The Watch That Changed Horological History

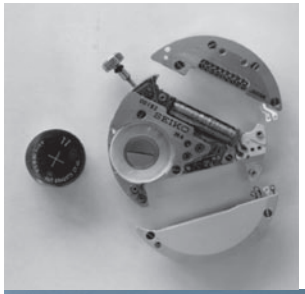
Epson's 59A Project, launched in 1959, led to the development of the world's first commercial quartz watch and engendered many new technologies that would serve as the foundations of the company's subsequent growth.

Accuracy over an extended period is an indispensable feature of timekeeping pieces. While this may seem obvious today, achieving such accuracy in a mechanism as small as a wristwatch was a daunting challenge just several decades ago.

Seiko Epson Corp. had developed a desktop quartz clock in 1963, and in 1969 it succeeded in building the Seiko Quartz Astron, the first commercially available quartz watch. This marked a new page in horological history, not only by setting a new standard for accuracy but also by transforming watches from high-precision machines into high-precision electronic devices.

It also launched a new chapter in the history of the company by establishing core technologies that would later give rise to its printer and semiconductor businesses.

No matter how fine the craftsmanship, true accuracy had remained elusive with the mechanical watch. An attempt was made, therefore, to use electricity to achieve more exacting standards. An electromagnet was used to drive the hairspring and balance wheel, but initial attempts made little progress. Another watchmaker had developed a metallic, tuning-fork-shaped oscillator, moreover, but it was found to be vulnerable to physical shock. Engineers thus focused on using quartz crystals instead of metal.



The Seiko Quartz Astron, below, the world's first commercially available quartz watch, and movement, left.

Accomplishing the Impossible

Pierre Curie, who shared the Nobel Prize in physics with his wife, Marie, discovered in the late nineteenth century that crystals could be made to deform when subject to an electric current—a property known as piezoelectricity. This was already being applied to timepieces in the first decades of the twentieth century by Warren Marrison at Bell Laboratories. While his quartz clock achieved remarkable accuracy, it was as large as an entire room.

When Epson began developing its own quartz clock, the size had been reduced to about that of a chest of drawers. It was with the goal of further miniaturizing the quartz clock and ultimately developing a quartz watch—which appeared impossible at the time—that the 59A Project was launched in 1959.

The company had aspired to achieve and had more or less attained technical parity with Swiss manufacturers for mechanical watches. These were selling quite well at the time, and so there were a number of in-house skeptics regarding the decision to develop quartz watches.

Team Leader Tsuneya Nakamura (who later became president), though, was unwavering in his commitment, convincing the skeptics that it was precisely when the company was in sound financial shape—thanks to strong sales of mechanical watches—that efforts should be made to embark on technologies of the future.

The project team first undertook to develop a desktop quartz clock for the Neuchatel Observatory competition in Switzerland. This resulted in the landmark development of the Crystal Chronometer QC951 in 1963. Just six years later, Epson engineers consolidated their collective strength and succeeded in building the first commercially available quartz watch, the Seiko Astron.

Breakthrough Technologies

The Astron contained a number of breakthrough technologies developed by Epson, namely, the tuning-

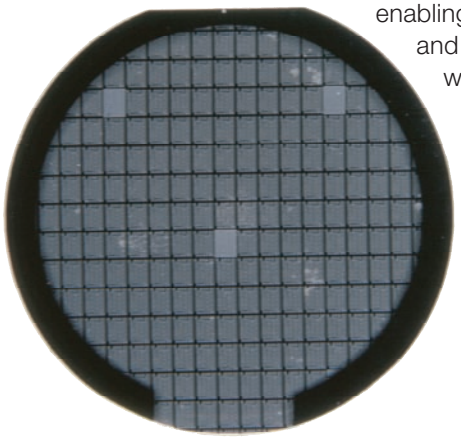
Crystal units used in the Astron containing the tuning-fork oscillator.

Mechanically cutting quartz crystals in the mid-1970s.

Quartz crystals cut into tuning-fork shape.

fork crystal oscillator and the open stepping motor. Both the Crystal Chronometer and a quartz watch developed by a Swiss manufacturer used a rod-shaped crystal oscillator, which was difficult to miniaturize and vulnerable to external shock. To circumvent this problem, a tuning-fork design was adopted; experiments showed that stability in performance was substantially enhanced with the tuning fork.

A key element in transmitting the steady vibration of the crystal to the hands was the stepping motor. To maximize the limited space of a watch, the motor was dispersed across a flat surface, rather than being placed together. By advancing the second hand at regular intervals, instead of a sweeping motion, moreover, battery life was extended 10-fold. This step motion continues to be the standard for analog quartz watches around the world.



CMOS IC developed by Epson in 1971.

Another major breakthrough enabling savings in both space and cost in quartz watches was the development of the CMOS integrated circuit. ICs operate either under a bipolar or MOS design; the processing speed of the former is quite fast, but it requires considerable electric power, while the latter is slow but features low power consumption. Most quartz clocks had been using the bipolar approach, and Epson too initially employed this method. But Jean Hoerni, a silicon transistor pioneer who worked closely with Nobel laureate William Shockley, strongly recommended the MOS format on his visit to Japan.

After a considerable period of trial and error, in 1971 Epson succeeded in developing in-house a CMOS IC that lent itself to mass production. This enabled quartz watches to be produced at much lower cost and opened the door to the popularization of these watches around the world.

“The ideal watch is accurate, never stops, and is beautiful,” Nakamura repeatedly used to say. He also believed that technology must be used to benefit people. This sentiment has since come to be shared by all Epson engineers. What they achieved with the development of the quartz watch was something quite close to the ideal. With the start of mass production, moreover, they also achieved the “democratization of high precision.”

Quartz technology has subsequently led to the evolution of the wristwatch in such forms as the Kinetic automatic power-generating system and the Spring Drive. It has also served as the foundation of new business divisions, including those for semiconductors, personal computers, and robots.

The micromechatronic skills honed in the manufacture of high-precision watches have been applied, moreover, in the building of print heads in Epson’s renowned inkjet printers.

The technologies that form Epson’s core competencies today are those that have been carefully nurtured by the company’s “artisans” over its illustrious history.