Navigation – Columbus style

Did you ever wonder how people were able to steer their way across the ocean without GPS or even a clock?

Before electronic and advanced celestial navigation, there were two main methods for navigating. First, sailors used a process called Dead Reckoning. This is where you use a little physics to tell where you are. If you know where you start, and you know what direction you are heading and how fast, you can calculate where you are after a certain amount of time. Keep track of these small displacements and you add them all up to arrive at your current position.

So how did early navigators know the time? They really didn't. But they did have a sand glass (also known as an hour glass). This is the device the crew would use to measure the length of watches and when to shift the watch to the next section. This was a pretty crude method. It was good enough for crew changes, but not near accurate enough for navigation. Still, it was the best they had. Other things could help mark the time at sea. The sunrise, sunset, and meridian crossing (when the sun passes through its highest point in the sky) could all be used to reset time to a more known amount (the sunset and sunrise do not change too much from day to day).

What about speed? Sailors could also estimate their speed through the water. As the ship moved through the water, someone could drop something off the front for the ship and begin a count. Someone could then watch for the object passing the rear of the ship. Knowing the length of the ship and the time it took for the object to float by it, they could easily calculate the speed of the ship through the water. Another method was to place a rope with knots tied in it at specific intervals in the water. The faster the ship moved, the more the rope was dragged down the ship and the more knots were exposed. To this day, we refer to the speed of a ship in *knots*.

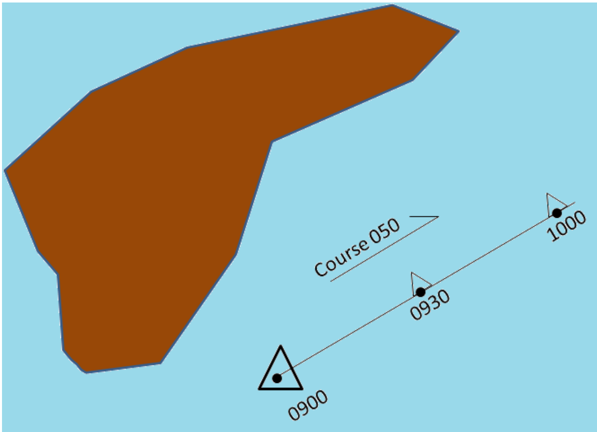
So with the speed of the ship and the time of travel known, the sailor could calculate the distance traveled by the simple relationship:

$$distance = speed\ x\ time$$

The last thing the sailor needed was to know what course he was steering. This came from the trusty ship compass. The navigator would then go from the last position he placed on the chart, put a straight line from that point in the direction of the course, and then tick off the distance along that line that the ship has traveled based on the above calculation. The new point would be the approximate location of the ship.

When you look at the cumulative errors associated with the poor accuracy of time keeping, the terrible speed detection, the fact that the water the ship was in was also moving, Dead Reckoning is not a very good method for traveling the oceans.

Below is a sample of what this might look like. Let's say you are on a ship passing an island. At 0900 (9:00 AM) you sight a couple of landmarks and are able to triangulate your position. This gives you a known starting point (called a fix) and you plot it on your chart and surround it by a triangle to show it as a fix.



From there, you lose sight of the island and can no longer get an exact position from sighting landmarks. But you know that you are traveling on course 050 (50 degrees clockwise of north) and are traveling at 10 knots (10 nautical miles per hour). Based on the formula above, at 0930, you know you have traveled:

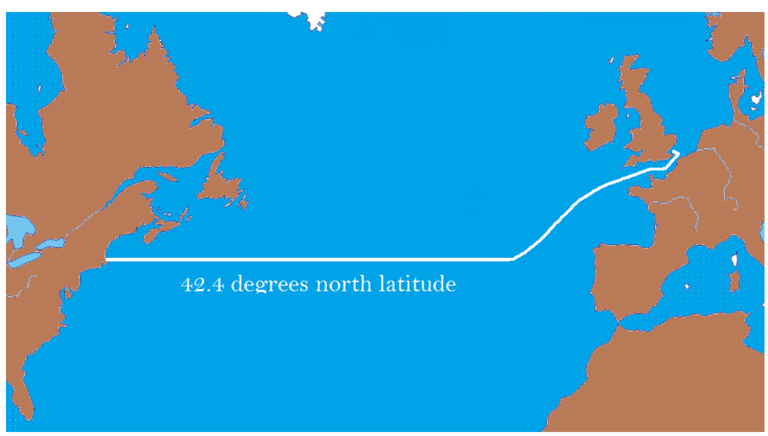
$distance = 10\ \frac{nm}{hr}$ x 0.5 hr = 5 nm

So you draw a line on your chart in the direction of your course and at a point 5 nm from where you started, you place a point marking your current dead reckoning location. To distinguish this estimated position from a real position (fix), you place a Λ symbol on your course line where the point is located. Using this method, you can continually estimate your position from when you originally knew it.

There are a lot of factors that make this a poor estimate over time so sailors learned a neat trick to help them cross the ocean without getting too off course. They followed **lines of constant latitude**.

It was recognized by astronomers that there was a star in the sky that didn't move around like the rest. In fact, it looked like all of the stars rotated around this star. We know it as the North Star or Polaris. This star is really close to being exactly over our North Pole. The practical effect of this is if you measure the angle from the horizon to this star, you have directly measured your latitude. Latitude is an angular measure of how far away (north or south) you are from the equator. The equator is considered 0 degrees latitude so latitude measurements run from 90 degrees north (the north pole) to 90 degrees south (the south pole).

Let's say a sailor sets out to sail from England to Massachusetts in the New World. London is at 51.5 degrees north latitude and Boston is 42.4 degrees north latitude. Using an instrument to view the angle of Polaris (an astrolabe, sextant, etc), the sailor could sail south and watch the angle to Polaris every night until he approached 42.4 degrees. He could then steer west (course 270). Each night, he could take the angle to Polaris. If the angle starts to increase (meaning he is drifting more north than he wants), he can steer a little to the south from his base course. If the angle starts to decrease (meaning he is drifting more south than he wants), he can steer a little to the north from his base course. By adjusting his course every day, he will zigzag along this line of constant latitude and will eventually sight land near his destination. This method worked pretty well for early sailors and minimized the time it took to get to the final destination.



Find your own Latitude

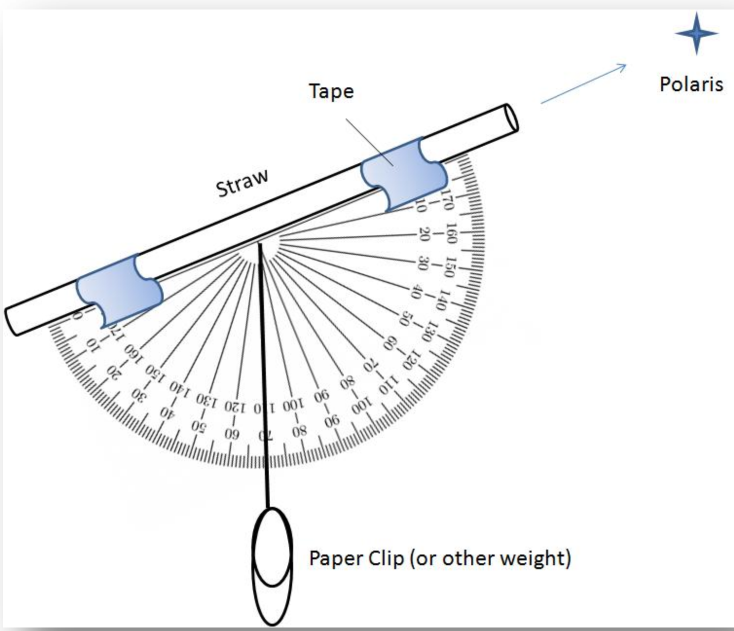
You can easily perform this measurement with some simple items to find your own latitude.

Equipment:

- Protractor
- A drinking straw
- Tape
- Small piece of string
- Small weight (paper clip, key, screw, etc)

Procedure:

Tape the straw to the protractor along the straight side. Tie the string to the hole in the protractor (or the zero center point if it doesn't have a hole) and tie the other end to the weight. See the diagram for the completed instrument.



On a clear night, go outside and sight in Polaris through the straw. Read the angle that the string marks on the protractor. Use the scale that is 0 to 90 degrees. Now, subtract the angle from 90 degrees to get the elevation of Polaris. This is your latitude. In the picture, the string is showing an angle of 70 degrees. When we subtract this from 90 degrees, we arrive at latitude 20 degrees.

To find out your actual latitude, go online to Google maps and plug in your address. When you see the map with your address, click on the spot where you took your reading. Right click the spot and select "What's here?" from the popup menu. Google will display the coordinates of the point in a small box. The first number is your latitude. How did you do?

Like we said, this is a crude method, but if it is all you have to cross the ocean with, it could be a life saver.

