



THE MASTERY OF PRECISION

A CONTINUING STORY OF INNOVATION AND EXCELLENCE – PAST, PRESENT AND FUTURE

Key facts:

- From raw metal to finished timepiece: precision at every step
- Shocks, magnetism and gravity: mastering the challenges to chronometry
- A ground-breaking solution to the incompatibility of timekeeping and complications

At Jaeger-LeCoultre it is a deeply held belief that it takes time, patience and effort to accomplish mastery in any field of human endeavour. For our Maison, precision is a core value and our quest to attain mastery in this area began two centuries ago – and will continue long into the future.

It was our founder Antoine LeCoultre's obsession with precision that drew him to watchmaking. Even before he opened his first watchmaking atelier – while working in his father's blacksmithing forge – he had invented machines that made it possible to cut pinions from steel with an unprecedented degree of accuracy. Taking their lead from the founder, subsequent generations of watchmakers, engineers, designers and craftsmen have worked to master precision in every area and at every stage of the watchmaking process – from conception and design to the transforming of raw materials into useable components, to the finest manual gestures involved in assembling, finishing and decoration. In 2024, Jaeger-LeCoultre tells its story of precision in four chapters.

The Precision of Production

In watchmaking, precision in the production process is the key to everything else, and this was well understood by Antoine LeCoultre, whose earliest inventions were to revolutionise the watchmaking business.

In 1830, three years before establishing his watchmaking atelier, he developed and patented a mechanical tool that cut pinion teeth from steel. Rather than being shaped by hand, one by one, multiple pinions could now be made to precisely the same pre-determined specifications, and with greater accuracy than ever before.



Fourteen years later, in 1844, Antoine LeCoultre invented the Millionometre. The first device capable of measuring a micron, it enabled not only to measure components with an unprecedented level of precision but also to miniaturise them even further. The Millionometre can be seen as Antoine LeCoultre's inventive response to the miniaturisation made possible by the machines that he himself had invented and, in turn, the precision of its measurements made further miniaturisation possible. Very few examples of the Millionometre were made and the technology was jealously guarded by the Manufacture, where it served as the standard for precision for more than 50 years.

Continuing his pursuit of precision, Antoine LeCoultre implemented new tools to the production process such as the rounding-up tool in 1850, and the milling-cutter tool in 1860, further enhancing the ability to produce precise watch components.

Among the exceptional timepieces made possible by the ability to measure with micron-accuracy was the world's flattest movement. Just 1.38mm thick, Calibre 145 was presented in 1907 in the pocket watch nicknamed Couteau (knife) owing to its thinness.

Ensuring that the legacy of Antoine LeCoultre's contributions to watchmaking precision endures, swages have been preciously conserved within the Manufacture walls since 1926. Today, Jaeger-LeCoultre has more than 1,900 stamps to produce or service the Maison's calibres.

Throughout his life, Antoine LeCoultre continued to develop new and precisely calibrated stamping and cutting machines, and mechanical lathes to turn parts. By making it possible to produce identical components in series, his pursuit of precision set the stage on which the modern watchmaking industry developed – an achievement recognised by a gold medal at the 1851 Great Exhibition in London.

As technology advanced throughout the 20th century and continues into our current century, Jaeger-LeCoultre has embraced modern aids to precision throughout the watchmaking process. The Manufacture was an early adopter of CNC (computer numeric cutting), acquiring its first CNC machine in 1982, and of CAD as an aid to design. More recently, technologies such as spark erosion, laser cutting and 3D prototyping have turned the core stages of the production process into an exact science. However, these technologies are an adjunct to, not a replacement for, the precise human gestures involved in initial design, various stages of prototyping and the assembly, finishing and decoration of watch calibres – for it is the craft of the human hand that distinguishes high-end watchmaking from the rest, imbuing an Haute Horlogerie timepiece with its ineffable 'soul'.

The Precision of Chronometry

Chronometry means, simply, timekeeping accuracy, and a chronometer is a mechanical calibre that exhibits a very high degree of accuracy that has been certified through a stringent testing process. Chronometer certification owes its genesis to the advancement of optic technology in the mid-19th century, which led to the establishment of observatories that enabled the precise measurement of the planetary movements that define time as we know it.



Honouring the founder's obsession with precision, the Manufacture Jaeger-LeCoultre has developed many chronometer calibres during its 190-year history. To achieve the necessary degree of accuracy, every chronometer timepiece is the product of deep research into how to compensate for the challenges that a watch is subjected to. To produce a chronometer mechanism requires great technical know-how: pinions must be precisely shaped and gears perfectly meshed; working surfaces must be immaculately polished to reduce friction; and metals must resist temperature variations.

In the quest for precision and durability, mechanical watchmaking faces several challenges, ranging from bumps and shocks and magnetism to energy and gravity.

Challenge 1: Bumps and Shocks

Movements that beat at a higher frequency are less disrupted by shocks. Addressing the need for more resilient movements, the Maison introduced in 1970 Calibre 916 which operates at a high-frequency of 28,800 vibrations per hour (4Hz). By doing so, the Manufacture set a new standard at the time, breaking the traditional 3Hz or 2.5Hz, which was the norm back then. In the constant quest for precision, Jaeger-LeCoultre developed the Calibre 781 for the Master Compressor Extreme Lab, achieving remarkable precision and reliability. Among other innovations, the hairspring has a special protection device that limits the motion of the spring during periods of extreme situations, such as shocks.

Challenge 2: Magnetism

Magnetism can affect the accuracy of mechanical watches by magnetizing certain components, causing them to run slower or faster. Early on, the Manufacture explored various materials to enhance hairspring performance, leading to the pioneering use of a palladium hairspring in the LeCoultre Calibre 18RV for the Chronograph Pocket Watch at the end of the 19th century. This innovation earned it a chronometer certification. To counteract magnetization further, the 1958 Geophysic was engineered for durability, water resistance, and precision, incorporating a soft iron inner case for magnetic protection, making it a certified chronometer and one of the first wristwatches to offer such functions.

Challenge 3: Energy

Mechanical watches operate on a wound spring that powers the movement. A low power reserve may affect timekeeping accuracy, as the unwinding mainspring reduces the balance wheel's oscillation amplitude, leading to unstable movement and inconsistent timekeeping. Watches with longer power reserves can delay the onset of 'low energy production,' ensuring a more regular 'heartbeat' and maintaining timekeeping accuracy for extended periods. In the 19th century, the Manufacture's watchmakers tackled the challenge of added complications by launching the minute repeater Calibre 19/20RMSMI in 1881, featuring two barrels powering a single gear train for both timekeeping and complications. This innovation laid the groundwork for the 21st-century revolutionary Duometre concept. Pursuing the optimization of energy efficiency, in 2004 the Master Eight Days Perpetual emerged as a perpetual calendar with an 8-day power reserve, embodying excellence in performance and elegance in design.



Challenge 4: Gravity

Gravity influences mechanical watch accuracy by affecting the balance wheel and escapement depending on the watch's position, resulting in timekeeping variations. To counteract this, some watches feature tourbillons that continuously rotate these components to even out gravity-induced errors. Jaeger-LeCoultre introduced the remarkable Calibre 170 in 1946 for chronometric competitions, achieving multiple awards. Always driven by the inventive spirit of Antoine LeCoultre, in 2004 the Maison pushed back the boundaries of watchmaking by introducing multi-axis tourbillons.

The Manufacture LeCoultre was already producing chronometer-certified pocket watches in the 19th century – 100 years before modern aids to precision, such as CNC machines and laser-cutting, had even been imagined. While some of these watches had simple mechanisms – and thus fewer variables that can affect timekeeping accuracy – the Manufacture also created chronometer-certified watches with complications and, in 1890, met the ultimate challenge of producing a chronometer-certified Grande Complication pocket watch.

In 1992, Jaeger-LeCoultre introduced its 1,000-Hour Control certification. One of the watch industry's most stringent testing protocols, it tests not only the calibre alone but also the entire cased-up watch and demands greater accuracy than the standard Swiss chronometer certification. The first movement to receive the 1,000-Hour Control certification was Calibre 899, the pillar of the Master Control collection.

Continuously seeking ways to improve chronometry, innovations in recent years have focused on materials for key components – including silicone and new lubricants to reduce friction and thus enhance energy transmission – new constructions for gears and balance wheels, and new shapes for escapement wheels and pallets, all of which have improved isochronism and thus accuracy of timekeeping.

The Precision of Regulating Organs

The regulating organ is one of the most important parts of a movement. Composed of the balance wheel and the hairspring (known as the spiral in French), it is the element that we find so mesmerising to observe in mechanical calibres, the part of the movement that appears as if living and breathing – its beating heart. Controlled by the expansion and contraction of the hairspring, the regularity of that heartbeat – known as isochronism – is crucial to accurate timekeeping.

Jaeger-LeCoultre is one of the few watchmaking Maisons with the specialised skills in-house to craft and shape hairsprings in different forms and this key component has been the subject of deep research by the Manufacture's engineers for many decades. In the early days, considerable attention was



devoted to materials and, in 1890, the Manufacture pioneered a palladium hairspring. More recently, efforts have been focused principally on the form of the hairspring and on tourbillons.

The shape and attachment (terminal curves) of a hairspring determine the way that it expands and contracts. While it is standard practice use flat hairsprings, Jaeger-LeCoultre's engineers have studied different configurations to identify the shapes that offer the most concentric – and therefore regular – oscillation according to the particular construction of the regulating organ. They discovered, for example, that a flat (Breguet) hairspring delivered the best results in the Gyrotourbillon 5 while maintaining a very small Gyrotourbillon size, whereas in the Tourbillon Cylindrique, a cylindrical hairspring with two terminal curves beats with a concentricity impossible to achieve with a traditional hairspring. The Manufacture's specialists have also developed spherical and semi-spherical hairsprings for different calibres – and their research continues.

Recognising that the effect of gravity also has an impact on the finely tuned balance of a watch mechanism, they also studied the regulating organ as a whole and found a solution in the tourbillon. A device that had been largely neglected since its invention at the end of the 18th century, the tourbillon counters the effects of gravity by rotating the balance wheel within a cage. In 1946, Jaeger-LeCoultre's first tourbillon movement – Calibre 170 – won the Neuchâtel Observatory chronometry competition, and in 1993 the Maison created its first tourbillon wristwatch.

Because the tourbillon was initially devised for pocket-watches, so does not compensate for the effects of gravity in all positions, Jaeger-LeCoultre's watchmakers added a second axis that turns perpendicular to the first, to achieve a three-dimensional rotation. The Maison broke new ground with the launch of its first multi-axis tourbillon in 2004 – the emblematic Gyrotourbillon – followed in 2012 by the Spherotourbillon. This was followed in 2014 by the ultra-thin Calibre 362 featuring a flying tourbillon held on a peripheral ball bearing system and fitted with Jaeger-LeCoultre's patented S-Shape hairspring. Further development of the original Gyrotourbillon led to the release of a 4th generation in 2016 and in 2019, the Gyrotourbillon 5 housed in the Master Hybris Mechanica Calibre 184.

The Precision of Complications

The fundamental requirement for accurate timekeeping is that the power supply delivered from the movement's barrel to the regulating organ should be absolutely steady, in order to maintain isochronism – the perfect regularity of the mechanism's 'heartbeat'.

Requiring a watch movement to drive an additional complication carries the risk of jeopardising its timekeeping accuracy – for the simple reason that the complication itself requires power in order to function. Moreover, while displaying the time accurately, the watch must also ensure that the complication's indications – for instance, a moon phase, a celestial map, elapsed seconds – are displayed on the dial with the greatest possible precision.



Some complications create a slow and relatively steady drain on the power supply over time – for example, calendars of varying degrees of complexity. Other complications – including chronographs and minute repeaters – require a high burst of energy for a very short period. The chronograph poses an added challenge to precision because its entire purpose is to accurately measure and display precise, and very small, intervals of elapsed time.

Since the early days of the Manufacture, our watchmakers have not only mastered the chronograph but also have associated it with other complications, devising ways to successfully manage the transfer of energy between the timekeeping function and the operation of the complications, while minimising its effect on isochronism.

In their search for a solution to the conflicting demands of timekeeping and complications, Jaeger-LeCoultre's engineers developed the Duometre concept. Patented by the Manufacture and introduced in 2007, a Duometre mechanism features two barrels, each with a separate and independent gear train, housed within a single calibre and linked to a single regulating organ. One gear train is responsible for powering the time indications, and the other for driving any additional functions. Because it ensures that the operation of the complication does not compromise the timekeeping function, and thus guarantees operating accuracy, this concept has opened the door to continuously expanding horological complexity.

For the first application of the Duometre concept in 2007, Jaeger-LeCoultre watchmakers set themselves the hardest challenge: to develop a chronograph watch that would be as accurate as a chronometer. The result was the Duometre à Chronographe, fitted with Calibre 380 – a fully integrated column-wheel chronograph movement. The Duometre mechanism has since been employed for other complications, including moon phases, a GMT function, a classical tourbillon and, in 2012, a spherical tourbillon.

In 2024, Jaeger-LeCoultre introduces two new Duometre movements: Calibre 388, which powers the Duometre Héliotourbillon Perpetuel, features an entirely new tourbillon configuration, which rotates on three axes and creates a 'spinning top' effect. And Calibre 391 unites a chronograph with a moon-phase display in the Duometre Chronograph Moon.

Incorporating almost eight decades of accumulated expertise, the new Duometre calibres represent another step forward in the Maison's continuing quest to master precision. And thus, the story begun by the founder continues...



Since 1833, driven by an unquenchable thirst for innovation and creativity, and inspired by the peaceful natural surroundings of its home in the Vallée de Joux, Jaeger-LeCoultre has been distinguished by its mastery of complications and the precision of its mechanisms. Known as the Watchmaker of Watchmakers™, the Manufacture has expressed its relentlessly inventive spirit through the creation of more than 1,400 different calibres and the award of more than 430 patents. Harnessing 190 years of accumulated expertise, La Grande Maison's watchmakers design, produce, finish and ornament the most advanced and precise mechanisms, blending passion with centuries-old savoir-faire, linking the past to the future, timeless but always up with the times. With 180 skills brought together under one roof, the Manufacture creates fine timepieces that combine technical ingenuity with aesthetic beauty and a distinctively understated sophistication.

The Precision Maker

A core value since the company was founded in 1833, the quest for precision has particular significance at Jaeger-LeCoultre. The very foundations of the Maison rest on two of Antoine LeCoultre's crucial inventions: a tool that cut pinion teeth with unprecedented accuracy (1830) and the *Millionometre* (1844), the world's first instrument able to measure a micron. Both devices were to have a profound influence on the entire watchmaking industry. Within the Manufacture, research into precision has resulted in a series of breakthroughs, including the development of the first multi-axis tourbillon, known as Gyrotourbillon, and different forms of hairspring. For complication calibres, the invention of the Duometre system ensures that isochronism (the regularity of the mechanism's 'heartbeat') is not compromised by operation of the complication. For Jaeger-LeCoultre the pursuit of precision is a central tenet of the Maison since it was established and will continue long into the future.

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