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Buoys have been used since the 16th century to mark channels. The word buoy is pronounced "BOY" in the U.K. and "BOO-ee" in North America.

WORLD OF WONDER

NAVIGATION

Early sailors sailed close to the shore and used landmarks, celestial bodies and primitive compasses to find their way. Today, navigators have a variety of sophisticated technologies to help them identify their location and heading. This article focuses primarily on maritime navigation.

Finding your way

Today, computers are used to guide ships, aircraft and spacecraft, as well as cars and

Navigation techniques are also used by astronomers, mathematicians, physicists and geological scientists.

Longitude & latitude

Any location on Earth can be described by two numbers: latitude and longitude. Meridians, imaginary lines that run north and south, measure longitude. The Prime Meridian runs through Greenwich, England, designating 0 degrees longitude. Latitude lines, which measure northsouth position, circle the globe horizontally. The equator is at 0 degrees latitude. Navigators use these coordinates to describe their position.

Basic methods

There are several methods of navigation:

Dead reckoning estimates current position by using a past known position (a fix) and factoring in speed, course and time traveled.

In pilotage, position is determined by using a compass to find bearings to at least two landmarks and marking a **chart** (map) with lines along those bearings. The point where the lines cross indicates current position.

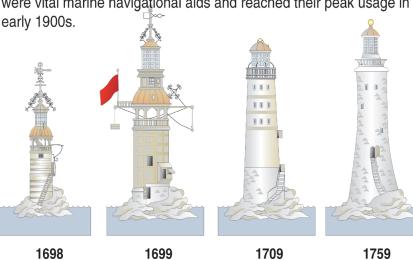
Using **celestial navigation**, position is found by measuring the angle between the horizon and a celestial body and comparing this with an almanac.

By measuring radio waves sent out by beacons at known locations, a navigator can calculate his or her position. This method is called **radio** navigation.

Inertial guidance uses a device to send motion information to a computer, which calculates position and course based on distance and direction traveled. This type of navigation is used by aircraft and submarines.

Lighthouses

A lighthouse is a tower with a bright light at the top that serves as a navigational guide for ships. Lighthouses warn sailors of dangerous rocks or reefs, help ships determine their position and let them know that a harbor is near. Lighthouses date as far back as 280 B.C. They were vital marine navigational aids and reached their peak usage in the



For centuries, ships were wrecked on a dangerous reef called Eddystone south of Plymouth, England. Henry Winstanley, a merchant, lost several ships on the reef and decided to build a lighthouse on the rocks. The Eddystone lighthouses (shown above) are interesting examples of how lighthouses have changed.

Finding a way

Early sailors navigated by landmarks, as well as by the sun and stars. Today, we use nautical charts and instruments such as electronic gyrocompasses.

Radar and sonar identify the locations of other ships and underwater hazards, and global positioning systems (GPS) make use of data sent via satellite to calculate a vessel's exact position.



A sonic depth finder determines the water's depth.

Charting a course

In the 13th century, mariners began to make nautical charts called portolan charts. These loosely accurate maps did not have latitude or longitude lines.

1882

Modern nautical charts are one of the most basic and essential mariner tools. Nautical charts show the shape of coastal regions, water depths and general topography of the ocean floor. These charts also note tidal information and locations of lighthouses, bouys and other human-made navigational aids.



Modern navigation

The invention of radio and satellite navigation made identifying location and charting a path much easier. The first practical radar (radio detection and ranging) system came into use in 1935. The **Loran** (a hyperbolic **lo**ng **ra**nge **n**avigation system) was developed in the early 1940s.

The world's first operational satellite navigation system was launched by the U.S. Navy in the early 1960s. Today people use their phone's GPS (Global Positioning System) to know where they are and to find their way around. Scientists and engineers continue to work on new technologies to make navigation even more accurate.

Navigation satellites orbit Earth at an altitude of about 12,000 miles, completing two full orbits per day.

Observation

Early star navigation involved observing the positions and movements of celestial bodies to determine direction and location at sea.

The astrolabe has served since ancient times as a star chart and physical model of the visible dome of the sky.



The quadrant became a crucial tool for sailors in the 15th century.

> determine latitude.

Made of brass or wood,

quadrants

Cross-staff

The crossstaff originated in the Middle The cross-staff East around was easier to the 11th use than the century.

Quadrant

The hourglass was used to keep time on board a ship. Accurate longitude depended on turning the hour glass in a timely manner.

astrolabe.

Chronometer

Hourglass

Sextant

The chronometer was invented In 1675. It is an accurate clock used in measuring longitude.

invented in 1730.

The sextant was

A sextant measures the distance between the horizon and a celestial body.

SOURCES: World Book Encyclopedia, World Book Inc.; https://en.wikipedia.org; https://www.britannica.com; U.S. Naval Institute; https://kids.kiddle.co; https://seahistory.org

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Newspapers

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