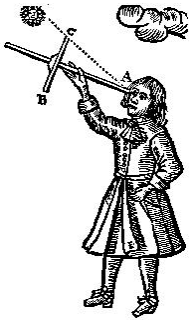
LA COUNTY LIBRARY

DIY Library Program

ANCIENT TECHNOLOGY

THE CROSS STAFF

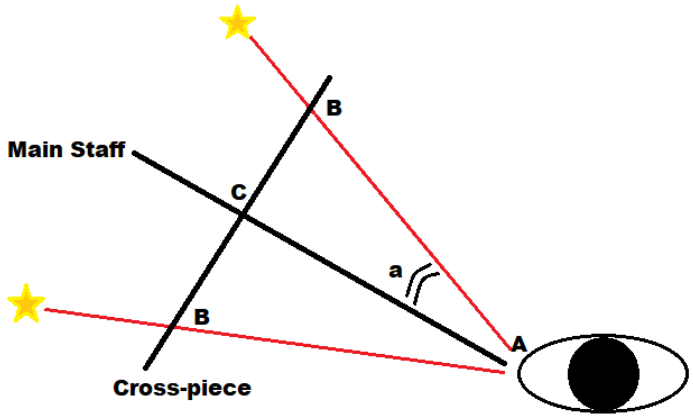
Recommended for Ages 13 and up



In the ancient world, a cross-staff was a tool used for both astronomy and navigation, in order to measure the angle between celestial bodies, such as stars. While the exact origins of this instrument are unknown, we do know that the cross-staff was first described in detail by Gersonides, a mathematician and astronomer who lived in France during the 14th century CE.[1] The cross-staff consists of a main staff with a perpendicular crosspiece affixed to the middle of the staff that is able to slide up and down along the length of it. The cross-piece would have several notches, or sights, along their length at symmetric locations along its length on either side of the main staff.

How It Worked

To measure the angle between two celestial bodies, an astronomer would place the main staff just below one eye and slide the cross-piece up and down. The cross-piece would have pairs of open sights at symmetrical locations on either side of the main staff. The astronomer adjusts the cross-piece until one open sight (**B**) covered one of the celestial bodies, while the corresponding symmetrical location on the other side of the cross-piece covered the other celestial body. Afterwards, the distance **AC** would be measured. Then, if '**a**' is the angle between the staff and the direction of one star, then from the definition of the tangent:



$$\tan \mathbf{a} = \mathbf{BC/AC}$$

The distance **BC** between the sight and the main staff is already known, so the astronomer would calculate the angle **a** by using a table of tangents. Since the cross-staff is symmetric, the angle between the directions of the stars was simply double that.

[1] Paselk, R. (2015, April 7). *The navigator's cross-staff*. Humboldt State University.

The cross-staff was widely used as a navigational tool in the Age of Discovery in the 16th century, and was eventually replaced in both astronomical and navigational uses by the inventions of the telescope and backstaff. Now that you know what a cross staff is, and how it works, it is time to make your own.

Materials Needed:

- Wooden yardstick
- Wooden 1-foot ruler
- Thick manila folder
- Cereal Box
- 4-6 rubber bands
- Stapler
- Two paper clips
- Printer Paper

Instructions

1. Using the cardboard and the rubber band, make a "slider" on the yardstick, as follows. Using the side of a cereal box, cut a 5" x 2" strip out of the box and wrap it around the yardstick, with the glossy side touching the wood.

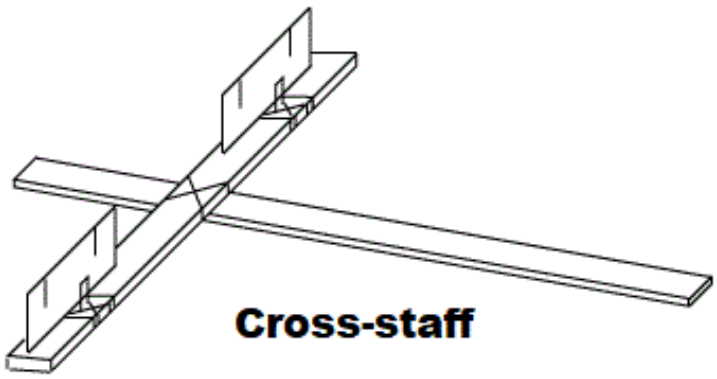
2. Move the slider near the end of the yardstick and bind it firmly with a rubber band. The bands should fit tightly, so that the slider is easily moved when handled, but does not shift once at rest.

3. Spread two turns of the rubber band wrapped around the slider to form an "X" shape. Push a wooden ruler, the cross-piece, through the "X" until the halfway point (6"). The cross-piece should be perpendicular to the yardstick.

4. Make two more sliders from your cereal box and place them on the cross-piece--one to the left of the yardstick, one to its right. These sliders should be 5" x 1.25", and their rubber bands should also form an "X" shape. From the cereal box, cut two 4" x 5/8" strips. Slip each strip through the "X" in a direction perpendicular to the cross-piece, so that its middle is under the "X", then crease and bend both pieces upwards to make a U-shaped support – this will hold the cards we will make in the next step.

5. From the manila folder cut two 5" x 2.5" cards. For each card, cut two slots about 1.25" from the edges, each about 1/8" wide and 1.75" long.

6. Insert a card between each of the U-shaped supports, making sure the slits are perpendicular to the cross-piece. Use the stapler to fix each card to their U-shaped support, and the cross-staff is complete.



Cross-staff

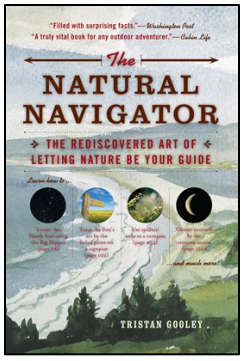
Extension Activity
Use your new cross-staff and see if you can successfully measure the angle between the directions of two stars. Keep a star chart and see if relative directions between the stars changes as time passes.

Warning: *Please do not use the cross-staff during the day to look at the sun. While seafarers of old did use the cross-staff during noontime in order to measure the elevation angle of the noontime Sun above the horizon (useful for calculating latitude), we now know that staring straight at the Sun has very harmful effects on the eyes.*

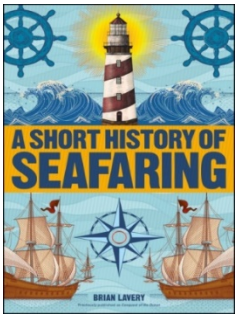
Questions for Discussion
- What aspects of astronomy influence navigation, and vice versa? How do they supplement each other?
- What advantage(s) did an expertise in astronomy and navigation grant a nation over its rivals?

DIGITAL RESOURCES AVAILABLE THROUGH LA COUNTY LIBRARY

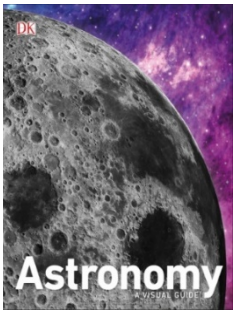
eBooks & Audiobooks
LA County Library offers numerous resources that can help you learn more about astronomy and ancient navigation. Here are just a few, all of which are available as eBooks on Hoopla, OverDrive and Libby:



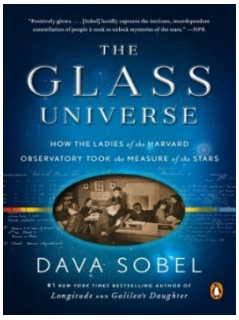
The Natural Navigator: The Rediscovered Art of Letting Nature Be Your Guide **by Tristan Gooley**
The natural world has been used as a navigational aid since humans began going from place to place. In *The Natural Navigator*, Tristan Gooley guides the reader, and provides entertaining anecdotes, on wayfinding by phenomena of the sky, earth, and creatures in between.



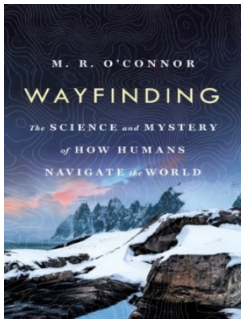
A Short History of Seafaring **by Brian Lavery**
A compendium of historical voyages and events that make up our history of sea travel. This book tells the story of man's search for new lands, trade, conquest, and uncharted waters from early Polynesian seafarers to the first full circumnavigations of the globe, along with great milestones of nautical history.



Astronomy: A Visual Guide
An accessible yet comprehensive illustrated handbook of every aspect of astronomy, with a tour throughout human history of discoveries, a tour of the solar system, a guide to our night sky, star charts, and an almanac for astronomical events. Over 100 star charts and profiles of all 88 constellations are included, as well as tips on how to observe the skies using the naked eye, binoculars, and telescopes.



The Glass Universe **by Dava Sobel**
A history of how women employed at the mid-nineteenth century Harvard College Observatory helped make extraordinary discoveries in the field of astronomy. Excerpts from their letters, diaries, and memoirs help us understand how their contributions to the field of astronomy helped change our understanding of the stars and our place in the universe.



Wayfinding: The Science and Mystery of How Humans Navigate the World
by M. R. O'Connor
A fascinating look at the relationship between navigation and our humanity. With research from neuroscientists, anthropologists, and navigators, *Wayfinding* explores both the tradition of human navigation, its effects on the human brain, and how it ultimately makes us human.

Streaming Videos on Kanopy
The Remarkable Science of Ancient Astronomy from The Great Courses
Explore ancient astronomy from ancient Egyptians, Greeks, Chinese, and Native Americans. Learn how they saw and used the sky to navigate and track times and seasons.
https://tinyurl.com/y9ko34bm

Our Night Sky from The Great Courses
Take a tour of the night sky in this 12-video series. Discover constellations and learn about how the night sky changes from season to season.
https://tinyurl.com/y75zm5x4