# A Sun Clock, Cuckoo, Looney, and a Watch at the West Coast Clock & Watch Museum
## - Ed Pasahow

In his *Devil's Dictionary*, Ambrose Bierce defined a clock as a machine of great moral value to man, allaying his concern for the future by reminding him what a lot of time remains to him. This observation is certainly true of the oldest clock known to us—the sun. Solar observations made primitive humans aware of time long before they were capable of conceiving mechanical devices to track the passing years, seasons, days and hours. Thousands of years later, people found that solar movement could be more conveniently followed using a sundial. The WCCWM is fortunate to be the recipient of an equatorial sundial constructed in the new Metal Arts Building. (See the June – July 2017 *Ignitor* for full construction details.) We will look at this device and how it allows us to tell time. Other fascinating clocks in the museum include those that announce the time with birdcalls and those that display the phases of the moon. We will conclude this investigation with a noteworthy watch.

### Equatorial Sundial

**Equatorial sundial**

**Equatorial sundial hour circle**

The sundial comprises a stand supporting two circular arcs. The vertical arc (the bow) holds a thin rod (the gnomon). The gnomon casts a shadow on the horizontal arc (the hour circle) and allows us to read the time. For that reason, the design and construction of sundials is known as gnomonics. Setting up the dial requires that the bow be aligned with a north-south line through the museum's location. This line represents the meridian of our position. The meridian delineates the longitude, which in our case is 117.25° W. The bow also has to be tilted upward at an angle corresponding to our latitude, which is 33.23° N. Now the gnomon is parallel with a line joining the earth's north and south poles and the hour circle is parallel with the earth's equator, hence the name for the dial.

Unfortunately, we must now interject the M-word. Don't be overly concerned because only simple addition and subtraction are required. Obtaining a time reading that would match that shown on an accurate clock requires corrections to the time designated by the gnomon's shadow. Clock time is based on an average of solar movement over a period of years and requires considering time zones. By international agreement, the earth is divided into 24 zones, each 15° wide because the sun crosses 15° of longitude in approximately 60 minutes, accounting for the 24hours in a day. The actual speed of the sun, however, varies. Around Christmas day, the day is about 30 seconds longer, and by mid-September, the day is about 20 seconds shorter.

Although those errors do not sound like much, other factors add variation. The sun does not travel around the earth's equator, but instead its path is tilted. Additionally, the distance between the earth and the sun is not constant. We are closest to the sun around January 3 and farthest from the sun around July 4. All of these variations are lumped together in the "equation of time." Do not be alarmed by the name because the equation of time is listed in a table, so we just need to look up the correction for the current date and apply it to the sundial reading. The equation of time shows that the sundial can be up to 14.5 minutes late in mid-February and 16.5 minutes early in the beginning of November.

We are not yet done with our corrections. Because the sun takes an hour to traverse our Pacific Time zone, sundials located on the eastern border of the zone will read a time almost an hour earlier than those located on the western border will. We compensate for our location within the zone by computing how many minutes we are either ahead or behind the center of the Pacific Time zone. In the case of the WCCWM, this is 11 minutes early.

We also cannot forget that between March 12, 2017 and November 6, 2017 we are using Pacific Daylight Time, which is an hour earlier that Pacific Standard Time used the remainder of the year. Of course, the sun knows nothing about Daylight Saving Time, so we have to correct our sundial reading for that earlier hour when we are on Pacific Daylight Time. Finally, we can determine what time it is from the sundial by adding an hour if Daylight Saving Time is in effect, adding 11 minutes to compensate for our position in the time zone, and adding or subtracting the equation of time value.

**Cuckoo Clock**

The origin of the cuckoo clock is lost in history, but we know that much of the development of the modern clocks started in the Black Forest region of Germany. In 1629, Philipp Hainhofer described a clock that had all of the features of the modern cuckoo clock. Prince Elector August von Sachsen owned the clock, which had a bird that announced the hour. By 1650, these clocks grew more elaborate incorporating a mechanical organ, automated figures, and the mechanical cuckoo as documented in a music handbook authored by Athanasius Kircher. From these and other early examples, Black Forest clockmakers imitated and expanded the clock designs. The clocks evolved in many directions, but most of them were weight driven and regulated by a pendulum.

So why was the cuckoo bird selected to star in this clock? The cuckoo is native to Northern Europe, Africa, and Asia. The birds, with a wingspan of only 14 inches, are noteworthy for their extreme flying endurance. They arrive in the Black Forest on their annual migration in April. The male cuckoos announce their presence during the mating period with constant cuckoo calls. These calls delineate the male's territory and sometimes entice a female partner.

The cuckoo is a parasite, which never builds its own nest. Instead, the female lays her eggs in the nest of smaller songbirds. When the cuckoo eggs hatch, the emerging cuckoos boot the smaller songbird hatchlings out of the nest. The songbird parents, not realizing what has happened, end up feeding the cuckoos. Even so, the familiar call entered folklore promising everything from good luck, to long life and good weather. Looked upon as a favorable omen, many clock owners welcome the cuckoo on their clocks and into their homes.

**Beha cuckoo clock**

**Beha cuckoo bird**

The Johann Baptist Beha Company, located in Germany's Black Forest, made the cuckoo clock in our collection about 1880. The elaborate hand carved walnut case is in the Renaissance Revival Style. The movement runs for eight days after winding, and a bird in the upper arch sounds the hours.

Beha was born in Oberbränd in 1815 and was trained by his father Vincenz Beha, who was a master clockmaker. After building several hundred clocks for his father, he set up his own clock shop in Eisenbach where he manufactured clocks that received widespread recognition. Johann was an innovator with many firsts to his name:

- Built the first Bahnhäusle (gatekeeper's house) style clock containing a cuckoo in 1854.
- Made the first Black Forest wall and shelf cuckoo clocks with spring-wound movements.
- Framed cuckoo clocks with oil-painted frames around 1850.
- Fitted cuckoo clocks with music boxes.

Johann had eleven children, and he made his two sons Lorenz and Engelbert partners in the firm in 1876. While other clock factories moved to mass-produce cheap cuckoo clocks, Johann Baptist Beha und Söhne maintained their high quality, low production strategy. A Gold Medal awarded by the 1873 Vienna World Trade Exhibition recognized the value of these clocks. Beha was the only Black Forest cuckoo clock maker to receive this honor. His products also received awards in London, Paris, Philadelphia, Chicago, and other exhibitions from 1862 through 1895. After Johann died in 1898, his sons continued has manufacturing program. The WCCWM is fortunate to have one of these sought after collector's pieces in its collection.

**Beha cuckoo movement**

A cuckoo clock must perform all of the functions of other clocks in addition to providing the vocal music. The brass frame supports all of the clock components. Two main springs contained in cylindrical barrels drive the clock. These are the two large geared wheels in the center. The going train that keeps time is to the right. The strike train for the cuckoo calls is on the left. The pendulum, mounted on the top center of the frame and swinging at the bottom, maintains a steady beat for the going train. The count wheel, in the top left corner, regulates the number of calls the bird makes to designate the hour. Extending upward from the left side is the rod that opens the door and makes the bird pop out.

At the bottom of the frame is a fusee, which provides constant force to the strike train over the eight days the clock runs between windings. The fusee is required because the torque provided by the spring varies considerably over time. When first wound, the spring generates maximum force. The force decreases significantly, however, as the spring unwinds. This variation, unless corrected, would cause the intervals between calls to be fast just after winding then slower as the spring unwinds. The fusee, which is cone shaped pulley, provides a more constant torque over time. A cord running from the mainspring barrel winds around the fusee. The first coil is at the larger end of the fusee with the last coil on the narrow end. Consequently, when the mainspring is fully wound and producing maximum torque the smaller radius of the fusee reduces the torque. As the mainspring unwinds the larger radius of the fusee increases the torque. The result is a much more uniform torque output. This even power keeps the intervals between the cuckoo calls the same.

The calls are produced on a pair of pipes – one for each syllable of the call. The pipes are mounted on either side of the clock (covered in this case with a marbled paper). Sounding the pipes uses the same method of airflow as is used in playing a flute. Air is blown across the mouth of the pipe to produce the note. Small bellows are mounted on top of each pipe. At the proper time, the strike train moves rods attached to each of the bellows to inflate and then deflated them blowing air across the pipes.

**Moon Phase Clock**

**John Lewis clock**

**John Lewis clock dial**

**John Lewis clock**  **movement**

John Lewis made the museum's tall case clock with a lunar phase display around 1860. The clock, with an eight-day movement and bell strike is cased in solid oak in the Birmingham, English style. The case waist is engraved with representations of Doric columns, but otherwise is undecorated. A broken arch tops the hood, which houses the movement. The arch has reeded pilasters in the center and on either side. Simple turned Doric columns decorate the sides. The glazed dial door protects the dial and opens to provide winding and setting access. The hand-painted dial provides winding holes on the left for the strike and on the right for the time. Two falling weights, behind the case door, power the clock. The bell that announces the hour is clearly seen in the movement photo.

The clock has a hand painted iron dial. The upper arched aperture frames the lunar phase display. Schematics of terrestrial globe hemispheres on each side of the aperture reveal the moon phases, in this case near the last quarter. Arabic numerals mark the hours. The railroad track minute chapter ring is divided into five-minute intervals. A subdial below the 12 o'clock position displays seconds. A calendar aperture, above 6 o'clock, marks the date.

The moon phase is the most common astronomical complication found in timepieces because it has high visual impact and is the simplest one to implement. The moon orbits the earth every 27 days with each cycle comprising four gradually changing phases: new, first quarter, full and third quarter. In other words, the moon waxes for two quarters and wanes for two quarters.

Viewed from earth, the full lunar cycle takes 29.53 days. Why not 27 days? As the moon orbits the earth, the earth is also orbiting the sun in a counterclockwise direction. The lunar cycle reflects not only the moon's orbit but also the earth-solar motion.

The moon display on this clock is painted on a toothed disk mounted behind the dial aperture, which has a curved entry and exit to show the changing appearance of the orb. The simplest manner for implementing the lunar display, and the one used here, is to cut 59 teeth in a disk with two opposed moon images painted on it. A finger, on the hour hand, drives the teeth that advance the disk one tooth daily. Consequently, each of the lunar images passes through the aperture in 29.5 days.

Because this interval is 0.03 days early, the error accumulates into being one full day out of sync with the physical moon in about three years. At that time, the user will have to manually correct the lunar disk's position. Better accuracy is possible using geared transmission systems, and some timepieces do so. This additional expense is not practical because the clock has to be stopped for cleaning and lubrication every three to five years.

**George Graham Watch**

**George Graham watch dial**

**George Graham watch movement**

**George Graham watch paper**


This exquisite pocket watch was produced by the legendary British clockmaker, George Graham around 1750. A British horological organization donated the watch to the WCCWM. The watch is wound and set using a separate key in contrast to using the crown as on most modern watches. The handmade silver case houses the original bullseye crystal and the movement. Here again, a fusee is put to use. In this case, the fusee provides constant force to the going train to maintain time accurately. Watch papers are included with the case. Watchmakers and repair shops of the time used these papers for advertising. They are rarely seen because most owners would discard them.

George Graham was born July 7, 1673 and during his 78 years, he combined clockmaker with inventions and geophysical research. The Royal Society recognized his outstanding abilities by electing as a Fellow of the society. Born a Quaker, Graham was befriended by another famous Quaker British clockmaker, Thomas Tompion. He later married a niece of Tompion. His knowledge extending to astronomy and he is probably the inventor of the orrery, which models movements of the planets accurately. He was an early user of the deadbeat escapement in his clocks, which offered more accurate time keeping with less friction and wear to the components.

These timekeepers are just a small sample of the collection that provides visitors with both views of beautiful clocks and watches and a historical insight into the history of horology. Should you have any questions, be sure to ask one of the friendly docents to explain the inner workings or to demonstrate how the timepieces operate?

---

I wish to thank WCCWM curator Ernie Lopez for his knowledgeable assistance in preparing this article.