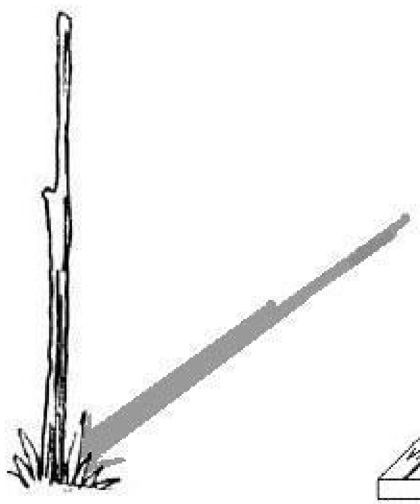
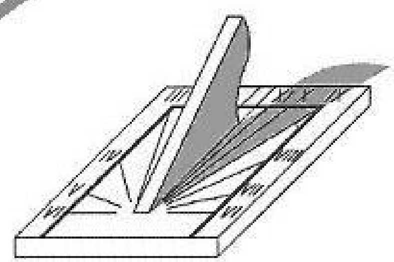
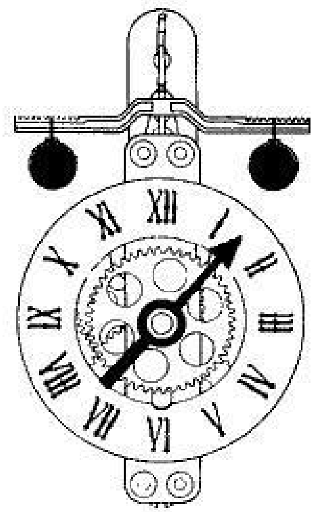
Throw Away Your Wristwatch
THL Warder Maximilian der Zauberer, Middle Kingdom
Part One of Eight: Time changes
Sundials have been used by almost every culture throughout history. For many, a sundial wasn't even necessary. You got up when the sun came up, ate lunch when the sun was directly overhead, and went to bed when the sun went down. It mattered little to you, living near London, that dawn to dusk in the summer took twice as long as it did in the winter. You measured time in temporary, or unequal hours, where dawn was the first hour and dusk was twelfth hour everyday and life followed a natural rhythm.

But one day they installed a large mechanical clock in the town hall to chime the hours and soon the "natural" unequal hours were put aside for mechanically defined equal hours. Ironically, that clock was so unreliable it had to be reset almost daily by referring to a sundial.
As clocks improved, people noticed that 12 noon on the sundial varied up to 30 minutes from spring to fall when compared to 12 of the clock. And since mechanical clocks could indicate the time, day or night, sunny skies or cloudy, clocks eventually displaced sundials and clock time diverged more from "natural" time.
When clocks improved farther and became smaller, people set their portable clocks to match the city clock. But they noticed that when they set their clock in London and then travelled to Wales, their clock was off by 12 minutes when compared to the city clock in Cardiff. So time zones were established taking us farther from "natural" time.
And later, when countries desired more daylight in the afternoons, Daylight Saving Time took us even farther from "natural" time so now your sundial can be off by one and a half hours or more.
Tomorrow: Adapting to modern influences

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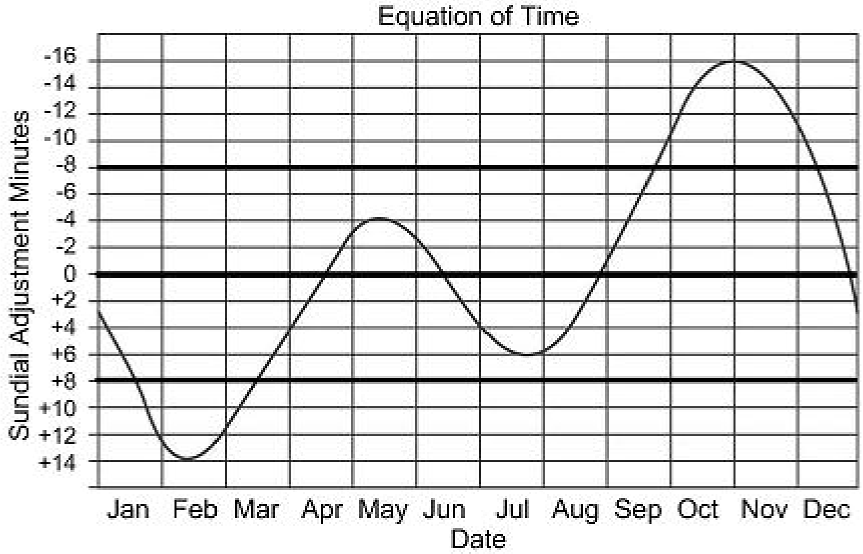
Throw Away Your Wristwatch
THL Warder Maximilian der Zauberer, Middle Kingdom
Part Two of Eight: Adapting to modern influences
EDUCATION ALERT!: A good sundailer is also a cartographer, a physicist and a mathematician.

Sundials "run" fast and slow due to the tilt of the earth and the earth's orbit around the sun. The way these two natural events interact yields the Equation of Time (Google "Equation of Time" for an orbital physics lesson). Its effects can be seen below. So on February 11th, your sundial will be about 14 minutes slow (add 14 minutes to indicated sundial time) and on November 3rd, your sundial will be about 16 minutes fast (subtract 16 minutes from indicated sundial time).




Additionally, sundials are accurate only when they are located exactly on the line of longitude (meridian) associated with a particular time zone (Zero degrees for Greenwich Time. 75 degrees for Eastern Time). Since local apparent noon continually moves east to west, we must subtract or add four minutes (math omitted) for each degree our sundial is east or west respectively of that time zone's associated meridian in order for noon on our sundial to match our clock. All of the British Isles are included in the Greenwich Time Zone and the Greenwich Prime Meridian is very near London. Yesterday, it was noted that a portable clock set in London did not match the time in Cardiff, Wales. Since Cardiff is located at 3 degrees west of London, 12 minutes must be added to the sundial to get the correct clock time. When the British Isles shift to British Summer Time another hour must be added to the sundial to get the correct clock time.

QUIZ TIME!: Here at Pennsic it's early August and we're on Eastern Daylight Time. Pennsic is located at approximately 80 degrees longitude (5 degrees west of 75 degrees longitude). How many hours and / or minutes do you need to add or subtract to the time indicated on your sundial?

ANSWER: Add 1 hour, 26 minutes. (+ 1 hour for Daylight Saving Time + 20 minutes for longitude adjustment + 6 minutes for the equation of time).

Tomorrow: Daytime time telling

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Throw Away Your Wristwatch

THL Warder Maximilian der Zauberer, Middle Kingdom

Part Three of Eight: Daytime time telling

Did you know you could tell the time by pacing off the length of your shadow? It worked for Geoffrey Chaucer around 1400 CE. From the Canterbury Tales "Parson's Prologue" he relates, "It was four o'clock according to my guess / Since eleven feet, a little more or less / My shadow at the time did fall / Considering that I myself am six feet tall." Seems pretty straight forward doesn't it? All you need to know is how many paces your shadow is long, at different times of the day. However, in Chaucer's "Man of Law's Tale" he states, "…the shadow of each tree /

had reached a length of the same quantity / As was the body which had cast the shade; / and on this basis he conclusion made: / …for that day, and in that latitude, / The time was ten o'clock…" Did you notice that he says something about "that day" and "that latitude"?
It is common knowledge that there is more daylight in the summer than in the winter and correspondingly the sun travels higher in the sky in the summer than in the winter and also correspondingly your shadow will be shorter in the summer and longer in the winter. Even the Venerable Bede knew this around 700 CE when he related the following information (Please note that Bede's day began with the first hour at dawn, noon at the sixth hour, and dusk at the twelfth hour).

**Length of one's shadow in "feet" for various hours of the day at various times of the year**

| Hour of the day | Jan / Dec | Feb / Nov | Mar / Oct | Apr / Sep | May / Aug | Jun / Jul |
|---|---|---|---|---|---|---|
| 1 or 11 | 29 | 27 | 25 | 23 | 21 | 19 |
| 2 or 10 | 19 | 17 | 15 | 13 | 11 | 9 |
| 3 or 9 | 17 | 15 | 13 | 11 | 9 | 4 |
| 4 or 8 | 15 | 13 | 11 | 9 | 7 | 5 |
| 5 or 7 | 13 | 11 | 9 | 7 | 5 | 3 |
| 6 | 11 | 9 | 7 | 5 | 3 | 1 |

If you want be able to tell time at Pennsic by the length of your shadow, buy yourself another Pennsic Independent and cut out this table. At the corresponding times pace off your shadow and enter the value into the appropriate box. Pacing off your shadow using the heel to toe method will yield the best accuracy (assuming you wear the same pair of shoes every day).

| Paces | Time |
|---|---|
| | 7 am |
| | 8 am |
| | 9 am |
| | 10 am |
| | 11 am |
| | 12 noon |
| | 1 pm |
| | 2 pm |
| | 3 pm |
| | 4 pm |
| | 5 pm |
| | 6 pm |
| | 7 pm |
| | 8 pm |

QUIZ TIME!: When will your shadow be shortest? 12 noon? Noooo! Your shadow will be shortest at 1:26 pm. Haven't you been reading this series every day? Go buy yesterday's Pennsic Independent and read "Adapting to modern influences."
If you want to have tables like this for other SCA events you'll need to create one for each event. Remember that each event will have its own adjustment for longitude, Daylight Saving Time and the Equation of Time. (Adding 1 hour, 26 minutes only works for Pennsic).
* The historical references were extracted from "Sundials: Their Theory and Construction" by Albert Waugh.
Tomorrow: Another method for daytime time telling

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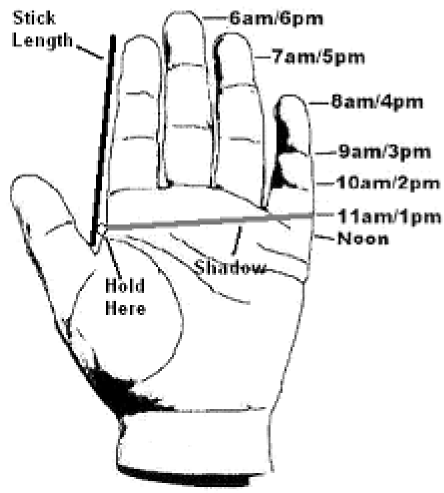
Throw Away Your Wristwatch
THL Warder Maximilian der Zauberer, Middle Kingdom
Part Four of Eight: Another method for daytime time telling
J. Prevost relates in his 1584 book "Clever and Pleasant Inventions, Part One" an interesting way to use a shadow's length to find the time. He writes, "Because one does not always have a clock or a watch or sundial, here is a most ingenious method to serve you on the spot, by using the hand instead of a watch. Thus, during the spring and summer, place the wrist of your left hand to point towards the sun; that is to say, turn your back to the sun and hold your hand and its fingers stretched out fully, so that the rays of the sun strike your wrist from behind. Then take a straw or

a small peeled stick (to serve as an indicator) of the length there is from the root of the thumb to the tip of the index finger. Hold it by one end, between the thumb and the mount of the index finger, at the beginning of the life line." He continues on in quite a verbose manner, but this illustration sums it up nicely (The stick should be held straight up and down, perpendicular to your hand).




Remember a shadow is shortest at local apparent noon and is progressively longer each hour before and after local apparent noon. The shortest dimension on your hand sundial is the width of your hand, so this point is local apparent noon (You'll have to adjust the height of your stick from summer to winter since winter's shadows are longer). Throughout the course of the day, turn your body until the top of the shadow just touches the edge of your hand and "read" the time according to the illustration. Don't forget to add or subtract for modern influences (see Part Two of this series). With a bit of practice you should be able to tell time to within 15 minutes between 6 AM and 6 PM local apparent time (outside of those times the shadow is too long). Please note that I'm not convinced J. Prevost's method works exactly as he relates it. My interpretation; based on his method; does. Buy the book and if you disagree, please let me know.
Tomorrow: Nighttime time telling

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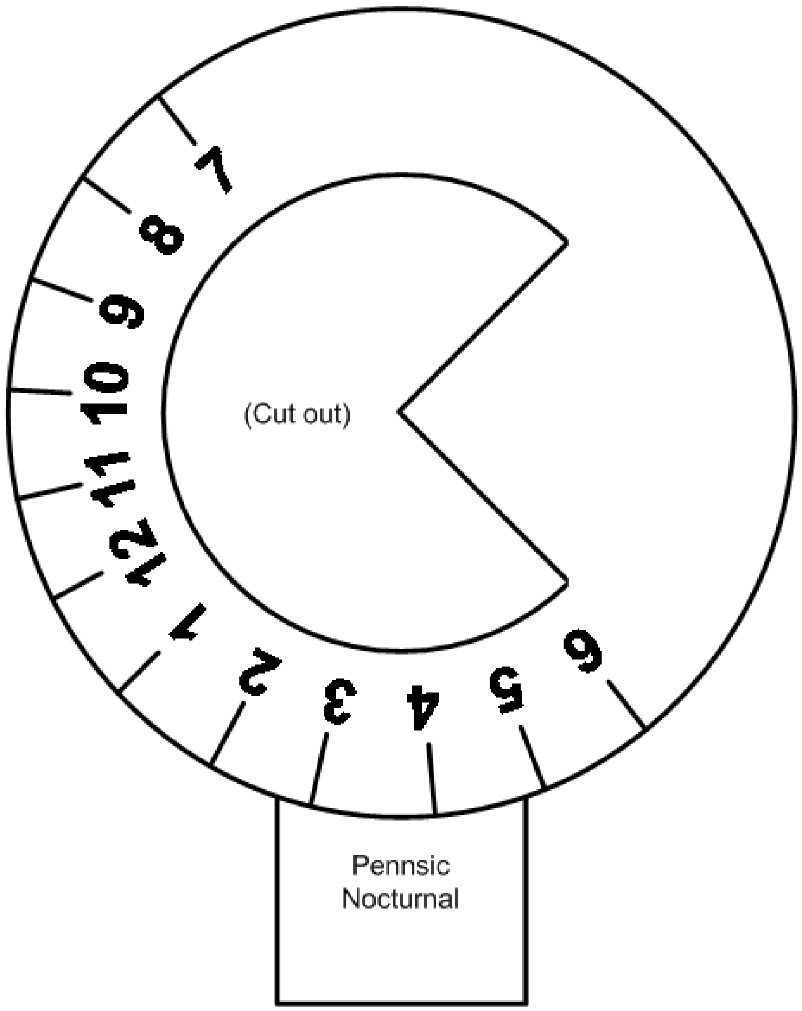
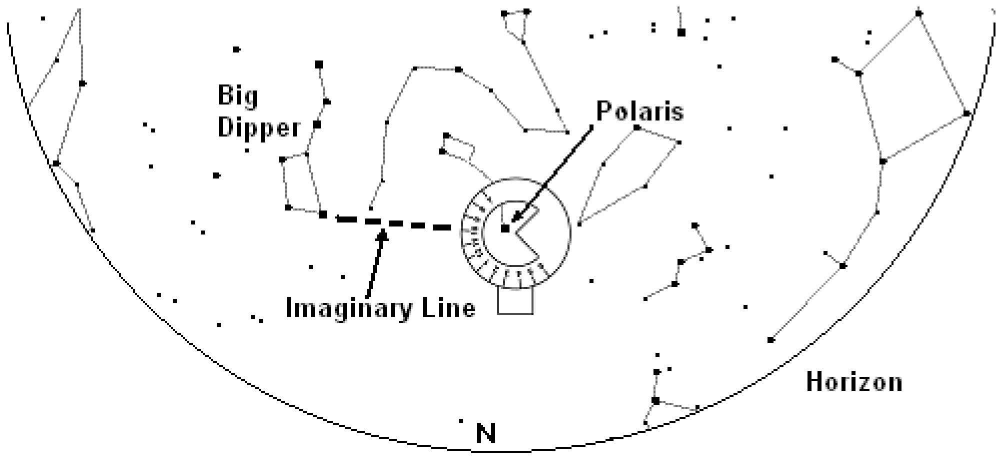
Throw Away Your Wristwatch
THL Warder Maximilian der Zauberer, Middle Kingdom
Part Five of Eight: Nighttime time telling
Everyone knows how to find Polaris, the North Star, correct? (Everyone in the northern hemisphere at least). Did you also know you can use the position of Ursa Major (the Big Dipper) to tell time? And none of this mucking about with longitudes and the Equation of Time either. We're talking about a Galactic clock, not a mere Solar clock. The nighttime sky is a great big, backwards running, 24-hour clock. You just need to learn how to read it. But for simplicity's sake I've created the Pennsic Nocturnal.



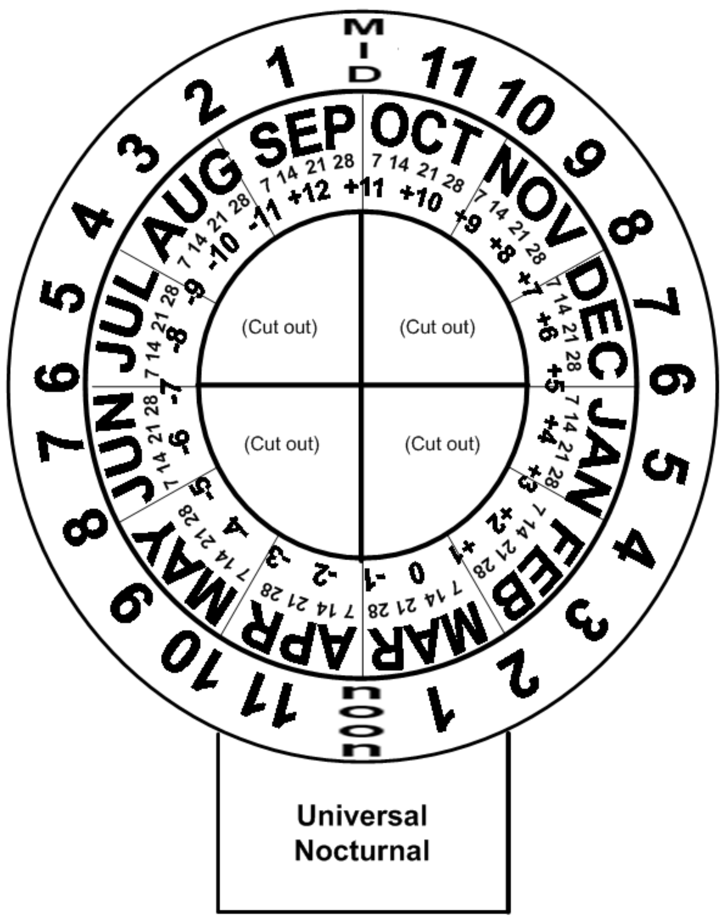

Go buy yourself another Pennsic Independent (or pickup a copy of just the illustrations at the PI tent. There are also limited quantities on cardstock) and cut out the Pennsic Nocturnal. Be sure to cut out the center also (the Pac-man shaped piece).

Hold the nocturnal by the handle in front of your face so the tip of the center triangle points at Polaris. Keeping the Nocturnal perfectly vertical, visualize a line extending from Polaris to the lip of the Big Dipper (the reverse of finding the North Star). Where the line crosses the nocturnal you can read the time directly (approximately 10 PM in the illustration).




With some practice you should be able to tell time without having to use the nocturnal at all. But before you get to thinking that you now have a fool-proof way to determine the time at night all year around, read the handle of the nocturnal. It's only good for Pennsic, or, more generally, the first week of August. In fact, this nocturnal will work anywhere in the northern hemisphere, during the first week of August.

What about other times of the year? Well as the earth orbits the sun, the position of the stars change also. Six months from now, the Big Dipper will have progressed to the exact opposite side of Polaris. So for you truly dedicated night watchmen I present my Universal Nocturnal.



Don't be intimidated, it's really pretty easy. Cut it out with or without the crosshairs. Determine the time the exact same way as above, holding it so the North Star is in the center of the Nocturnal, but then you must adapt. Find the date on the inner ring (The dates are listed in 7-day increments). Immediately below the date is your time adjustment (-9 for the first week of August). So if you were to use the Universal Nocturnal to read the time illustrated above, you'd see it was almost 6 AM. You would then subtract 9 and get 9 PM. But during Pennsic we're on Daylight Saving Time, you'll have to add back an hour, hence, 10 PM Pennsic time. What could be easier?

Tomorrow: How to use your Aquitaine.

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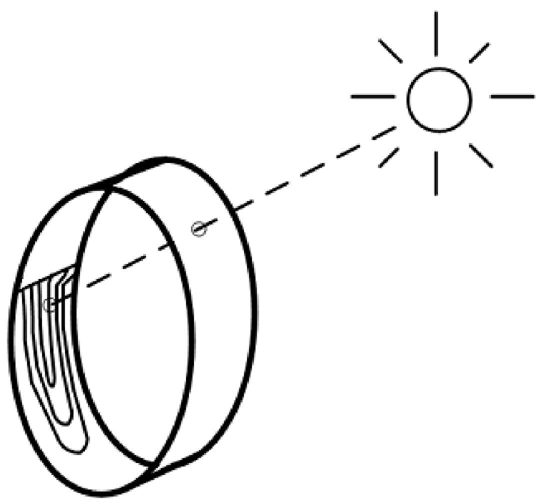
Throw Away Your Wristwatch

THL Warder Maximilian der Zauberer, Middle Kingdom

Part Six of Eight: How to use your Aquitaine

Ring dials have a small hole pierced in them that allow sunlight to filter through and cast an image on a scale displayed on the inside of the ring. Ring dials typically have a single hole pierced at your co-latitude (90 degrees minus your latitude) and a complex graph to enable you to read local solar time directly (then you must adapt for modern influences).



The Aquitaine is a special form of ring dial. Its hole is pierced through a second, adjustable ring that allows you to move the hole to correspond with a specific date. The Aquitaines that you can by today for about $30, although perfectly period (I've seen museum pieces from the 16$^{th}$ century), typically do not keep accurate time (nor do I think the museum pieces did).

(As a side note, the Aquitaine derives its name for Eleanor of Aquitaine, who supposedly, in 1152, gave one to King Henry II so they could coordinate their love trysts. Although every website that sells Aquitaines recites this story, I can find no evidence that it is true. If you have a resource, please let me know).

If you want to see if you are one of the lucky ones whose Aquitaine was made by a sundailist and not by a jeweler, I'll give you a simple way to check. But first some physics. Ring dials are constructed with the number 12 as the lowest number on the dial. The sun is highest at local apparent noon and so the beam of light will be lowest. One hour before and one hour after noon, the suns relative angle is the same; hence 1 & 11 are adjacent. Two hours before and after noon, 2 & 10 are adjacent. Et cetera. (Also see Part Three of this series).

Now the simple check. (If you're doing this at home and not at Pennsic, you'll need to compensate for your local latitude, i.e. do math). Turn the ring so the hole is on May 1st. Look at the side of the Aquitaine and draw an imaginary line straight across from the hole. It should align with the 5 am / 7 pm mark. Turn the dial to October 1st and it should also align with 6 am / 6 pm and February 1st should also align with 7 am / 5 pm. It doesn't, does it. Mine doesn't either. They're still cool looking, perfectly period, great conversation pieces and like a broken clock, will still indicate the correct time on occasion, but in this case you can't throw away your wristwatch. .

Any metal workers out there? I have a design for a period AND accurate ring dial. Let's talk.

Tomorrow: A stationary sundial

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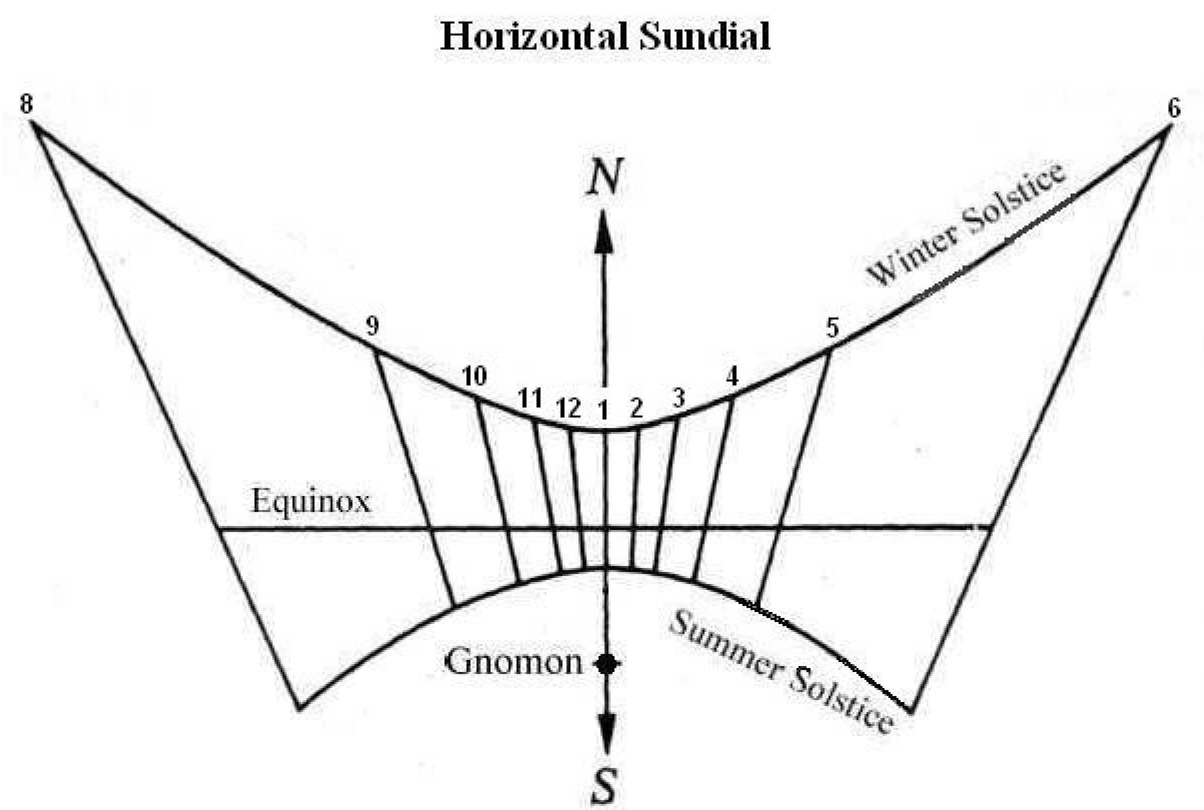
Throw Away Your Wristwatch

THL Warder Maximilian der Zauberer, Middle Kingdom

Part Seven of Eight: A stationary sundial

By now you have learned that in order to read clock time off your sundial you must compensate for your latitude, your longitude within your time zone, Daylight Saving Time, the Equation of Time and the time of year.

Take a look at the horizontal sundial illustrated below. For this sundial the gnomon (the shadow casting element – Greek for "indicator") is simply a vertical rod placed at the spot marked gnomon.




As the sun rises and sets from summer to winter, the top of the gnomon traces out the pattern seen here. This butterfly shape compensates for the time of year (The sun is lower in winter, hence the shadows are longer). Notice that 12 O'clock is not on the N-S line where you would expect it to be. This compensates for longitudinal offset. Also, if like most people, you only use your sundial in the summer, shifting the numbers can also compensate for Daylight Saving Time. Referring to the Equation of Time (see Part Two of this series) you'll see that in May this dial is 4 minutes fast, in July it is 6 minutes slow, and in mid-September it is 4 minutes fast again. So this horizontal sundial is accurate to about 5 minutes of clock time during the summer.

This dial also illustrates how the hours change more rapidly in the morning and evening and more slowly around solar noon. (The basic Aquitaine; Part Six of this series; doesn't compensate for this natural effect either).

Some trivia. Face north and look at your shadow on the ground. In the morning your shadow starts to your left, it moves until it's in front of you at noon and then moves to your right in the evening. So now you know how clockwise became clockwise.

Tomorrow: A common garden sundial and dialing Down Under

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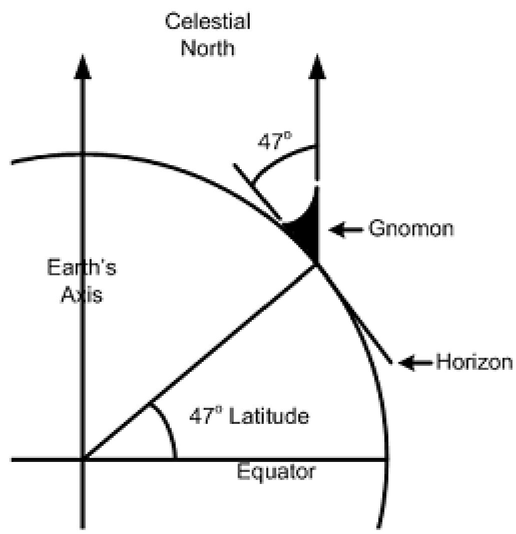
Throw Away Your Wristwatch

THL Warder Maximilian der Zauberer, Middle Kingdom

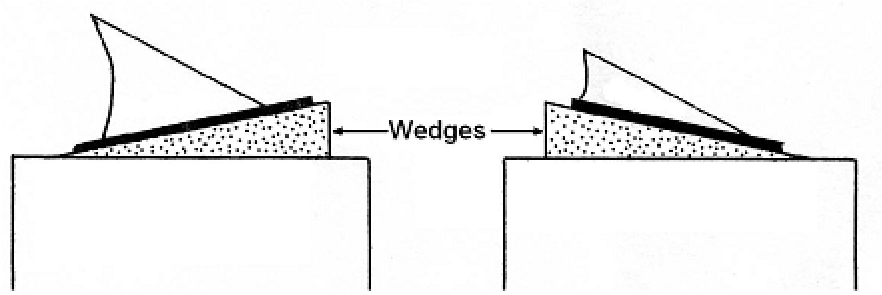
Part Eight of Eight: A common garden sundial and dialing Down Under

In order to tell time accurately the gnomon of your garden sundial (that triangle sticking up in the center) must point toward Celestial North. Hence, the angle of your gnomon must be the same angle as your latitude on the earth.




However, most sundials that you buy at your local garden center in the United States are set at 40 degrees north latitude which happens to run right through the center of the United States. It'll work just fine if you live in Dayton, Ohio, but if you set it up in Seattle, Washington, it won't be accurate. (Sundials bought in Great Britain are set at 52.5 degrees north latitude, which runs right through the middle of England and Ireland).

If you live in Seattle, you live near 47 degrees north latitude so you'll need to add a wedge to your garden sundial to tilt it 7 degrees higher (or 5.5 degrees lower if you have a British sundial). The ultimate objective is so the gnomon of your sundial is parallel to the earth's axis (pointing at the North Star; Celestial North).




So what happens south of the equator? Well all the same adjustments for modern influences need to be made; longitude, latitude, Equation of Time and Daylight Saving Time; but your gnomon will be pointing south. Oh, and your sundial will run anti-clockwise. At night, you'll need to learn to navigate by the Southern Cross, not Polaris, but in the southern hemisphere the 24-hour Galactic clock will be rotating clockwise (see Part Five of this series) with the Southern Cross as your time indicator instead of the bear brothers.

After reading this series are you still confused? I highly recommend buying a basic sundialing book. A good one to start with is, "Sundials: Their Theory and Construction" by Albert Waugh (ISBN 0486229475, $9.95 new). Another good place to go is www.sundials.org, or heck, just Google "sundials". You'll get half a million websites in a tenth of a second.

Corrections? Opinions? Unadulterated praise? Please let me know. scheltem@yahoo.com.

Copies of these articles can be found at www.michiganleftturn.org (Click on the sundials).

About the author: Maximilian is a completely harmless Landsknecht picking up all sorts of interesting things while he travels around Europe; all for purely academic reasons of course.
Bob Scheltema is an Aerospace Engineer supporting the US Army in Metro-Detroit.