**Definition:** navigation from *Dictionary of Energy*

*Transportation.* 1. any or all of the various processes used in determining position and directing movement from one place to another, especially the movement of a craft in water or air. 2. the science and technology of guiding such movements.

**Summary Article:** navigation

From *The Columbia Encyclopedia*

science and technology of finding the position and directing the course of vessels and aircraft.

**Early Navigational Techniques**

In ancient times, mariners navigated by the guidance of the sun and stars and landmarks along the coast. The Phoenicians were among the most daring of the ancient navigators. They built large ships and, traveling out of sight of land by day and by night, probably circumnavigated Africa. The Vikings and Norsemen, who crossed the Atlantic to Iceland, Greenland, and Newfoundland, are reputed to have used a sunstone to aid their voyages. The Pacific islanders navigated from island to island across the open ocean using observations of guide stars and the moon, the winds, waves, and currents, and birds, knowledge of which was passed from generation to generation; the Polynesians especially traversed enormous stretches of the Pacific.

In England, Queen Elizabeth I did much to establish navigation laws, giving additional powers to Trinity House, a guild that had been created in 1514 for the piloting of ships and the regulation of British navigation. During this period the study of bodies of water, or hydrography, was given much attention, and harbors and the outlets of rivers were surveyed and buoyed. A tremendous advance in navigation had taken place with the introduction of the compass. Early in the 15th cent. there was progress by the Portuguese under the leadership of Prince Henry the Navigator, who built an observatory and formulated tables of the declinations of the sun; collected a great amount of nautical information, which he placed in practical form; made charts; and sponsored expeditions that led to numerous discoveries.

**Introduction of Navigational Instruments**

With the development of shipbuilding and the increase in knowledge of astronomy, there was increased use of instruments. The cross-staff was used to find latitude early in the 15th cent. It consisted of two pieces of wood, the cross at right angles to, and sliding on, the staff. At each end of the 26-in. (66-cm) cross a small hole was bored, and at the end of the staff a sight was fixed. To measure the altitude of a heavenly body, the instrument was sighted in that direction, and the cross was moved forward or back until the heavenly body appeared through the upper hole and the horizon through the lower. The altitude could then be read on a scale marked on the staff. Another device used for finding latitude was the astrolabe. Both were far from accurate.

The navigating equipment carried by Columbus probably was simply a compass, a cross-staff, and a table of the sun’s declination. Vasco da Gama on his first voyage around the Cape of Good Hope in 1497 used an astrolabe. The Flemish geographer G. K. Mercator’s work in improving charts at the end
of the 16th cent., the works of the Spanish scientist Martín Cortés during the same period, the
determining of the earth's circumference, and the introduction of logarithms at the beginning of the
17th cent. by the Scottish mathematician John Napier all helped advance navigation.

By the middle of the 18th cent., a quadrant could be used to find latitude and a log line and half-minute
glass could help keep track of distance traveled; but the problem of finding the longitude remained
unsolved until the invention of the chronometer. The appearance of the Nautical Almanac (see
ephemeris) in 1767 was a great step forward in navigation, and the 19th cent. saw the development of
books on navigation that far surpassed any earlier instructions, such as the standard book by Nathaniel
Bowditch, an American mathematician. The system of dead reckoning, which was much refined, is the
art of finding a position by calculating the point of departure (i.e., the last known point of latitude and
longitude), the course (as shown by the compass), the speed and the distance traveled according to the
log, and the time elapsed. The use of buoys and the making of careful charts made navigation easier,
while the fixing of positions by sextant and astronomical charts was greatly improved.

Modern Navigational Tools

The next great revolution in navigation occurred in the 20th cent., when radio signals came into wide
use. The development of radar, loran, and radio direction finding during World War II caused fundamental
changes in navigational practice; a mariner or pilot today can turn on a Loran or Global Positioning
System receiver and determine position and course to within a few yards. Inertial guidance systems,
most often used to navigate submarines, aircraft, and spacecraft, allow navigation without contact with
a ground base. In such systems, a computer navigates the vehicle with the aid of an inertial navigator
device, which consists of a gyroscope to indicate direction and an accelerometer to measure changes
in speed and direction. Inertial guidance systems and terrain-following radar allow a cruise missile to fly a
thousand miles and hit its designated target. The development of navigation satellites beginning in the
1960s led in the 1990s to the U.S.'s Global Positioning System (GPS), which provides location and other
information through the reception and interpretation of signals received from satellites; Russia and
China have since created similar navigation systems. GPS receivers, which are now incorporated into
smartphones and other devices, have made it possible to create navigation systems for vehicles and
other forms of transportation.

See also air navigation.

Bibliography

See latest edition of Bowditch's Practical Navigator;
see also Sobel, D., Longitude (1995).

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