A NAVIGATION RETROSPECTIVE

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Abstract: *In this article I briefly present the evolution of navigation over the centuries, orienting navigators with maps and simple and more complex instruments that evolved from antiquity to the Middle Ages and up to the 20th century. After defining the word navigation, the necessity of the ancient Greeks is explained to navigate the Mediterranean, as a result their maps highlighted only 3 continents: Europe, Libya (Africa) and Asia. Later portulanes appeared and then the planiglobe, all of which were accompanied by the instruments of thet time for sea navigation, the sextant being still used today.*

Keywords: *navigation; map; portolan; astrolab; sextant*

1. Introduction

Two thousand years ago the Romans even put the need to sail before life: Navigare necesse, vivere non necesse.

The word navigation has its origin in the Latin words navis, meaning "ship" and agere, "to lead".

Navigation is the science that deals with the study of methods of determining the position of a ship and the safe course to follow between two points on the surface of the Earth.

Navigation is not only a science but also an art. In the beginning it was definitely just an art. Moving from one point to another was done only on the basis of skill and experience. Over time, the development of specific methods, instruments, mathematical tables, etc., made navigation a real science.

2. The origins of navigation

Since ancient times, the Babylonians and Egyptians have drawn up summary maps, in order to delimit properties. Then maps of vast territories were drawn up to facilitate travel, after which maps specially designed for navigation appeared.

Fig. 1. Map on clay tablets.

In 1930, the oldest cartographic representation known today was discovered. It is a tablet representing a region, with mountains, streams, villages, etc., all accompanied by

explanations (including the indication of the cardinal points east and west) (Fig. 1.). This engraved map dates from at least the end of the 3rd millennium BC.

In Greece, the need for maps was felt especially after the conquests of Alexander the Great. The first cartographic document of the era is attributed to Anaximander. The known world is inscribed in a circle, with Europe at the top and Asia at the bottom, separated by the Mediterranean Sea. [3]

Starting with the end of the 4th century, the scientific foundations of cartography were laid. Eratosthenes provides a measure close to the earth's radius and makes a world map on which the known lands form three continents: Europe, Lybia (ie Africa) and Asia. The continents are surrounded by the Outer Sea (Atlantic). On this map appears, for the first time, a system, still embryonic, of parallels and meridian (Fig. 2.).

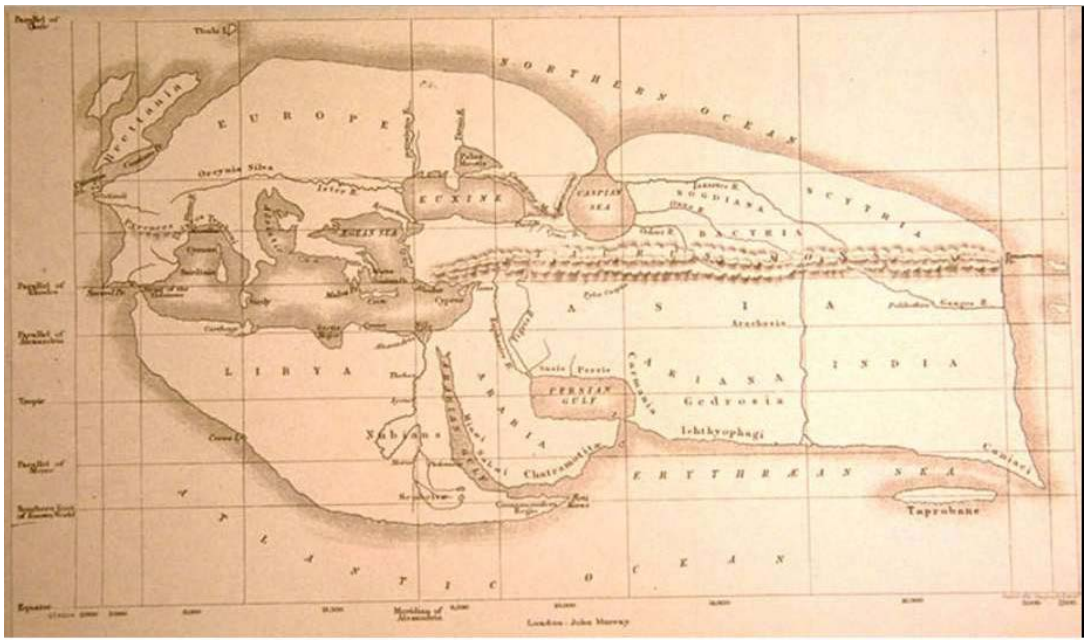

Fig. 2. Eratosthenes' map.

In the 2nd century BC, Hipparchus formulated the rules for representing the curved surface of the Earth in a plan. Only a few Roman documents have been preserved: a fragment of a plan of Rome, made during the time of Septimus Severus (2nd century) and the "Peutingerian Tabula" (Fig. 3, 4, 5), which is a map of the roads of the empire and dates from the 3rd century. [4]

Fig. 3. Peutingerian tabula.

Fig. 4. Detail Britannia.

Fig. 5. Detail of Calatis, Tomis and the Danube River with the Danube Delta.

The greatest cartographer of antiquity is undoubtedly the Greek astronomer and philosopher Ptolemy, who lived in Alexandria in the 2nd century. [1]

He reduced the deformations resulting from the planar projection of the spherical surface of the Earth and found methods for determining the coordinates. He also wrote a geography accompanied by 27 maps, foreshadowing the modern atlas. The maps made by him and his disciple, Agathodemon, will inspire generations of cartographers and will be used until the 16th century.

In the 13th century, with the appearance of caravels and the compass, the era of great voyages began, which led to the appearance of nautical maps, "portulanes", drawn on parchment, sometimes even by sailors, corrected and updated permanently (Fig. 6).

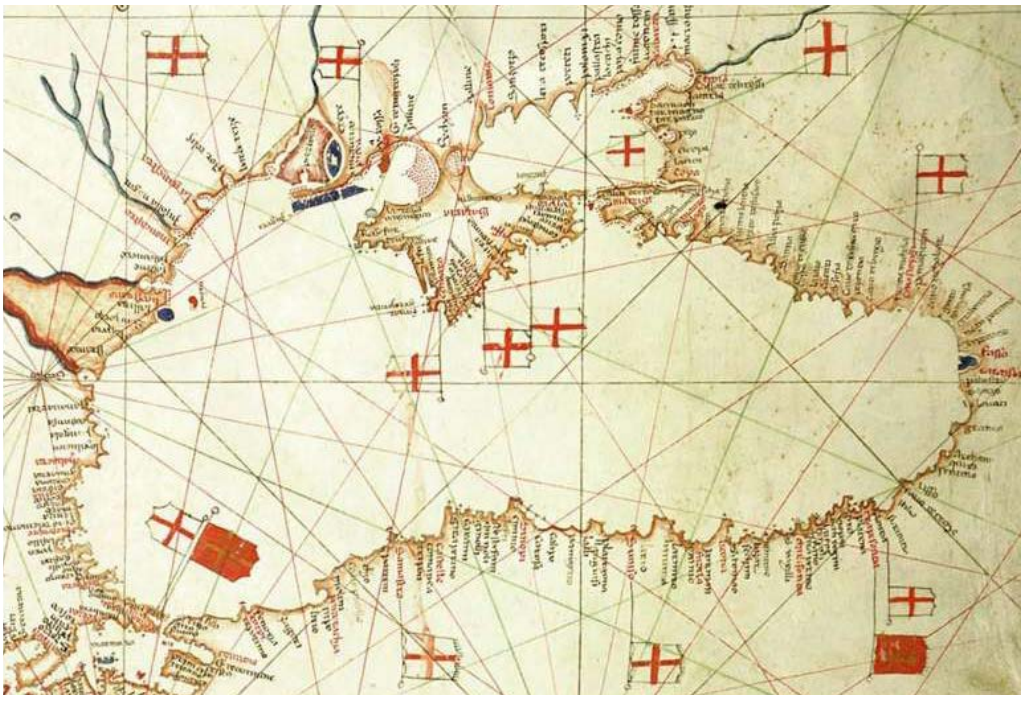
Fig. 6. Portulan for the Black Sea.

The portulan indicates the distances between the main ports and mooring points, locating these points with the help of the wind rose, whose rhombuses are extended by lines.

Fig. 7. Mercator's Planiglob.

The 16th century was extremely fruitful in the field of cartography. It is the period when geodetic studies progress, and the projections of spherical surfaces in the plane are studied mathematically. Now, two great representatives of Flemish cartography appear: Gerhard Kremer, nicknamed Mercator, and Abraham Ortelius. In 1538, Mercator made a map of the known world, and three years later, a terrestrial globe (Fig. 7). [2], [7]

In 1550, one of his maps has, for the first time, the directions indicated by the magnetic needle. He later invented and perfected his famous cylindrical projection method, still used today, especially for making nautical charts.

His research did not stop there, and in 1569 he began to make the first large map of the world intended for navigation, and in 1585 he created a work he called "Atlas" (an allusion to the name of the giant in mythology who had the world on his shoulders). But the first atlas worthy of the name had already been published in 1570 by Ortelius and contained 70 maps in 53 copper-engraved plates.

In the 18th century, the researches of the Englishman Isaac Newton and the Dutchman Christiaan Huygens lead cartographers to abandon the outdated hypothesis of the round Earth and adopt the ellipsoid of revolution, whose flattening they calculate. It is a period of great achievements in the field of cartography, and in 1791, in England, the first National Institute of Cartography was established.

3. Navigation tools

The navigators of those times used these maps and a number of instruments, which we can say were ingenious. Among these we can mention:

Astrolab - this was the equivalent of today's "laptop". [5]

With an astrolabe, an astronomer could make fairly accurate measurements of the following:

- the position of celestial objects
- measure the time of night (or day, by measuring the altitude of the sun)
- measure the time of year,
- calculate which part of the sky is visible at any moment,
- determine the altitude of any object above the horizon,
- determine the current latitude
- determine (very precisely) the orientation (relative to the North Pole).

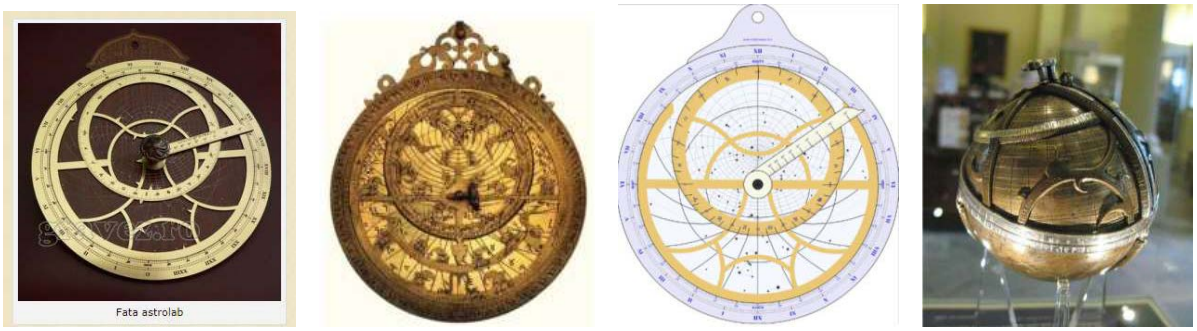

Fig. 8. Various types of astrolabe.

While the earliest known astrolabes were created several centuries BC, probably by Hipparchus, they were improved and more features added by the Middle Ages, when they became very complex instruments (Fig. 8). [6]

Backstaff - is a navigational tool used to measure the altitude of a celestial body, especially the sun or the moon (Fig.9). It was invented by the English navigator John Davis in 1594.

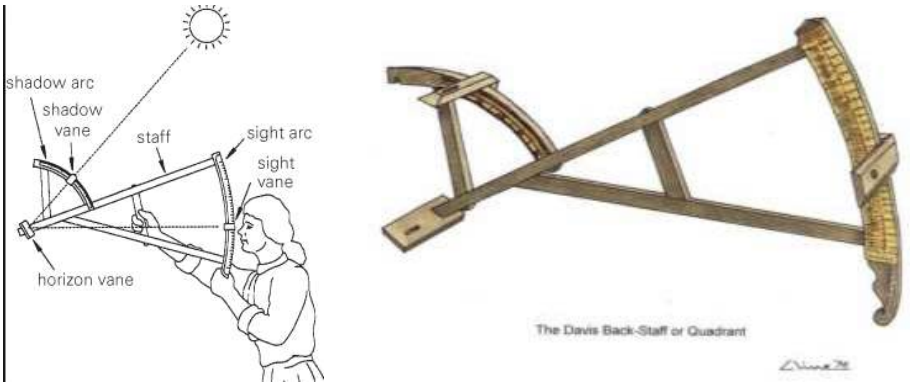

Fig. 9. The Backstaff Navigation Tool.

The observer places the instrument on his shoulder and sits with his back to the sun. With the Horizon Slit aligned with the horizon, he moves back and forth until the shadow of his slit falls over the lower slit, while the horizon remains visible through the slit.

By doing this, the observer is able to look at both the sun and the horizon while his back is to the sun.

The backstaff can only be used to measure the altitude of the sun and not other celestial bodies, because only sunlight is strong enough to cast a shadow. [5]

Nocturnal - is an instrument used to determine local time based on the relative positions of two or more stars in the night sky, sometimes called "horologium nocturnum" (time instrument for the night).

A nocturnal is a simple analog computer consisting of two or more dials that will provide local time based on the time of year and a view of Polaris and any other star (Fig. 10).

It is not possible to convert local time to a standard time such as UTC without exact knowledge of the observer's longitude. Similarly, it is not possible to determine longitude unless the observer also knows the standard time from a chronometer.

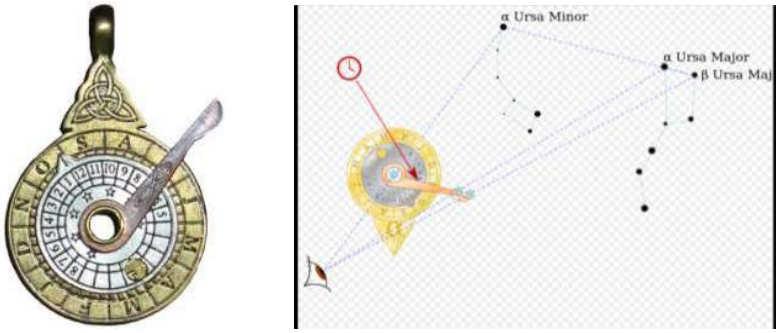

Fig. 10. The nocturnal

Quadrant – was the first instrument to measure the altitude or height of an object and was used in celestial navigation dating from the 15th century. The first use at sea was recorded by Diego Gomes in 1461. [5], [6]

It was a very simple device, made of wood or metal, in the form of a quarter circle with degrees from 0^o to 90^o (Fig. 11). One can look along one of the radial arms to a known star and the suspended plumb line gives us the vertical angle reading. Use the principles of gravity. This tool can only be used to find the altitude of a celestial body.

Fig. 11. Quadrant Navigation Tool.

Sextant – is an instrument for determining the angle between the horizon and a celestial body, such as the Sun, Moon or a star, used in celestial navigation to determine latitude and longitude (Fig. 12). The device consists of a circle spring, marked in degrees, and

a movable radial arm pivoted at the center of the circle. A telescope, rigidly mounted on the frame, is aligned with the horizon. The radial arm, on which a mirror is mounted, is moved until the star is reflected in a semi-transparent mirror, in line with the telescope, and appears, through the telescope, to coincide with the horizon. The angle between the horizon and the star is then read on the graduated arc of the sextant. With this angle and the exact time of day, recorded by a stopwatch, the latitude can be determined (accurate to a few hundred meters) by means of tables. [6]

In the case of coastal navigation, by measuring the horizontal angles between two terrestrial landmarks with the help of the sextant, the position of the observer, therefore of the ship, can be determined. [7]

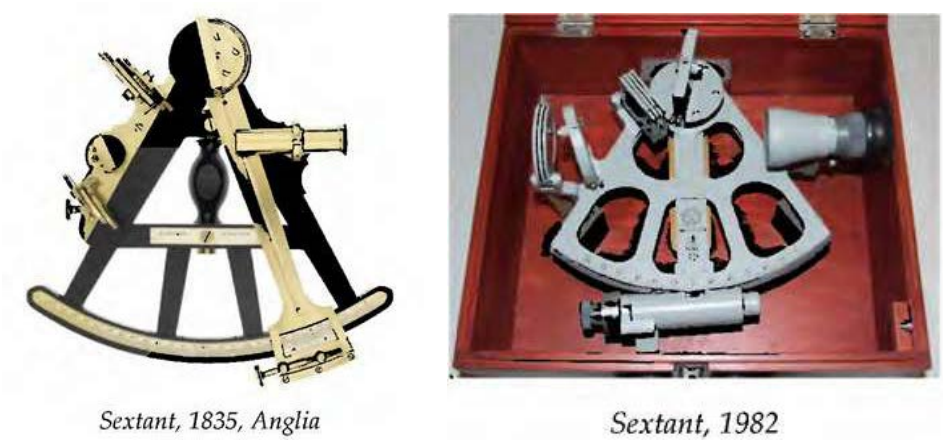

Fig. 12. The sextant.

The navigation chronometer – is actually a spring clock, which differs from ordinary clocks by its dimensions and by the fact that it has a uniform and precise movement (Fig. 13).

Any sailor could find the latitude fairly accurately by the height of the sun. To find out the longitude, however, it is necessary to simultaneously know what the time is on board the ship and in another place on the globe with known longitude. This way the time difference can be converted (calculated) into distance. [6]

Fig. 13. Navigation timers.

The sea hourglass – is a clock of simple design, which is a relative of the common hourglass, an instrument known from the 14th century (although it is reasonably assumed to be of very ancient use and origin) (Fig. 14) . They were used to measure time at sea or on a particular sailing course, in repeated measurements of small time intervals (eg 30 minutes). Used in conjunction with other instruments, smaller hourglasses were also used to measure ship speed in nautical knots. [7]

Fig. 14. Nautical hourglasses.

Compass – is a tool used for navigation and orientation, showing the North direction. The compass needle is mounted on a low-friction pivot point so it can turn easily. When the compass is held horizontally, the needle oscillates until, after a few seconds, the oscillations disappear and adjust to its equilibrium orientation, i.e. the magnetic North direction (Fig. 15). [6], [7]

Fig. 15. Types of compasses used for sea navigation.

4. Conclusions

Knowing the history and evolution of such a popular field today as sailing can help us realize how big a leap it is if we look around and see how accessible it is today for anyone to travel even as a tourist from one continent to another with different means of transport. The new generations use positioning and communication technology even in urban areas to get from one location to another, with new smart means of travel at their fingertips.

5. References

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