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THE ORIGINS OF THE STATION POINTER

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The hydrographic achievements of the 19th century would have been impossible without the sextant and the station pointer. The sextant was developed in the late 1750's; it provided a means of accurate angle-measurement at sea, but its full potential for taking horizontal angle fixes could not be exploited until the development of the station pointer to plot the results. Together, these instruments made it possible to insert large numbers of soundings accurately, an impractical task for previous generations of surveyors. The concept of a 'station pointer' was first published in 1774 in Murdoch MACKENZIE's *Treatise of Maritim Surveying*. The description coined the name 'station-pointer', and explained the proposed instrument in detail but there is nothing to suggest that one had ever been made. By 1819, however, HORSBURGH's new edition of MACKENZIE's work included a footnote: 'station pointers are now made by most of the mathematical instrument makers, and frequently used by surveyors'. This article traces the advance between these two dates from pioneering idea to practical instrument in common use.

The potential value of a fix using simultaneous horizontal angles was realised in the second half of the 17th century. As early as 1665, Robert HOOKE was working on a quadrant for measuring angles and thence distances on land; and, in 1674, a mathematical solution to the problem of finding the point of observation from the angles between three fixed points was described by John COLLINS in a paper read to the Royal Society(1). COLLINS specifically referred to the relevance of the problem to hydrographic work, and, in 1701, Edmond HALLEY in a letter to Sir Robert SOUTHWELL, gave a detailed description of the mathematical solution in marine surveying cases(2).

Although the method was understood in theory, its adoption was hindered, both by lack of a sufficiently accurate angle-measuring instrument and the impracticality of using the mathematical solution on a large scale. The

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(1) *Phil.Trans.Roy.Soc.* No. 69, p. 2093.

(2) Royal Society. *Collectanea Newtoniana*, Vol. IV (Ne 4 27)

development of HADLEY's octant in the 1730's provided the first adequate instrument, and, in 1765, the Rev. John MITCHELL[3] specifically recommended it for horizontal use in surveying[4].

The method was described in the first specialist work on marine surveying, Alexander DALRYMPLE's *Essay on Nautical Surveying*, in 1771; DALRYMPLE pointed out the advantage in accuracy over fixes by magnetic bearings and also that, unlike a compass, a sextant could be used for observations from the masthead. He recommended MITCHELL's solution for finding the point of observation. Three years later Murdoch MACKENZIE in his *Treatise*[5] explained the solution of several cases of the problem by both calculation and construction, or protraction as he called it. Where he broke new ground was with the suggestion of an instrumental solution for plotting the fixes, either in the crude form of a piece of tracing paper with the angles drawn on it or by a purpose built instrument: 'such an Instrument as this may be called a Station-pointer; and would be found convenient for finding the Point of Station readily ...'

MACKENZIE's work was published in 1774, four years after he had finished active surveying. He reports in the introduction to his sailing directions that, in his own work in Scotland and Ireland, he inserted the soundings and much of the coastline by magnetic bearings rather than horizontal angles. It is noticeable that his charts included very few offshore soundings, which would have been difficult to insert accurately by his method. His *Treatise* is therefore recommending what he by then realised was an improved survey technique rather than one he had used himself. After his explanation of several cases of the problem MACKENZIE acknowledges a contribution by Captain John CAMPBELL. This section seems to have been added at a late stage. The diagrams which illustrate it are not in the main sequence, but are numbered at the end and added to the right hand side of the plate; only one of them is referred to directly in the text. Like DALRYMPLE, but not MACKENZIE, CAMPBELL described the more practical two-circle method of solving the problem which was adopted as the recognized method by later surveyors. CAMPBELL's cases are immediately followed by the description of the station pointer before the text reverts to the layout and sequence of numbered problems used by MACKENZIE. It seems entirely possible that, although MACKENZIE has long been credited with the conception of the instrument, its description was part of CAMPBELL's contribution. This would be consistent with MACKENZIE hearing of the instrument at a late stage in the preparation of his book, as already remarked on by A.H.W. ROBINSON[6], and not including any reference to it anywhere else in the book.

It is almost certain that the CAMPBELL referred to by MACKENZIE was Vice-Admiral John CAMPBELL (1720-1790), who was a captain in 1774. CAMPBELL was an outstanding navigator, a Fellow of the Royal Society and responsible for the introduction of the sextant. Between 1757 and 1759, he tested MAYER's lunar

(3) *Phil.Trans.Roy.Soc.* No. 55, p. 70.

(4) A.H.W. ROBINSON, *Marine Cartography in Britain*. Leicester University Press, 1962. Describes the resection problem and the early history of horizontal angle fixes in more detail.

(5) M. MACKENZIE. *A Treatise of Maritim Surveying*. London, 1774.

(6) ROBINSON, *op.cit.* pp. 65-7.

tables at sea using a reflecting circle designed as an improvement on HADLEY's octant which did not measure large enough angles. He found the circle cumbersome at sea and ordered a 'brass HADLEY's sextant' from BIRD which he considered would be a handier but no less accurate instrument. The methods attributed to him by MACKENZIE suggest that he must have been familiar with horizontal angle fixes at sea, and it seems more likely that someone with that practical experience, who had already shown ingenuity in devising an instrument to meet a navigational need, would propose the station pointer than MACKENZIE who had not used the method at sea.

Other young surveyors already active when MACKENZIE wrote would have been familiar with the recommendations of DALRYMPLE, and it is likely that some of them, like CAMPBELL, would have been using horizontal angle fixes at least some of the time. James COOK is one of those who may have been supplementing recognized methods of fixing by using horizontal angles(7), and others would have included the surveyors working in North America with DES BARRES. Evidence of practical methods in use is rare, however, and it is only possible to speculate on the extent of the practice and whether any of them could have been experimenting with plotting their fixes instrumentally.

The first real evidence of a change of practice comes from the work of Murdoch MACKENZIE's nephew, Lt. Murdoch MACKENZIE, junior, and his assistant Graeme SPENCE. There is a sudden difference in the quality of chart produced by them between the survey work in Cornwall in the first years of the decade and their work in the Thames estuary in 1774. The number of soundings inserted increased dramatically between 1773 and 1774; and this evidence is corroborated in writing in their accompanying nautical descriptions. Lt. MACKENZIE's description of the coast of Cornwall, where they worked in 1772 and 1773, makes no reference to the use of horizontal angles(8); whereas the description written by SPENCE to accompany the Thames estuary work of 1774 does: ' ... it will be proper to shew in what manner, and upon what principles, the survey was conducted, ... the landwork, was first of all surveyed trigonometrically, from a sufficient base line, measured on Margate Sand when dry; the principal angles, being taken with a theodolet: the water work, was surveyed by sextant angles, between the several fixed objects on the land; and no compass bearings, were used to fix or protract, any part of work ...'(9). SPENCE's nautical descriptions for the later surveys make comparable statements about the method used and this, taken in conjunction with the evidence of the charts themselves, seem conclusive proof that Lt. MACKENZIE and SPENCE began working with the new method in 1774, the exact year in which MACKENZIE senior's book was published.

Although there is good evidence of a change of method in 1774, there is still no conclusive evidence of how MACKENZIE and SPENCE were plotting their

(7) A.C.F. DAVID (ed.) *The Charts and Coastal Views of Captain Cook's Voyages.* Vol. I. Hakluyt Society, 1988, p. xxix.

(8) Ministry of Defence, Admiralty Library, MMS 65. I am grateful to Lt. Cdr. DAVID for pointing out this reference.

(9) Public Record Office. ADM7/846.

horizontal angle fixes. However, the fact that the advance coincides with MACKENZIE senior's publication of the idea of plotting such fixes instrumentally, and also the sheer labour of inserting large numbers of soundings by any other method, makes it likely that it was at this date or very soon after, that Lt. MACKENZIE and SPENCE began to use some form of instrumental solution. At first, this may have been the tracing paper method suggested in MACKENZIE senior's *Treatise*. This involved drawing the observed angles on a piece of transparent paper, laying it over the chart with the lines passing through the observed points, and pricking the point of observation through onto the chart. Until well into the present century, this was a recognized method in the standard manual of hydrographic surveying[10]; although it was awkward to use in the open in windy conditions, it was recommended for cases when a station pointer could not be used, for example when the points were so close that they would be hidden by the scale of the instrument.

At some time between 1774 and 1784, MACKENZIE and SPENCE must have moved on to the use of a station pointer, at first making their own prototype. In 1842, an unsigned article on SPENCE published in *The Nautical Magazine* reported that in 'about the year 1784' Lt. MACKENZIE's eyesight was failing, and in order to do more surveying work, single-handed SPENCE invented a double sextant by which two angles could be taken by one observer and 'also made a model of a New Station-pointer as a counter-part to this double sextant'. The choice of words suggests that the writer thought the instrument was a prototype made with SPENCE's own hands and possibly not the first version. It was apparently shown to the First Lord of the Admiralty, Lord HOWE, 'who was pleased to order others of the same pattern, from TROUGHTON the skilled instrument maker'[11].

Lt. MACKENZIE retired from surveying in 1788 and at last comes the first contemporary reference to a station pointer. Instruments 'returned by Mr. MACKENZIE to the Storekeeper of Deptford Yard, April 11th, 1788' are listed on 25th June 1789 for re-issue to SPENCE for his Scillies survey and they include two station pointers and a double sextant[12]. On 7th July 1789, the instrument maker George ADAMS sent the Navy Board a list of instruments which he was holding, belonging to His Majesty's Navy. This includes '2 brass station pointers in cases'[13], which were probably the same two instruments as it was usual for instruments to be passed to ADAMS for cleaning and repair pending re-issue. The Admiralty gave similar instructions to supply SPENCE with instruments for the surveying seasons of 1790 and 1792, but in neither case does the list of instruments appear to have survived.

After 1789, references to station pointers become more frequent. In January 1790, Captain ROBERTS of the DISCOVERY, preparing for the expedition to the N.W. coast of America, wrote to the Admiralty requesting among other instruments two station pointers[14]. The Navy Board were ordered

(10) W.J.L. WHARTON, *Hydrographical Surveying*. 1920, p. 24

(11) *Nautical Magazine*, 1842, pp. 313-9. L.S. DAWSON, *Memoirs of Hydrography*, Part I, p. 14.

(12) National Maritime Museum ADM/A/2825 Admiralty to Navy Board, 25 June 1789.

(13) Public Record Office. ADM106/1447.

(14) ROBERTS to Philip STEPHENS, secretary of the Admiralty, 4 Jan. 1790. ADM1/2395. I am grateful to Lt. Cdr. DAVID for alerting me to the Navy Board station pointers lent to VANCOUVER's expedition.

to supply these[15] and they were delivered to VANCOUVER, who had by then taken over command, at Spithead, on 6 February 1790. ROBERTS was an accomplished draughtsman who had served with COOK, and had spent the early eighties preparing the charts of COOK's third voyage to the Pacific for publication; it is not surprising to find he was among the small group of people who knew of the existence of the station pointers.

Apart from the Navy Board station pointers already referred to, the Board of Longitude also acquired at least two, mainly for loan to expeditions with pioneering navigational or astronomical objectives. There was no station pointer among the Board of Longitude instruments lent to William BAYLY in 1785, or to Lt. DAWES going to Botany Bay with Governor PHILIP in the SIRIUS in 1786; they are first recorded in 1791, when the Board appointed an astronomer to joint Vancouver's expedition. In March 1791, when the Astronomer Royal first put before the Board 'a list of instruments proper to be provided for the astronomer who may be appointed for this service'[16], it did not include a station pointer. However, by the time William GOOCH received the instruments on 2 July 1791, two surveying items had been added: 'an instrument to lay a place down in a chart from the two observed angles between three given places, by TROUGHTON' and 'a HADLEY's quadrant with two moveable clamps, for surveying in a boat or vessel in motion' [17]. The name station pointer was evidently not familiar to the writer of the list, though it has been added afterwards by another hand which also added the surveying quadrant. One can only speculate whether these instruments were included at the request of GOOCH himself, VANCOUVER or one of the members of the Board. GOOCH's instructions did not include any duties particularly related to surveying, but his books included both DALRYMPLE's and MACKENZIE's manuals.

VANCOUVER himself is known to have been familiar with the horizontal angle fix from a note he wrote on his survey of Kingston, Jamaica, in 1788: 'this survey ... has been made with much care. The positive situation of every point and near land-marks as well as the situation and extent of every shoal has been fixed by intersecting Angles, taken by a sextant and protracted on the Spot, the Compasses only used to determine the Meridian, and observe its Variation'[18]. Although his chart includes relatively numerous soundings, his use of the word 'protraction', the word used by MACKENZIE to describe the solution of the problem by construction, suggests he had no station pointer.

Certainly, contrary to what might be expected, the evidence of accurate close soundings alone is not enough to prove use of a station pointer; long after horizontal angle fixes became the norm, there are examples of surveyors inserting very detailed soundings by far more laborious methods; as late as the 1790's, HURD, in his massively detailed survey of Bermuda, did not use a station pointer

(15) Admiralty to Navy Board enclosing a list of instruments, 19 Jan. 1790. National Maritime Museum ADM/A/2827.

(16) Board of Longitude papers, Vol. XII, p. 153.

(17) Board of Longitude papers, Vol. XII, p. 155-6.

(18) Ministry of Defence, Hydrographic Department, HD.14. Quoted by M. BLEWITT, *Surveys of the Seas*. Macgibbon & Kee, 1957, p. 104.

as he did not see one until 1806[19]. Another example is the work of BEAUTEMPS-BEAUPRÉ on D'ENTRECASTEAUX's expedition in 1791. BEAUTEMPS-BEAUPRÉ was the leading French hydrographer of the day and, in his description of his work, he devotes considerable space to the horizontal angle fix and methods of plotting it by calculation and construction[20]. He also remarks 'in many cases the soundings to be marked on the draught are so numerous that it would be almost impossible to calculate all the positions'; in this context, the omission of any reference to quick methods of instrumental plotting seems to me sufficient evidence that he had no station pointer.

Another surveyor who might have been expected to have been an early user of station pointers is William BLIGH, who had served with COOK and been one of VANCOUVER's tutors, but there is no evidence he had one in the BOUNTY or PROVIDENCE. He wrote to the Admiralty on 7 February 1791, giving a list of property he lost in the BOUNTY; the list includes a number of instruments but no station pointer[21]. It is also missing from the more extensive list of instruments which he requested from the Admiralty for the PROVIDENCE [22] and the list of those actually supplied[23]. BLIGH might have used a private instrument of his own, but it is more likely a reflection of the restricted circle of surveyors as yet aware of the existence of the instrument.

Even ten years later, in 1801, FLINDERS does not appear to have been issued with a station pointer by the Navy Board; their list of instruments for him includes two small HADLEYS for surveying but no station pointer[24]. However his expedition did get one from the Board of Longitude who lent one to John CROSLEY, INVESTIGATOR's astronomer[25].

The Board of Longitude's station pointers can be traced up to 1829 in the schedules of instruments in their warehouse[26]. They are sometimes described as station pointers and sometimes as station finders, never more than three were in the warehouse at a time and the only two makers named are TROUGHTON and ADAMS.

There is one early example of the use of the instrument outside naval circles. In January 1804, NICHOLSON's *Journal of Natural Philosophy* published a description of a station pointer 'constructed by Joseph HUDDART, Fellow of the Royal Society, and communicated by him to the Editor'[27]. The article was

(19) HURD to MARSDEN, 25 June 1806. PRO ADM1/1932 f.263.

(20) *An Introduction to the Practice of Nautical Surveying*. Translated from the French of C.F. BEAUTEMPS-BEAUPRÉ by Captain Richard COPELAND. London, 1823.

(21) PRO. ADM1/1507.

(22) BLIGH to the Admiralty, 24 April 1791. PRO. ADM1/1507.

(23) Admiralty to Navy Board, 4 May 1791. NMM. ADM/A/2838.

(24) Admiralty to Navy Board. NMM. ADM/A/2938.

(25) Board of Longitude letterbook, Vol. IX, pp. 99ff.

(26) Board of Longitude papers, Vol. XII.

(27) W. NICHOLSON. *A Journal of Natural Philosophy* ... Vol. VII, pp. 1-5. See also David BAXANDALL, 'The Inventor of the Station Pointer', *Empire Survey Review*, Vol. II, No. 7, Jan. 1933, p. 18, which quotes extensively from the Nicholson article.

written by NICHOLSON using information provided by HUDDART and implied that the instrument was original or even unique. HUDDART was a meticulous surveyor, inventive mechanically and capable of metal work with his own hands. He would have been familiar with MACKENZIE's *Treatise* and he had been using horizontal angle fixes from at least the mid-eighties. In 1786, he wrote to his publisher Robert SAYER 'I never use the needle in taking the angles' with the implication that this had been his practice for some time. It is therefore conceivable that his instrument was an independently developed prototype; however, HUDDART was not averse to accepting credit and might well not have disabused NICHOLSON if the picture had been rather different. It is far more likely that HUDDART saw one of TROUGHTON's station pointers, which he reputedly first made for the Admiralty, twenty years earlier in 1784, and ordered one for himself. From at least 1793, John TROUGHTON and HUDDART knew each other well through the Society of Civil Engineers; in 1797 TROUGHTON did the precision work for HUDDART's astronomical telescope and when his brother Edward TROUGHTON became a Fellow of the Royal Society in 1810, his proposers included HUDDART. In 1784, HUDDART had borrowed a quadrant from the Board of Longitude and so was aware they had a stock of instruments. It therefore seems most unlikely that HUDDART did not know of TROUGHTON's station pointers. Whether or not HUDDART should take any credit for independent development of the instrument, the NICHOLSON's *Journal* article was the first published description of an actual station pointer and included an illustration which shows an instrument virtually identical with the 20th century form.

In spite of the existence of several instruments by the first years of the 19th century and the publication of the NICHOLSON article, they did not immediately become well known even among naval surveyors. In June 1806, Thomas HURD, visiting the Hydrographic Office in connection with his Brest survey saw a station pointer belonging to Graeme SPENCE, which was clearly the first he had ever seen. He wrote to MARSDEN, on June 25, 'having seen an instrument called a Station Pointer in the possession of Mr. SPENCE in the Hydrographer's Office which was invented and used by him while employed on the seacoast survey of England under Mr. MACKENZIE' and requested to be supplied with a similar one[19]. The letter was minuted that HURD should be supplied with the instrument if it belonged to the government and that DALRYMPLE would shown HURD 'Mr. SPENCE's memorandum'. However, the instrument was not available as HURD wrote again on June 28 '... as the station pointer belonging to the government is in present use and cannot be altogether spared from the work Mr. SPENCE is employed upon and as it is the only instrument of the kind ever made and entirely his own invention I pray Their Lordships will be pleased to permit my having a similar one made under his direction in which case he agrees to spare me that now in his possession. The expense I understand will be about 16 or 18 pounds'. This request was granted [28]. SPENCE, who was employed at that time on the sailing directions for MACKENZIE's surveys, clearly regarded himself as the inventor and may have been unaware that there were other instruments in existence. His 'memorandum' has never been found, though it may have been 'the small clasped volume containing drawings of the ... instruments with descriptive particulars'

(28) HURD to MARSDEN, 28 June 1806. PRO ADM1/1932, f.264.

which the writer of the *Nautical Magazine* article later claimed was shown to Lord MELVILL on SPENCE's death.

MACKENZIE senior originally proposed an instrument with a semicircular scale: 'Provide a graduated Semicircle of Brass, about 6 Inches in Diameter, having three Radii with chamfered Edges, each about 20 Inches long, ... one of which Radii to be a Continuation of the Diameter that passes through the Beginning of the Degrees on the Semicircle, but immovably fixed to it, the other two moveable round the Center, so as to be set and screwed fast to the Semicircle at any Angle. In the Center let there be a small Socket, or Hole, to admit a Pin for marking the central Point on the Draught'[29]. However, from an early stage, the instruments developed with the more useful full circular scale used to-day. HUDDART's instrument, the first to be illustrated, differed very little from a modern instrument[30]. The moving arms had verniers reading to single minutes of a degree. Most early station pointers followed the same basic design; the only exception found is a station pointer at the National Maritime Museum by Edward TROUGHTON dated tentatively 1820 but possibly earlier. John TROUGHTON was probably the maker of the first station pointer and this instrument may show the form some early examples took. There is no separate graduated circle; the scales, each graduated to 130° are on the ends of the moving arms beyond the centre of the instrument and are read against verniers on the fixed central arm also beyond the centre. The angles are set by tightening a milled locking screw at the centre of the instrument, and the arms are aligned along wire threads instead of a bevelled edge.

Some conclusions can be drawn from this incomplete story. After the idea of the station pointer was published by Murdoch MACKENZIE senior in 1774, perhaps at the suggestion of John CAMPBELL, the first instrument was made by or for Graeme SPENCE while he was working with MACKENZIE junior, probably before 1784. The exact date this happened may never be discovered but the labour involved in producing charts like MACKENZIE and SPENCE's without a station pointer when the idea of one had already been published suggests a date in the mid-seventies. SPENCE's remarks to HURD in 1806 suggest he had a personal instrument, and MACKENZIE handed in two Navy Board station pointers when he retired in 1788, though SPENCE seems to have forgotten about these by 1806. Like many specialists who develop tools for personal use, MACKENZIE and SPENCE were not quick to publicise the new instrument. For the next twenty years, the only station pointers recorded in use were those issued to the exploring expeditions of VANCOUVER and FLINDERS; although it could be argued that the instruments would have been more useful for inserting large numbers of soundings on the type of detailed survey which had stimulated their development than on exploring expeditions. The only recorded example of a station pointer, if not independently developed, at least used actively outside naval circles, is that of Joseph HUDDART. It is the illustration of this last instrument, published in 1804, which shows that by then station pointers were being made to the general design they have retained ever since. Although by the opening years of the 19th century there were several station pointers in use, it can have been only in the last few years, before 1819, when HORSBURGH wrote of it as a common instrument that familiarity with it spread beyond a very small specialist circle.

(29) MACKENZIE, *Treatise*, p. 24.

(30) This illustration is reproduced in ROBINSON, *op.cit.* p. 67