Willard Boyle

(1924–2011)

Physicist who helped invent the 'eye of the digital camera'.

One afternoon in 1969, Willard Boyle and I had a brainstorming session in his office at AT&T Bell Laboratories in Murray Hill, New Jersey. Our aim was to work out how to move electrical charge through a semiconductor to make a memory device for computer applications.

At the time, researchers were pursuing a type of computer memory called 'bubble memory'. This involved using a magnetic field to create small magnetized bubbles, each of which stored one bit of data, within a thin film of magnetic material, and then making these shift from one site within the film to the next. With an input device to inject the bubbles and a detection device at the other end, the system offered a way to preserve and retrieve information.

Boyle and I knew that we couldn't create magnetic bubbles in a semiconductor. But we wondered about storing the charge that exists in a semiconductor in a device called a metal-oxide-semiconductor capacitor. Eventually we worked out that by placing two such capacitors very close together, we could make charge pass from one capacitor to the next.

Our theory for how to produce a charge-coupled device (CCD) — versions of which are now found in technologies from digital cameras and bar-code scanners to the Hubble Space Telescope — was completed in about an hour. After we published papers demonstrating proof of principle, more than one person commented, "I could have invented that if I'd thought of it."

Boyle, who in 1969 was in charge of research and development for semiconductor devices (and my boss), had arrived at Bell Labs via an unusual route. He was raised in a remote logging community in Sanmaur, Quebec, and schooled by his mother. He went to Lower Canada College at the age of 14 and then to McGill University, both in Montreal, for 7 years of formal education.

For a few years, the Second World War pulled him away from his studies. Soon after joining the Royal Canadian Navy in 1943, he served as a Spitfire pilot. Indeed, he later took pride in wearing his 'Fleet Air Arm' wings on his lapel. Once the war was over, he returned to McGill, eventually earning a doctorate in physics in 1950. Three years later he joined Bell Laboratories, initially as a member of the company's technical staff.

Soon after our brainstorming session in his office, a rapidly assembled team of researchers produced the first crude CCD. We then demonstrated that the CCD could in principle be used as a type of digital circuit — a shift register — and as an imaging device. For the latter, charge could be injected into the system by shining light on the array of capacitors.

Fortuitously, my 'Device Concepts' department was developing a silicon diode-array camera tube — a device used to convert an optical image into an electrical signal — for use in a 'Picturephone'. (The Picturephone never took off but the idea was to allow people to see as well as hear each other over the telephone.) The possibility of an imaging device that didn't rely on bulky, inefficient tube-based cameras prompted a research programme at Bell Labs to develop a CCD video device. The first CCD imaging device was produced in 1970. Other companies, including the Radio Corporation of America, Texas Instruments, Fairchild Camera and Sony soon developed the CCD concept for an array of applications.

Today, the CCD has replaced electron-beam TV cameras and photographic film, and is used in scanning devices, medical imaging and in space applications including in military surveillance satellites. Indeed, the CCD has improved astronomers' ability to observe the Universe by several orders of magnitude. Boyle and I shared half of the 2009 Nobel Prize in Physics for our invention. (Charles Kao received the other half for his work on optical fibres.)

Boyle's other major contributions include the first continuously operating ruby laser, which he invented with Don Nelson in 1962. He was also awarded the first patent (with David Thomas) proposing a semiconductor laser. Although the technology needed to produce the laser wasn't available when Boyle proposed it, semiconductor lasers are now used in a vast range of applications, including in compact-disc players.

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Willard Boyle (left) and George Smith in 1974 with their charge-coupled device.

In 1962, Boyle became director of space science and exploratory studies at Bellcomm, an AT&T subsidiary that provided technological support for NASA's Apollo space programme. While at Bellcomm, he helped NASA researchers select the best spot for man's first landing on the Moon. In 1964 he returned to Bell Labs and switched from pure research in solid-state physics to developing electronic devices, particularly silicon integrated circuits — the now essential building blocks of telecommunications, computers and electronics in general.

Both as a research scientist and as an administrator, Bill was continually looking for new ideas and new ways of doing things. He always gave the impression that he was having fun and not just doing a job. Once he demonstrated the feasibility of his concept for a new type of snow-making machine in his garage.

He had an insatiable curiosity and love of life. He loved experimenting with his digital camera, showing his work in local galleries — and with four children (one deceased), eight grandchildren and one great grandchild, his family life was a full one. An intrepid traveller, he and his wife Betty were driving around the Canadian Maritimes in their Mini Cooper — with its 'CCD' licence plate — even in the last week of his life. ■

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