The "Quartz Crisis" and Swiss Watchmaking: Part 1

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The term "quartz crisis" is often used to describe the troubles in the Swiss watch industry between 1975 and 1985. Wikipedia reflects a commonly held opinion: "It caused a significant decline of the Swiss watchmaking industry, which chose to remain focused on traditional mechanical watches, while the majority of the world's watch production shifted to Japanese companies such as Seiko, Citizen, and Casio which embraced the new electronic technology."[1]

This topic has been discussed at length and has been the subject of numerous studies, most notably that of Cécile Aguillaume.[2] More recently, in 2011, Pierre-Yves Donzé observed that Japanese manufacturers, headed by Seiko, did not build their success solely on quartz watches, since they mostly manufactured mechanical watches in the early 1970s. They also built on an industrial blueprint, through the mass production of quality watches, and on a conscious strategy of conquering markets, in particular the American market, which until then was the private preserve of the Swiss.[3]

Why then return to this topic? In recent years, a great many periodicals have posted their archives online, making it easier to conduct focused research over extended periods of time. *L'Impartial*,[4] a newspaper based in La Chaux-de-Fonds, Switzerland, and the *New York Times*[5] in the United States are two notable cases in point. For this article, moreover, the Swiss trade press (*Journal Suisse d'Horlogerie* and *La Suisse Horlogère*) for the period in question was consulted, and the entire corpus of monthly editions of *La France Horlogère* magazine between 1969 and 1979 was examined. The purpose was to revisit some of the assumptions that might explain the sharp drop in Swiss watch sales from the second half of the 1970s onwards, as well as to try to draw a more comprehensive explanation for it.

THE FIRST WAVE: 1969–1974

THE STRATA OF THE SWISS WATCH MARKET IN THE 1970S

At the end of the 1960s, the Swiss watch industry supplied 80% of the world watch market in value (45% in volume). It employed 80,000 workers spread over 1,700 companies.[6] Every segment of the market was under Swiss control.

The beautiful Swiss watch, primarily made in Geneva, had no competition. Prestigious brands such as Vacheron & Constantin, Audemars Piguet, and Patek Philippe reigned supreme in luxury watches, highly complex watches, and jewelry watches.

The quality-made, mass-produced Swiss anchor watch was recognized the world over. This success was based on healthy competition among Swiss brands, which vied with each other in technical innovation such as the

chronograph, the alarm watch, and the automatic watch. This success also derived from several other factors: continuous improvement in watch quality, reliability, and accuracy; a high-performance manufacturing base that had benefited from the protection of the Swiss Confederation, with the creation, for example, of the *ébauches* and *assortiments* trust; well-established and reliable distribution networks across the globe; and, finally, a streamlined after-sales service system, under the impetus of Ébauches SA and its supply network, which could send any spare part to any point on the planet within a few days.

The Roskopf watch, a low-cost watch with pin pallet escapement, occupied the final stratum of cheap watches, which was very significant in terms of volume. It stood up well to American competition (Timex), the only company that actually gave Swiss watchmaking a run for its money,[7] thanks to a remarkable streamlining of its production, which was carried out on a massive scale in modern factories, and thanks to reliable, high-performance calibers despite the technical disadvantage.

THE THEN-EXISTING TECHNOLOGIES

It's worth remembering that the obsession of Swiss watchmakers at the time, and for decades, had been precision. A good watch had to be precise. And to measure themselves, there were the Observatory competitions in Geneva and Neuchâtel, as well as the institutes for official watch timekeeping tests in Le Locle, Biel, La Chaux-de-Fonds, Saint Imier, and Le Sentier. Successes in precision competitions were the subject of blaring headlines, though all brands came out ahead, since prizes and competitions were legion and foreign brands were not invited.

Without getting into technical details, it can be stated that in the 1960s watch precision was quite adequate thanks to the many improvements made to balance springs, oils, alloys, and manufacturing precision over the years. The factor that could further improve running quality and accuracy was the increased frequency of the oscillating system. This is what explains the technological advances that gradually appeared during this period.

The traditional lever watch had a frequency of 18,000 or 21,600 A/h (2.5 and 3 Hz). Chronographs and counters already existed with higher balance frequencies enabling measurement to 1/10th of a second, if not less. But mass production of high-frequency mechanical watches required a capable escapement. Fabriques d'Assortiment Réunis was able to achieve this in 1966, introducing the Clinergic 21 escapement with a frequency of 36,000 A/h. First used by Girard-Perregaux, it was later adopted by a group of manufacturers brought together under the name Comité d'Horlogerie de Précision (Favre-Leuba, Eberhard, Cyma, Ebel, Ernest Borel, Doxa, Zodiac [Figure 1], Heuer, Juvénia) and by Longines.[8] The accuracy reached was remarkable, at 2 seconds/day, and rivaled that of tuning-fork watches. The high-frequency mechanical watch was indeed the subject of an extensive promotional campaign by ASUAG in 1972.

The first industrial attempts to introduce electronics into wristwatches came from the United States and France, with the release of the first electric watches in 1957 and 1958, respectively, by Hamilton and Lip in collaboration with Elgin. Their frequency was no higher than that of lever watches, but they fostered in particular the development of miniaturized batteries to supply

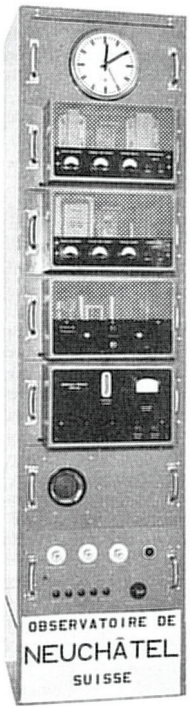
Figure 1. A 1970 advertisement for a watch with a 36,000 A/h caliber.

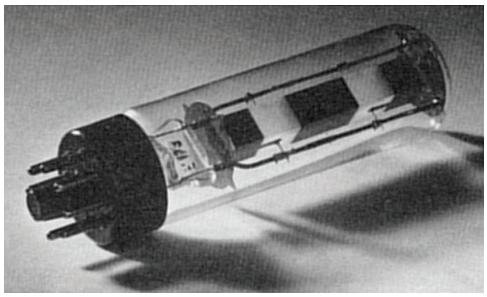
energy (Figure 2). The electric watch met with limited success, and Swiss attempts in this field were no more encouraging (Dynotron). The Accutron tuning-fork watch, launched by the American company Bulova in 1960, had a different result. With a vibration frequency of 360 Hz, it guaranteed a precision of 2 seconds/day, or about 1 minute per month. At the time of its unveiling, it sold for $175 to $325, while the average price of a classic Bulova hovered around $50. Yet the price soon dropped, and the Accutron proved so successful that it was even manufactured in Neuchâtel, Switzerland, from 1965 onwards. By 1968, Bulova had sold over 1 million Accutrons. The threat became serious for the Swiss watchmaking industry, which chose collaboration rather than competition: Bulova and Ébauches SA signed a technology transfer agreement in September 1968,[9] spawning the development of the Swissonic tuning-fork watch. In 1970, Bulova also signed agreements with Citizen in Japan for the production of tuning-fork watches.[10]

Quartz had even greater precision potential, since its vibration frequency could reach several tens of kHz. It was well known to watchmakers. As early as the 1930s, quartz clocks equipped physics laboratories[11] and observatories in Paris, Hamburg, Greenwich, and Washington. Their frequency ranged from 20 to 200 kHz, and their accuracy could reach a thousandth of a second/day, prompting horological author Léopold Reverchon to say in 1939, "Today, it seems that quartz has found the gateway through which it will be allowed to enter the field of chronometry once and for all. It is therefore with good reason that we recommend watchmakers to keep an eye out without delay. And the right one."[12] The first quartz clocks were quite impressive. They were the size of a large wardrobe and required strict conditions of use: perfect size of the quartz crystal, placed in a vacuum, and strict temperature control, as quartz vibrations are very sensitive (Figures 3 and 4).

Over the course of the 1940s and 1950s, quartz clocks became more compact and were used by Swiss watchmakers to regulate their watches. They were also used for certain measuring instruments such as Longines's Chronocaméra or Omega's Time Recorder, developed for sports timing.[13] Quartz became even more widespread with the development of the first quartz chrono-comparators, such as the Vibrograf from Reno SA or the Chronografic from Chs. Montandon SA, which became the benchmark for the evaluation of watches by watchmakers the world over. In 1949, Ébauches SA created its Oscilloquartz branch to research this technology. It was thus Oscilloquartz that supplied the quartz resonators later used in the first Swiss quartz watches.

◀ **Figure 2.** Hamilton's "energy cell." COURTESY OF THE NATIONAL WATCH & CLOCK MUSEUM.





▲ **Figure 3.** Vacuum quartz rod manufactured by Laboratoires Radio électriques SA, ca. 1948, as shown in *Journal Suisse d'Horlogerie,* 1948.

◀ **Figure 4.** Quartz clock at the Neuchâtel Observatory, as published in *Revue Internationale d'Horlogerie,* 1951. This clock was built by the Oscilloquartz department of Ébauches SA.

In 1952, Patek Philippe in Geneva designed a quartz clock that was far ahead of its time, with no hands and no wheels (Figure 5). The time was indicated by illuminated 12-hour markers and 60-minute markers.[14]

A further impetus was given to electronic watchmaking in Switzerland with the creation of the Centre Électronique Horloger (CEH), which was up and running in 1962. The effort devoted to the development of a quartz caliber by the CEH was considerable: nearly 90 engineers and 30 million Swiss francs (equivalent to $136 million in 2023).[15] The Beta caliber by the CEH was the product of a community of interest, made up of Swiss industrialists that included Ébauches SA, the Fédération Horlogère (FH), and numerous manufacturers such as Rolex, Longines, Jaeger-LeCoultre, Ebel, Doxa, Zenith, Omega, Enicar, and IWC.

The 1960s witnessed the arrival of the first quartz table clocks, in France in 1960 (Lip), Switzerland in 1961 (Ulysse Nardin in conjunction with Oscilloquartz), the United States in 1963 (Bulova, produced in Switzerland), Japan in 1965 (Seiko), and Germany in 1967 (Junghans).

Quartz marine and on-board chronometers were admitted to the chronometric competitions of the Neuchâtel Observatory in 1963, where they shattered

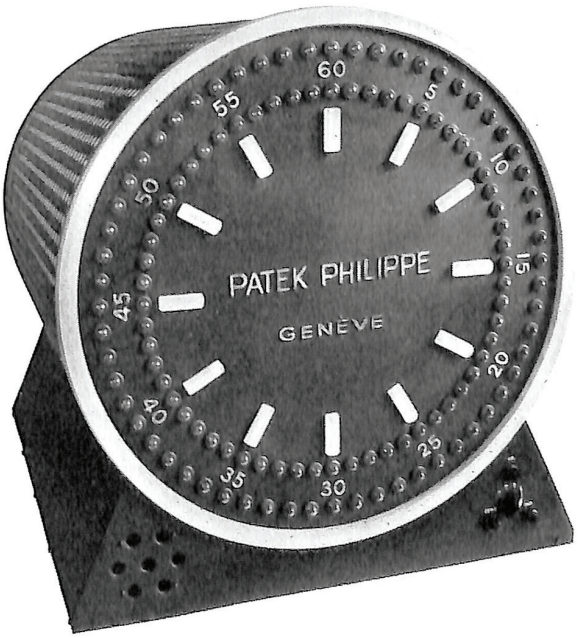


Figure 5. Patek Philippe quartz clock from 1952 in *Journal Suisse d'Horlogerie.* This clock has no wheels and no hands: markers light up on the dial to tell the time.

◀ **Figure 6.** As early as 1963, quartz chronometers were shattering precision records.

Figure 7. A 1971 Longines ad featuring watches with three different technologies.

records: Ébauches SA in 1963 and 1964, Voumard in 1965 (Figure 6). In that year, however, it was a foreign company that won the series prize for pocket chronometers: Seiko. And two years later, the same firm placed five quartz pocket chronometers in the top five spots! In the wristwatch chronometer category, the CEH presented its prototypes, which performed brilliantly in competition, just ahead of...Seiko.

On April 27, 1968, the Counsel of State suspended the competition in the "bracelet" category. The quartz watch had, in fact, become a reality in several countries.

A quartz watch was presented to the press by Longines in August 1969,[16] but Seiko was the first to bring a quartz watch to market on Christmas Day 1969. It was a gold watch with a quartz frequency of 8,192 Hz, selling for $1,250 (equivalent to about $10,450 in 2023).[17] The Swiss quartz watches (frequency of 8,192 Hz),[18] produced by the CEH and presented at the Neuchâtel Observatory competition in 1967, were prototypes, though the first watches equipped with the CEH's Beta 21 caliber were not marketed until 1970.

At the beginning of the 1970s, Switzerland was home to several cutting-edge technologies for the manufacture of modern watches. A very noteworthy example was presented by the Longines company, which offered the following in 1971 (Figure 7):

- High-frequency mechanical watches (36,000 vph) under the name Ultra-Chron
- Tuning-fork watches under the name Ultronic
- Analog quartz watches under the name Ultra-Quartz

Therefore, the Swiss watchmaking industry was not lagging behind technologically and was poised from the early 1970s to invest in any and all technologies that would be successful with the general public.

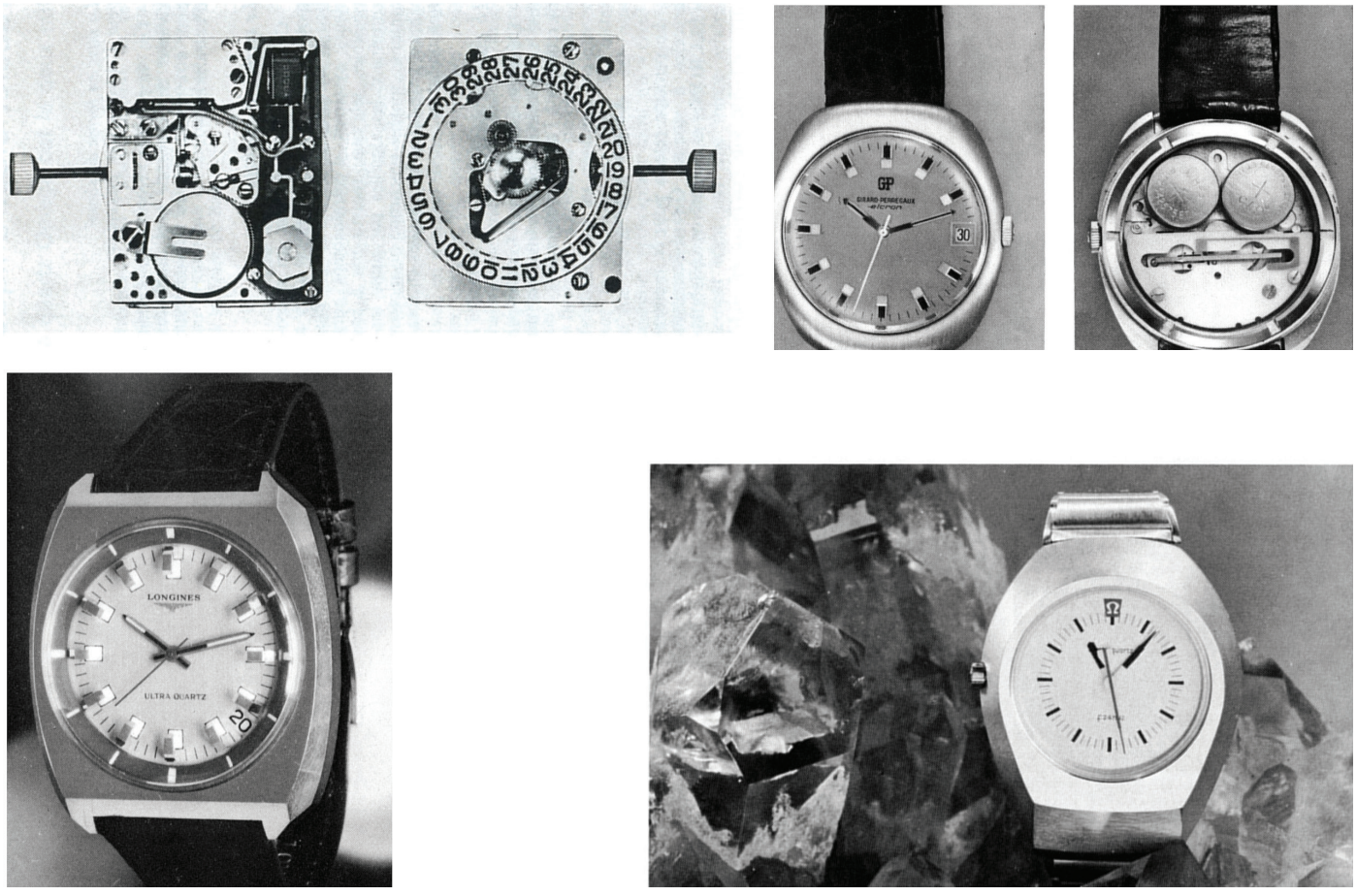


Figure 8. Quartz watches presented at the 1970 Basel Fair and appearing in the *Journal Suisse d'Horlogerie.* From top to bottom and left to right: caliber Béta 21, Girard-Perregaux Elcron, Longines Ultra-Quartz, and Omega Megaquartz.

This is what can be verified by examining the chronology of events at the beginning of this decade.

CHRONICLE OF EVENTS

This first period, from 1969 to 1974, witnessed a strong response from the Swiss watchmaking industry, which stepped up its investments and innovations. This was done in a chaotic manner, as competition was fierce between manufacturers and assemblers.

By 1970, there were five Swiss quartz watch technologies, each different from the other, evidence of considerable effort expended in a short period of time (Figure 8):[19]

- Longines[20] (Ultra-Quartz,[21] in collaboration with Bernard Golay SA, 8,192 Hz)
- Girard-Perregaux (Elcron, in collaboration with Thomson, 8,192 Hz)

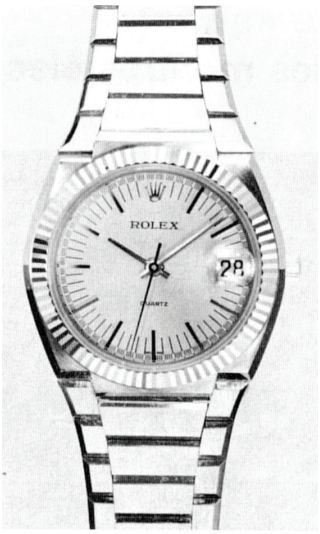


Figure 9. Rolex quartz watch, 1971, in *La Suisse Horlogère.*

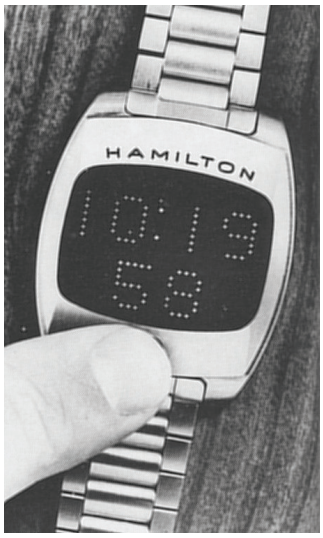


Figure 10. Hamilton Pulsar, the first quartz watch with an LED display, 1970, in *Journal Suisse d'Horlogerie.*

Figure 11. Second version of the Girard-Perregaux quartz watch, 1971, in *Journal Suisse d'Horlogerie.*

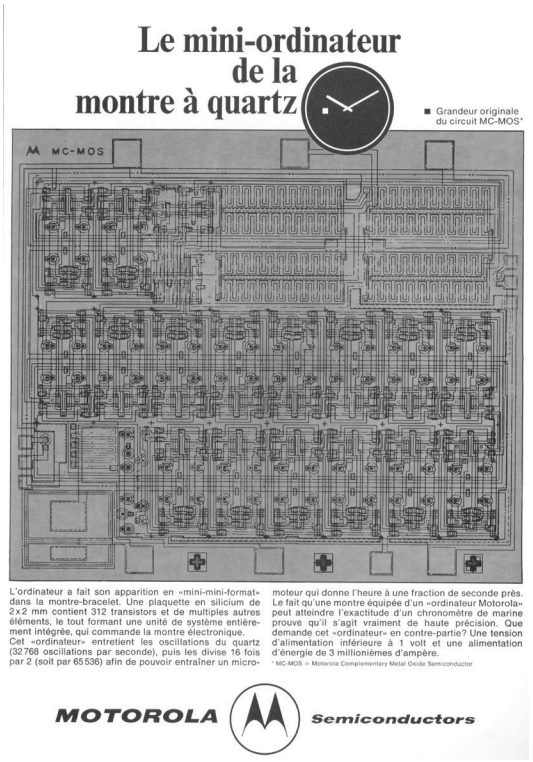
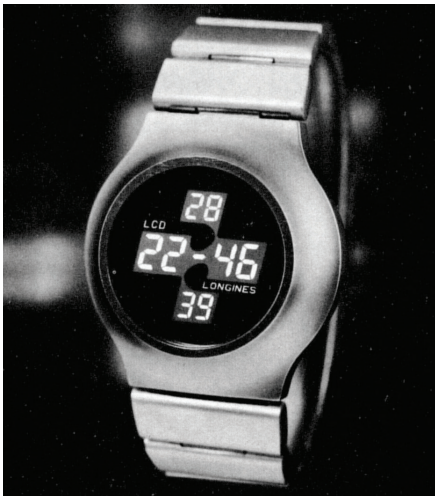


Figure 12. As early as 1971, Motorola offered its electronic technologies to Swiss watch manufacturers.



▲ **Figure 13.** View of Ébauches Électroniques SA in Marin, near Neuchâtel, in 1971, as shown in *La Suisse Horlogère.*

◀ **Figure 14.** Longines watch equipped with the Swissonic 2000 caliber, 1972, in *L'Impartial.*

- Néosonic (participating firms: Büren-Hamilton, Certina, Roamer, and Rolex [Figure 9]), in collaboration with the Institut de Physique Technique de Zurich, 16,384 Hz)
- Omega (Megaquartz, in collaboration with the Institut Battelle in Geneva, 236 kHz)
- The CEH supplied its Beta 21 movement, at a rate of 500 per month and at the not inconsiderable price of 700 Swiss francs per unit (around $2,500 equivalent in 2023), to numerous brands, which marketed it under their own name: Universal, Bulova, Cyma, Ebel, Enicar, Zenith, IWC, Eberhardt, Jaeger LeCoultre, Favre-Leuba, Juvénia, Doxa, Borel, Zodiac, Rado, Patek Philippe, and even Omega.

The CEH prepared for the future and signed a collaboration agreement on diode displays with an American firm.[22]

In 1970, the first quartz watch with digital display was released: the Hamilton Pulsar (Figure 10), with LED display, developed in collaboration with Electro/Data[23] and sold in the United States for $1,500 ($12,500 equivalent in 2023). Quartz had a vibration frequency of 32,768 Hz, which gradually became the standard for quartz watches worldwide.[24] It was also in 1970 that the first French (Lip Exachron, Motorola circuits) and German (Junghans Astro-Quartz) quartz watches were announced, though they were marketed later.

In 1971, Girard-Perregaux introduced a second version of its quartz watch (Figure 11), with Motorola integrated circuits (Figure 12),[25] 32 kHz frequency, mechanical parts in collaboration with LeCoultre & Cie, and marketed at around 700 Swiss francs ($2,500 equivalent in 2023).

Ébauches SA opened the Ébauches Électroniques SA center in Marin, near Neuchâtel, a vast complex that could accommodate 1,200 workers (Figure 13).[26] But there were two rounds of bad news: the Swiss franc was revalued by 7% and Zenith-Movado passed into American hands. SSIH (Omega-Tissot-Lémania) saved face by taking a stake in Hamilton.

It was also in 1971 that RCA (Radio Corporation of America) rolled out a watch with a liquid crystal display (LCD).[27] This had the advantage of the time remaining permanently displayed, whereas LEDs, which consumed a great deal of energy, appeared only briefly at the touch of a button.

Figure 15. Ditronic quartz watches, 1972, in *Journal Suisse d'Horlogerie.*

Figure 16. The two types of quartz watches presented by Roamer in 1972, in *La Suisse Horlogère.*

In 1972, Ébauches SA fulfilled its role as the official supplier to the Swiss watchmaking industry by coming out with two quartz movements: the Swissonic 1000 (ESA 9170), a 32 kHz analog movement, and the Swissonic 2000 (ESA 9260), in collaboration with Longines, whose LCD display was supplied by Texas Instruments (Figure 14).

The number of firms producing quartz watches increased rapidly. In Switzerland, with astonishing speed, several firms introduced quartz watches with LCD display, even though this technology had only been available for a year. The SGT group (Helvétia, Avia, Silvana, Titus, Sandoz), in association with its American subsidiary Waltham[28] and the electronics company Optel, offered a watch with LCD display for 650 Swiss francs ($2,000 equivalent in 2023). The Ditronic group (BWC, Delvina, Milus, Glycine, Wyler) unveiled its own versions at the Basel Fair (Figure 15).

Roamer then offered quartz watches with LCD display and, in collaboration with General Time Corporation,[29] with

Figure 17. Bulova quartz watch from 1972, whose quartz drove a tuning fork.


Le renom de Jaeger-LeCoultre: une garantie.

Une garantie aussi pour notre plus récente réalisation: la Master-Quartz.

Les maîtres-horlogers de Jaeger-LeCoultre aiment les idées révolutionnaires. N'ont-ils pas créé l'Atmos, cette extraordinaire pendule dont on dit qu'elle "vit de l'air du temps", parce qu'elle se remonte automatiquement par les variations de la température? La Memovox, la première montre ultra-précise munie d'une sonnerie?

Mais les chercheurs de Jaeger-LeCoultre ont une autre caractéristique: ils aiment pousser les idées très loin. Ainsi, on leur doit la plus petite montre du monde, un chef-d'œuvre de l'industrie horlogère.

Aujourd'hui, Jaeger-LeCoultre présente sa Master-Quartz. Ce n'est pas la première montre à quartz. Mais elle atteint la qualité et la fiabilité que l'on attend d'une Jaeger-LeCoultre.

La Master-Quartz est pilotée par un cristal de quartz qui vibre 32768 fois par seconde. Or, plus on fractionne la seconde, plus la montre est précise! Un circuit intégré comprenant 312 éléments entretient et divise cette fréquence. Les aiguilles sont entraînées par un moteur pas à pas de conception entièrement nouvelle. Le résultat de ces performances techniques est une précision fantastique, que seuls le quartz et le savoir-faire de Jaeger-LeCoultre pouvaient vous assurer.

JAEGER-LECOULTRE
marque son temps.

MASTER-QUARTZ

Figure 18. Jaeger-LeCoultre advertisement for Masterquartz quartz watches, 1973.


Zenith XL-Tronic Quartz. Une minute au plus d'écart par an: sa précision tient les promesses de sa beauté

ZENITH

Zenith. Nous donnons l'heure et signons sa beauté.

Figure 19. Zenith XL-Tronic Quartz advertising, 1973.

analog display (Figure 16). It succeeded in bringing down the retail price to less than 300 Swiss francs ($940 equivalent in 2023) by replacing the stepper motor with a spiral balance, which was well known to watchmakers. This was also the solution adopted by Corum, in collaboration with RCA and Bernard Golay SA, for its "µ Quartz" watch.[30]

Production of quartz watches in Switzerland remained insignificant: 325,000 in contrast to over 70 million mechanical watches.

In 1972 in the United States, Bulova launched the Accuquartz (Figure 17), whose quartz drove a tuning fork, and, most importantly, Timex, a specialist in economical watches, offered a quartz watch at $200 ($1,450 equivalent in 2023, then in 1973 down to $550 equivalent in 2023).[31] Gruen followed suit with an LCD display watch at $150 ($1,000 equivalent in 2023).

In 1973, the quartz phenomenon gained steam. Jaeger-LeCoultre presented its analog Master-Quartz version (Figure 18), Synchron (Cyma, Borel, Doxa) also opted for analog (Stratoquartz 2000), as did Zenith (XL-Tronic Quartz; Figure 19), Mido, Favre-Leuba (Quartz Raider), Zodiac (Astroquartz), and Certina. Nivada opted for LEDs, and Nepro for LCDs (Figure 20). Fiercely independent, Omega had chosen an unusual frequency of 240 kHz for its Constellation quartz, but in 1973 also developed a caliber with a more conventional frequency of 32 kHz (Figure 21).

Ronda, the independent specialist in low-cost movements, introduced its Ronda-quartz at an affordable price.

Oscilloquartz (Figure 22), a subsidiary of Ébauches SA, produced 1,000 quartz wristwatches a day, and intended to double its output in short order.[32] Ébauches SA was developing an all-Swiss quartz caliber; the field-effect LCD display was developed with two Swiss firms: Brown Boveri and Faselec (Figure 23).[33]

But production of electronic watches in Switzerland remained marginal: 650,000 out of 75 million. The dollar lost more than 10% against the Swiss franc.

It could be argued that a turning point took place in 1974. In that year, mechanical watches broke sales records (88.8 million watches and movements exported by Switzerland), which of course put into perspective the importance of the market penetration of quartz watches. This also led the Fédération Horlogère's Department of Economic Research to publish a voluminous study on the evolution of the cost of electronic watches. This study contained two errors that will explain the events that

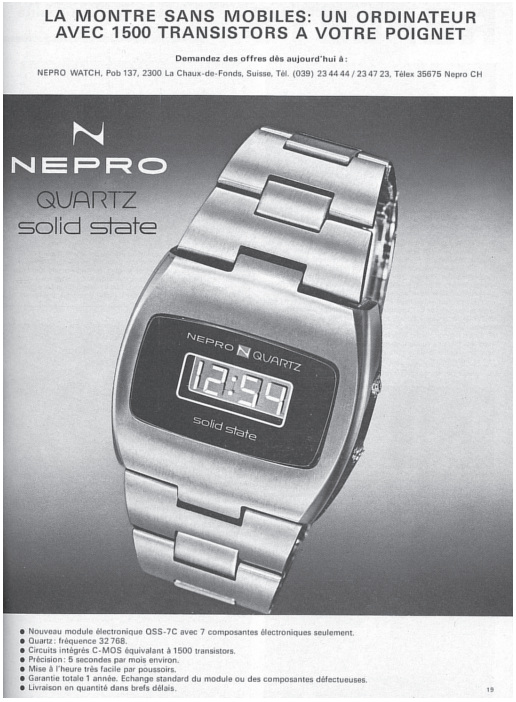


Figure 20. Advertising for the Nepro quartz watch with LCD display, 1973.

Figure 21. Omega chose an unusual frequency of 240 kHz for its quartz Constellation, but in 1973 it also developed a caliber with a more conventional frequency of 32 kHz. PHOTO COURTESY OF FRANCK INEICHEN.

Figure 22. In 1973, Oscilloquartz proudly proclaimed its manufacture of quartz crystals for electronic watches.

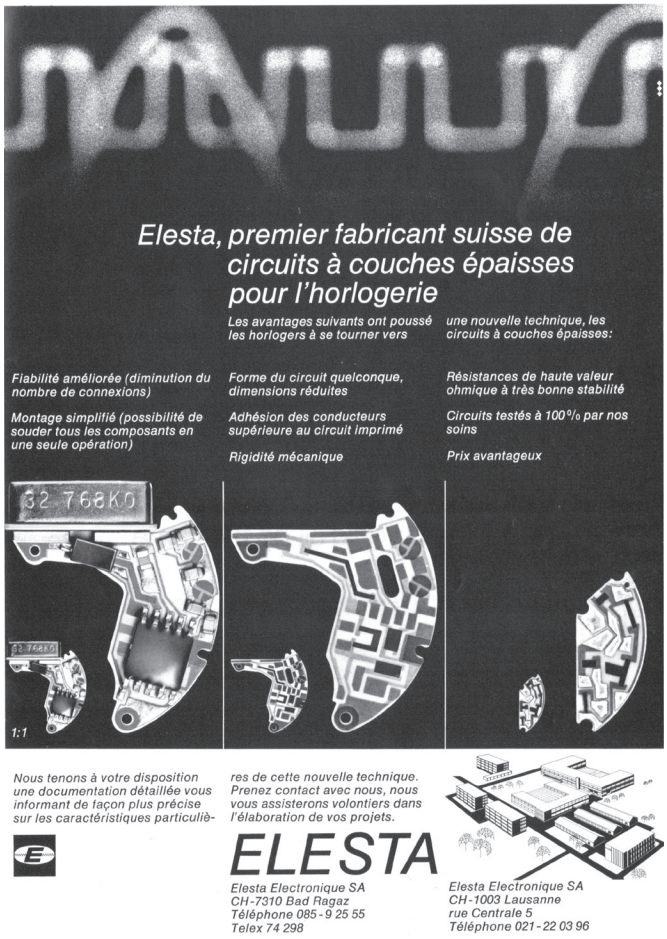


Figure 23. In the early 1970s, several Swiss electronics manufacturers, including Elesta, ventured into electronics for quartz watches. This ad is from 1973.

followed: the underestimation of the electronics industry's capacity for innovation, and the underestimation of the speed at which this industry could bring its innovations to market. Among these innovations, most pertinently, was the ability to reduce costs. In this report, the tone was evident from the outset: "Indeed, it has been claimed that the cost price of the electronic watch would be considerably lower than that of its mechanical counterpart, whereas in the current state of affairs, the price of quartz alone is sometimes higher than the cost of a simple hand-wound timepiece."[34]

The Fédération Horlogère neither believed in a reduction in the price of quartz ("the quality quartz that is already produced industrially currently costs around Fr.12-... but it seems unlikely that it will fall below Fr.10- in the foreseeable future"[35]), nor in a reduction in the price of electronics ("the C-MOS circuit used in liquid crystal watches is much more complex...and its price cannot, according to experts, be reduced in the short term by more than a few percent"). The Fédération Horlogère then concluded that "there is a big difference between the wish expressed by some to see costs disappear, as if by magic, and the reality of a highly complex product: the watch."

In retrospect, it's easy to argue that the Swiss manufacturers' mistake was not to invest in the mass production of quality quartz watches. But which quartz watch in 1974? Analog? Solid State? LCD? Field effect? LED? C-MOS? A host of acronyms alien to traditional watchmaking terminology. Manufacture one's own quartz, like Omega or Ébauches SA? Join forces with American electronics specialists like Roamer, Ébauches SA, or Girard-Perregaux? What, then, is Swiss Made?

In summary, during the first period of the "quartz years," the Swiss watchmaking industry demonstrated great agility and remarkable responsiveness. Working in a disorganized manner imposed by the very structure of this industry, companies explored the various technological options with manufacturers who wanted to retain control of their production, trusts that invested to meet demand, and independents eager for any association. At the 1974 Basel Fair, Swiss quartz watches were in every window. Nonetheless, facts are stubborn things: they weren't selling very well.

Part 2 of the article will examine the coming wave of American competition on price, Japanese competition on quality, the devaluation of the dollar against the Swiss franc, and the arrival of a new competitor in Asia.

Acknowledgment
Swiss trade journals were consulted at the research center of the Musée International d'Horlogerie in La Chaux-de-Fonds, thanks to the team of archivists under the direction of Régis Huguenin, whom I could not thank enough for their warm welcome and helpfulness. Part of the MIH's documentary collection is available online at The Watch Library: https://watchlibrary.org/.

Notes and References

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4. Available at https://www.arcinfo.ch/pages/archives-d-arcinfo-l-express-et-l-impartial-437575.
5. Subscription required: https://timesmachine.nytimes.com/browser?searchResultPosition=0.
6. *L'Impartial*, January 6, 1972, 1.
7. Russian production outstripped American production (20 million units vs. 19 million) but in very limited markets. Japanese production (21 million units) was essentially limited to its domestic market. In 1969, total Swiss production reached 72 million units.
8. *La Suisse Horlogère* (1967): 6, 36.
9. *Journal Suisse d'Horlogerie* (1968): 6, 649–52.
10. *Journal Suisse d'Horlogerie* (1970): 6, 682.
11. *Journal Suisse d'Horlogerie* (1936): 7–8, 43–45.
12. *Revue Internationale d'Horlogerie* (1939): 9, 126–29.
13. *Journal Suisse d'Horlogerie* (1951): 1–2, 46–51.
14. *Journal Suisse d'Horlogerie* (1952): 9–10, 271–76.
15. *L'Impartial*, April 15, 1970, 23. Swiss francs were updated using the Switzerland Inflation Calculator website, https://www.in2013dollars.com/switzerland/inflation/. US dollars have been updated using https://www.saving.org/inflation/.
16. *L'Impartial*, August 21, 1969.
17. *The New York Times*, January 5, 1970.
18. This frequency of 8,192 Hz, lower than the 32,768 Hz that would later become the standard, is linked to the difficulties that initially existed in reducing the frequency to drive a ratchet wheel. This constraint meant that the quartz rods were quite long (nearly 24 mm). Advances in integrated circuits have facilitated downsizing and enabled the use of smaller crystals oscillating at higher frequencies.
19. *Journal Suisse d'Horlogerie* (1970): 3, 312–18.
20. The Longines Ultra-Quartz watch did not actually come onto the market until the following year. Its development, with the help of Bernard Golay SA, was complex, and few examples were built.
21. Some of the first Longines quartz watches bore the name Quartz-Chron.
22. *L'Impartial*, May 22, 1970, 31.
23. Electro/Data, founded in 1966 in Garland, TX, was already working on prototypes of solid-state quartz watches; see http://oldpulsars.com/ElectroData.htm.
24. Girard-Perregaux claims to have first used this frequency for its quartz watches. This is indeed the case for the second generation of Girard-Perregaux quartz watches, released a year after the Hamilton Pulsar. When contacted about this via their website, the company did not reply.
25. *L'Impartial*, January 20, 1971, 3.
26. *Communications Ebauches SA* (1971): 29, 6.
27. *L'Impartial*, June 26, 1971, 1.
28. *La Suisse Horlogère*, Edition Hebdomadaire (1972): 271.
29. *La Suisse Horlogère*, Edition Hebdomadaire (1972): 428.
30. *Journal Suisse d'Horlogerie* (1972): 3, 310.
31. Its frequency was very different from that of its competitors: 49,152 Hz.
32. *Journal Suisse d'Horlogerie* (1973): 6, 602.
33. *La Suisse Horlogère*, Edition Hebdomadaire (1973): 426.
34. *La Suisse Horlogère*, Weekly Edition (1974): 1479–80.
35. It will be Fr.1.50 in 1977!

About the Author

Joël Pynson, MD, ophthalmologist, has spent most of his career as an R&D and engineering manager in the field of eye surgery and contact lenses. He holds some 20 patents in this field. A watch enthusiast and collector, he has published numerous articles on the history of Swiss watchmaking and is the author of two books: *Le chronographe de poche Suisse,* published by Chronométrophilia/Simonin, and *Chronographs for Collectors,* published by Time to Tell.