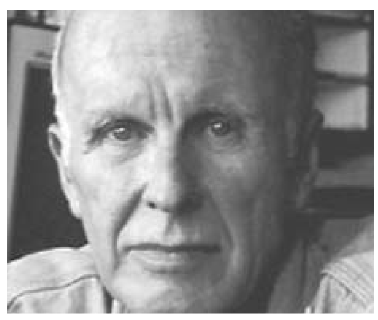
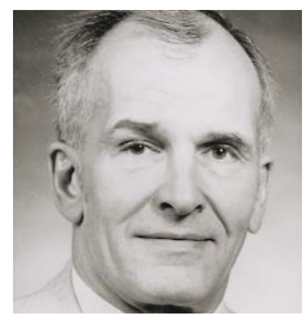
2002 INDUCTEES

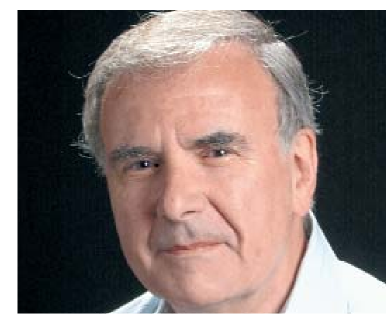
Edwin Armstrong
Radio's premier inventor, Armstrong created the electronic circuits that form the foundation of all modern radio, radar, and television technologies: the regenerative circuit, the superheterodyne circuit, and a complete FM system. While a junior at Columbia University, he designed a regenerative circuit that became the first radio amplifier and the key to the continuous-wave transmitter. As a U.S. Army Signal Corps officer in Paris during World War I, Armstrong adapted a little-used technique called heterodyning to design a receiver that amplified weak signals to a previously unheard-of degree. The superheterodyne circuit remains the basic component in virtually all radio and television receivers. In 1933, Armstrong's wide-band FM system provided clear reception through the most violent storms and the highest fidelity yet heard in radio.



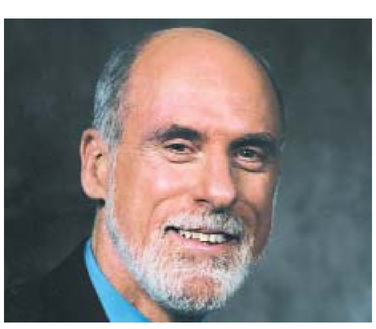
John Backus
Working at IBM in 1949, Backus invented "speedcoding," the first program to include a scaling factor. This enabled the easy storage and manipulation of both large and small numbers. In late 1953, he was given the go-ahead to design a programming language for IBM's new 704, which had a built-in scaling factor, also called a floating point, and an indexer, which significantly reduced run time. For Backus and his team of programmers and mathematicians, the real challenge was coming up with a way to translate that language into something the computer could understand while eliminating the laborious hand-coding that had hampered programming. They came up with the IBM Mathematical FORmula TRANslating System, or FORTRAN. Designed for mathematicians and scientists, FORTRAN remains the pre-eminent programming language in those fields.



Paul Brokaw
Inventor of the "Brokaw cell," a bandgap voltage reference technique that resulted in monolithic voltage references, Brokaw has designed a wide variety of leading-edge products. These include analog-to-digital and digital-to-analog converters, sensors, voltage references, amplifiers, power-management circuits, and application-specific ICs. Long before these achievements, he cultivated his versatility by designing geophysical instrumentation and earth satellite and planetary probe instrumentation. In 1963, Brokaw joined Arthur D. Little Inc. as a circuit design consultant to industrial, scientific, and government clients. In 1971, he joined Nova Devices, which became the semiconductor division of Analog Devices. Holder of nearly 90 U.S. patents in analog IC designs, Brokaw now concentrates on developing new products and engineering resources for Analog Devices.



Hans Camenzind
In 1970, Camenzind founded Interdesign Inc., the first company to develop, manufacture, and market semicustom ICs. During the company's startup phase, Camenzind conceived and designed several standard linear ICs, notably the 555 timer for Signetics, which has become the highest-volume IC. He also developed the concept of the phase-locked loop for ICs for Signetics. For Intersil, he conceived and designed the 8038 waveform generator. Camenzind sold Interdesign to Ferranti (GEC Plessey) in 1977. Since 1978, Camenzind has been responsible for the development of linear ICs (bipolar and CMOS) at Array Design Inc. Designer of more than 100 standard, custom, and semicustom linear ICs, and holder of 20 patents on linear ICs, Camenzind has written more than 25 articles and two books on linear circuit and system design.



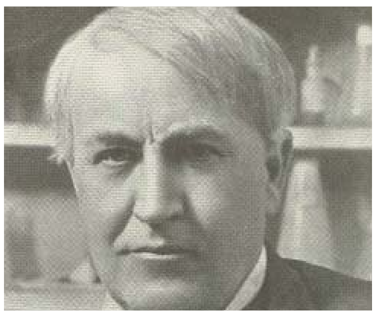
Vinton Cerf
Recognized as one of the "fathers of the Internet," Cerf co-designed (with Robert E. Kahn) TCP/IP. This computer networking protocol was used for communications between the diverse university, government, and commercial data networks known collectively as the Internet. From 1976 to 1982, Cerf played a key role at the U.S. Department of Defense's Advanced Research Projects Agency, where he sponsored the development of Internet and Internet-related data packet and security technologies. As vice president of MCI Digital Information Services from 1982 to 1986, Cerf acted as the chief engineer of MCI Mail, the first commercial e-mail service connected to the Internet. Currently senior vice president of architecture and technology for WorldCom, Cerf leads a team in designing advanced networking frameworks.

Seymour Cray
Cray devoted his entire career to the design of large-scale computer equipment. In 1957, he helped found Control Data Corp. He was responsible for the design of that company's most successful large-scale computers: the CDC 1604, the CDC 6600, and the CDC 7000. In 1972, Cray founded Cray Research to design and build the highest-performance, general-purpose supercomputers, notably the Cray-1, which established a new standard in supercomputing in 1976. In 1981, Cray relinquished his position as chairman of the board to devote himself full-time to the design of the Cray-2, which was introduced in 1985. Cray invented of a number of large-scale computer technologies, including the Cray-1 vector register technology, the cooling techniques for the Cray-2, the CDC 6000 freon-based cooling system, and a magnetic amplifier for ERA.

Bob Dobkin
Dobkin developed the first three-terminal adjustable voltage regulator and the first bipolar low-dropout regulator. He has been involved in designing high-performance linear ICs for more than 30 years, from boosting the speeds of early operational ampifiers to generating many industry-standard circuits. Dobkin was director of advanced circuit development at National Semiconductor for 11 years until 1981, when he co-founded Linear Technology Corp. to design, develop, and manufacture proprietary high-performance analog ICs. As vice president of engineering and chief technical officer at Linear, Dobkin spearheaded all new product development until 1999. A graduate of the Massachusetts Institute of Technology, Dobkin holds more than 50 patents pertaining to linear ICs and has written more than 50 articles and papers.

William Dubilier
The mica capacitor—a Dubilier design that revolutionized wireless communications—was inspired by a demonstration of a wireless telegraph transmitter by Guglielmo Marconi. The transmitter required more than 50 Leyden jars for circuit capacitance. Dubilier's mica capacitor was sturdier, more efficient, smaller, and lighter than the Leyden jar. It made smaller electronic equipment possible. Dubilier became chief electrician of the Continental Wireless Co. at the age of 19. In 1915, he founded Dubilier Condenser Corp. of New York, where he pioneered the development of self-healing, metallized dielectrics for capacitors, high-voltage transmitting capacitors, and antenna-shortening capacitors. Dubilier was granted more than 355 patents. In 1933, Dubilier's company merged with the Cornell Electric Company to form the Cornell-Dubilier Electric Corp.

2002 INDUCTEES



Thomas Edison
To say that Edison was a major influence on life in the 20th century is an understatement. In 1877, Edison worked on a telephone transmitter that significantly improved on Alexander Graham Bell's work by allowing voices to be transmitted more clearly at higher volume. His experiments led to his invention of the phonograph later that year. In 1878, Edison turned to development of a long-lasting incandescent light bulb, then an entire light system that could be supported in a city. In 1888, Edison charged his associate, William K.L. Dickson, to invent a motion picture camera. Dickson developed a device that recorded images on a celluloid strip. In 1891, patent applications were made for the camera, called the kinetograph, and a motion picture peephole viewer. The holder of an astounding 1093 patents, Edison successfully manufactured and marketed his inventions.

John M. Fluke Jr.
In 1936, when Fluke was completing his master's of science degree in electrical engineering at the Massachusetts Institute of Technology, he developed a unique power meter. In 1949, Fluke launched the John Fluke Engineering Co. in the basement of his Connecticut home. The first product introduced by his new company was the power meter that he had developed at MIT. Fluke sold the product to his first employer, General Electric, and the modest startup company was on its way. Fluke relocated his company in his native Pacific Northwest in 1952, and three years later he introduced the first differential voltmeter. Under Fluke's leadership, first as president and later as chairman of the board, the company expanded to become a world leader in the development and manufacture of compact, professional electronic test and measurement tools.

David Fullagar
In 1968, three years after he emigrated from Scotland to take a job with Fairchild Semiconductor, Fullagar designed the first compensated operational amplifier. Almost 35 years later, the µA741 remains the industry standard. With its unique, fixed internal compensation capacitor, the µA741 requires no external components. But Fullagar was far from done. Subsequently, he joined Intersil as the company's first IC designer, then went on to become the company's manager of European operations and vice president of research and development. In 1983, Fullagar co-founded Maxim Integrated Products, along with Jack Gifford and Fred Beck. As vice president of R&D and vice president of applications, Fullagar was instrumental in helping Maxim to secure its position as a major contributor to the design, development, and manufacture of linear and mixed-signal ICs.

Bernard M. Gordon
Acknowledged as the "father of high-speed analog-to-digital conversion," Gordon began his career auspiciously at the Eckert-Mauchly Computer Co., where he contributed significantly to the development of Univac, the world's first digital computer. At 26, he co-founded and set the technical direction for EPSCO Inc., inventing data-acquisition and telemetry systems based on his pioneering work in pulse-code modulation and analog-to-digital conversion. In 1964, he founded Gordon Engineering, whose products included the first solid-state X-ray generator. Gordon went on to found Analogic Corp. in 1969. Under his leadership, Analogic has conceived and developed major advances in data acquisition, medical electronics, industrial monitoring and control, special-purpose computation, automated test equipment, and digital communication. He remains chairman of the board and executive chairman.

Andrew S. Grove
Recognized worldwide as the guiding force behind Intel Corp., Grove began his engineering career in 1963 at Fairchild Semiconductor's R&D Laboratory. He became assistant director of R&D in 1967. One year later, Grove co-founded Intel. In 1979, he was named president; in 1987, CEO; in 1997, chairman and CEO; and since 1998, he has been chairman of the board. Under Grove's leadership, Intel has grown into the largest and most recognized semiconductor company in the world. Grove has written more than 40 technical papers and several books, and he holds several patents in semiconductor devices and technology. For six years he taught a graduate course in semiconductor device physics at the University of California, Berkeley. Currently, he lectures at the Stanford University Graduate School of Business.

Marcian (Ted) Hoff
In the late 1960s, Hoff, convinced that semiconductors were the wave of the future and would replace magnetic-core memories in computers, became one of the first employees of a spinoff company of Fairchild Semiconductor that shared his view: Intel Corp. When a Japanese company contacted Intel about developing custom chips for its new desktop printing calculator, Hoff proposed developing one universal central processing unit (CPU) chip that could handle each specific function that the custom chips would have handled individually, and run the calculator itself. In the fall of 1969, with the help of Stan Mazor, an applications engineer, Hoff developed an architecture for a 4-bit CPU. In November of 1971, Intel introduced the 4004 "microprogrammable computer on a chip." The microelectronics era had truly begun.

Grace Hopper
A visionary who early on recognized the computer's potential for commercial applications, Hopper devoted her career to developing software tools that were easier to use. Her work in the U.S. Navy and the private sector spanned programming languages, software development concepts, compiler verification, and data processing. At the Eckert-Mauchly Computer Corp., which she joined in 1949, her unwavering belief that programs could be written in English spurred Hopper and her team to develop a compiler for the Univac I and II that translated a language for typical business tasks. Convinced that an entire programming language could be developed using English words, Hopper overcame widespread skepticism to spearhead the design of the COmmon Business-Oriented Language. The first COBOL specifications appeared in 1959.

Charles House
Considered the "father of the logic analyzer," House created and defined the field of logic analysis, building on earlier work in directed-beam computer graphics displays for Sutherland and Englebart products. In a 30-year career at Hewlett-Packard, House developed pioneering logic-state analyzers (HP 1600 series) and computer graphics displays (HP 1300A). He also led the projects that developed network protocol analyzers and the MOTIF 3D Look-and-Feel Graphical Interface. House was also the leader of a number of startup activities that became HP business units, including the Logic Systems Division and the Software Engineering Systems Division. Co-author of two textbooks and 20 articles on logic analysis and microprocessor design, House is currently the chairman of Applied Microsystems Corp. and director of Societal Impact of Technology at Intel Corp.

2002 INDUCTEES

Walt Jung
Widely considered a "guru" of audio op-amp design, Jung has been a prolific, authoritative writer on analog design topics for nearly 35 years, specializing in op-amp and audio-related applications. His articles have appeared in numerous audio-oriented periodicals. His first article appeared in *Electronic Design* in 1968, and there have been many more since then. His analog-oriented column, *"Walt's Tools and Tips,"* ran in *Electronic Design* from January 1997 through December 1998. Jung has also written several books, such as *IC Op-Amp Cookbook* and *Audio IC Op-Amp Applications*, both considered primary sources for a generation of professional audio engineers. In 1991, following a three-and-a-half-year tenure at Linear Technology Corp., Jung joined Analog Devices Inc., where he is a corporate staff applications engineer.

Charles Kao
Recognized as the "father of fiber optics," Kao did his pioneering work during a 10-year period beginning in 1960 as a research scientist, then manager, at Standard Telecommunications Laboratories Ltd., ITT's central research facility in the United Kingdom. Kao predicted the performance levels that fiber optics could attain and described the basic design and means to make fiber optics a practical and significant communications medium. Thereafter, he contributed significantly to the development and subsequent commercialization of optical fiber components and systems. In the early 1980s, as the first executive scientist and subsequently as corporate director of research at ITT, Kao addressed the high-frequency limits of signal processing, known as "terabit technology," to help R&D managers improve the effectiveness of materials and device research.

Jack Kilby
In early 1958, Kilby joined Texas Instruments in Dallas. By the end of that summer, he had changed the course of the electronics industry. Working with borrowed and improvised equipment, Kilby conceived and built the first electronic circuit in which all components, both active and passive, were fabricated in one piece of semiconductor material half the size of a paper clip. Demonstrated successfully on Sept. 12, 1958, Kilby's monolithic integrated circuit laid the conceptual and technical foundation for the entire field of modern microelectronics. Kilby went on to pioneer military, industrial, and commercial applications for microchip technology and headed construction of the first military system and the first computer to incorporate ICs. He also co-invented the handheld calculator and the thermal printer. Kilby won the Nobel prize in physics for his part in inventing the IC.

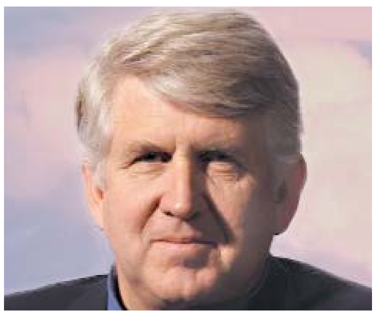
Gary Kildall
In 1973, while working for Intel Corp., Kildall created the first computer operating system (OS) to see popular use. Seeking a way to control the storage and retrieval of data on floppy disks, Kildall realized the need for a basic OS that could accept and interpret operator commands using less than 4k of memory. Originally named Control Program/Monitor, the initials later came to stand for Control Program/Microprocessor or Microcomputer. But it was best known as CP/M, and the programming language he developed for it was called PL/M. Intel saw no use for CP/M and gave the rights to Kildall, who sold it himself, eventually through his own company, Intergalactic Digital Research (later Digital Research Inc.). CP/M proved to be the OS that fueled the birth of the PC. For the first few years, it was used on virtually every PC manufactured.

Photo courtesy of Anthony Loder

Hedy Lamarr
Dubbed by MGM's Louis B. Mayer as the "most beautiful girl in the world," Lamarr fled the rise of Nazism, leaving her native Austria for Hollywood in 1937. But the most fascinating chapter in her life occurred during World War II, when Lamarr and the avant garde musician George Antheil received a patent for a "secret communications system" intended for use in guiding U.S. Navy torpedoes. Lamarr and Antheil conceived the idea of "frequency hopping" to quickly shift the radio signals of control devices, making them invulnerable to radio interference or jamming. Truly ahead of its time, the system was never implemented by the military, in part because the technology of the time was inadequate. The system finally came into its own in the cellular telephone age. Now called "spread spectrum" instead of "frequency hopping," the basic idea is the same.

Bob Mammano
A pioneer in the power electronics industry with more than 40 years of experience in analog power control, Mammano is widely recognized for giving birth to the pulse-width modulation (PWM) controller IC industry. He designed the first PWM controller IC, the SG1524, in 1974. The founder of power IC divisions at both Silicon General (now Linfinity Microelectronics) and Unitrode (now part of Texas Instruments), Mammano continues to expand the state of the art in power ICs by both designing and guiding the development of new products. Holder of more than 20 patents in this field, Mammano shares his insights on power IC design and development as a Fellow in TI's power-management products division and as a popular speaker on topics important to the work of power-system designers at TI's power-supply design seminars.

Guglielmo Marconi
Immortalized as the inventor of radio, Marconi conducted his first experiments on wireless signals at his father's estate in Pontecchio, Italy, in 1895. His success in sending wireless signals over a distance of one-and-a-half miles made Marconi, at 21, the inventor of the first practical system of wireless telegraphy. One year later, he received the world's first patent for such a system. In 1899, Marconi established wireless communication between France and England. In 1901, one year after his famous patent No. 7777 for "tuned or syntonic telegraphy," Marconi transmitted the first wireless signals across the Atlantic Ocean, between Poldhu, Cornwall, and St. John's, Newfoundland—2100 miles. Marconi's research into shorter wavelengths culminated in the opening of the world's first microwave radiotelephone link in 1932.

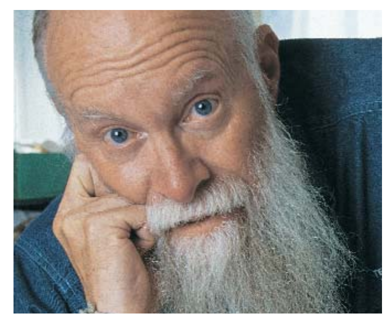


Robert M. Metcalfe
In 1972, one year before completing his doctorate in computer science at Harvard University, Metcalfe began working at the Xerox Palo Alto Research Center, where he met D.R. Boggs. Together they invented a local-area networking (LAN) technology that turned PCs into communications tools by linking them. Since its invention, the protocol, Ethernet, has become the most widely used LAN technology, connecting more than 50 million PCs. At Xerox's Systems Development Division, Metcalfe was responsible for developments that led to the Xerox Star workstation, the first PC to include a bit-map screen, a mouse, word processing, Ethernet, and software to handle text and graphics in the same document. In 1979, Metcalfe founded 3Com Corp., which stands for "computer, communication, and compatibility."

2002 INDUCTEES

Gordon E. Moore
Co-founding two of the major companies manufacturing ICs today is just one major achievement that has distinguished Moore's career. In 1965, eight years after co-founding Fairchild Semiconductor, Moore noted in a magazine article that for the previous three years, the number of components on a chip had doubled every year. Moore predicted that this trend would continue for another 10 years, with chips doubling in complexity until they reached 65,000 components per chip. However, chip complexity continued to double long after 1975. To Moore's surprise, what he had postulated as a "rule of thumb" became "Moore's Law," the guiding principle that spurred the industry to deliver ever more powerful chips at proportionate decreases in cost. This principle has been the driving force behind the growth of Intel Corp., which Moore co-founded in 1968.

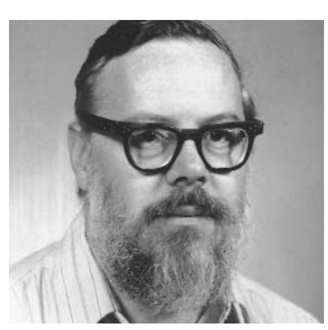
Robert N. Noyce
Noyce's career was closely interwoven with the IC evolution and the multibillion dollar industry that it created. Not only was Noyce responsible for key inventions that made the IC practical, but he co-founded and managed two of the major companies manufacturing ICs today: Fairchild Semiconductor Corp. in 1957, and Intel Corp. in 1968. At Fairchild, Noyce was responsible for the commercial realization of the double-diffused mesa and planar silicon transistors. In 1959, as general manager of the Fairchild semiconductor operation and a vice president of the Fairchild Camera and Instrument Corp., Noyce saw his IC-based inventions incorporated into a wide range of electronic products. He held 16 patents on semiconductor methods, devices, and structures, as well as the basic patent relating to metal interconnect schemes.



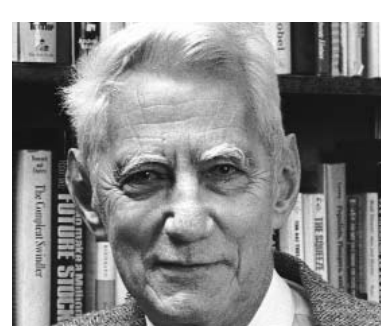
Robert A. Pease
A champion of common-sense analog design, Pease created the first adjustable negative regulator at National Semiconductor. After graduating from MIT with a BSEE in 1961, Pease joined George A. Philbrick Researches. In a 14-year tenure, he designed many leading-edge operational amplifiers, analog computing modules, and voltage-to-frequency converters. Pease joined National in 1976 and has designed several leading-edge analog ICs, including power regulators, voltage references, voltage-to-frequency converters, temperature sensors, and amplifiers. Currently staff scientist at National, Pease holds 21 patents. His definitive book on resolving analog design problems, *Troubleshooting Analog Circuits*, is in its 12th printing. Moreover, his column in *Electronic Design*, "Pease Porridge," received a Jesse H. Neal Certificate of Merit in 1992.

Donald O. Pederson
Pederson's development of Spice (Simulation Program with Integrated Circuits Emphasis) was the crowning point of an illustrious career that covered a half-century in teaching and research—with over half of it at the University of California at Berkeley. Beginning in the vacuum-tube era, Pederson devoted his efforts to the design and performance of electronic circuits that eventually evolved into transistors and, ultimately, into large-scale ICs. Spice was a landmark combination of software engineering, numerical analysis, and modeling of transistors for use in ICs. For more than 25 years, Spice has been the standard means of simulating circuits at the transistor level. At U.C. Berkeley, he became the inaugural E.L. and H.H. Buttner Professor of Electrical Engineering. Before his retirement in 1991, his research was reported in more than 100 technical publications.

George A. Philbrick
The father of both electronic analog computing and modern operational amplifiers, Philbrick began his distinguished career at the Foxboro Co. shortly after graduating in 1935 from Harvard's School of Engineering. He was teamed with Clesson E. Mason. In the course of their working out a complete mathematical analysis of process control, Philbrick developed what he called an "automatic control analyzer," an electronic analog computer hardwired to carry out a computation, or simulation, of a typical process-control loop. After World War II, he built a high-speed analog computer that spurred the formation of George A. Philbrick Researches. In 1952, the company introduced the first commercial full-differential, unstabilized op amp, the K2-W. Ten years later, G.A. Philbrick Researches and Burr-Brown Research Corp. introduced the first modular solid-state op amps.



Dennis M. Ritchie
Ritchie came to Bell Labs in 1967 from Harvard University, where he had completed undergraduate work in physics and a doctorate in applied mathematics. Soon, he began helping Ken Thompson create Unix for minicomputers. He later transported Unix to the Interdata 8/32. The foundation for this portability was a general-purpose language created in 1972 by Ritchie, who added data types and new syntax to Thompson's B language and renamed it C. In 1978, Ritchie co-authored *The C Programming Language* with Brian Kernighan, introducing this highly efficient language to the world. Since then, C has become the most widely used language in computers of all sizes. The American National Standards Institute eventually established an ANSI standard for C.

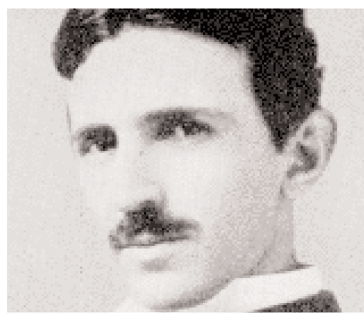


Claude E. Shannon
As a graduate student at MIT, Shannon discovered the analogy between Boolean algebra and digital switching circuits. His master's thesis, *A Symbolic Analysis of Relay and Switching Circuits*, demonstrated the use of Boolean algebra to analyze and optimize relay switching circuits. In 1948, as a research mathematician at AT&T, Shannon published a ground-breaking paper in the *Bell System Technical Journal,* "A Mathematical Theory of Communication." In it, he proposed a linear schematic model of a communications system in which pictures, words, and sounds could be more easily and quickly transmitted by sending a stream of 1s and 0s rather than electromagnetic waves. Shannon's discovery that the binary digit was the fundamental element of communication became the foundation for information theory and the springboard for the communications revolution.

Alan F. Shugart
The pioneer of floppy-disk technology began his career as an IBM field engineer in 1951. During Shugart's 18 years at IBM, he managed of a variety of programs, notably IBM's 2321 data cell drive, and was instrumental in the development of the first slider bearing head disk drive, the Advanced Disk File, which became the IBM 1301. After a stint at Memorex, he co-founded Shugart Associates. In 1979, Shugart founded Seagate Technology Inc., which became the largest independent manufacturer of disk drives and related components, as well as a leading developer of software tools and applications in the area of data management. In 1998, he left Seagate to establish Al Shugart International, a resource center focused on helping entrepreneurs transform great ideas into great companies with lasting value.

2002 INDUCTEES

Philip H. Smith
Smith was a man of many achievements and contributions to electrical and microwave engineering. As a young engineer at Bell Laboratories in 1929, he worked on an antenna connected to the transmitter by a two-wire transmission line. In those days, the technique for matching the line to an antenna high up was a slow, primitive two-person job. One individual moved a cumbersome signal-sensing device along the line at the end of a pole, while a second read the signal through a telescope. To simplify this task, Smith developed a graphical solution that evolved from a rectangular plot accommodating only a limited range of data to a more practical diagram. Based on the principles of conformal mapping, the diagram accommodated data from zero to infinity. Introduced in 1939, the Smith Chart remains the basic tool for determining transmission-line impedance.

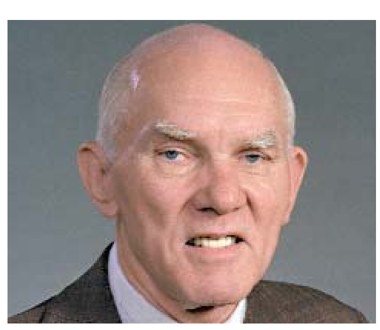


Nikola Tesla
A dreamer who combined self-discipline and precision with a poetic touch, Tesla began as an engineering student at the Technical University at Graz, Austria. When he viewed the Gramme dynamo, which operated as a generator and, when reversed, became an electric motor, Tesla conceived a way to use alternating current to advantage. Later, he visualized the principle of the rotating magnetic field. He also developed plans for an induction motor that would become the first step toward the ac induction motor, which he constructed in 1883. In 1885, one year after arriving penniless in New York, Tesla sold the rights to his polyphase system of ac dynamos, transformers, and motors to George Westinghouse. After establishing his own laboratory, Tesla invented the "Tesla coil," which is still widely used in radio and television sets and other electronic equipment.

Linus Torvalds
In 1991, Torvalds, a 21-year-old computer science student at the University of Helsinki, wanted to run Unix on his home computer. However, the software cost too much, and at that time it ran only on expensive workstations. So Torvalds began writing a Unix clone that would bring the power of Unix to a PC. Torvalds soon created a kernel that worked directly with the processor and named it "Freax." But when he tried to post it on the Web, the FTP site manager, fearing the word had negative implications, renamed Torvalds' FTP site "Linux," the label Torvalds had included for his personal use. In October 1991, the first functional Linux operating system was released. Torvalds patented Linux under the Free Software Foundation's General Public License, which made it free and available to everyone, but prevented distribution without the source code.

Alan M. Turing
A great visionary of the computer field, Turing used his mathematical abilities to apply the concept of the algorithm to the digital computer. His research into the relationships between machines and nature created the field of artificial intelligence. Turing left King's College, Cambridge University, in 1936 for Princeton University, where he began to explore what came to be called the "Turing Machine." This computing machine could read a series of ones and zeros from a tape—a forerunner of today's multipurpose computers. Turing continued his research at the National Physical Laboratory, where he developed the Automatic Computing Engine, one of the first attempts at creating a truly digital computer. In 1950, he wrote a paper describing what is now known as the "Turing Test," which was used to determine the presence of intelligence in a machine.

Patrizio Vinciarelli
Founding Vicor Corp. in 1981, Vinciarelli has served as its president, CEO, and design inspiration ever since. In the early 1980s, Vinciarelli invented zero-current and zero-voltage switching technologies, enabling the design of power converters that were much smaller and more efficient than conventional units. Vicor created the power-component industry by offering its patented technologies as families of high-density "bricks" that could be used as building blocks to create power systems. The holder of 60 patents with others pending, Vinciarelli came to the U.S. in 1977 to be an instructor and a fellow at the Institute of Advanced Studies at Princeton University. This followed a four-year tenure as a fellow at the Center for Nuclear Research in Geneva, which Vinciarelli joined in 1973 after receiving his doctorate in physics from the University of Rome, Italy.



Charles H. Vollum
Howard Vollum's revolutionary Type 511 oscilloscope had its roots in his teenage years in the 1930s, when he designed a primitive oscilloscope with newly commercialized cathode-ray tubes. This project helped him obtain admission to Reed College in Portland, Ore., where he built an oscilloscope that proved useful in testing audio amplifiers. in 1946, he co-founded Tektronix Inc. in Portland with M.J. Murdock. As the company's first president and chief engineer, Vollum directed Tektronix's focus on oscillography. The Type 511, also called the "Vollumscope," set a new standard for speed. Other developments followed, including the first direct-coupled high-gain oscilloscope; the Type 104 generator, the first to use square waves for transient testing of scopes; an oscilloscope plug-in unit that accepted interchangeable units; and ultimately, the design of the Tektronix cathode-ray tube.

John L. von Neumann
Inventor and proponent of the "stored program" concept, von Neumann applied his idea to the logical design of a computer infrastructure that became known as the "von Neumann architecture." One of the six original mathematics professors appointed to the Institute for Advanced Studies in 1933 at Princeton University, von Neumann made this architecture the foundation for the institute's first computer, the IAS Machine, in 1944. Von Neumann quickly perceived the application of computers to applied mathematics for the solution of complex problems and not merely for the creation of mathematical tables. The IAS Machine inspired the building of several "supercomputers" by National Laboratories. In 1990, the IEEE established the von Neumann Medal, which it presents annually "for outstanding achievements in computer-related science and technology."

Jim Williams
The designer of hundreds of fundamental analog circuits, Williams has perfected the art of getting maximum performance from high-performance amplifiers and data converters. He spent 11 years at the Massachusetts Institute of Technology in Cambridge, teaching and researching analog circuit techniques to solve biochemical and biomedical problems. Concurrently, he served as a consultant to U.S. and foreign concerns and governments, specializing in analog circuits. Williams joined National Semiconductor Corp. in 1979 and continued his work with the company's Linear Integrated Circuits Group. In 1982, he joined Linear Technology Corp. as staff scientist. He holds that position to this day, still focusing on product definition, development, and support. Williams has also written more than 250 publications relating to analog circuit design.

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John M. Birkner **Hua-Thye Chua**

By the early 1970s, logic chips had evolved from primitive devices with just a few gates to programmable devices that greatly enhanced their versatility. However, the early programmable logic devices were customized chips. They were relatively expensive and required customers and chip makers to work together closely on the chip design, with the chip maker modifying the final fabrication stages to produce the desired logic. In 1977, Birkner and Chua, fellows at Monolithic Memories Inc., co-invented a logic IC that provided a "design-your-own-chip" methodology. It could be bought "off-the-shelf" and programmed at the customer's plant. Named a programmable array logic, or PAL, device, this major new circuit contained 2048 tiny fuses, which could be blown to create almost any configuration of up to 250 logic gates. Properly programmed, a PAL device could replace a dozen or more hardwired chips. In addition to co-inventing the device that would become the precursor of today's field-programmable logic technology, Birkner and Chua co-authored PALASM design software, the first EDA tools for programmable logic. In 1988, they co-founded (along with Andy Chan) Peer Research Inc. in Sunnyvale, then spent three years developing a proprietary programmable metal-to-metal technology (ViaLink), which later greatly enhanced the performance of programmable devices. In 1991, the company name was changed to QuickLogic. Seven years later, QuickLogic introduced a new class of devices called embedded standard products, which combined the performance and lower cost of standard ICs with the flexibility of programmable logic. The co-founders remain active members of the QuickLogic management team.

James H. Clark **Marc Andreessen**

In 1994, Andreessen was working as a programmer in Silicon Valley. He had recently graduated with a BS in computer science from the University of Illinois where, as a programmer at the university's National Center for Supercomputer Applications, he had conceived and helped develop the first Internet browser. Named Mosaic, this browser enabled point-and-click Web navigation, reducing the learning curve for Internet use from months to minutes. Within weeks of starting his job, Andreessen received an e-mail from Clark, the founder of Silicon Graphics Inc., a manufacturer of high- and middle-end workstations, processors, and software for the creation of 3D images. Clark wanted to produce an inexpensive system for interactive television, for which Mosaic could serve as a subscriber interface. Andreessen convinced Clark that the Internet, with millions of new users, offered a better immediate market. The two decided to build an enhanced version of Mosaic and give it away to establish their product as an Internet standard. Later in 1994, Clark and Andreessen co-founded Netscape Communication Corp. and recruited four of the five programmers who had worked with Andreessen on Mosaic. Netscape Navigator was released at the end of that year. It quickly became the Web browser of choice for the great majority of Internet users as well as many corporations that adopted Netscape's browser and server software as standards for their intranets. Netscape led the technological revolution that transformed the Web from an elite research tool for scientists and researchers into one of the most popular and important media applications in modern time.

Robert Widlar

A legendary figure in analog IC design, Widlar is considered the creator of the IC op amp. His first op-amp design at Fairchild Semiconductor, the µA702 in 1964, used only nine transistors and had relatively low gain and significant limitations on the input common-mode range. A year later, he introduced the first commercially successful analog functional block, the legendary µA709, which provided much larger open-loop gains and had an input common-mode range that included positive voltages. In 1967, he challenged the belief that it was impossible to build a monolithic high-power voltage regulator by designing the 20-W LM109. In 1971 at National Semiconductor, he designed the first bandgap reference, the NM113. Then in 1981, Widlar and Bob Dobkin co-founded Linear Technology Corp.

J. Presper Eckert **John W. Mauchly**

Mauchly and Eckert met by chance during the early years of World War II at the University of Pennsylvania's Moore School of Electrical Engineering. Mauchly, an established physicist, was taking a defense training course taught by Eckert, an engineering graduate student 12 years his junior. Eckert grew interested in Mauchly's vision of a computing machine that could use electrons to perform all mathematical operations done by humans at that time, but with much more accuracy and speed than the single-problem-solving mechanical devices of the time. In 1943, the Army was persuaded to fund the building of a machine that could quickly calculate ballistic missile trajectories in Europe and Asia. Eckert was named the project's chief engineer and Mauchly provided the mathematical theory. They led a 50-member team that took three years to build the "electronic numerical integrator and computer." The first true general-purpose electronic computer, ENIAC stood 10 feet tall, weighed approximately 30 tons, occupied 1000 square feet of floor space, and used more than 70,000 resistors, 10,000 capacitors, 6000 switches, and 18,000 vacuum tubes. In 1946, Eckert and Mauchly founded the Electronic Control Co., which became the Eckert-Mauchly Computer Corp. In 1952, Eckert-Mauchly built the Universal Automatic Computer (UNIVAC), the first computer that could handle numerical and alphabetical information with equal success.

James Truchard **Jeff Kodosky**

The idea for starting a company first came to Truchard in 1967, when he completed his master's thesis at the University of Texas at Austin. After developing an ultra-low-noise amplifier that was used widely for measurement applications, Truchard felt he was ready to go out on his own. But he decided to pursue a PhD first. Early in 1976, after finishing his doctorate, Truchard met with Kodosky (and William Nowlin), colleagues from the Applied Research Labs at UT. Their inaugural product was an IEEE 488 (GPIB) interface. It enabled users to connect a measurement device to a computer and take such readings as temperature, voltage, and pressure. Their prototype was finished in the spring of 1977, and the first unit was sold to Kelly Air Force Base in San Antonio. In 1983, Kodosky began research on what would become a graphical instrumentation software package. Introduced in 1986, LabView pioneered the concept of virtual instrumentation, enabling engineers to define their own solutions using graphical representations. From its simple origins, National Instruments has grown into a global manufacturer of industry-standard graphical software and modular hardware for test-and-measurement and automation solutions. Both Truchard and Kodosky continue to play active roles in the company, helping to guide the research and development of new products.

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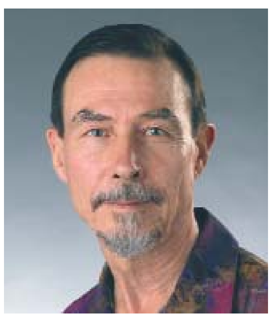


Carver A. Mead **Lynn Conway**

By the mid-1970s, digital system designers eager to create higher-performance devices were frustrated by having to use off-the-shelf large-scale-integration logic. It stymied their efforts to make chips sufficiently compact or cost-effective to turn their very large-scale visions into timely realities. In 1978, a landmark book titled *Introduction to VLSI Systems* changed all of that. Co-authored by Mead, the Gordon and Betty E. Moore professor of computer science and electrical engineering at the California Institute of Technology, and Conway, research fellow and manager of the VLSI system design area at the Xerox Palo Alto Research Center, the book provided the structure for a new integrated system design culture that made VLSI design both feasible and practical. *Introduction to VLSI Systems* resulted from work done by Mead and Conway while they were part of the Silicon Structures Project, a cooperative effort between Xerox and Caltech. Mead was known for his ideas on simplified custom-circuit design, which most semiconductor manufacturers viewed with great skepticism but were finding increasing support from computer and systems firms interested in affordable, high-performance devices tailored to their needs. Conway had established herself at IBM's research headquarters as an innovator in the design of architectures for ultrahigh-performance computers. She invented scalable VLSI design rules for silicon that triggered Mead and Conway's success in simplifying the interface between the design and fabrication of complex chips. The structured VLSI design methodology that they presented, the "Mead-Conway concept," helped bring about a fundamental reassessment of how to put ICs together.



William B. Shockley **John Bardeen** **Walter H. Brattain**

As World War II drew to a close, Mervin Kelly, president of Bell Telephone Laboratories, decided that a major reorganization was needed to turn Bell Labs into a top-notch basic research facility. One result was the creation of the Solid-State Physics group. Shockley, one group leader, was a Bell Labs physicist since 1936. He soon created a subgroup to focus on research into semiconductors used in radar systems during the war. Brattain had been employed at Bell Labs since 1929 and joined Shockley's subgroup along with Bardeen, a physicist and former professor hired after the war. In 1947, Bardeen and Brattain designed a solid-state amplification circuit whose key components were a slab of germanium and two gold point contacts just fractions of a millimeter apart. Brattain discovered that putting a ribbon of gold around a plastic triangle, slicing it through at one point, and pressing the point of the triangle gently down onto the germanium created a dramatic amplification of electric current. Thus was the first point-contact transistor made. But two months later, Shockley stunned Bardeen and Brattain with a significantly improved design. It consisted of three semiconductor layers stacked together, with current flowing through the semiconductor material instead of along the surface. As voltage on the middle layer was adjusted up and down, it could turn current in the three-layer "sandwich" on and off at will. Introduced in 1949, the solid-state transistor could amplify an electrical signal much more efficiently than a bulky vacuum tube. It became the building block for all modern electronics and the foundation for microchip and computer technology. For their work, Shockley, Bardeen, and Brattain received the Nobel Prize in physics in 1956.


William R. Hewlett **David Packard**

In 1938, five years removed from their undergraduate days, Hewlett and Packard were reunited at Stanford University. Hewlett, having earned an MSEE from MIT, had returned to Palo Alto to attain the title of engineer. Packard had left the General Electric Co. in Schenectady, N.Y., to undertake a fellowship arranged by Frederick Terman, dean of Stanford's School of Engineering. Envisioning a new technical community in the Palo Alto area, Terman encouraged the pair to found this community. In 1939, the young engineers started their own enterprise in the garage of Packard's Palo Alto home, with an initial investment of $538. Their first product, a resistance-capacitance audio oscillator based on Hewlett's graduate work, was purchased by Walt Disney Studios for use in the production of the now-classic movie *Fantasia*. From its modest beginnings, the partnership of Hewlett and Packard grew to become one of the primary forces behind the growth of the technical community known today as Silicon Valley. Under their leadership, Hewlett-Packard became renowned for its technological innovation and its corporate philosophy, which valued creativity and invention over bureaucracy. Among HP's many firsts were the desktop scientific calculator, the handheld scientific calculator, and the desktop mainframe computer. In 1984, HP pioneered ink-jet printing technology, followed by laser-jet printing technology. Both founders remained actively involved in the management of their company for several decades—Hewlett until 1987, Packard until 1993. The single-car garage that spawned a multibillion-dollar company has been named a California state historical landmark and hailed as the birthplace of Silicon Valley.


Steven Wozniak **Steven P. Jobs**

Wozniak and Jobs first met as teenagers in 1968 while working for Hewlett-Packard. Their inaugural business venture was the infamous "blue box," a pocket-size telephone attachment that allowed the user to make free long-distance phone calls. Wozniak helped design the device in his spare time and, when it was completed, Jobs helped sell it. In 1974, Jobs became a video designer at Atari Inc. Later that year he renewed his friendship with Wozniak, attending meetings of Wozniak's Homebrew Computer Club. Much more interested in marketing computers than in designing them, Jobs persuaded Wozniak to work with him on building a PC. In 1976, they developed the prototype of what would become the Apple I, the first single-board computer with a built-in video interface and an on-board ROM, which told the machine how to load other programs from an external source. Wozniak and Jobs then started a company that they called Apple Computer Corp. in Jobs' parents' garage in Los Altos, Calif. Jobs convinced a local electronics retailer to order 25 Apple I computers. The pair raised $1300 to build these machines by selling their most valuable possessions—Jobs, his Volkswagen van; Wozniak, his programmable calculator. The following year, Wozniak and Jobs developed the Apple II, which had built-in circuitry allowing it to interface directly to a color video monitor or to a television set with add-ons. To promote its use, Jobs challenged programmers to develop applications for the new computer. The result was a library of 16,000 software programs, from games to budgeting packages. Within six years of its founding, Apple Computer Corp. became a public company and was listed in the Fortune 500.