

THE HISTORY OF HYDROGRAPHY

An Enlightened European Era 1660-1800

by Rear Admiral G.S. RITCHIE (*)

'The best thing that we get from history is the enthusiasm it rouses.'

Goethe

INTRODUCTION

In recent years many retiring Hydrographers have, in their new-found leisure hours, turned enthusiastically to the writing of the history of their national hydrographic agencies. Thus, many of the Member States of the IHO have published histories of their own hydrographic achievements over the last two hundred years or so. A number of such histories are not yet available in the official languages of the Organization.

The world history of hydrography, as Europeans see it, extends from the end of the 13th century over the subsequent 700 years. The complete story, if it is ever to be set down, will entail the work of many writers from different nations, each dealing with a period and a region which seem significant to them.

Three early stages in the evolution of European chart-making, each of which has secured the attention of at least one major historian, may be identified. The first era extends from the appearance of the 'Carta Pisana' towards the end of the 13th century through two centuries of Mediterranean portulans until the second stage may be said to have been reached; this is the period of the drawing of the Atlantic portulans stimulated by Henry the Navigator early in the 15th century. A third epoch began towards the end of the 16th century when Dutchmen recognised the potential of manuscript portulans, which they saw onboard visiting Mediterranean vessels, for the engraving and printing of charts for widespread sale to seamen.

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Dutch supremacy in the production of seamen's charts continued for about one hundred years towards the end of which time a dramatic surge forward in scientific thought, particularly in France and England, was to have a pronounced effect on sea surveying and chart compilation.

The year 1660 appears to be a good starting point for this fourth European era, which this paper attempts to explore and define. Before doing this however, it will be well to provide a starting benchmark by reviewing the charts available to seamen at that date.

CHARTS AVAILABLE TO SEAMEN IN 1660

Sailors currently regarded the plane chart as a navigational tool slowly superseding the pilot book which was becoming supplementary to the chart. Pedro NUÑEZ, a Portuguese cosmographer, had in the mid-16th century drawn attention to the imperfection of the plane chart for ocean navigation, but could not solve the problem. Mercator's world map of 1539 could have been a major breakthrough for seamen, a point which Edward WRIGHT made in his 'Certaine Errors of Navigation'; published in 1599, it was reprinted in 1656 but was only studied by a few enlightened navigators.

There had been a school of chartmaking in London under the patronage of the Drapers' Company since the middle of the 16th century. Known today as the Thames School, the system was one of apprentices serving their time under recognised masters before joining them in their business, or setting up on their own as 'platt makers'. Nicholas CUMBERFORD, John BURSTON, John THORNTON and Joel GASCOIGNE were some of those who provided hand-drawn charts on vellum. These were generally small scale plane charts of oceanic areas drawn in a style reminiscent of the portulan [Ref. 1].

The first engraved charts printed on paper to gain wide popularity with mariners were those published by the Dutchman Lucas Jansz WAGHENAER in his atlas 'De Spieghel der Zeevaerdt' in 1584. These charts covered the principal ports and the coasts of Western Europe. English and French editions quickly followed, the English version being published on the orders of the Lord High Admiral in 1588, the year of the Armada [Ref. 2].

WAGHENAER was a former pilot of Enckhuysen who sought navigational information from seamen. Many innovations made these plane charts uniquely functional — soundings were shown over harbour bars and in anchorages in fathoms at half-tide; deliberate distortion of scale was often made within the same chart to facilitate pilotage in complex areas; coastal views, for recognition purposes, as seen from seaward, were printed on the charts. WAGHENAER adopted the symbol + for a submerged and dangerous rock, in use since the 13th century on portulan charts, and the danger lines to limit such features, as used by Pedro and Jorge REINEL on Portuguese charts in 1500. He added further new symbols including the anchor to denote a safe anchorage and self evident images of buoys and beacons of various shapes.

Subsequent Dutch cartographers improved on WAGHENAER's style of sea charts. Wilem Janszoon BLAEU published his 'Licht der Zeevaart' in 1608 and Jacob Aertz COLOM, who founded a Navigation School in Amsterdam, 'Vyerighe Colom', which appeared in English editions as 'Fiery Sea Colomne' in 1648.

SCIENTIFIC AWAKENING ON BOTH SIDES OF LA MANCHE

In May 1660, Lord MONTAGU, later the Earl of Sandwich, the General at Sea, sailed with the English Fleet for Holland to embark and bring back Charles II for the Restoration. MONTAGU was accompanied by Samuel PEPYS who had been his major domo for some years; he promised PEPYS that 'they would rise together', thus ensuring the latter's close association with the Navy for many years [Ref. 3].

Charles II's interest in science soon became apparent. A recently formed Society of learned gentlemen became the Royal Society, receiving its charter in 1662, but already the Society had recorded in its Minutes the preparation of a document setting out plans for sea depth and tidal measurements to be made by the Earl of Sandwich during an impending naval voyage to the Mediterranean [Ref. 4].

Charles II established the Royal Observatory at Greenwich in 1675 and appointed the Reverend John FLAMSTEED as the first Astronomer Royal to map the heavens, with the prime object of solving the problem of finding longitude at sea.

Across the Channel, King Louis XIV took over the Government of France in 1661, appointing as his Chief Minister Jean Baptiste COLBERT, a man of consuming interests in both science and the sea.

Within two years the Académie des Sciences was formed, followed by the establishment of the Observatoire de Paris, two years later. In 1665, an Italian professor of astronomy at Bologna University named Giovanni Domenico CASSINI was invited to come to Paris to direct the work of the Observatoire. He took French nationality four years later, and, together with his son and grandson, contributed massively to the establishment of geodetic control and subsequent mapping of France (*).

Thus the scene was set on both sides of the Channel for significant moves forward in marine cartography.

(*) Giovanni Domenico, father of the Cassini cartographic dynasty was born in 1625 at Perinaldo, in the Alpes Maritimes not far from Ventimiglia in Northern Italy, where a cubist style statue in the village portrays Cassini at his telescope. After attaining French nationality he changed his forenames to Jean Dominique.

HYDROGRAPHIC PROGRESS IN BRITAIN

PEPYS was highly critical of the marine charts currently available, and in particular those in the English Pilot published in London by John SELLER in 1668 which, PEPYS averred, were derived from cast-off copper plates bought from Dutch cartographers.

PEPYS persuaded the Brethren of Trinity House to associate themselves with the first comprehensive survey of Great Britain's coasts which had been ordered by Charles II. The survey was to be undertaken by a naval captain, Greenville COLLINS, who was appointed Hydrographer in Ordinary to the King.

Although COLLINS did not set down in any detail how he conducted his surveys there is in existence a list of instruments that he had purchased for the work which he sent to the Controller of the Navy in the hope that he would be compensated for the expense involved. With this list one can study COLLINS's charts to get some idea of his methods [Ref. 5].

There were no established geodetic stations in Britain and accordingly the coastal surveys were based on courses steered and distances run by log to reach one headland from another. The survey was controlled by occasional celestial observations for latitude determination, either made onshore with a five foot radius brass quadrant set on a upended cask or at sea with a handheld quadrant (*). Meridian compasses, not corrected for variation, were used to orientate the harbours and their approaches, the control for which was extended from one or more baselines measured onshore with a measuring wheel or chains. From shore stations, or from the ship at anchor, bearings taken with an azimuth compass with sighting bar were used to intersect the positions of coastal features and visible, or buoy marked, offshore dangers which were then plotted on a plane table.

The atlas which resulted from seven years of survey work by Captain Greenville COLLINS was entitled 'Great Britain's Coasting Pilot' published in 1693. It comprised forty or so crisply engraved charts supplemented by sailing directions and many coastal views. This pilot met the needs of seamen visiting British ports for the next 100 years or so, during which eleven editions were printed.

HYDROGRAPHIC PROGRESS IN FRANCE

Greenville COLLINS' charts were unfavourably compared by PEPYS and others with those appearing in the 'Neptune François' published in Paris in the same year of 1693 covering the Atlantic coasts of Europe from Norway to Gibraltar, including the Baltic [Ref. 6].

(*) This would have been a Gunter's or seamen's quadrant made from a quarter circle of wood or metal. It indicated the altitude of a heavenly body viewed through sighting pinholes and recorded by a plumb line falling across the perimeter scale.

The smaller scale charts in the 'Neptune' were drawn on the Mercator principle. They carried scales of both latitude and longitude, the latter in the earlier editions being referred to a prime meridian passing through the île de Fer (*).

The content of the charts owed much to COLBERT although he had died ten years earlier. There had been schools of pilotes-hydrographes in several French ports for many years, the most noteworthy in Dieppe, and in 1681, COLBERT had introduced an ordinance creating from these groups of pilots a corps of professors of hydrography [Ref. 7].

PROGRESS IN HYDROGRAPHY IN NEW FRANCE

France had an overseas hydrographic programme from 1685 onwards when the Secretary of State of the Navy sent Jean DESHAYES, a former protégé of COLBERT, to Quebec to make astronomical observations to find its latitude and longitude and, later, to make a hydrographic survey of the St. Lawrence River. [Ref. 8, 9]

For the survey he was supplied with a small bark, an open boat, a canoe and seven seamen. DESHAYES measured a base with waxed cords across the ice at Quebec from which he extended a triangulation traverse for 350 miles along the northern shores of the river. He sketched in the southern shore with reference to mountain peaks which he fixed by intersection from the stations in his triangulation. He then sounded out the more intricate parts of the river channel. His methods were similar in many ways to those of Greenville COLLINS, using altitudes of the Pole Star to control his scale.

DESHAYES had a unique plane table with two alidades pivoted centrally so that angles could be taken, and to which he could attach a compass. This instrument had been specially made for him by Michael BUTTERFIELD, an Englishman who had gone to Paris as an instrument maker to Louis XIV [Ref. 10].

DESHAYES' 'Carte de la Rivière Saint-Laurent levée sur les lieux en 1686', now in the Bibliothèque Nationale is a fine hydrographic work; it was printed and published by Nicholas de FER in 1702 with sailing directions written alongside the river as appropriate.

(*) France had continued to use île de Fer, the most westerly of the Canary Islands, as the prime meridian, assuming that to have been the island used by Marinus and Ptolemy. See Fournier, Georges 'Hydrographie' (Michel Soley, à l'Enseigne de Phenix, Paris — 1643) Livre XII Chapitre II. The use of île de Fer had been prescribed by ordinance of Louis XIII in 1634. In the 1753 Edition of 'Neptune François', the Paris Meridian was chosen as the prime meridian. (See op. cit. Pastoureau).

Men of Consequence

Jean Baptiste COLBERT (1619-1683)

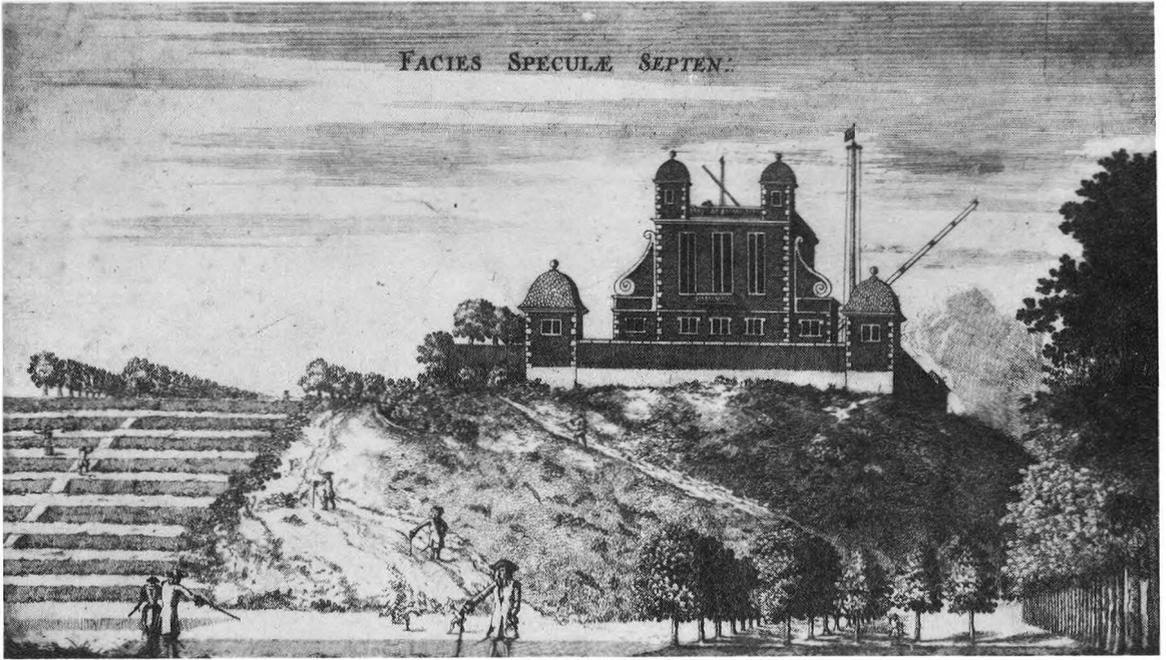
Portrait by Guillaume CHASTEAU, Bibliothèque Nationale, Paris, France.



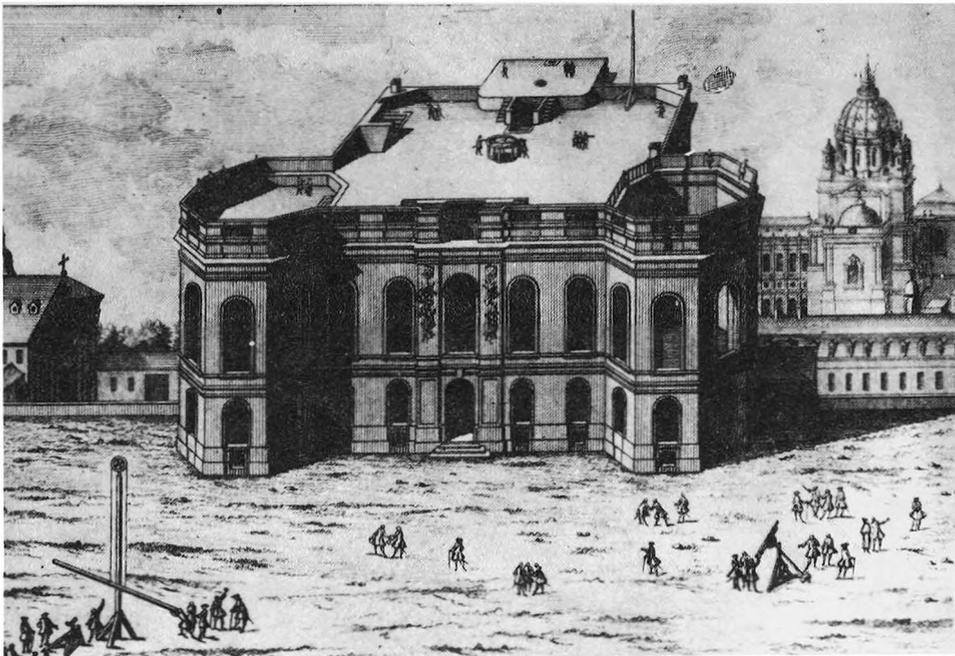
Samuel PEPYS (1633-1703)

Portrait by Sir Godfrey KNELLER, National Maritime Museum, Greenwich, U.K.

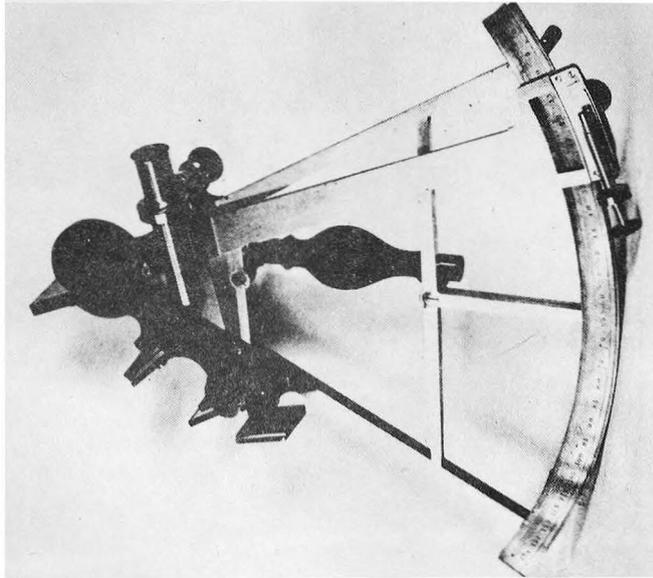
Cradles of Science



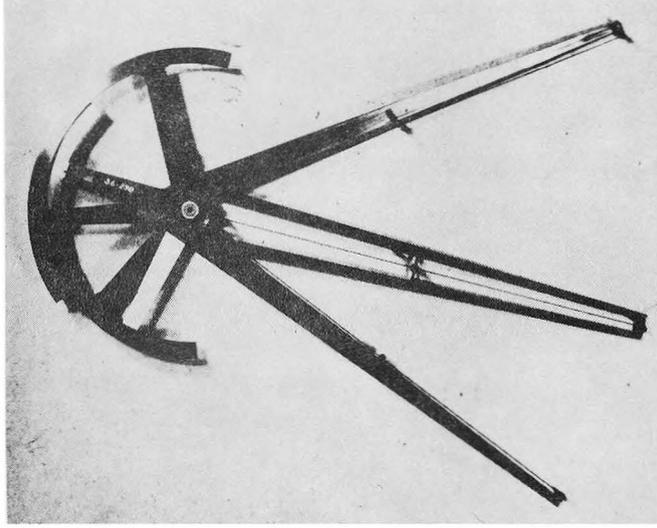
‘View of the North Face of Flamsteed House in 1676’
Royal Observatory, Greenwich
Engraving by Francis PLACE, National Maritime Museum, Greenwich, U.K.



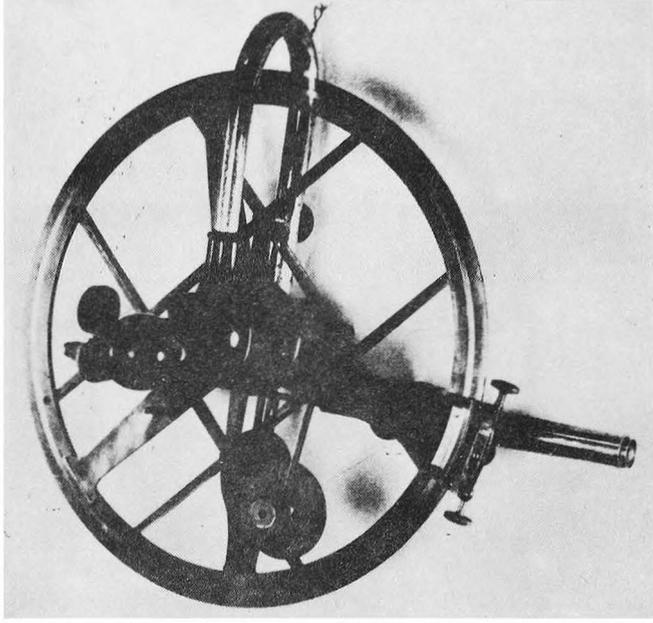
‘Façade Sud de l'Observatoire de Paris en 1740’
Dessin de Martin DUMONT, gravure de DHEULLAND, Observatoire de Paris



Sextant



Station Pointer



Reflecting Circle

Illustrations from 'The Geometrical Seaman'

E.G.R. TAYLOR and M.W. RICHEY
Hollis & Carter, London (1962).

THE DÉPÔT DES CARTES ET PLANS DE LA MARINE

There were other hydrographers in New France including FRANQUELIN and JOLLIET. The amount of cartographic material reaching Paris in the early years of the 18th century from New France was probably the culminating factor which led to the Ordinance of 19th November 1720 establishing the Dépôt des Cartes et Plans. The Navy was to appoint a competent officer to examine and archive the incoming material. Within fifteen years charts were being compiled from these data, and under the direction of Jacques Nicolas BELLIN, the Royal Hydrographer, a chart of the Mediterranean in three sheets was published in 1737, the first chart to be issued by a national hydrographic office. It was not, however, until after 1800 that the personnel of the Dépôt took to the field themselves to conduct surveys [Ref. 11].

DUTCH HYDROGRAPHY

During the whole period of this review the main Dutch marine cartographic effort was concentrated on making and supplying charts to the masters of the ships of the Dutch East India Company which had been founded in 1602. Very considerable secrecy was attached to the hydrographic data gathered in the East Indies, and to the resulting charts.

There were two divisions of the Hydrographic Office of the East India Company; the chartmakers of the Amsterdam Chamber and a similar body in Batavia, the Asiatic headquarters of the Company, each headed by a chief cartographer [Ref. 12].

From 1705 to 1743, Isaak DE GRAFF was the chief cartographer in the Amsterdam Chamber where copies were made of all charts and plans, whilst copies were sent from Batavia of charts compiled there. On the death of DE GRAFF in 1753, Joannes VAN KEULEN became the supplier of printed charts, to the Company and in that year published the sixth part of 'Zee-Fakkel' which contained charts of a great part of the East Indies. From then onwards, secrecy declined as did cartographic effort in Batavia, which finally ceased when the Company was wound up in 1799.

THE SHAPE OF THE EARTH

From the latter years of the 17th century onwards, NEWTON in England and the CASSINIS in France, together with other scientists in both countries, were locked in animated controversy as to the true shape of the globe which had to be resolved before more precise mapping and ocean charting could be achieved.

The CASSINIS were misled by measurements of a meridian across France from the Channel to the Pyrenees refuting NEWTON's theory that the earth was flattened towards the poles. The Académie des Sciences decided to resolve the matter by sending out two geodetic expeditions, one to measure the length of a degree of latitude in the Arctic and the other to do likewise at the Equator [Ref. 13].

MAUPERTUIS, already a Fellow of the Royal Society of England, was the French geodesist sent with a party of scientists to Lapland in 1736 where he completed his triangulation by measuring a baseline with toise-long fir rods across a frozen river.

His results, when set against the measurement of the meridian in France, proved the earth to be an oblate spheroid, which was further substantiated seven years later when Pierre BOUGUER, a professor of hydrography, and Charles Marie DE LA CONDAMINE returned from their measurements in Peru.

MURDOCH MACKENZIE

A Scotsman who was aware of French progress in geodesy in the early 18th century was MACLAURIN, Professor of mathematics at Edinburgh University on the recommendation of Sir Isaac NEWTON, and a Fellow of the Royal Society at the age of 21. He included in his teaching plane trigonometry, surveying and astronomy. He frequently visited France and was friendly with Jacques CASSINI, who had succeeded his father in 1712, and CASSINI DE THURY, the grandson, who from 1744 was to be engaged in making the great topographic map of France (*).

In 1739, Professor MACLAURIN was approached by Lord MORTON on behalf of a number of landowners on the Orkney Islands to arrange for a survey of those islands, which was to include the adjacent sea. MACLAURIN recommended an Edinburgh graduate, Murdoch MACKENZIE, to undertake the work; he having the mathematical qualifications necessary for 'making a geometrical survey'.

The reason for this maritime survey was the emergence in the middle of the 18th century of a kelp making industry in the Orkneys which developed into a veritable boom by the end of the century. Seaweed was gathered along the extensive shores of the islands and burnt in pits to form 'kelp' a substance which was then shipped in very considerable quantities to the mainland of Britain as a source of soda, potash and iodine. Udal law in the Orkneys which gives ownership down to low water line to proprietors of adjacent lands, reflects the importance of the kelp industry in former times.

(*) The 'Scots Magazine' (Edinburgh, 1741) gives details of the subjects taught at Edinburgh University by Professor MACLAURIN. These were plane trigonometry, tables of log sines etc, surveying and fortification. Once a fortnight he gave a general lecture on geography, which included astronomy and optics. MACLAURIN was one of four scientists who shared a prize, donated by the Académie des Sciences for an essay on tides.

The influence of MAUPERTUIS' base measurement in the Arctic three years earlier can be detected when Murdoch MACKENZIE commenced his survey by measuring a baseline with 30 foot poles on a frozen lake. At the base terminals he observed with a theodolite angles between the baseline and various beflagged or natural marks thus fixing by intersection what he called his 'stasimetric points.' From these stations many features of the survey were fixed by further angles using the Hadley horizontally.

When 'Orcaades', the atlas of charts resulting from Murdoch MACKENZIE's surveys was published in 1750 it impressed the Lords Commissioners of the Admiralty so favourably that they engaged him to make an exact survey of the northwest coast of Scotland. He was provided with the small vessel CULLODEN for the work, during which a triangulation network was carried across the Minch. The survey then progressed southwards along the west coast of England.

In 1771, Murdoch MACKENZIE was superseded as Admiralty Surveyor by his nephew of the same name, a lieutenant in the Navy who had learnt his trade as a midshipman sailing round the world with Lord BYRON. Lieutenant Murdoch MACKENZIE continued surveying where his uncle had left off in the Bristol Channel and worked his way round the coast to Plymouth Sound. From here in 1774 he was called away by the Admiralty to search for a new channel off Margate said to lead into the Thames.

THE STATION POINTER

Meanwhile Murdoch MACKENZIE the elder settled down to write his important 'Treatise of Maritim Surveying' which was published in 1774. It was about this time that he is believed to have conceived the idea of an instrument to supersede the laborious graphical operation of plotting a resection fix of which HALLEY had written to Sir Richard SOUTHWELL over seventy years earlier (*).

Joined by an able assistant, Graeme SPENCE, Lieutenant MACKENZIE measured his base on the sands at Margate, extended to his 'stasimetric points' and went afloat with some form of 'station pointer'. His chart of Margate Road is thickly carpeted with soundings, clear evidence of the great simplification of fixing afloat which such an instrument had brought about. Within a few years the first commercial models of the station pointer were being made by John and Edward TROUGHTON [Ref. 14].

The instrument consisted of graduated arcs with a central leg and a movable leg on either side. Two simultaneously observed angles between three fixed and visible marks may be set on the movable legs to the nearest minute of arc. With these legs clamped the instrument may be moved on the fieldboard until each leg passes through the plotted and marked position of the fixed marks.

(*) The letter is now in the Royal Society but a copy may be found, together with a diagram, in the Hakluyt Society's 'The Three Voyages of Edmond HALLEY 1698-1701' (1981) edited by Dr Norman THROWER. It would appear that this important letter received little publicity from Sir Richard SOUTHWELL and probably remained unread by hydrographers until it saw the light of day when in 1809 it was bought by the Royal Society at a Sotheby's sale.

The observer's position may then be pricked through at the centre of the instrument. It is by no means certain that the MACKENZIES were the inventors as others in England laid claims to have devised the instrument. More research is required before the inventor can be confidently named.

MEASUREMENT OF ANGLES AFLOAT

HADLEY demonstrated his reflecting quadrant for observing the altitude of heavenly bodies to the Royal Society in London in 1731. By the 1770s, Captain John CAMPBELL and associated English instrument makers had developed the more refined sextant which could be used to take angles up to 120° using a Vernier to read off the minutes of arc.

Tobias MAYER of Göttingen, who had produced the first tables for finding longitude by lunar distances, had seen the need for observing even greater angles and proposed a completely circular scale. Jean Charles de BORDA, an astronomer who had been involved with the measurement of the meridian in France, developed the reflecting circle, a sophisticated hand-held instrument which met MAYER's requirements, by 1775 [Ref. 15].

With the advent of the station pointer in the closing years of the 18th century, sea surveyors turned their sextants and reflecting circles into the horizontal mode and the resection fix for soundings at sea was widely adopted.

THE BRITISH ESTABLISH A HYDROGRAPHIC OFFICE

The British East India Company had appointed Alexander DALRYMPLE, whom they had long employed chartmaking in the Far East, as their own Hydrographer in 1779, realising the importance of having someone competent in charge of their growing collection of charts.

It was not until 1795 that the British Admiralty came to the same conclusion. An Order in Council recommended that a proper person should be appointed Hydrographer charged with the duty of selecting and compiling all the existing information and making it available to the Commanders of His Majesty's Ships. Alexander DALRYMPLE was appointed Hydrographer to the Board of Admiralty, whilst retaining his post for a time with the East India Company.

Following the French pattern, it was not until 1808, when Captain HURD of the Royal Navy took over from DALRYMPLE as Hydrographer of the Navy, that a corps of sea surveyors began to be formed and its members sent out to make hydrographic surveys in specific areas.

CONCLUSION

The 1660s saw an upsurge of scientific thought on both sides of the Channel under Charles II and Louis XIV which led, among other developments, to a dramatic increase in the charting of the sea.

The continuing co-operation between French and British scientists during the first half of the 18th century resulted in the geodetic ideas formulated by the CASSINI dynasty passing to British and other European surveyors, and to the use of triangulation to control land, and later, sea surveys.

By the end of the 18th century the horizontal use of the sextant and the reflecting circle with the station pointers had enabled the sea surveyor to fix with speed and accuracy his sounding craft.

This technical breakthrough led directly to a widespread increase in precise sea surveying by an increasing number of maritime nations. At least a dozen of these countries in Europe and the Americas established their own hydrographic offices before the end of the 19th century.

Acknowledgement

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