Alberta Geomatics Historical Society

The Baseline

The Newsletter of the Alberta Geomatics Historical Society
Collecting, Preserving and Sharing the History of Land Surveying in Alberta
Vol. 2 No. 2 **December, 2025**

Message from the President

It's been a busy few months as we continue updating and improving the Society's website to make it more user friendly and informative. Although much of this work is behind the scenes, many hours are spent preparing and refining content before a topic or article is placed online. Thank you to Ed Titanich for reorganizing the website, to Gord Olsson for ongoing article and post updates, and to Hal Janes for joining the website team. As always, if anyone has any questions, suggestions, or comments about the website, please contact Gord Olsson at *curator_gord@albertalandsurveyhistory.ca*. The Society's website remains our primary connection with the public and we want it to represent us at our best.

University of Calgary Artifact Display Update

As mentioned in the June 2025 newsletter, we have been actively pursuing an opportunity to showcase some of the Society's artifacts at the University of Calgary. I am pleased to report that we've reached an agreement with the University to begin planning and developing a display that will highlight the evolution of the measurement of angles and distances and relates it to the history of surveying in Alberta. Many thanks to member Jalen Giroux, who was the initial contact with the University, and to Syd Loeppky, who has also been involved in the project from the beginning.

Our goal is to unveil the exhibit at the 28th Annual Geomatics Exposition at the University on February 5, 2026. We are in the process of designing the storyline and selecting the associated survey artifacts to tell the story. This is a great opportunity to promote the Alberta Geomatics Historical Society and raise our profile within the geomatics community. This is a very ambitious timeline, and we'll need a few volunteers to help bring it to life. If you're interested in getting involved and helping with this project, please let me know. Your help will be greatly appreciated.

Other News...

Another project we are beginning involves the transferring of 46 cassette tapes of 31 oral history interviews of land surveyors to digital files and ultimately transcribing these interviews. These interviews were performed in the early 2000's as reference material for the "Laying Down The Lines, A History of Land Surveying in Alberta" book published in 2005. Some of the surveyors interviewed were true stalwarts of the ALSA- names such as Charlie Weir, W. A. Wooley-Dod and Army MacCrimmon. Preserving these voices is an important part of the Society's mission.

We are also initiating work on an AGHS Sustainability Fund policy. The purpose of this fund is to ensure the long-term financial stability and operational capacity of the Society. It will ultimately provide a dedicated, perpetual source of income to support our mission and safeguard the Society's future. As members, it is vitally important that we take steps today to ensure the AGHS remains strong and viable for generations to come. Hal Janes, Gord Olsson and I are currently preparing a proposal to bring to the Board.

Finally, as we wind down the second year of the AGHS, I want to thank everyone who has contributed to the success of the Society so far. I am proud of all we have accomplished and I look forward to the year ahead and the projects to come. Wishing you all a wonderful winter season and all the best in the New Year!

Les Frederick, AGHS President

Names from the Past: John 'Longitude' Harrison, an extraordinary clockmaker

On the evening of October 22, 1707, Admiral Sir Cloudesley Shovell, one of Britain's most skilled naval commanders, was returning from Gibraltar with a fleet of 21 ships. Misjudging their location in stormy darkness, his fleet struck the Western Rocks near the Isles of Scilly, sinking his flagship, HMS *Association*, along with four other ships and killing over 1,400 sailors, including Shovell. The disaster was largely due to a critical navigational problem of the time: while sailors could measure latitude, there was no reliable method for determining longitude at sea. Without knowing their exact east-west location, navigation could be extremely dangerous. This tragedy highlighted the urgent need for accurate longitudinal measurement and prompted the British government to pass the Longitude Act of 1714.


"Longitude", A & E TV Mini series, 2000

Longitude measures how far east or west a location is from a starting line called the Prime Meridian. (For the purpose of this article, I will refer to the Prime Meridian at Greenwich which was officially established in 1884.) Unlike latitude, which could be found by the sun or stars, longitude required sailors to calculate their east-west position with extreme precision. In the 1700's, determining longitude at sea was a major challenge. The main method was the lunar distance technique, which involved measuring the angle between the moon and stars or the sun and then consulting detailed lunar tables to estimate the time at a reference point like Greenwich. These calculations could take hours and, of course, depended on a clear night sky. By comparing this with local time on the ship, navigators could calculate their east-west position.

Another method was referred to as dead reckoning. A log would be thrown overboard, and by tracking speed, direction, and time from a known location, an estimate of distance travelled could be determined — although it was often inaccurate. Errors in longitude often led to ships running aground or getting lost. This difficulty dominated ocean navigation throughout the 18th century, shaping exploration, trade, and naval operations. Mastering longitude was essential for safe and accurate sea travel during this era.

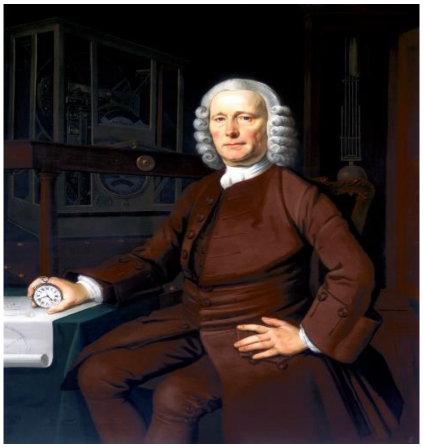
The Longitude Act of 1714 offered a large reward to anyone who could find a practical way to determine longitude at sea. The reward depended on the proven accuracy attained after rigorous testing. The top prize of £20,000 (almost $4 million Cdn. dollars today) would be won by determining longitude to an accuracy of ½ degree of a great circle. The second and third prizes of £15,000 and £10,000 respectively, reduced the accuracy to ⅔ of a degree and 1 degree. To put this in perspective, a degree of longitude is widest at the equator with a distance of approximately 69 miles and decreases as you move closer to the north or south pole.

The Act created a Board of Longitude, composed of astronomers, naval officers, and government officials, to evaluate proposals. Many believed that the solution would come through astronomical observation—particularly the "lunar distance" method. Yet others, including Sir Isaac Newton, acknowledged that a sufficiently precise timekeeper might work in theory, but he doubted it could ever survive the harsh conditions at sea. No one had built a timekeeper that could handle motion, heat, cold, and humidity—and still stay accurate.

Time is essential in determining longitude because the Earth rotates 360° in 24 hours, or 15° per hour. By comparing the local time at a given location (measured by the sun's position) with the time at a fixed reference point—usually Greenwich, England—a navigator can calculate how far east or west they are. For every hour of time difference, the longitude changes by 15°. For example, if local noon occurs two hours later than at Greenwich, the location is 30° west.

The clocks of the day were highly inaccurate. Many gained or lost as much as 15 minutes a day, were fairly large and, having a pendulum, could not be used on a ship in rough seas. Temperature changes made metal parts expand or shrink, throwing off the timing. Even the oil used to keep gears turning could thicken or thin depending on the weather. Small timing errors grew into huge navigation mistakes, sometimes hundreds of kilometers wide.

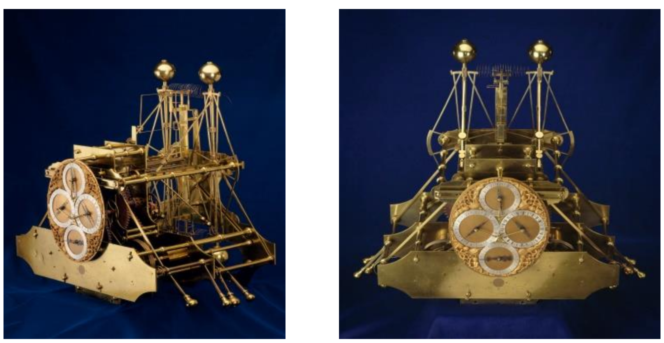
Many bright minds would become involved in the timekeeping problem — names such as Galileo, Christiaan Huygens, and Robert Hooke, to name a few. But it would be an English carpenter and self-taught clockmaker by the name of John Harrison who would ultimately produce a marine chronometer that solved the problem of determining longitude at sea.



Portrait of John Harrison by Thomas King, c. 1767. Courtesy Science Museum (London)

John Harrison was born in 1693 in Yorkshire, England. As a young boy, he was trained as a carpenter by his father. Although he had no experience as a clockmaker, he completed his first clock in 1713. This pendulum clock is unique in that it is constructed almost entirely of wood. Harrison noticed that changes in temperature caused metal pendulums to expand or contract, which made clocks speed up or slow down. To solve this, he invented the gridiron pendulum, made of alternating brass and steel rods that expanded at different rates, keeping the pendulum the same length overall. He also used *lignum vitae*, a tropical, oily hardwood that didn't need grease to keep the gears moving smoothly. These clever ideas made his wooden clocks extremely accurate. In fact, in 1720, Harrison was hired to build a tower clock in Brocklesby Park, which has been running continuously for over 300 years and is accurate to within a minute a week.

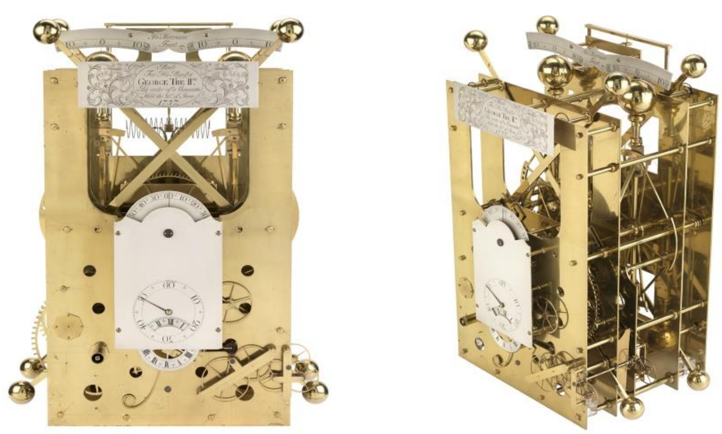
Between 1725 and 1727, Harrison and his brother James, also a superb craftsman, created two grandfather clocks which utilized two precision inventions, referred to as the grid-iron pendulum and the grasshopper escapement, which resulted in the clocks being accurate to one second a month.



John Harrison's first marine timekeeper, H1

Harrison's success with these clocks gave him the confidence to try solving the longitude problem. In 1735, after five years of work, he completed his first sea clock, which he called H1. The clock was made of brass, with two swinging bar balances connected by springs. It was housed in a four-foot-square cabinet and weighed 75 pounds. This design helped the clock resist the rocking motion of a ship. When tested at sea, H1 performed well, keeping time within a few seconds per day.

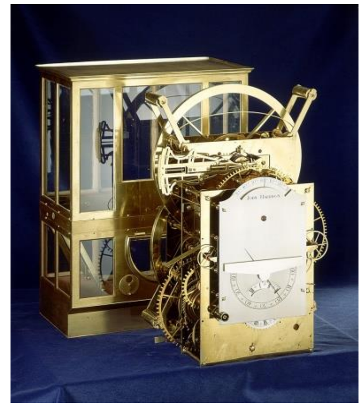
Even though Harrison conceded he could create a smaller, more accurate clock, the Board of Longitude was impressed and gave him more money to improve his design. He went on to build H2 in 1739 and H3 in 1759. Each new clock introduced new features and improvements. H2 had stronger parts and steadier movement, while H3 included a bimetallic strip that corrected for temperature changes. But even after years of work, Harrison still wasn't satisfied. The large sea clocks were still too affected by motion and temperature. He began to design a smaller, faster-moving watch which could be more reliable.



Made between 1737 and 1739, the H2 timekeeper was a refined version of H1

H3, Harrison's third timekeeper

Begun in 1740, it took nineteen years to complete, and like its predecessor, was never tried at sea.



While working on H3, Harrison was also developing the first true marine chronometer accurate enough to solve the longitude problem. In 1759, Harrison completed H4, a large pocket watch about five inches wide and weighing only three pounds. It was completely different from his earlier sea clocks. Instead of using a pendulum, it had a balance wheel that swung back and forth five times every second. A carefully made spiral spring controlled the wheel's motion, and the design included temperature-compensating metals. H4 was a beautiful piece of craftsmanship, made with great precision and skill. When tested on land, it kept time to within one second a day, far better than any other timekeeper of its day.

To prove that H4 worked at sea, Harrison's son William took it on a voyage to Jamaica aboard the ship *Deptford* in 1761. After eighty-one days at sea, the watch was found to have lost only about five seconds. This meant that the ship's position could be calculated within five miles—a stunning success that far exceeded the accuracy required for the Longitude Prize. It was the first time in history that sailors could determine longitude so precisely.

H4, the fourth timekeeper

"I think I might make bold to say, that there is neither any other Mechanical or Mathematical thing in the World that is more beautiful or curious in texture than this my watch or Timekeeper for the Longitude..... John Harrison, 1759

Despite this incredible achievement, Harrison faced intense frustration in dealing with the Board of Longitude. He expected to receive the £20,000 prize, but the Board—dominated by astronomers and naval officers did not immediately award Harrison the prize. Some members, including the Astronomer Royal, Nevil Maskelyne, were skeptical and favored the lunar distance method instead. They insisted on more tests and demanded that Harrison disclose the inner workings of H4, explain exactly how his clock worked, and show that his clock could be replicated.

Even after Harrison reluctantly revealed his mechanism, the Board continued to withhold payment, insisting he build another version of the timekeeper to demonstrate consistency. This became his fifth and final clock, the H5, a masterpiece of precision completed in 1772. Tested personally by King George III at the Royal Observatory, H5 performed superbly, losing only fractions of a second per day. The King, outraged by the Board's treatment of Harrison, intervened on his behalf. In 1773, Parliament finally awarded Harrison £8,750—less than the full prize but still a major victory. Although he never officially "won" the Longitude Prize under the original rules, he was recognized as the man who had solved the longitude problem.

H5, the fifth timekeeper

Mechanically, this timekeeper is very similar to H4. Its main purpose was to meet the accuracy demands of the Board of Longitude.

John Harrison died on March 24, 1776 in London. A memorial tablet, unveiled in Westminster Abbey in 2006, shows a meridian line in two metals to highlight Harrison's most widespread invention, the bimetallic strip. The strip is engraved with its own longitude of 0 degrees, 7 minutes and 35 seconds west.

Harrison's invention changed the world. His sea clocks, later called marine chronometers, made ocean travel safer and more accurate. Sailors could now find their exact position anywhere on Earth, reducing shipwrecks and improving trade and exploration. Copies of his H4 design, such as the one made by Larcum Kendall called K1, were used by explorers like Captain James Cook, who said the watch was "our never-failing guide." Harrison's work also influenced the future of clockmaking, leading to more accurate watches and better understanding of temperature control and friction.

Today, Harrison's four famous timekeepers—H1, H2, H3, and H4—are displayed at the National Maritime Museum at the Royal Observatory in Greenwich, England. They still run, more than 250 years after they were made. The H5 clock can be seen at the Science Museum in London. John Harrison's story shows how curiosity, patience, and skill can solve even the toughest problems. With no formal education, he achieved something that the greatest scientists of his time thought was impossible. By mastering time, he made the seas safer and helped map the world more accurately.

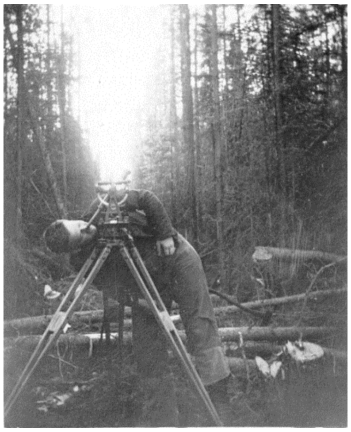
Content of article information courtesy of "Longitude: Illustrated Edition, The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time" by Dava Sobel and William J. H. Andrews, Fourth Estate (1998). ISBN 1-85702-714-0

For an animated visual look inside the workings of Harrison's clocks, visit https://redfernanimation.com/the-harrison-timekeepers/

Content also created with the help of AI

Les Frederick

From the Past: *Annual Report of the Topographical Surveys Branch of the Department of the Interior, for the fiscal year ending 31st March, 1917.*



"Most surveyors and engineers in the past have dreaded azimuth determinations of any kind; observations were looked upon as a terrible ordeal, were dispensed with as much as possible, and were taken only when considered absolutely imperative. The two methods most commonly adopted for determining the azimuth of a line were by means of the sun and of Polaris at elongation.

Observations by means of the sun have the great advantage that they are of course always taken in daylight and may be taken at almost any time in the summer months, except within say two hours of noon; they have the great disadvantage in that they are not very accurate, and the computations are long.

The observation on Polaris at elongation is both easy to take, simple to compute and accurate in results, and land surveyors who desired accuracy in their work have adopted it almost universally in the past. It has the great disadvantage however, that, as elongation takes place only twice in twenty-four hours, the observation can be made at only two particular times of the day, and as one of these times is generally unsuitable on account of strong daylight and the consequent difficulty in seeing the star, in practice it generally happens that the observation can be made only once a day; if the weather conditions should, as may very likely happen, be unfavourable at that particular time the opportunity for observing is gone for another twenty-four hours. This is one of the main reasons why for some time back it has been the practice among an ever increasing number of surveyors and engineers to observe on Polaris at any time. The method, except when the star is close to upper or lower culmination is just as accurate as the elongation method but entails considerable computation.

To overcome this, various forms of tables have been prepared. One form gives the azimuth with the hour angle and latitude as arguments, the declination being considered constant. A table of corrections for change in declination is also required. This form therefore requires the calculation of the hour angle from the watch time by means of a table giving the right ascension or the time of elongation by the star, double interpolation in the main table for hour angle and latitude, and a correction to this for change in declination, the last requiring also a table of declinations. Another form of table even less simple, is to compute the hour angle as above, interpolate in the table supplied for this value and for the year of the observation to obtain the approximate value of the azimuth, and interpolate in another table for this approximate azimuth and for the measured altitude to obtain a correction to the former. These tables are all arranged so as to be suitable for many years and are a great convenience over the actual computations, but the double interpolations and the various correction tables make them clumsy to use".

"Aren't you glad we live in the 21st century?"

Les Frederick

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