# THE DRAPER PRIZE

Henry Petroski

The Charles Stark Draper Prize has been described as the world's most prestigious engineering award. Yet the biennial announcement of its winners goes largely unnoticed by the general press, and its origins and significance remain obscure even within the engineering and scientific community. This is unfortunate, given the history of the prize and the inspiration its namesake and winners may hold for aspiring young engineers. The origins and significance of the Draper Prize are best understood by looking back nearly 100 years to the creation of the Nobel Prizes, the world's most widely known prizes for engineering-scientific achievement.

The Nobel Prizes have their origin in the handwritten will that the Swedish-born engineer and inventor of dynamite, Alfred Bernhard Nobel, drafted in late 1895, a year before his death. The short document of about 275 words specified clearly that the interest on a fund to be established from his considerable estate was to be "distributed in the form of prizes to those who, during the preceding year, shall have conferred the greatest benefit on mankind." Nobel designated five prizes to be presented to the persons who shall have "made the most important discovery or invention within the field of physics; ...made the most important chemical discovery or improvement; ...made the most important discovery within the domain of physiology or medicine; ...produced in the field of literature the most outstanding work of an idealistic tendency; ...done the most or the best work for fraternity between nations, for the abolition or reduction of standing armies and for the holding and promotion of peace congresses."

Charles Stark Draper Laboratory, Inc.

**Charles Stark Draper**

Nobel also designated who would award the prizes, and the first two, which have come to be known as the science prizes, were the charge of the Swedish Academy of Sciences. Although there seems little doubt that Nobel intended to endow prizes for recent accomplishments at least as much along the lines of invention and engineering as pure science, the Swedish Academy effectively captured them for basic research in physics and chemistry. In addition, the Swedish Academy has generally recognized long-term achievement and life's work, rather than carrying out Nobel's intention of bestowing the awards soon after an accomplishment.

The first Nobel Prizes were awarded in 1901, and the first winners were well-known scientists: the German physicist Wilhelm Röntgen, who discovered x rays in 1895, and the Dutch chemist Jacobus van't Hoff, who set down laws of chemical dynamics and osmotic pressure in solutions more than a decade before the prize was awarded. After seven or eight years of such awards, a clear pattern had been established, and an editorial in the *New York Tribune* expressed what many outside observers were thinking: "One of the most remarkable features of the [Nobel Foundation] is that it ignores the profession in which Nobel was himself trained." Perhaps in response to such criticism, the Nobel Prize in physics was awarded in 1909 to the Italian electrical engineer Gugliemo Marconi and the German physicist Ferdinand Braun "in recognition of their contributions to the development of wireless telegraphy," and in 1912 to Swedish inventor Nils Dalén "for his invention of automatic regulators for use in conjunction with gas accumulators for illuminating lighthouses and buoys." But such acknowledgments of engineering achievement were, in the final analysis, anomalies; the engineering achievement that Nobel seems so clearly to have wanted to recognize and reward has remained effectively excluded from the Nobel Prizes.

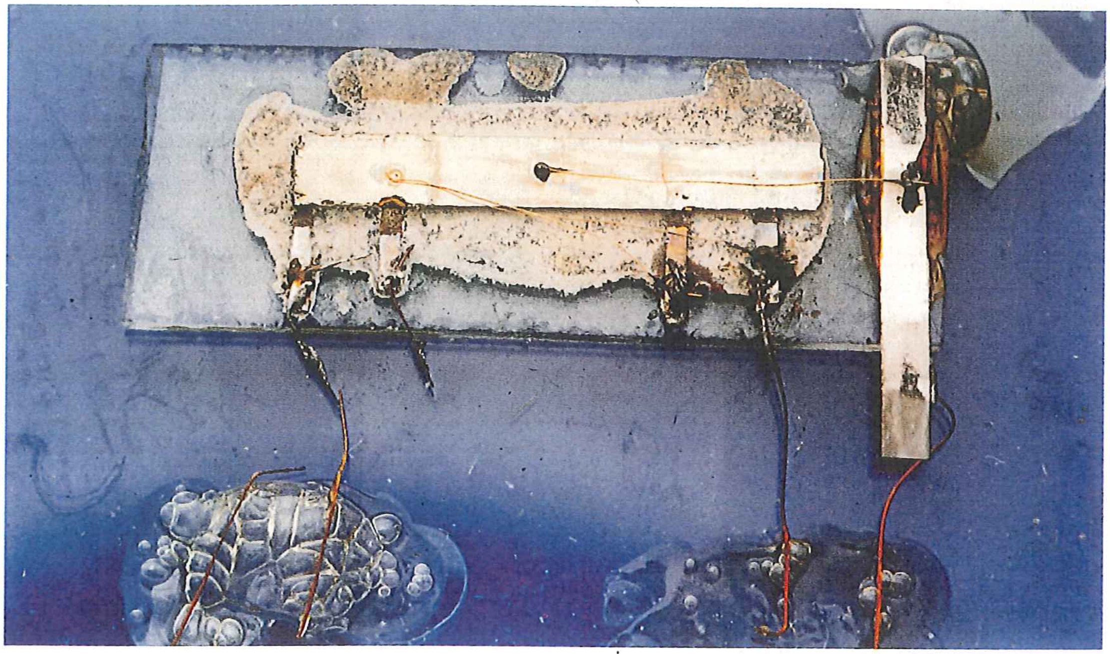

**Figure 1. Early integrated circuit designed by Jack S. Kilby, a co-winner of the first Draper Prize. (Photograph courtesy of Texas Instruments.)**

A prize for economics was not designated in Nobel's will, and the so-called Nobel Prize in that field was awarded for the first time in 1969. This sixth prize category was established by the Swedish bank, Riksbank, in celebration of its 300th anniversary, and the prize is known officially as "The Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel." Such a fine distinction is often lost in the flurry of announcements each year, however, and representatives of other fields of scholarship and practice, such as mathematics, soon approached the Nobel Foundation to establish just one more prize. By the early 1980s, it was clear that the foundation would not add any new prizes. Therefore, no one should have been surprised in 1986 when the Nobel Foundation rejected the formal plea of the American Association of Engineering Societies for a Nobel Prize in engineering, but the idea of establishing a prestigious engineering award was clearly in the air.

### The Draper Prize

In 1988 the National Academy of Engineering established the Charles Stark Draper Prize, which is awarded biennially "to recognize individuals whose outstanding engineering achievements have contributed to the well-being and freedom of all humanity." Backed by an endowment from the Charles Stark Draper Laboratory, of Cambridge, Massachusetts, the Draper Prize consists of a gold medal and a cash award of $375,000, which puts it in a monetary class with the individual Nobels. But who was Draper and who have been the Draper Prize recipients, and from where have they come and how did they achieve what they did? Are there any patterns in their education and careers that can serve as models to inspire future engineers?

Charles Stark Draper was born on October 2, 1901, the first year in which the Nobel Prizes were awarded, and he was raised in the small town of Windsor, Missouri. Draper began college as a liberal-arts student at the Missouri School of Mines and Metallurgy, now the University of Missouri in Rolla, but after two years he transferred to Stanford University, from which he graduated in 1922 with a B.A. in psychology. He then attended the Massachusetts Institute of Technology, where he received three degrees: a B.S. in electro-chemical engineering in 1926, an M.S. in 1928 and a Sc.D. in physics in 1938. In the meantime, he had become a member of the MIT faculty, beginning as an assistant professor in aeronautical engineering and becoming a full professor in 1939. In a long and distinguished career in Cambridge, he served as head of the Department of Aeronautics and Astronautics and developed an extensive program in instrumentation and control.

Draper had tried unsuccessfully to become an Air Corps pilot, and so he turned to civilian flying. After qualifying as a pilot, he acquired an airplane and soon began noticing the shortcomings of its instruments, which he once demonstrated to passenger Jay Stratton, a future president of MIT, during stalls and spins. According to a memorial tribute to Draper, "Stratton was duly impressed by the inadequacy of the instrumentation and Draper's ideas about needed improvements," but chose never to fly with him again. Others did follow Draper into the sky, both literally and metaphorically, in pursuit of ever-better instrumentation and control under rapidly changing conditions, such as exist in

*Henry Petroski is the Aleksandar S. Vesic Professor and chairman of the Department of Civil and Environmental Engineering at Duke University, Durham, NC 27708-0287. His book* Design Paradigms: Case Histories of Error and Judgement in Engineering *will be published this spring by Cambridge University Press.*

rocket- and gunfire-control systems. Draper played a significant role in the development of guidance, control and navigation systems for the Apollo program. NASA awarded its first contract in the Apollo program to Draper's Instrumentation Laboratory, for the design of the systems for the Command and Lunar Modules. In 1973 the Instrumentation Laboratory, which was established at MIT in 1930, became the Charles Stark Draper Laboratory, Inc., a separate, nonprofit research-and-development corporation. Shortly after Draper's death in 1987, the laboratory's board of directors authorized the endowment of a memorial award.

### Integrated Circuits and Jet Engines

The first Draper Prize was awarded in 1989 to two engineers, Jack S. Kilby and Robert N. Noyce, who independently invented and developed the integrated circuit. Like Draper, both Kilby and Noyce had Midwestern roots. Kilby was born in Jefferson City, Missouri, in 1923, and received degrees in electrical engineering from the University of Illinois and the University of Wisconsin. For 10 years he worked on the design and development of thick-film integrated circuits at the Centralab Division of the Globe-Union Corporation in Milwaukee. In 1958 he moved to Dallas to assume responsibility at Texas Instruments for integrated-circuit development and applications and is now a retired Fellow. Kilby's central idea was to place the circuit components on a single substrate, and he turned eventually to carving the components on a piece of silicon.

Robert Noyce was born in Iowa in 1927 and received a B.A. from that state's Grinnell College before going to MIT, where he received his doctorate in physical electronics. In 1956 Noyce joined Shockley Semiconductor Laboratory in Palo Alto, California, one of dozens of electronic companies that was working to commercialize the transistor. The following year, Noyce cofounded Fairchild Semiconductor Corporation in Mountain View, California. Noyce's idea was to make connections among components by printing a circuit board through a lithography process.

The second Draper Prize also went to one-time competitors, if not downright enemies. On October 2, 1991, the National Academy honored Sir Frank Whittle and Hans J. P. von Ohain for their independent development of the jet engine in the 1930s. Whittle was born in Coventry, in central England, in 1907, and he graduated from Leamington College, the Royal Air Force (RAF) Aircraft Apprentices Wing, the RAF College in Cranwell, the RAF Officers' School of Engineering and Cambridge University. As a student at Cranwell, he reportedly became obsessed with the possibility of jet propulsion and wrote his graduate thesis on future developments in aircraft design. He remained in the RAF for 25 years, but the military establishment did not give his idea much support. He applied for his first patent on the turbojet engine in 1930, but it was not until the end of that decade that he incorporated his engine into an experimental airplane, employing funds that he raised. The first plane with a Whittle engine flew during World War II, in 1941.

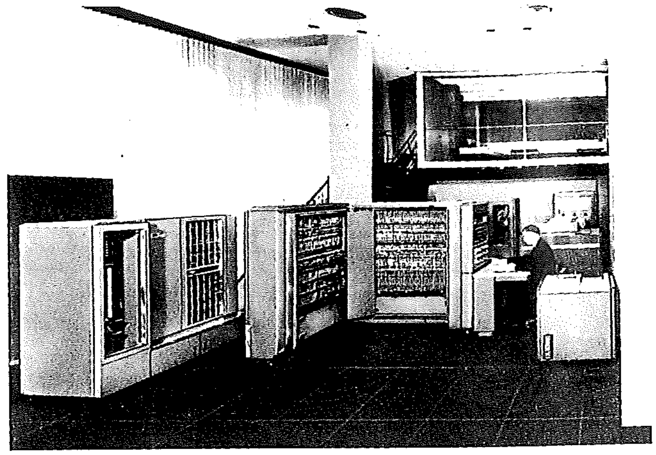

Figure 2. IBM 704 computer ran FORTRAN I, which was created by John Backus, winner of the third Draper Prize. (Photograph courtesy of IBM.)

Hans von Ohain received his doctorate in physics from the University of Göttingen in 1935 and was encouraged by one of his professors to pursue his studies of jet engines. When von Ohain showed a model of his engine to the German aircraft manufacturer Ernst Heinkel, he hired the young man immediately, and by 1937 a successful laboratory test was completed. Soon, the Air Ministry was pushing the development of the jet engine, but with the onset of war the effort was shelved in order to produce more propeller-driven aircraft. Von Ohain continued to develop his engine, however, and in late August, 1939, just days before the Nazis invaded Poland, a Heinkel aircraft powered by a turbojet engine completed a successful seven-minute fight. Although there was limited combat use of both German and British jet fighters toward the end of World War II, they never encountered each other in a dogfight. Von Ohain emigrated to the United States in 1947 to continue his work at Wright-Patterson Air Force Base, in Dayton, Ohio, where he retired.

### The Father of FORTRAN

The third Draper Prize, announced in October 1993, was awarded to John Backus, who created the first general-purpose, high-level computer programming language, FORTRAN, named for its principal purpose, FORmula TRANslation. By developing a compiler that translated a more user-friendly language into the computer's binary machine language, Backus enabled computers to be used much more easily and efficiently for a wide range of problems and applications.

John Backus was born in 1924 and was educated at the Hill School in Pottstown, Pennsylvania. His postsecondary education began during World War II at the University of Virginia, where he studied chemical engineering for less than a year. Then, as part of the Army Specialized Training Program, he attended the University of Pittsburgh to study engineering. But after a year there he was transferred to pre-med at Haverford College and then, after another year, sent on to New York Medical College. In the meantime the war ended, and in 1946 he attended the Radio Television Institute, a trade school in New York, before enrolling in Columbia University, from which he finally received a B.S. from the School of General Studies in 1949 and an M.A. in mathematics the following year.

Backus's employment history is less checkered. He joined the IBM Corporation in 1950 as a programmer and rose to become an IBM Fellow, the highest technical honor achievable in the company, in 1963. It was 10 years earlier, as a project manager in programming research, that Backus proposed the idea for FORTRAN for a forthcoming computer, and in 1957 FORTRAN I was released to IBM 704 customers. It has been estimated that 44 percent of engineering and scientific computer applications run in FORTRAN and that as much as 25 percent of all computing stems from FORTRAN programs. Backus, who made all this possible, is now retired in California. Upon the announcement of his receiving the Draper Prize, Backus acknowledged the help of friends and teammates for making the FORTRAN project "the most exciting and enjoyable" one he had ever worked on and for making FORTRAN "a reality by solving a great number of difficult problems."

As might be expected, there are no clear patterns of education or career path distinguishing Draper or the five recipients to date of the Draper Prize, but there may be a bit of a surprise in the apparent lack of focus in their early years. When Whittle and von Ohain were asked how to stimulate the development of more engineers like them, both stressed the need for more simplicity and individual effort. "Breakthrough ideas are not from teams," according to von Ohain, and "radical innovations are usually created" by solitary figures in a simple way, albeit often within a significant laboratory infrastructure. Whatever the route to accomplishments that have been recognized by the Draper Prize, its biennial announcement is a welcome counterpoint to the annual media blitz associated with the Nobel Prizes. Philip Abelson said it well in an editorial in *Science* on the occasion of the awarding of the second Draper Prize: "It is also fitting that great engineering achievements be recognized by prizes, for they often involve levels of creativity comparable to or greater than those recognized by the Nobel Prize."

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