Figure 4A.

Figure 4B.

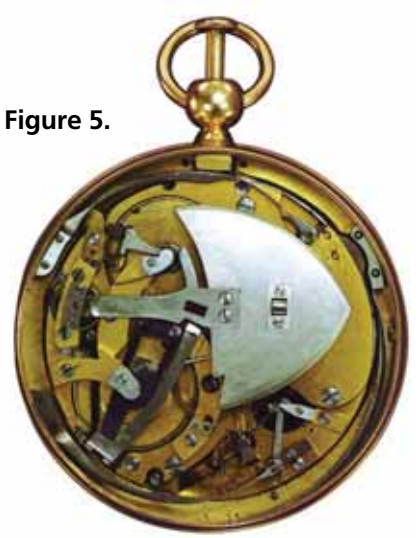

Figure 5.

allowed the striking to occur only when a button or "nib" was moved. Figure 4A shows the rack and snail in a modern minute-repeating movement while Figure 4B shows how the gong wires are curved to fit the case in a modern minute-repeating watch. It should be noted that the watch in Figure 4B has only two gong wires while the Queen strikes on three gongs and is therefore even more complicated.

A. L. Perrelet is said to have invented the self-winding mechanism for watches in the 1770s. Breguet modified the original design and described his watch with this feature as a "perpetuelle." The mechanism uses a weighted pendulum (Figure 5) and swings back and forth as one walks, in the same way that a pedometer works. In the Marie-Antoinette the weight is made of platinum. Because there is less movement of one's body than one's arms, this mechanism did not work well, and self-winding watches didn't become truly practical until after the 1920s when wristwatches became fashionable.

An interesting complication in this watch is the independent seconds hand. The incorporation of this feature, which allows the second hand to be stopped and reset, makes this watch the first chronograph or stopwatch.

A watch measures the oscillations of a balance wheel. Because these oscillations are regular and unvaried from one hour to the next, there are exactly 86,400 seconds between noon on a given day and noon on the next. This 24-hour period is called a mean solar day. The true day length will only be 24 hours long at any point on the Earth four times each year. The difference in day length is caused because the Earth travels in an elliptical orbit around the Sun and the Earth's axis of rotation is inclined relative to the Sun. This difference in day length may vary from about 14 minutes slower to 14 minutes faster during the course of the year. It is possible for a watch to indicate the correction that must be applied to correct for this variation. This indication is called the Equation of Time. Typically, such an indicator is driven by a follower that rides a kidney-shaped cam that rotates once per year (Figure 6). Breguet included an equation of time mechanism in the Queen.

It is interesting to note that the watch incorporates a thermometer based on a bimetallic strip. The bimetallic strip is credited to John Harrison, and it is conceivable that at the time of the design of this watch it may have been considered cutting-edge technology.

In addition to these ten complications, Breguet adapted Mudge's lever escapement. The pivots of the escape wheel, the balance wheel, and the lever are all in a straight line. The lever is made of two pieces of sapphire.

Another innovation that Breguet used was one he referred to as a parachute or "elastic suspension." This involved using conical pivots for the balance staff so that if the watch were to receive a shock the balance pivots would remain unbroken.

Breguet 160 remains an exquisite work of art even today. The quality of its materials, workmanship, and technical complexity attests to the genius and skill of Abra-

Figure 6.

ham-Louis Breguet. It was the most complicated watch of its time and remained so until the twentieth century.

The history of the watch from the time of its creation is a story worthy of the best novelists.

The records of the Breguet firm indicate that the watch remained in its possession after the fall of the French monarchy. Yet the records also show that in 1838 the watch was taken in for repairs by the firm from a Marquis de la Groye. Furthermore, the watch was never called for and remained in the firm's possession until 1887, when it was sold to Sir Spencer Brunton. How the Marquis acquired the watch and why it was never called for remain a mystery. The watch ultimately came into the possession of Sir David Lionel Salomans. Salomans was a wealthy nobleman who was a politician, philanthropist, and inventor. He was an avid collector of timepieces and the most knowledgeable Breguet authority in his lifetime. When he died in 1925, his collection included 124 Breguet clocks and watches. Of these, his daughter Vera inherited 57; his wife inherited the remainder.

Figure 8.

Vera lived part of her life in Palestine and believed strongly that for Jews and Arabs to coexist peacefully it was necessary to understand and appreciate each culture. She found a kindred spirit in Professor Leo Mayer, of the Hebrew University in Jerusalem. Professor Mayer was an expert and collector of Islamic art. Vera endowed a museum in Jerusalem to house both Professor Mayer's collection and the collection of timepieces she inherited from her father. The museum (Figure 7) was opened in 1974.

In April 1983 the museum was broken into and 106 items, including all the Breguet watches, were stolen. At the time, the police examined the site and concluded that it was the work of a gang of professional thieves. It seemed that the Marie-Antoinette was lost forever.

In the early 1980s the Swiss watch industry was suffering from the effects of low-cost Asian competition. Nicolas Hayek, an engineering management consultant, was hired to oversee the liquidation of some watchmaking firms. Hayek believed that the Swiss watch industry could survive and flourish. One of his ideas was the production and marketing of a fashionable watch with fewer parts than were in the typical quartz watch of the day. The result was the Swatch, produced by a company formed by a merger of the two companies that Hayek was managing. This company became the Swatch Group with brands such as Swatch, Blancpain, Omega, Longines, and Hamilton, to name only a few. Hayek was to remain chair of the company until his death in 2010.

In 1999 the Swatch Group took over the Breguet company, and by 2005 the Marie-Antoinette had not been recovered. The Breguet archives held the original drawings of the masterpiece, so Hayek directed that a reproduction of Number 160 be made as faithfully as possible. This was to be Breguet 1160 (Figure 9). Hayek even made a very large donation to the restoration of the Queen's residence, Le Petit Trianon, to secure wood from a 300-year-old oak tree from the grounds of the residence to make the wooden case to house the reproduction (Figure 8).

But before 1160 could be finished, around 2007, the Mayer Museum was approached by a woman who wished to sell them some of the articles that had been stolen. The woman was the American wife of a notorious Israeli thief, Na'amen Diller. It was he who single-handedly carried out the robbery. So that the remaining articles could be recovered and not to interfere with the police inquiries, the Israeli museum made no mention of the development to the public. Breguet unveiled the 1160 to the public at the Baselworld watch and jewelry trade fair in the spring of 2008. The original Marie-Antoinette and all but ten of the stolen artifacts were recovered. Today, the original can be seen in the L. A. Mayer Museum in Jerusalem, and the replica is occasionally shown in displays of Breguet's works. Both are incredible works of art. The original was, indeed, the most complicated watch for its time. Nonetheless, time passes and technology changes and it has since been superseded.

Figure 7.

Figure 9.

Figure 10.

Figure 11.

Figure 12.

Part Two:

The Sky in La Lucie with Jewels

António Augusto Carvalho Monteiro (1848-1920), (Figure 10) was an unbelievably wealthy Portuguese individual. Born into a wealthy family in Rio De Janeiro, he amassed an additional fortune trading in coffee and precious stones. Having accumulated this great wealth, he emigrated from Brazil and settled in Portugal where he received a degree in law. He is remembered for his eccentricity, his varied collections including rare books, and most of all for his philanthropy, which led to his nickname, "Monteiro of Millions."

Figure 13.

This remarkable watch (Figure 13) has 25 complications:

1. Day of the week
2. Date of the month
3. Months of the year corrected for leap years
4. Leap year indicator
5. Indication of the year for 100 years
6. Phase of the moon, indicating its age
7. Indication of seasons, solstices and equinoxes
8. Equation of time
9. Chronograph to 1/5th sec, with fly-back
10. Minute counter with fly-back
11. Hour counter with fly-back
12. Power reserve (state of winding indication)
13. Full and quarter striking with silent option
14. Repeating hours, quarters and minutes with 3 gongs
15. Northern Hemisphere sky map on the calendar date (Paris sky, 236 stars; Lisbon sky, 560 stars)
16. Southern Hemisphere sky map (Rio de Janeiro, 611 stars)
17. Local time in 125 cities around the world
18. Sunrise time in Lisbon
19. Sunset time in Lisbon
20. Bimetallic centigrade thermometer
21. Hair-tension hygrometer
22. Barometer
23. Altimeter up to 5,000 meters
24. Corrector system enabling adjustment of the watch from the exterior
25. A compass concealed in the crown

Figure 14.

In 1896 Monteiro acquired a watch (Figure 11) that had been made in 1878 by L. LeRoy and Company, of Paris, for a Russian Count, Nicholas Nostitz. This watch had 11 notable complications and, as can be seen in the photograph, was primarily a chronograph or stopwatch with settable seconds, minutes, and hour hands. These features allowed the watch to be set to show the time in

more than one place by the use of the dial ring on the back of the watch on which the longitude of various cities in Europe and the Americas were appropriately marked. It is interesting to note the heavily decorated crown on the watch. The ability to wind the watch without a key was a development of Adrien Philippe, who, before forming a partnership with Antoni Patek, worked for the LeRoy firm. Monteiro had LeRoy recase the watch and, it is surmised, had a new dial ring on the back made to show European cities and, in particular, several in Portugal.

At the same time Monteiro entered into discussions with Louis LeRoy (Figure 12), principal of the firm, to create a watch that would bring together in one portable timepiece all that science and mechanics could then achieve. LeRoy 01 (Figure 13) was the result.

The feature that was most innovative in the watch was the display on the reverse side (Figure 14). Here, in a window, is a sky map that may be set for the northern sky in either Paris or Lisbon or the southern sky as seen from Rio De Janeiro. The display will move so that it represents what one would see at that time of night in the chosen location. The time in any of the 125 cities of the world can be read directly from that ring surrounding the window. On the front face of the watch the gold hand with the sun on it marks the equation of time. The crown of the watch contains a compass and is encrusted with jewels and pearls.

Although the watch was not completed until 1904, LeRoy entered it in the Paris Industrial Exposition in 1901. The LeRoy 01 was awarded the gold medal at the fair. One American entry in the exposition that won a gold medal in a totally different class was the Campbell Soup Company, which still displays the award on its labels. When the watch was completed in 1904, it was the most complicated in the world. LeRoy presented it to another of his patrons, the king of Portugal, who took the watch to Lisbon and called Monteiro to his court. It was here that Monteiro took possession of the watch. It seems quite strange that a king was acting as a delivery person.

On his death the watch remained in the Monteiro family until 1955. It then came up for auction. The people of France raised Fr.2 million (about $3 million dollars today), which was sufficient to purchase the watch. It then became part of the collection of the Time Museum in Besancon, France. The curator of this museum was Lucie Cornillot. The watch remains on display in the museum and is referred to as "La Lucie."

Part Three:
A Tale of Two Tycoons

Figure 15.

The twentieth century might well be defined as the century of the automobile. One marque that was synonymous with luxury automobiles was Packard. The company was founded by James Ward Packard (Figure 15) and his brother in 1899 in Warren, OH, and by 1906 the company had attracted investors and filled such a niche in the market that it was able to move production to Detroit, MI. The company was one of the premier manufacturers of luxury cars before World War II. James Packard was an engineer with a lifelong passion for mechanical things. He was a passionate watch collector who ordered custom-made watches from companies like Vacheron Constantin and Patek Philippe. In fact, he purchased no less than 17 highly complicated watches, made to his specifications, from Patek Philippe alone, from 1905 until 1927, the year before his death.

In 1916 Packard took delivery of the most complicated watch that Patek Philippe had ever produced, Number 174,129. This watch had 16 complications, including perpetual calendar, moon phase, split seconds, jumping seconds, grande and petite sonnerie, minute repeating, up-and-down chronograph, and double power reserve indicators.

In 1927 Packard received watch Number 198,023 from Patek Philippe (Figure 16). This watch is currently on display at the firm's museum in Geneva. It was believed to be unique because on the back of the watch was a display accurately showing the sky as seen from Packard's home city, Warren, OH. The watch had nine other complications.

James Ward Packard's passion for collecting fine and complicated watches was, if not exceeded, at least matched by Henry Graves

Figure 16.

Jr. (Figure 17). Graves was born into a family of great wealth accumulated through banking. He, too, entered the family firm and continued to add to his fortune. Recently, it was discovered that he had acquired Patek Philippe Number 198,025 in the mid-1920s. What is most revealing is that this watch is documented to have a large sky chart and is similar to Packard's Number 198,023. The watch was previously undocumented and has not yet been found. The presentation box, description, and sales records were part of the effects of the late Reginald "Pete" Fullerton, Henry Graves' grandson, and these comprised a single lot that was auctioned by Sotheby's in June 2012. Both Graves and Fullerton were lifelong collectors of fine and complicated watches.

Figure 17.

Figure 18.

It is commonly thought that Packard and Graves competed to own the watch with the most complications. Whether they actively competed may be a subject for further research. In any case, when Graves ordered what was to become Patek Philippe Number 198,385 (the "Supercomplication") he is quoted as writing that Patek Philippe should plan and construct "the most complicated watch...and, in any-case, certainly more complicated than that of Mr. Packard!". The order was placed in 1928 and the watch was delivered in 1933.

Grande sonnerie and petite sonnerie describe the manner of striking in a clock or watch. At each quarter, the grande sonnerie strikes the most recent hour and then the quarter (on two different gongs). The petitie sonnerie sounds only the quarter except on the hour when it strikes the four quarters on one gong and the hour on another.

Complications 18 through 24 are displayed on the back side of the watch, which is labeled "Sidereal Time". Sidereal time is based on the amount of time it takes the Earth to make two consecutive transitions of a meridian by a fixed star. By measuring the transits of a fixed star, one is able to measure the actual time it takes for the Earth to turn on its axis. This period of time is known as a sidereal day which is approximately 23 hours, 56 minutes, and 4.1 seconds. The difference between sidereal day length and solar day length is caused by the variations in the way the Earth actually rotates on its axis (precession and nutation). This sidereal complication requires a transmission ratio of exactly 1.0027379092, which is driven by a 62-tooth wheel on the arbor of the fourth wheel.

After Graves' death, the watch eventually was acquired by the Time Museum in Rockford, IL. It was one of the pieces sold in the first auction that Sotheby's held for the dispersal of the Museum's treasures in 1999. At that sale it was purchased for the record sum of $11,002,500, making it the most expensive watch ever sold at auction. The purchaser loaned the watch to the Patek Philippe museum in Geneva, but it has now reverted to its owner and is no longer on public view.

The Graves' Supercomplication (Figure 18) contains over 900 parts and 70 jewels. There are 24 complications:

1. Split seconds
2. 30-minute recorder
3. 12-hour recorder
4. Westminster chime
5. Grande sonnerie
6. Petite sonnerie
7. Minute repeater
8. Alarm
9. Going train power reserve
10. Striking train power reserve
11. Twin barrel differential winding
12. Three-way setting system
13. Perpetual calendar
14. Date
15. Day of the week
16. Month
17. Phases of the moon
18. Sidereal time hours
19. Sidereal time minutes
20. Sidereal time seconds
21. Time of sunrise (for New York City)
22. Time of sunset (for New York City)
23. Equation of time.
24. Star chart (for New York City)

Part Four:

The End of an Era

Producing custom timepieces for the likes of Packard and Graves did not prevent Patek Philippe from the effects of the Great Depression in the 1930s. In 1932 the company was sold to Charles and Jean Stern, who had been owners of a company that made dials exclusively for Patek Philippe. The Stern family still owns the firm and it is the largest family-owned watchmaking company in Switzerland today. After their acquisition, it was necessary to make many changes to the operations to meet customer demands and to remain viable. For example, as

The Calibre 89 watches have 33 complications:

1. Day of the month
2. 12-hour recorder
3. Chime spring reserve
4. Day of the week
5. Hour in a second time zone
6. Chronograph
7. Phases of the moon
8. Winding-crown-position indicator
9. Century decade and year
10. Year in the four-year cycle
11. 30-minute recorder
12. Time spring reserve
13. Month
14. Split seconds (Rattrapante)
15. Thermometer
16. Hours of sidereal time
17. Date of Easter
18. Minutes of sidereal time
19. Time of sunrise
20. Equation of time
21. Seconds of sidereal time
22. Star chart
23. Sun hand (indicates sign of the zodiac)
24. Time of sunset
25. Minute repeater
26. Carillon
27. Grande sonnerie
28. Petite sonnerie
29. Tourbillon
30. Gyromax® balance wheel
31. 4-way setting system
32. Striking train stopwork
33. Twin barrel winding system

wristwatches became more popular, more of these were produced. Production runs were larger, and the manufacture of bespoke or custom timepieces was discontinued.

For almost five decades, no watch more complicated than Number 198,385 had been produced by anyone, anywhere. Nonetheless, because there are no hard and fast rules defining the term "complication," there were two watches that could qualify for the title of "Most Complicated Watch in the World." On one hand, were the advocates of the Graves' Supercomplication with its

Figure 19.

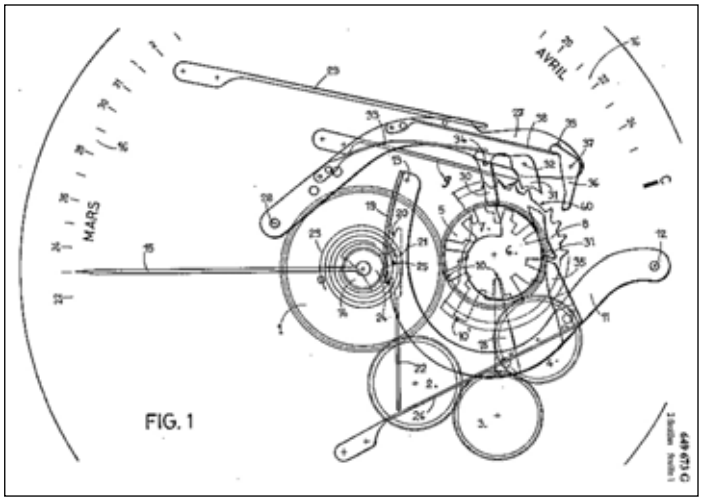

Figure 20.

24 complications. The champions of "La Lucie" reasoned that the watch, although only possessing 17 time-related complications was still more complicated than the Graves because of its total 25 features.

As Patek Philippe approached its 150th anniversary, management decided to embark on a costly and speculative undertaking. They decided in 1980 to produce a watch that would incorporate more features than either of the two watches produced earlier in the century—one that would truly be the most complicated in the world. The effort took nine engineers five years to design and the firm four years to make.

The result was Calibre 89 (Figure 19). In addition to the prototype (which is on display at the Patek Philippe Museum in Geneva), there were four others produced: one each in white gold, rose gold, yellow gold, and platinum. The watches are marvels of mechanical design and manufacture, and a thorough description can be found in the catalog from the Antiquorum auction April 24/25, 2004, as lot 301. The description can be found on the Internet at www.antiquorum.com by accessing the catalog archive.

The first 15 in the above list are indications on the front of the watch, while numbers 16 through 24 are indications on the back of the watch. The astronomical indications are based on Geneva latitude and longitude.

The rattrapante complication is a second chronograph that allows for continuous timing to occur when the first chronograph is stopped.

A unique feature is the display of the date of Easter. Easter is a "movable feast" of the Christian Church, the date of which is always on the first Sunday after the full moon after March 21. The date can be anywhere between March 22 and April 25. Because this is an event that is most readily calculated by using sidereal time, the watch has a patented mechanism (Figure 20) that drives the indicator. It must be noted that it is impossible to devise a mechanism that will indicate the date of Easter on a perpetual basis. The driving cam of the mechanism in the Calibre 89 watches indicates the date of Easter correctly from 1989 until 2017. A second cam is provided with

each watch, which, when installed, allows the watch to correctly indicate the date of Easter from 2018 until 2046.

Abraham-Louis Breguet invented the tourbillon around 1795. It is a mechanism in which the balance wheel and escapement rotate within a cage. This rotational movement is necessary to counter the gravitational effects on the escapement in a pocket watch because of the vertical orientation of the balance wheel and escapement.

Patek Philippe patented the Gyromax® balance wheel around 1950. Instead of an adjustable screw surrounding the balance wheel, small eccentric weights or collets are placed on the balance wheel. By turning the radial orientation of the weights, both the rating and the poise of the balance can be adjusted.

After the production of the Calibre 89 watches it is clear that no single watch can make the claim of being "the most complicated watch in the world." Computer-aided design and manufacturing may allow more complex and intriguing watches to be created. Manufacturing economy in our present age means watchmakers make production runs with multiple units being produced. For this reason it is very unlikely that we will see the unique "most complicated watch" ever produced again.

Photo Acknowledgments

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About the Author

Bob Pritzker is a retired teacher and farmer. His curiosity about the way things work and appreciation for history led to his interest in horology. He has a modest collection of clocks and watches. This article based on a presentation he gave to Chapter 33 (Toronto) and was the result of an interest developed on a recent European tour with fellow enthusiasts.

In Memoriam
John Farnan, FNAWCC • 1935 -2013

Toronto Chapter 33, the Canadian horological community, and the NAWCC lost a knowledgeable and dedicated enthusiast with the passing of John Farnan on October 7, 2013.

John was a recognized authority on Black Forest clocks and often presented workshops on their operation and history. He held several chapter offices, including secretary, vice-chair, and president. His quiet and reserved demeanor belied an inner enthusiasm and determination with which he approached all that he did.

With an insatiable curiosity about the inner workings of machines, John learned to repair clocks and watches at an early age. His interests were varied—from motorcycles to aircraft. He was an early adopter and promoter of hang-gliding and ultra-light aircraft flying and at one time owned an airport. An active Rotarian, John was instrumental in many community and civic projects in his hometown of Dundas, Ontario.

The Toronto Chapter depended on John for all its communications, including preparation and distribution of its newsletter and maintenance of its webpage. He was the Chapter's "go-to guy," and he cheerfully took on many tasks so that the Chapter activities could take place seamlessly.

Above all, John was a loving husband, father, grandfather, and great-grandfather. To his wife Dina and his family we offer our sincerest condolences, knowing how deep their grief must be.

—Bob Pritzker and Chapter 33