History of Positioning

From Sextant to Satellite

Nowadays general access to positioning systems such as GPS seems a natural thing. The turbulent developments of the last decade appear almost an anti-climax when we consider the history of positioning.

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Octant equipped with artificial horizon for use on land (source: www.photolib.noaa.gov).

Until well into the Middle Ages, positioning as we know it today was virtually non-existent. Of course ships needed to know where they were, but they usually trusted their eyes and landmarks along the coast.
During the Middle Ages, the predecessor to our modern compass obtained its place in the history of navigation. And although the compass is today a trusted navigation and positioning instrument, in those days it was primarily used for navigation.
By determining how long (far) a certain course was sailed, an approximated position was obtained, a technique called dead reckoning. This method is excellent for navigating over short distances between known positions that, for example, can be obtained from landmarks.

Determining Latitude

When making longer voyages over open water, dead reckoning does not provide positions that are accurate enough. Under these circumstances a true position in latitude and longitude is needed.
For determining the latitude of a position, the star Polaris (or the sun) can be used in the Northern hemisphere. For example, the angle between the horizon and Polaris is nowadays almost equal to the geographic latitude.
For the determination of that angle, specialized instruments such as the astrolabe, quadrant and octant were developed from the Middle Ages onwards. These provided latitude with a precision of some tens of kilometers on open water, which was accurate enough for those days.
Those instruments have, of course, evolved into the modern sextant. The basic principle, however, has remained the same over more than 500 years.

Determining Longitude

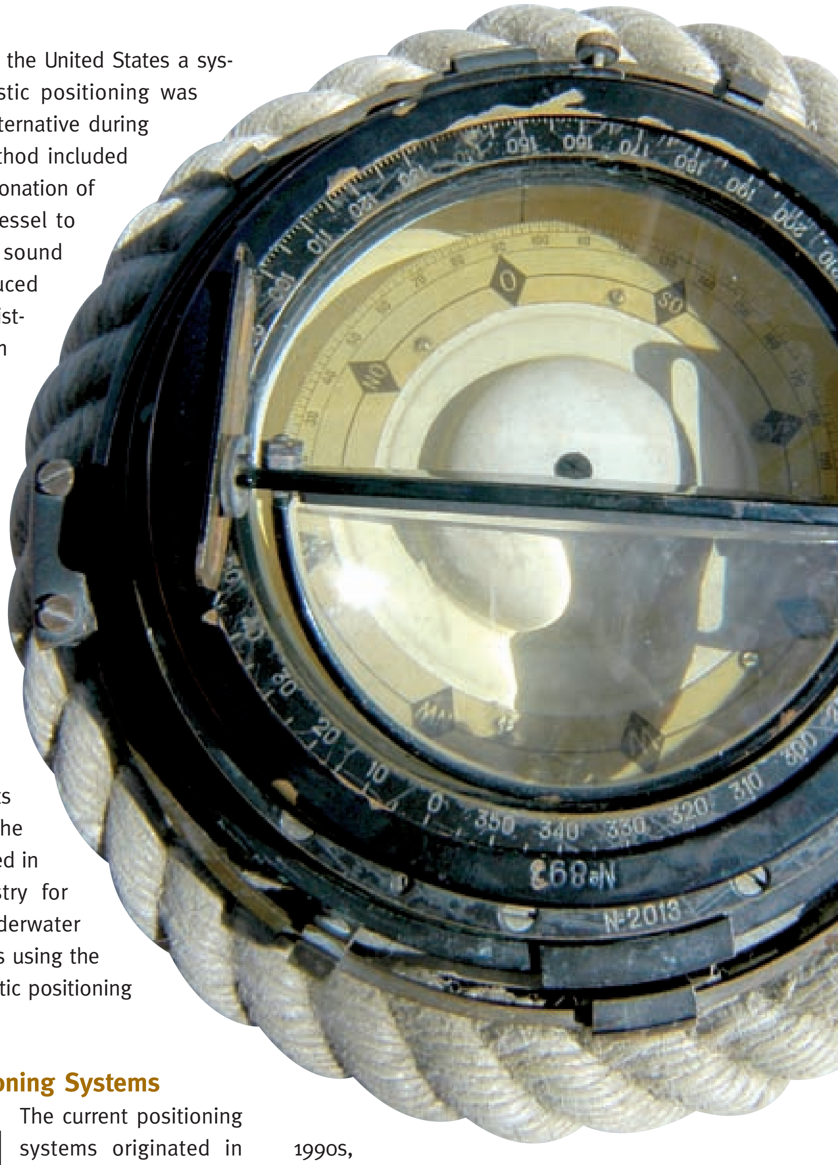
The determination of longitude is somewhat more complex. The theory is simple enough and uses the rotation of the sun around the earth. Since a complete revolution takes 24 hours, the sun covers 15 degrees of longitude for every hour. If we measure the time difference between two locations on earth, we can also determine the difference in longitude.
For centuries man sought a method for accurately determining this time difference. To speed up the process, the English offered a prize to the first person who could solve this problem. For a long time the money was bet on astronomic and magnetic methods.
The solution was finally found in a series of exceptionally accurate clocks or chronometers developed by the Englishman, John Harrison, between 1728 and 1761. His clocks were found to have a deviation of less than a few seconds during a crossing of the Atlantic Ocean. It took years, however, before John Harrison, who had no formal education, was awarded the prize; this despite the fact that his clocks were found to work as promised.
The use of chronometers was enhanced over the following centuries as

Copy of Harrison's chronometer H4 used by James Cook (source: www.portcities.org.uk).

well with, amongst other developments, the introduction of radio time synchronization signals. The basic methods for position determination on the oceans remained the same, however, until the introduction of inexpensive GPS receivers around the mid 1990s.

Radio Acoustic Positioning

Although radio communication was introduced in the 19th century, it was only used in positioning as a time reference. The speed of the signals was so fast that no measurement technique could be developed that was accurate enough. In the United States a system of radio acoustic positioning was developed as an alternative during the 1920s. This method included the under water detonation of a bomb near the vessel to be positioned. The sound wave thus produced was received by a listing station and from there broadcasted back to the ship by radio. The two-way travel time was used to determine the distance between ship and station. Ships on hydrographic surveys were positioned this way when away from land. In its modern form, the technique is still used in the offshore industry for positioning underwater robots and pipelines using the long baseline acoustic positioning method.



Electronic Positioning Systems

The current positioning systems originated in the development of radar during the Second World War. At first the technique was primarily used for finding enemy aircraft, but later was adapted for precision bombardments and positioning as well.

After the war, during the 1950s and 60s, the technique was further developed, resulting in the creation of a large number of electronic positioning systems. Probably the most famous were Decca and Loran, although both were used primarily for navigation. The precision of electronic positioning systems varied from a few meters to hundreds of meters. Although most systems were phased out in the 1990s, Loran is still active and is currently selected by the United States as a backup to satellite navigation systems.

The Tellurometer was one of the first electronic positioning systems used in land survey (source: www.photolib.noaa.gov).

Satellite Navigation

In 1964 the American Transit global navigation satellite system became operational, offering a precision of around 400 meters. The greatest disadvantage of the system was the relatively low update rate and precision compared to other terrestrial electronic positioning systems. As a result, the American government started developing the successor to Transit, the Navigation by Satellite Timing and Ranging (NAVSTAR) system. The system was later rechristened Global Positioning System (GPS), and we all know the GPS success story. In Russia a similar system, Glonass, became operational in the 1990s. It seems that nowadays every self-respecting country needs to have at least one satellite navigation system.

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