Medieval Lighthouses
Part 4 - Medieval Navigation
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The most important tool by far that was available to the navigator was his experience, indeed, it probably outweighed all others, which were in any case few in number. In times so much earlier than the scientific period of Galileo, Newton and those who followed, it was a complete understanding of the ways of nature, wind and tides in particular, that was most likely to result in a successful sea voyage, as well as a certain aptitude for numbers and magnitudes, and for the complex motions of the sun, moon and stars.

It is probably fair to suggest that the ancient mariner was better versed in this knowledge than any mariner today, reliant as he is on a plethora of modern navigational instruments and other aids. These resulted from the post-Newtonian scientific revolution and we can safely say that the details that follow would have been largely unchanged throughout the entire period covered by this book.

Objectives

The objectives of this chapter are:

1. To list and describe the tools available to the navigator at sea in the Medieval Period.

2. To examine the practices of medieval navigators.

3. To search for the possibility of lights as part of the navigators methodology.

4. To assess the use of the navigator's eye for shore-based indicators.

Introduction

In this search for signs of the showing of lights to navigators, it is inevitable that we must delve deeply into the toolbox and practices of the helmsman.

Taylor wrote:

> *"... the Sun by day and the stars by night served the helmsman as compass for his bold sailing during the three thousand years or more which elapsed before he knew the magnetic needle. And for chart, he relied upon his visual memory and experience of the coastal sky-lines."* [1]

There was little else to help for a very long time, and even by the early period covered by this book it was the navigator's knowledge and experience of the routes he sailed that were his primary aids.

The fundamental rationale for a navigation light is threefold:

1. Here is safety - come this way.

2. Here is a sign post to mark your way.

3. Here is danger - avoid this place.

In Volume 1, the history presented was almost entirely one of lights being shown as a marker of safety - the location of a haven, perhaps even the final destination being sought. The situation that prevailed was one in which a ship was on a voyage to a designated destination and that if the navigator

Above: A medieval quadrant.

saw the light shown from the port entrance he could steer towards it, hence avoiding the risk of misidentification with the ensuing possibility of hitting rocks unexpectedly on the way.

The second function of a light was to mark a particularly important waypoint - an ocean signpost that could indicate the navigator's position on his uncompleted journey. Such lights were not necessarily located at a place of habitation, but rather in a strategic, highly visible location that would not be missed.

It is my belief that the third function whereby a light is placed actually on a reef or group of rocks does not take place within the scope of this book, but with the building of a structure on the Eddystone Rocks by Winstanley in 1698. This is generally agreed to be the first building of a recognizable lighthouse on a wave-swept rock. This possibility will not be considered further here.

The Mariners' Tools

We will next consider what tools were available to the professional navigator during this period.[2] Medieval navigators had a limited array of tools compared to modern navigational aids, but they were still able to navigate across oceans and seas with surprising accuracy given the resources available to them.

The Lead Line

Probably the most used tool consisted of a lead weight attached to a long length of string or rope on which knots had been made at defined intervals. By simply dropping the weight over the side of the ship and determining when it hit the sea bottom, the depth of water could be known.

Compass

While the magnetic compass was known in the medieval period, its use in navigation was limited due to its unreliability and lack of understanding of magnetic variation. However, it was still used for general direction-finding.

Maps and Charts

Medieval navigators used maps and charts, although these were often rudimentary and lacked accurate representations of coastlines and distances. Portolan charts[3], for example, were used in the Mediterranean and surrounding waters and provided detailed coastlines and navigational aids.

Quadrant

A quadrant was used to measure the altitude of celestial bodies. It was simpler in design compared to the more accurate astrolabe (see below) and often consisted of a quarter-circle with a sighting device.

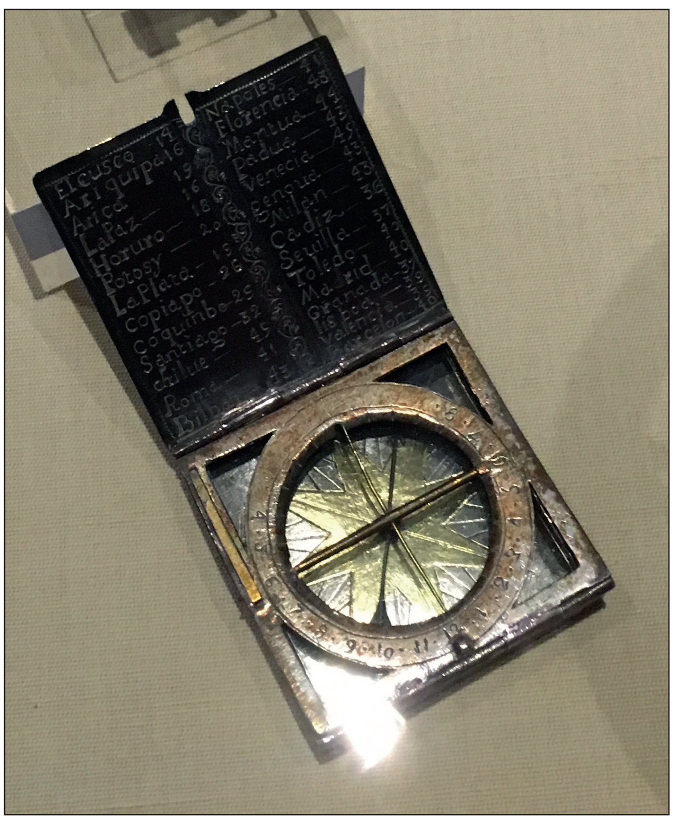
Celestial Navigation

Navigators also relied on celestial navigation techniques, using the positions of the sun, moon, and stars to determine their location. They would often use tables and almanacs to predict the positions of celestial bodies and later, back up their predictions with the cross-staff.

Cross-staff

The cross-staff is an instrument used to measure angles and altitudes, consisting of a trigonometrically graduated staff and one or more perpendicular vanes moving over it. First described in about 1342 by the Jewish philosopher and scientist Levi Ben Gerson, and originally used for astronomical and surveying purposes, it became a mariners navigational instrument in the 16th century, also known as Balastella, Jacob's staff, or Fore staff. The instrument was mainly used for finding the latitude by measuring the altitude of the polar star. The user would place the end of the staff near his eye and point the other end halfway between the horizon and the star. He would then slide the vane along the staff until its upper edge touched the star, while the lower edge touched the horizon. The altitude could then be read off the staff. It was probably not used in the Dark Ages.

Above: Celestial navigation using the stars at night was much easier in the Mediterranean because of the greater frequency of cloudless skies. Thus, whilst it was one of the most important navigational aids in ancient times, it was much harder for mariners of the dark ages to navigate in seas where skies were so often cloud-covered.



Above Left: The magnetic compass and Above Right: The lead weight were in early use by the navigator for determining the direction and the depth of water (soundings) respectively.

Pilot Books and Sailing Directions

These were written guides that provided sailors with information about coastal landmarks, navigational hazards, and safe harbors. While these tools were effective to a certain extent, navigation in the medieval period was still fraught with challenges and uncertainties, and sailors often relied on their experience and instincts in addition to their instruments.

Traverse Board

The traverse board was used to record direction and speed of travel over the course of a four hour watch. After each watch the board was cleared and the record began again. The board showed the 32 points of a compass with eight holes in each radius – 14 each hour of a four hour watch. A peg was inserted every half an hour to mark the direction the speed was recorded at the bottom of the board. This was not a very accurate method of recording direction and relied heavily on the interpretation of the information by the navigator.

Tide Computer

To calculate the high tide time the mariner would align the pointer on the middle wheel with north on the large wheel. Then he would align the pointer on the small wheel with the number on the middle wheel that equate equals the number of days since the last full moon. This pointer would indicate the time of the high tide on the large wheel. Adjustment then had to be made for the location of the port to obtain the correct time.

Log-line and Chip Log

These tools were used to measure the speed of a ship. The log-line was a length of rope with knots tied at regular intervals, which was thrown overboard. The speed of the ship was determined by counting the number of knots that passed through a sailor's hands in a certain amount of time.

Nocturnal or Night-time Clock

To calculate the time at night the mariner would hold the instrument by the small handle on the large wheel vertically in front of him. He would align the pointer on the small wheel with today's date on the large wheel and the north star through the hole in the centre. He would align the large pointer with the star coach and Read the night time from the small wheel where the large pointer cross it.

Astrolabe

The astrolabe was one of the most important tools for medieval navigators.[4] An early instrument was invented in the ancient Greek period by Apollonius of Perga between 220 and 150 BCE, though often attributed to Hipparchus. It allowed them to determine the altitude of celestial bodies, such as the sun or stars, above the horizon.

By measuring the angle between the celestial body and the horizon, navigators could determine their latitude. Astrolabes were further developed in the medieval Islamic world, where Muslim astronomers introduced angular scales to the design, adding circles indicating azimuths on the horizon.

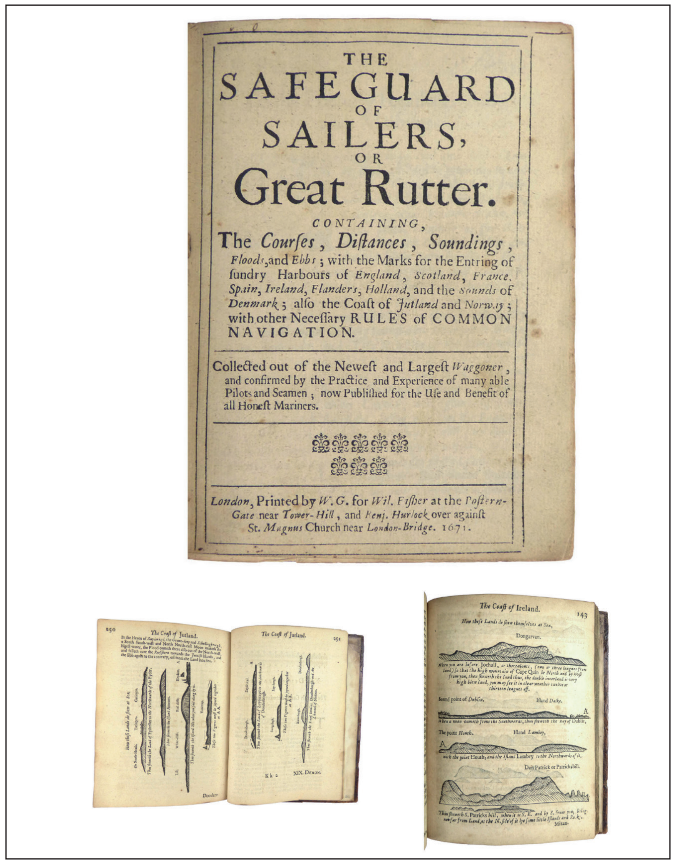
Astrolabes were widely used throughout the Muslim world, chiefly as an aid to navigation and as a way of finding the Qibla, the direction of Mecca. The eighth-century mathematician Muhammad al-Fazari is the first person credited with building the astrolabe in the Islamic world.

Navigating in the Middle Ages

It is well known that a needle magnetized to point north and south is mentioned in China earlier than anywhere else. However, it seems that there was relatively little need for the invention in other parts of the world before it was taken up by navigators in the Mediterranean around the thirteenth century.

Navigation in the Middle Ages was most highly developed in the Mediterranean where the activities were greatest and the greater chance of fair weather enabled navigators to use the sun by day and the stars by night. Mariners were not afraid of voyages that had no sight of land for their fear of rocks and reefs along the shore outweighed the risks of the open sea.

In voyages of discovery, navigators took far greater risks because of their journeys into the unknown, but for merchants and all those involved in trade, it was the successful completion of voyages that mattered most. At first, it was in the Mediterranean where the use of charts and compasses assisted the boom in commerce. By the middle of the thirteenth century, charts called Portolanos were being accurately drawn and by the early fourteenth century they had reached a high standard for the whole of the Mediterranean. Whilst the sun and the stars were good for determining



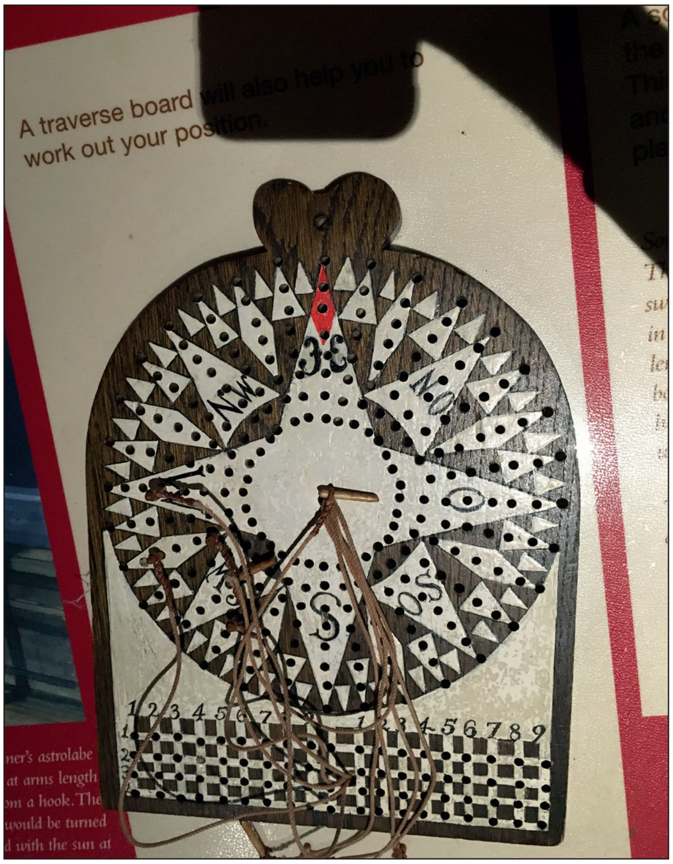
THE
SAFEGUARD
OF
SAILERS,
OR
Great Rutter.
CONTAINING,
The *Courſes*, *Diſtances*, *Soundings*, *Floods*, and *Ebbs*; with the Marks for the Entring of ſundry Harbours of *England*, *Scotland*, *France*, *Spain*, *Ireland*, *Flanders*, *Holland*, and the *Sounds* of *Denmark*; alſo the Coaſt of *Jutland* and *Norway*; with other Neceſſary RULES of COMMON NAVIGATION.

Collected out of the Neweſt and Largeſt *Waggoner*, and confirmed by the Practice and Experience of many able Pilots and Seamen; now Publiſhed for the Uſe and Benefit of all Honeſt Mariners.

London, Printed by *W. G.* for *Wil. Fiſher* at the *Poſtern-Gate* near *Tower-Hill*, and *Benj. Hurlock* over againſt St. *Magnus* Church near *London-Bridge*. 1671.

Above Left: The cross-staff was a graduated stick having a sliding vane. It was used to measure the elevation of stars, but only in later medieval times, it appears.

Above: An Astrolabe was another tool for measuring the position of celestial bodies.



Above Left: A Traverse Board was used for keeping track of a course steered during watches.
Above Right: A Tide Computer - a device for calculating the height of the tide.
Below: Two Night-Time Clocks.

the direction of travel, it was only possible with clear skies and so the addition of the compass to the navigator's tools facilitated sailing in overcast conditions. A great enhancement was that the compass allowed for the extension of the sailing season. The Greeks and Romans either tied up their ships or took them entirely out of the water between October and April. Even by the middle ages, a ship leaving Genoa in September would arrive in Syria or Egypt a month later and remain there until late spring. However, by the fourteenth century, Venetian ships were making two round trips per year with no need for wintering overseas. This great change to the activities in the Mediterranean was entirely brought about by the compass.

There were, of course, exceptions, and it is true to say that some winter voyages took place, although at much greater risk. Sometimes, with particularly favourable winds, a winter voyage was made possible by shortening the travel time. Indeed, in some summer months, unfavourable winds necessitated significant detours, adding much time to the voyage. Naturally, weather conditions were very different in other parts of the developed world and the arrival of the compass did not have the same impact as it did in the Mediterranean. In the Indian Ocean, monsoon winds could be so predictable that navigators did not need the compass for journeys to Arabia.

In the North and Baltic Seas navigation by chart and compass was for centuries conducted by taking soundings with lead and line because the waters are sufficiently shallow. This was not generally possible in much of the Mediterranean. The compass was a useful accessory in the north, but always subsidiary to soundings. Lane reports the case of a foreign ship arrested in Plymouth in 1449 that was prevented from leaving by confiscation of its lead and line.[5]

As for the use of the compass by Norse seamen, the consensus is that they did not use it. But the first records of contracts issued to Genoese masters for voyages between the Mediterranean and the English Channel were issued in 1277 and by the early fourteenth century, Venetian traders considered the route to be safe for it to become a regular proposition. It is in the period 1270-1300 when the first clear references to the use of charts and compass are made.[6]

Maps and Charts

Maps have been made since earliest times. Some of these early maps have already been described in volume 1.[7] Ancient civilizations such as the Egyptians, Greeks, and Chinese created maps for trade, exploration, and military purposes. One of the most famous early cartographers was Claudius Ptolemy (c. 150 CE), who developed detailed maps based on a grid system of latitude and longitude.

Nautical charts were a much later invention. In principle, the difference between a map and a chart is that a map has its primary focus on the land, whilst a chart is about the sea and its interface with the land. Perhaps it is just semantics, and may relate only to the English language. However, in our search for sites of medieval lighthouses we must consider all possibilities.

As of 2024, 98 countries are members of the International Hydrographic Organization (IHO), the principal international entity overseeing hydrographic surveying and nautical charting. While most of these member states maintain hydrographic offices responsible for producing and publishing nautical charts, the specific number actively engaged in chart publication can vary. Some nations rely on external agencies or international collaborations for their charting needs. We might rightly guess that the countries of the major industrial nations are also those that publish nautical charts today, most notably the United Kingdom from the UK Hydrographic Office (UKHO); United States from the National Oceanic and Atmospheric Administration (NOAA); France from the Service Hydrographique et Océanographique de la Marine (SHOM); Germany from the Bundesamt für Seeschifffahrt und Hydrographie (BSH); China from the China Maritime Safety Administration (MSA). (It's also noteworthy that the production of nautical charts is transitioning from traditional paper formats to digital versions. For example, the United Kingdom Hydrographic Office (UKHO) announced plans to cease production of all paper charts by 2026, focusing instead on digital navigation products and services.) Today, we might expect every chart to show relevant aids to navigation, including all those that are lit at night, but it has not always been the case. The introduction of lighthouse sites onto charts was gradual, evolving in tune to the development of the technology. At first charts might have shown the major lights, especially those covering the

Above: Map of Denmark by Willem Blaeu [Inset], a master Dutch mapmaker from the 16th century.

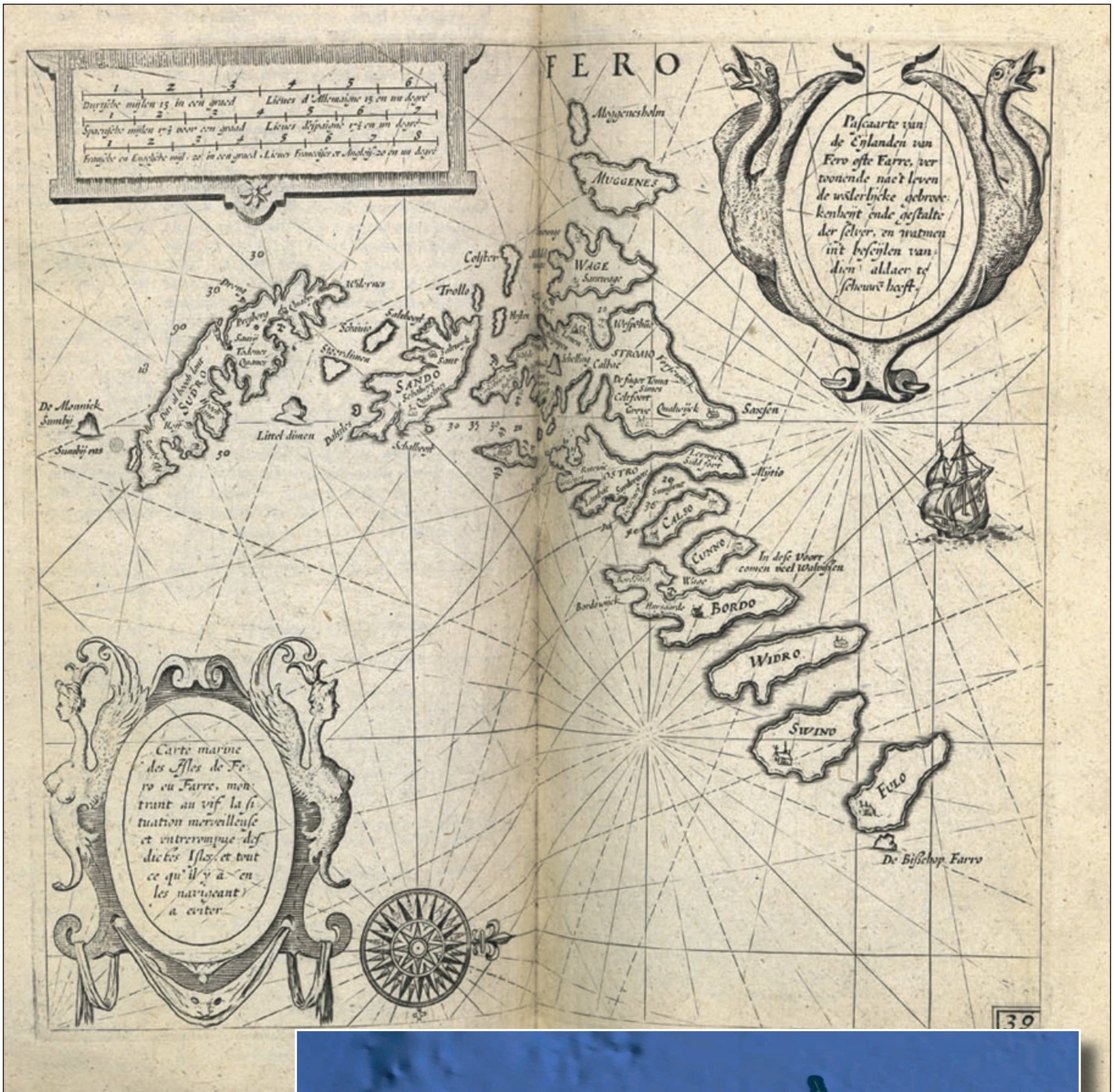
busiest seaways. Thus the British and the Dutch were probably the first to mark lights on their charts from the 1600s onwards, especially those charts covering the English Channel due largely to them being the two most powerful seafaring nations at that time.

In history, Egyptians and Phoenicians (1300 BCE – 500 BCE) used rudimentary coastal guides and star charts for navigation, whilst the Greeks and Romans - during the period approximately 200 BCE – 100 CE also made early attempts at mapping coastlines. Portolan Charts began to appear around the 13th century CE, and some of the earliest known true nautical charts, appeared in the Mediterranean embracing coastlines, compass roses, and sailing routes. The Carta Pisana (c. 1290 CE) is one of the oldest surviving examples.

During the age of Exploration (15th – 17th century CE) maps and charts became more detailed, incorporating new lands and sea currents. However, lighthouses were of little interest to explorers in lands of which they knew little.

One famous cartographer was Willem Janszoon Blaeu (1571-1638), a Dutch mapmaker and publisher who, along with his son, Johannes (Joan), published many fine maps of the world.[8]

It is clear that extensive knowledge of much of the world's coastlines existed at the time, but any lack of knowledge of hazards to navigation was due to the limited dissemination of that knowledge. Until sufficient maps and charts were in the hands of those whose lives depended upon it, there were bound to be many shipwrecks. We might have thought that lights that were considered to be of sufficient importance to users of maps and charts might be marked thereon, especially if they had been long established and had become well known. Indeed, there are many instances in which this was done, but sadly it was not the case on Blaeu's maps.



ABOVE: Blaeu's 1640 map of the Faeroe Islands (Fero) shows a good representation of the archipelago compared to the satellite image shown on the right. Note that north is not in its usual orientation.

Above: Part of a map published in the early 17th century by Willem Blaeu and showing the southern Black Sea and part of modern Turkey. There is evidence for the use of lightstructures in this region during the Classical Period.[9] *However, on this map the only indication of a lighthouse in these important waters is the label "Fanar" on the northwestern corner of the Bosphorus - the word Fanar meaning "lighthouse". It is likely that Blaeu was using the label to refer to the small village that had grown up adjacent to the lighthouse.*

Below: A medieval map of the English Channel.

Sailing Directions

In the earliest times, sailing directions represented knowledge of the seas, the coasts and harbours. They were the landmarks and geographical features that could be seen from afloat that help the navigator to identify his position. Everything that would help a navigator achieve a safe passage was passed by word of mouth from master to apprentice. When writing became more commonplace and when literacy improved this knowledge was committed to papers that were carried with the navigator. They were not maps or charts although they often included drawings and sketches to improve clarity, and they were called Sailing Directions or Rutters. Such compilations are published to this day with a new array of names, though they amount to the same thing - a compendium of everything a sailor needs to know for a particular area of coastline. Of course, they complement rather than replace maps and nautical charts, and more recently have been digitized and integrated into modern electronic aids. Sailing directions were first created in Classical times and were called a Periplus[10]. Perhaps the earliest known version was written by a Greek man around 330 BCE, although there are several others in existence.

> *The term periplous (sic) is currently employed to designate a particular category of ancient texts. Even though it has been traditionally assumed that some of them originally had practical purposes and were therefore used to plan sea journeys, the surviving periploi should rather be described as geographical works, by and large without any literary pretensions. Unlike other geographical works, however, periploi have at least two things in common. Firstly, they focus on the coast and, even though they occasionally contain land descriptions, usually use the sea ... as their common thread or guiding principle. Secondly, they frequently repeat the same formulas, employing a limited vocabulary and short main clauses following one another in hypotaxis. These characteristics suggest that - even though in the form in which they have come down to us, they were actually of little use at sea - they might have been based on prior nautical knowledge, thus reflecting real sea journeys.*[11]

In essence, the purpose of these sailing directions was threefold:

1. What course to steer;

2. How far to sail to reach the desired destination;

3. How to sail, i.e. decisions on hugging the coast or crossing directly from one island to another, or on where and when to stop to refurbish the ships.

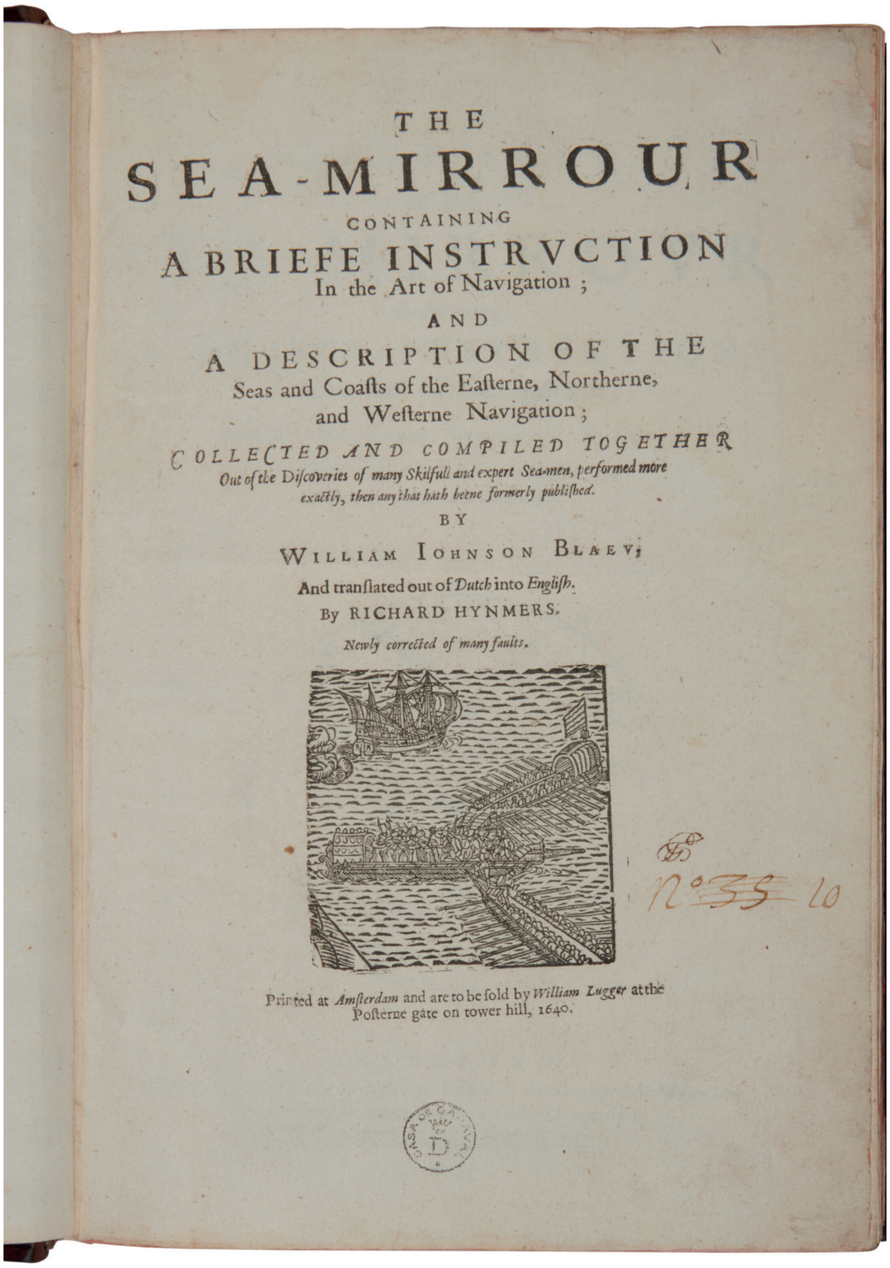
There was little change to this strategy for the best part of two millennia!

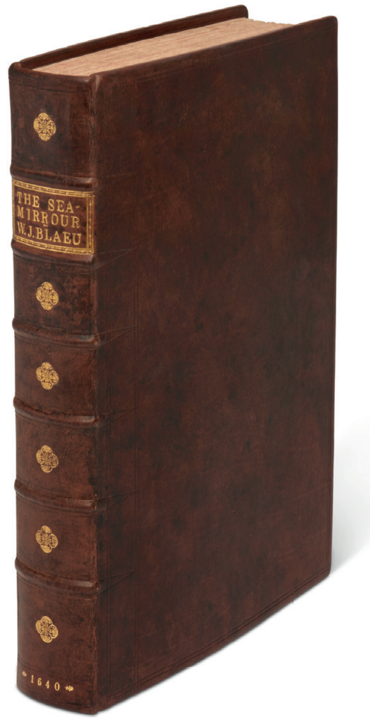
Ward has written about the earliest surviving copies of Rutters in English.[12] These are handwritten and date from the fifteenth century. In his careful study of these remarkable manuscripts, there is only one indirect reference to a navigational light useful for making the English Channel crossing from Dover to Calais and referred to as a 'fanal'. There is also one clear illustration of a fire beacon but with no indication that it refers to a specific location.

Willem Blaeu was not only a master mapmaker but also a publisher of books of sailing directions. One was entitled, *The Sea Mirrour* and dated 1640. References to it are made using the following:[13]

> *"The light of navigation Wherein are declared and lively pourtrayed, all the coasts and havens, of the VVest, North and East seas. Collected partly out of the books of the principall authors which have written of navigation, (as Lucas Iohnson VVaghenaer and divers others) partly also out of manie other expert seafaring mens writings and verball declarations: corrected from manie faults, and inlarged with manie newe descriptions and cardes. Divided into tvvo bookes. Heerunto are added (beside an institution in the art of navigation) nevve tables of the declination of the sonne, according to Tycho Brahes observations, applied to the meridian of Amsterdam. Together with newe tables and instructions to teach men the right use of the North-starre, and other firme starres, profitable for all seafaring men. By William Iohnson."*

On p37 we see excerpts from The Seaman's Guide, a slightly different version of sailing directions that concentrated on giving times of tides and the variations of the moon that determine them. Although published in 1797, such guides were part of the handovers from one master mariner to another.

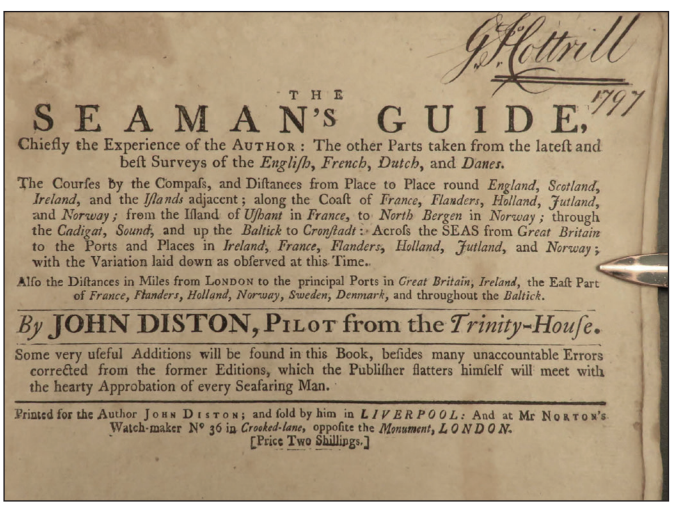


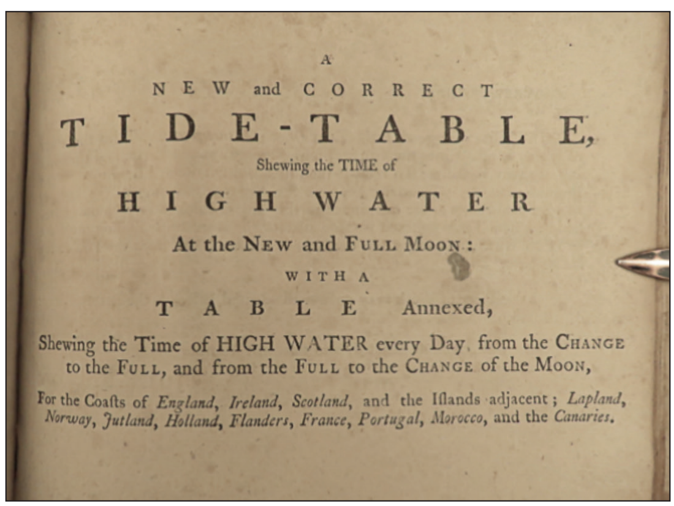


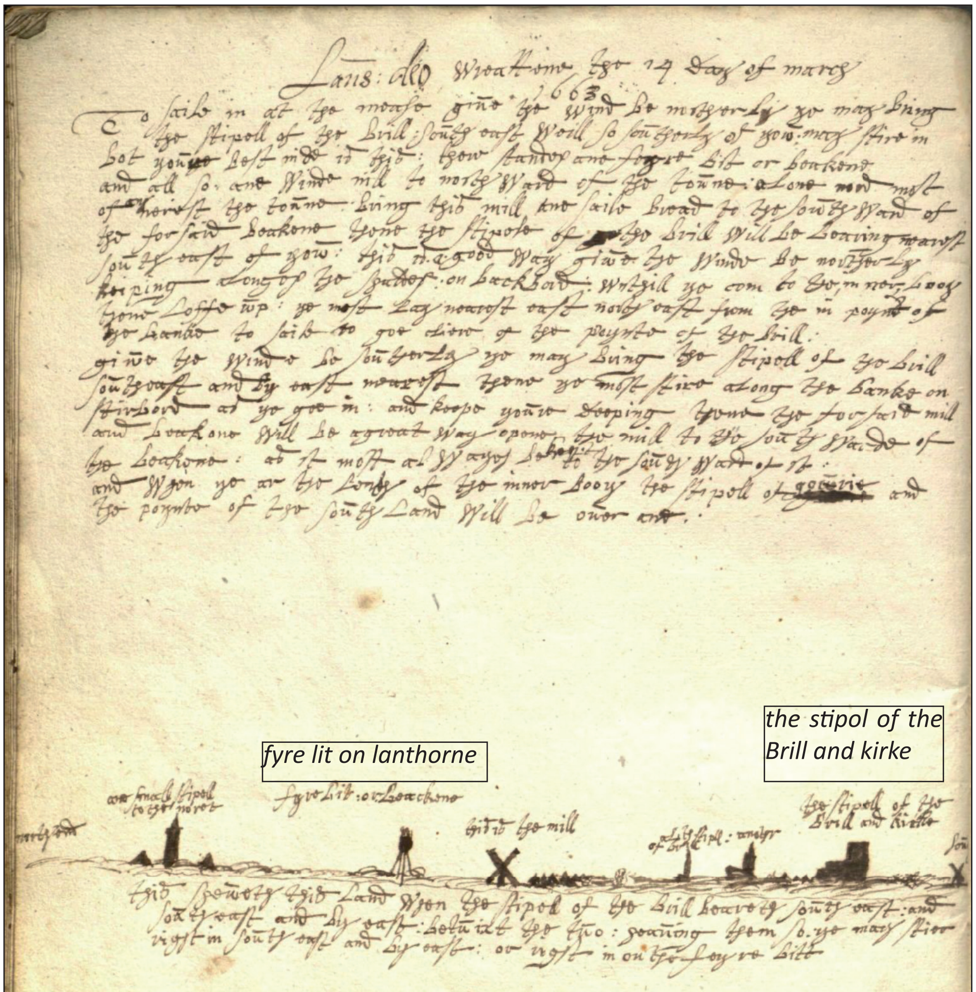
XIII. How to sayle in to the Havens of Flanders.

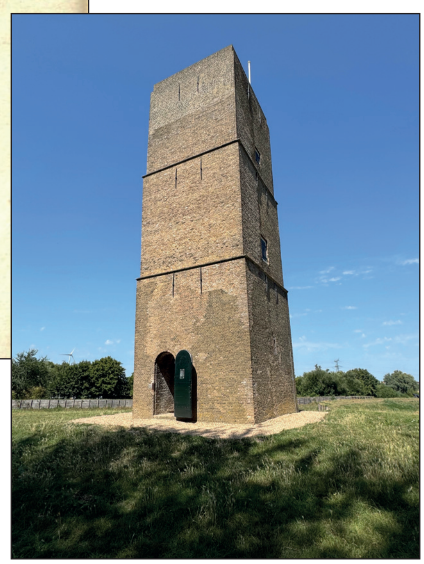
TO sayle into Ostende let the new church stand westward from the old church, & so goe in close by the west head, it is a tyde haven which you must use with high water, you must keepe the fire-beakons one right against the other, or a litle a sunder, that they may stand southeast & by south from you, and so goe in right upon them, with a ship that draweth not much water, you may sayle in there at half flood, and by night you may sayle in by the lights of the fire.

Above: Willem Blaeu's Sea-Mirrour of 1640. [University of St Andrews Library] Included in the book is the following direction for Ostend which makes explicit reference to more than one lightstructure.
Below: Two pages from the Seaman's Guide, a publication by a Trinity house Pilot named John Diston.









ABOVE: A page of sailing directions[14] taken from the journal of Alexander Gillespie, a skipper in medieval Elie, Scotland. He was a much travelled mariner who compiled his own notes. This extract was chosen for its inclusion of a fire beacon. It details the course to be taken into the Dutch port of Brielle or den Briel, a very old fortified town and seaport. (In English it was often written as the Brill.) Dated 14 March 1663, the instructions are for steering east of southeast to Brielle with the steeple (stipol) and church (Sint Catharijne kerk with a tall square tower) of Brielle on the right. The way into the port is past the "fyre lit on lanthorne", a reference to the old lighthouse now known as Stenen Baak (below right) built in 1650.[15] The Hook of Holland is to the north of Brielle and today there is a lighthouse at Vuurtoren. The modern map is greatly altered because this is the entry into the giant port of Rotterdam and there has been a great deal of land reclamation.

Practical Lighting Methods In The Medieval Period

By this point in the book, you will be entirely aware that we are fundamentally concerned with the creation of light. We take it so much for granted in times when the flick of a switch, or even a spoken command to a smart speaker, can result in our immediate environment being bathed in as much light as we might have in full daylight. It is difficult to imagine a world in which that was not possible. Electricity has been available to ordinary people in their homes for little more than a century, before which light could be made from lamps burning town gas (if you were lucky) or else paraffin.[16] In medieval times, the only way to make light was to burn something. And to make bright lights you had to burn your chosen material at a faster rate - usually using more of the same, making the flame bigger. There was no way to amplify that. It was not until the 18th century that practical methods were developed for magnifying the intensity of light with parabolic reflectors.[17]

Fuels

Various fuels were used for making light, depending on factors such as availability, affordability, and local customs. Some of the most common fuels used for lighting during this period included:

Tallow Candles

Tallow candles were among the most widespread sources of artificial light in medieval Europe. These candles were made from animal fat, usually rendered from beef or sheep, which was poured into moulds along with a wick made from cotton or hemp. Tallow candles provided a relatively inexpensive and accessible source of light, although they tended to produce a smoky flame and an unpleasant odor. When science was eventually applied to light, it was the amount of light emitted from a 'standard' candle that became the unit of measurement, remaining in use until quite recently.[18]

Beeswax Candles

Beeswax candles were considered a luxury item due to their higher cost compared to tallow candles. Beeswax candles burned cleaner and emitted a pleasant fragrance, making them preferred by the wealthy and in religious ceremonies.

Oil Lamps

Oil lamps were another common form of lighting, especially in areas where animal fat or beeswax was less readily available. These lamps typically burned vegetable oils such as olive oil or rapeseed oil. Oil lamps could be made from materials like clay, metal, or glass, and they were often suspended or placed on surfaces to provide illumination.

Rushlights

Simple, homemade alternatives to candles, rushlights were found, particularly among poorer households. They were made by soaking the pith of rush plants in animal fat or grease, then allowing them to harden. Rushlights provided a dimmer light compared to candles but were an affordable option for those with limited resources.

Wood and Biomass

In some cases, wood and other biomass materials were burned in open fires or enclosed braziers to provide both heat and light. However, this method was less common for indoor lighting and was typically reserved for outdoor gatherings or larger spaces.

Oil

It is true that oil - a fuel created by the fossilization of ancient organic matter - has been seeping to the Earth's surface from deep underground for millions of years, and there are historical accounts of ancient civilizations using naturally occurring oil for various purposes, including as a fuel source. One of the most famous examples is the ancient city of Babylon (located in present-day Iraq), where bitumen, a form of petroleum, was used for waterproofing and construction as early as 4000 BCE.

The Sumerians and other Mesopotamian civilizations also used bitumen for various purposes, including as a binding agent in construction. Additionally, indigenous peoples in various parts of the world, such as Native American tribes in North America, used oil from natural seeps for medicinal and ceremonial purposes. Despite that, the widespread use of petroleum as a fuel source didn't occur until much later in history, with the development of refining techniques and the invention of the internal combustion engine in the late 19th century.

This transition occurred gradually throughout the 19th century with the arrival of paraffin oil, also known as kerosene or lamp oil, that was derived from the refining of petroleum. Its discovery and development parallel the broader understanding and utilization of petroleum products.

The modern production of kerosene as a lighting fuel can be attributed to the Canadian geologist and inventor Abraham Gesner. He developed a process to distill and refine crude oil into various useful products, including kerosene. He patented this process in 1854. Gesner's invention greatly improved the efficiency and affordability of lighting, leading to the widespread adoption of kerosene lamps in households and businesses around the world.

So, while paraffin oil itself may not have a single 'discovery' moment, its development and commercialization are closely tied to the broader understanding and refining of petroleum, which began in the 19th century.

Above: The fire grate or chauffer which was used to provide the coal fire light at St. Agnes lighthouse in the Isles of Scilly is preserved in the gardens on the island of Tresco.

Coal

The discovery of coal dates back thousands of years, and it's difficult to pinpoint a single location as the first discovery. However, some of the earliest known uses of coal were in China, where it was used for heating and cooking as early as 3,000 years ago. We do not, at this stage consider the burning of coal for making light. While coal did exist in some parts of Europe during medieval times, its use was limited.

The earliest documented coal mining in Europe dates back to the Middle Ages, with coal being mined in places like England, Germany, and France. These early mines were typically small-scale operations, and coal was primarily used for local consumption. Since it was not transported, it was never generally available.

It wasn't until the Industrial Revolution, again, in the 18th and 19th centuries, that advancements in technology, transportation, and mining techniques led to the widespread adoption of coal as a primary fuel source for industry, transportation, and domestic heating.

The expansion of coal mining grew with the development of steam engines, which were powered by burning coal. Steam engines were integral to the Industrial Revolution, driving machinery in factories, powering locomotives for transportation, and facilitating the mechanization of various industries.

By the mid-19th century, coal had become the primary fuel for industrial processes, transportation, and heating in many parts of the world. Its abundance, relatively low cost, and high energy content made it indispensable during this era of rapid industrialization and urbanization.

It is perhaps surprising that coal was not a more prominent material in medieval times, since it was such an important material for making iron and steel in later centuries. However, during the early stages of the Iron Age, which began around 1200 BCE in the Near East, iron was primarily produced using wood charcoal as the fuel source. Clearly, this predates the widespread use of coal in iron production.

The process of production involved smelting in a bloomery furnace. Iron ore, an oxide of the metal, typically hematite or magnetite, was heated with charcoal in a furnace to high temperatures. The carbon in the charcoal reacted with the oxygen in the ore, reducing the iron oxide to metallic iron. Charcoal was preferred over raw wood because it burns hotter and produces less smoke and impurities. Moreover, charcoal was readily available and could be produced through the controlled burning of wood.

We conclude, therefore, that while coal was known to ancient peoples, it wasn't widely used in iron production until much later, during the Industrial Revolution.

The availability of coal in medieval times varied depending on the region. While coal deposits existed in certain parts of Europe during the medieval period, its use as a widespread fuel source was limited for several reasons:

Knowledge and Technology

During medieval times, the technology for efficient extraction and utilization of coal was not well-developed. People were aware of coal deposits, but they lacked the means to mine and process coal on a large scale. Coal mining techniques were primitive compared to later centuries, and coal was often extracted from surface outcrops or shallow mines using manual labor.

Alternative Fuels

Other fuel sources such as wood, peat, and animal dung were more commonly used for heating and cooking in medieval Europe. These fuels were more readily available and easier to harvest or collect compared to coal.

Quality of Coal

The quality of medieval coal deposits varied widely, with some containing high levels of impurities such as sulfur and ash. This made medieval coal less desirable for fuel compared to later, higher-quality coal deposits discovered during the Industrial Revolution.

Social and Economic Factors

The socio-economic structures of medieval society also influenced the use of coal. In many regions, coal mining was controlled by feudal lords or religious institutions, and the production and distribution of coal were often limited to local markets.

Inescapable Fire

Statements of the obvious may seem trivial but must nevertheless sometimes be made. The common factor in all of the methods of making light that was known in medieval times was fire. It was necessary to burn some kind of fuel in order to create light when the natural light from the Sun was unavailable. Nothing would change that basic fact until Michael Faraday invented electricity in the mid-19th century.[19] And different fuels required different methods with which to make them burn.

In the English language, the word 'beacon' has been long used for an open fire that was intended as a signal. It would have used coal or wood in significant amounts that the resulting fire could be seen over a large distance. It is likely that the earliest beacons were used to warn of an impending threat, perhaps an approaching enemy force, for example. And, of course, it was well known that for the signal to have its maximum effect, it should be shown from a high elevation.

Over time, the word beacon became used in broader contexts where it still represented a signal but with a more specific purpose and the light might have been smaller, used a different fuel, and even been encapsulated in a dedicated device to make a lantern.

Thus, when we inspect old literature looking for references to the sites and use of possible lighted aids to navigation, we frequently come across the noun, beacon, without generally being able to describe it accurately or to know exactly why it was used. Nevertheless, we can confidently say that the beacon was a fire, whether small or large, and burning a fuel. Its purpose is less well defined, and a beacon could easily have been lit at a given location with no intention that it might be used for navigational purposes.

Another inescapable fact is that all of these firelights were primitive and by definition unreliable. Indeed, this was one of the most important elements in the improvements to lighthouse technology that had to wait until the industrial age.

Fires need to be kept supplied with fuel and could be obscured with smoke. They needed constant attention by a human if they were to continue to be of service. They could be extinguished by rain, wind or other inclement weather unless they were enclosed in some way, but to enclose any kind of fire required the transparency of glass which for centuries was a rare commodity in any other than the crudest form.

Inevitably, all lights that were set up during the medieval period were either ineffective or unreliable or both.

Left: An image showing the fleet of the Royal Navy under the command of Admiral Sir Cloudesley Shovel at the time of its almost total loss in the Isles of Scilly in 1707 and the deaths of some two thousand seamen. The tragedy occurred despite the presence of a coal-fired light being shown from St. Agnes.

Sailing In A Dark Age

Most of us cannot imagine steering a boat at sea in total darkness, tired and needing our beds back on dry land. Perhaps those readers who are experienced sailors will protest to the contrary, but logic tells us that in the act of steering a boat towards a destination the most fundamental need is to observe an approaching coastline. With no other artificial aids than, perhaps, a compass, the very experienced mariner will use a combination of observations and local knowledge to judge his position. The wind direction, the state of the tide, the time of year, and even intuition, are just some of the factors that come together to computing his location.

As you approach the land, the dark outline of the shore adopts many shapes, rounded, jagged, tall, flat, minimal to the point of being a thin line on the horizon, but surely it would be dangerous to rely upon these alone? Squinting hard through enlarged pupils, their width dependent upon the amount of moonlight, you would look for any kind of marker to help with the identification - a building, a group of trees, a small island shape or group of rocks just offshore, but these are all deceptive when viewed from a different angle, even in broad daylight, which there isn't at this moment. Something special is needed that stands out as being special, individual, even unique.

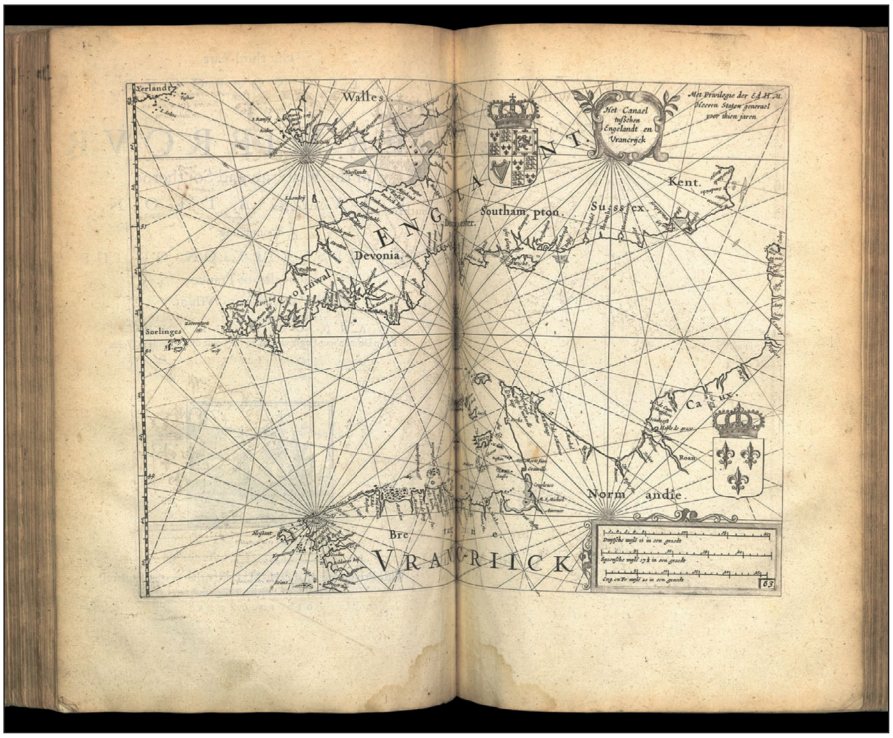
In times when populations were a small fraction of the size they are today, the darkness would have seemed even more pervasive. The number of havens, or just sites of habitation would have been so few compared to the extent of the sea surface to be travelled. Oh, for a light to guide us home!

A light in the darkness offers great hope, for when set in the context of all the other factors I mentioned above, the combination offers a big improvement in your chances of correct identification of position. The medieval mariner could not conceive of anything other than a simple glow in the gloom, frustratingly faint at first, hopefully stronger later. Its colour, its shape, its brightness were beyond reason and there could be no hope of any other confirmation of identity by such a wild idea as a coded flash. That was still many centuries away.

No, the light alone was enough. Or was it?

What if the flames had gone out ... they'd run out of fuel ... the light had been extinguished by rain, wind, or other bad weather? What if its minder had fallen asleep? You'd look for a light and see none. Catastrophe. You might be in entirely the wrong place ...

In 1707, Admiral Sir Cloudesley Shovel and his fleet were returning to England after a battle with the French. His navigation was flawed and he was in the wrong place - actually in the reef-strewn Isles of Scilly - and ignored the advice of a junior man who happened to be a local who recognised where he was. A terrible loss took place as 1,700 sailors were drowned when the ships ran onto rocks. Ironically, there was a coal-fired light on St. Agnes, established in 1680. It did not save them.[20]



ABOVE: Blaeu's map of the approaches to the English Channel was made before the Scilly light was established. Sadly, his maps did not show lighthouses.

Notes

1 Taylor, p3.

2 A much more detailed presentation about navigation in early times is given in Ancient Lighthouses, chapter 2.

3 Ancient Lighthouses, chapter 2.

4 The astrolabe is believed to have been invented in ancient Greece around the 2nd century BCE. The exact origin and inventor are not definitively known, but it is often attributed to Hipparchus, a Greek astronomer, mathematician, and geographer. The astrolabe was later refined and further developed by Islamic scholars during the medieval period, particularly during the Islamic Golden Age. It became an essential tool for astronomers, navigators, and astrologers for determining the positions of celestial objects, timekeeping, and navigation.

5 Lane, p612.

6 Lane, p613.

7 Ancient Lighthouses, p52-58.

8 Bound volumes of Blaeu's maps exist today and fine copies can sell at auction for as much as £50,000.

9 Ancient Lighthouses, 81ff

10 Mauro, Chiara Maria: Sailing Directions. Echoes of Ancient Nautical Knowledge in the Periplous of Ps.-Skylax. https://www.ancientportsantiques.com/wp-content/uploads/Documents/AUTHORS/Mauro/Mauro2022b-Skylax.pdf. The plural of periplus - or periplous - is periploi. The author of this was a Greek called Pseudo-Skylax, sometimes written as Ps-Skylax.

11 Mauro, Chiara Maria: Sailing Directions. Echoes of Ancient Nautical Knowledge in the Periplous of Ps.-Skylax p66.

12 Ward, Robin: The earliest known sailing directions in English. Deutsches Schiffahrtsarchiv, (2004) 27, 49-92. See p52 and p56. https://nbn-resolving.org/urn:nbn:de:0168-ssoar-55784-7.

13 In the digital collection Early English Books Online 2. https://name.umdl.umich.edu/A16189.0001.001. University of Michigan Library Digital Collections. Accessed March 16, 2025.

14 Collections: Alexander Gillespie - University of St Andrews, Part 14.

15 We note how the current stone tower is solid, compared to what looks like a simple elevated platform in the author's notes. Perhaps that is how it looked at the time.

16 A detailed history of the development of electricity in lighthouses is given in my book, Light on the Forelands. There are also significant descriptions of the making of lights on my pharology website.

17 This is despite the principle being discovered by the ancient Greeks. See my book on Ancient Lighthouses.

18 For detailed discussion of this subject see Light On The Forelands, p40-43. Also https://www.pharology.eu/howlighthouseswork/H14a_candles.html

19 The first serious use of electricity for making light was in lighthouses at South Foreland, England in the 1860s. The full detailed story of this is given in the book by Ken and Clifford Trethewey, Light On The Forelands (2022).

20 Whilst true in essence, this story about the causes of the tragedy has been discredited by historians, but remains popular in folklore.