

NATURE'S LABORATORY

"What's a sundial in the shade?"

-- Benjamin Franklin

Long before the advent of the wristwatch, mankind marked the passage of time by the height of the sun. The sun was a reliable timepiece, especially with the aide of an apparently simple, yet mathematically complex, tool known as a sundial. Today, more often than not, sundials have become nothing more than an ornamental fixture in the garden. But remember that if your watch batteries run dry, you can always count on the sun.

At first glance, sundials are relatively simple in design, consisting of a pointer, known as the "gnomon", and a base plate known as a pedestal. Hour lines are inscribed on the pedestal somewhat like the hours on a wristwatch. As the Earth rotates, the sun's position in the sky shifts. The sundial, however, is affixed to the earth and, therefore, stationary. The only moving part is the shadow cast by the gnomon as the sun travels through the sky. The shadow acts like the hour hand of a watch, naturally marking the hours.

The history of the sundial predates the bible, having been used by the Egyptians as early as 1500 B.C. In ancient Greece and Rome, towers and obelisks were used as gnomons as part of enormous timepieces. Arab, Chinese, Aztec, and Inca civilizations used sundials to tell time too.

One variation on the sundial is the shepherds watch. One such watch, known as an Aquitaine sundial, was named after Eleanor of Aquitaine who, in 1152, gifted a shepherds watch to King Henry II of England. By suspending the ring of the shepherds watch from a cord and dialing in the month, a ray of sunlight would spill through a tiny hole, illuminating the hour inscribed inside the ring. Eleanor's gift allowed the King to determine the hour so he could return home in time to meet her. In return, the King had a shepherds watch made for Eleanor inlaid with diamonds and engraved with the words *Carpe Diem*, "Seize the Day."

Another watch of old comes in the form of a ring, like those used by Benedictine monks in the 18th century to tell the hour for prayer. "Star" dials were nocturnal timepieces used by navigators in the 15th century to determine the hour based on the North Star and the Big Dipper constellation.

The hour indicated by a sundial or shepherds watch is known as the Local Apparent Time (LAT), since two different sundials will read different times unless they fall along the same meridian line of longitude (the lines running from pole to pole). That's true today, with or without a sundial.

Today, the planet is divided into time zones, preset agreed upon longitudinal regions within which the hour is always the same. There are 24 time zones throughout the world, each set at approximately 15 degrees longitude (24 times 15 equals 360 degrees, a full circle around the globe). Time zones aren't exact straight lines; instead, they tend to follow geographic and political boundaries. Moving eastward, each time zone is ahead one hour.

California, for example, falls within Pacific Standard Time (PST). Traveling eastward, the subsequent continental United State's time zones are known as Mountain Standard (MST), Central Standard (CST), and Eastern Standard Time (EST). Therefore, when it's 10:00am PST in California, it's 11:00am MST in Wyoming, 12:00pm CST in Louisiana, and 1:00pm EST in New York. Hawaii and part of Alaska fall under Alaska-Hawaii Standard Time, while the rest of Alaska falls under Nome Standard Time. Airports often have a series of clocks disclosing the different times in different cities throughout the world.

Time has to start somewhere, and since time is an arbitrary designation set by humans, the agreed upon 0 hour occurs at 0 degrees longitude, the Prime Meridian. Also known as Greenwich Mean Time (GMT), Universal Time (UT), Zulu Time, and Zebra Time, each time zone of approximately 15 degrees longitude, moving eastward, is one hour later, or +1h.

Hands On: It might be hard to believe a sundial or shepherds watch can tell time as reliably as a wristwatch. While they can't tell time to the second or minute, sundials and other solar clocks can be fairly accurate down to the hour. To test their accuracy, try comparing the different timepieces on a sunny day (sundials should be available at a nursery, and shepherds watches can be purchased online at www.shepherdswatch.com).

To avoid biasing the experiment, set up the sundial and shepherds watch first. Once the timepieces are in place, try to determine the time. Save the wristwatch for last to ensure your readings of the sundial and shepherds watch aren't prejudiced. Which one tells the time most accurately? What are the advantages and disadvantages of each timepiece?

Take the experiment one step further and compare the time on your wristwatch to that of other wristwatches. Record how many minutes fast or slow other watches are to yours. If you record enough data points, you might notice that at any given instant, watch times throughout a given time zone differ a great deal, enough to make a difference if you ask someone to meet you at the bus stop at exactly 12:37pm. Based on your findings, how accurate is your wristwatch?

If you have time on your hands, try making your own sundial. Visit <http://kids.msfc.nasa.gov/Earth/Sundials/SundialMake.asp> for sundial blueprints, or buy and erect one in your backyard.

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