modern computing.

John Backus: John Backus's work at IBM revolutionized computer programming. In the 1950s, he assembled and led the team that developed Fortran, the first high-level programming language, one rigorous enough to remain in use today. In the course of doing

Company Index