CAPTAIN COOK'S INFLUENCE ON HYDROGRAPHIC SURVEYING

by G. S. Ritchie

Before we can attempt to assess Captain Cook's contribution to hydrographic surveying, it is first necessary to try to establish the state of this art in the middle of the eighteenth century, when James Cook first went to sea in Captain John Walder's Whitby Colliers.

In the year 1693, two important atlases of sea charts were published in England and France respectively, the first major marine cartographic events for over a hundred years. Lucas Wagenaer, the one-time Netherlands sea pilot, had published his atlas of sea charts *Spieghel der Zeevaerdt* in 1585.[1] This provided for navigation from the Baltic to Cadiz. As *The Mariner's Mirrour*,[2] Wagenaer's atlas was published in England in 1588, the year of the Spanish Armada. Its success was such that British seamen confidently used their "waggoners," as they termed these atlases, for a century to follow.

When it became clear to Samuel Pepys, secretary of the Navy, that the Dutch knew more about British waters than English seamen knew themselves, he, with the backing of King Charles II, assigned to a former Navy master, Captain Greenville Collins, the work of surveying the British coasts and harbors. Even with the two yachts provided, Collins had an enormous task, for at that time there was no triangulation network or fixed stations in Britain on which to base his surveys. With a measuring chain, a compass and a leadline, and little else, it took Collins seven years to complete the work, which resulted in the publication of *Great Britain's Coasting Pilot*[3] in 1693, containing forty-eight harbor and coastal charts.

Collins's charts were plane charts, similar in many ways to those of Wagenaer, with well-executed views illustrating leading or clearing lines to facilitate safe entry into harbors.

Great Britain's Coasting Pilot ran into a half-dozen editions before the middle of the eighteenth century, proving that it met the British

[1]Lucas Janszoon Waghenaer, *Spieghel der Zeevaerdt* (Leyden: Ghedruct C. Platijn, 1585).

[2]Translated by Anthony Ashley.

[3]Greenville Collins, *Great Britain's Coasting Pilot* (London: F. Collins, 1693). The Mount and Page edition of 1753 was published recently in reduced facsimile by George G. Harrap & Co. Ltd., London.

coasting seaman's needs; nevertheless, the atlas was much criticized in official circles, and when it was compared with *Le Neptune François,*[4] published in Paris in that same year (1693), France's contemporary lead in hydrography was clearly apparent.

In the latter part of the seventeenth century, France, under King Louis XIV and his sea-minded Secretary of State Colbert, had been enjoying a scientific awakening. Among other advances were the establishment of the *Academie Royal des Sciences* and the *Observatoire de Paris.* An Italian cosmographer, Jean Dominique Cassini, was appointed Director of the *Observatoire,* where he developed a method of finding longitude on land by the observation of Jupiter's satellites. This enabled a number of geographical positions to be fixed along the coasts of France, and the coastline was redrawn which, by the apparent reduction of his territory, displeased the king, who is said to have observed that his surveyors had lost him more land than his armies had gained!

It is not surprising that the charts in *Le Neptune François,* based on these geographical positions and employing, on the smaller scales, Mercator's projection--so well suited to the navigator--were superior to their British counterpart. Their excellence led to the establishment of *Le Dépôt des Cartes et Plans de la Marine* in 1720, the first ever national hydrographic office, where many beautiful charts were compiled during the eighteenth century under the direction of Jacques Nicolas Bellin, who carried out, among other surveys, those in French North American territories prior to the Seven Years' War (1756-1763).

Both the British and French atlases made use of a number of the charting symbols used by Wagenaer, some of which he in turn had copied from Portuguese portulan charts. Thus began the international adoption of such practices as the use of figures to show water depths, an anchor symbol to denote a safe anchorage and crosses to indicate the presence of dangerous submerged rocks. All these remain in use on charts of all nations to the present day.

Much of the superiority of the French charts resulted from surveys controlled by a triangulation framework extended from a measured baseline. Slowly knowledge of this form of control of marine survey, which required measuring chains or poles, a theodolite, a sextant, and a portable azimuth compass, together with a protractor for laying down the angles on the plotting sheet, flowed along scientific channels from the Continent to Britain. One such route appears to have been via Edinburgh University, where the Professor of Mathematics, Cohn Mac-

[4] *Le Neptune François* (Paris: Ministère de la Marine, 1693).

laurin, an FRS (Fellow of the Royal Society) at the age of twenty-one, included in his teaching plane trigonometry, military surveying, and astronomy. He was a frequent visitor to France (he had won prizes in that country. for scientific essays, including one on tides) and was friendly with Jacques Cassini, who had succeeded his father at the *Observatoire* and was presently engaged on a national triangulation.

In 1749, Professor Maclaurin was requested by a number of landowners to draw up directions for a land and marine survey of the Orkney Island and to recommend a former pupil to undertake the work. He named Murdoch Mackenzie as having the mathematical qualifications necessary for making "a geometrical survey." We can detect the Continental influence when we read that Mackenzie measured a baseline on a frozen lake from which he extended a triangulation to beflagged stations which were subsequently used to fix the soundings by bearings taken from the boat with an azimuth compass.[5]

Orcades,[6] the atlas of charts resulting from Murdoch Mackenzie's surveys, was published in 1751. It impressed the Lords Commissioners of the Admiralty so much that they engaged him to make an exact survey of the northwest coast of Scotland and provided him with the small boat *Culloden* for the work, during which an extensive triangulation network was carried across the Minch.

During the five years when Cook sailed in Captain John Walker's Whitby Colliers from the northeast ports of London and the Baltic, it is doubtful whether he gave much thought to chartmaking, relying as he did for his navigation more on the lead and line, and traditional sailing directions passed on by masters to their mates; however, he must surely have become acquainted with *Great Britain's Coasting Pilot.*

After joining the Navy in 1755, Cook began studying for his warrant as master, which he received from the Trinity House examiners on 29 June 1757. At this stage he would have learnt some of the elements of simple hydrography, such as how to sound out a safe anchorage or channel, for such tasks fell to the ship's master.

It was possibly the greatest stroke of good fortune in Cook's life, and he was generally a lucky man, that his first appointment as master was to HMS *Pembroke* on the North American Station. His captain was John Simcoe, uniquely, in those days, an enthusiastic navigator (navigat-

[5]A. H. W. Robinson, *Marine Cartography in Britain* (Leicester: Leicester University Press, 1962), p. 61.

[6]Murdoch Mackenzie, *Orcades, or a Geographic and Hydrographic Survey of the Orkney and Lewis Islands in Eight Maps* (London: *s.n.,* 1750).

ing was a professional task which most naval captains left to their masters). Simcoe perceived Cook's potential and, lending him Leadbetter's mathematical works and other books on navigation, encouraged him to study trigonometry and astronomy.

It is most likely that by 1757 an officer having Simcoe's keen interest in navigation would be aware of the atlas *Orcades* and the description given therein by Murdoch Mackenzie of his method of hydrographic surveying based on triangulation, which he had now been developing on the west coasts of Scotland for a further six years. Whether or not Simcoe was able to impart detailed knowledge of Mackenzie's methods to Cook, he surely implanted in him a keen interest in chartmaking which prepared the young master to drink from the European "fountain of knowledge" to which he was soon to have direct access.

In his biography, Professor Evans gives a brief description of the surveyor Samuel Holland: "Born near Nijmegen about 1728, he was an amiable man who, after mathematical training enlisted in the Dutch Army before transferring to the British. . . . He was an Officer in the Royal American Regiment and served in New York in military, engineering, and cartographic capacities."[7]

Cook's meeting with Holland in July 1758 is described in a letter Holland wrote many years later to Captain Simcoe's son, who was, in 1792, the newly appointed Lieutenant Governor of Upper Canada. A portion of the letter is reproduced here:

> The day after the surrender of Louisbourg, being at Kensington Cove surveying and making a plan of the place, with its attack and encampments, I observed Capt. Cook (then Master of Capt. Simcoe's ship, the *Pembroke* man of war) particularly attentive to my operations; and as he expressed an ardent desire to be instructed in the use of the Plane Table (the instrument I was then using) I appointed the next day in order to make him acquainted with the whole process; he accordingly attended, with a particular message from Capt. Simcoe expressive of a wish to have been present at our proceedings; and his inability, owing to indisposition of leaving his ship; at the same time requesting me to dine on board; and begging me to bring the Plane Table pieces along. I, with much pleasure, accepted that invitation, which gave rise to my acquaintance with a truly sci-

[7]G. N. D. Evans, *Uncommon Obdurate; by Several Public Careers of J. F. W. Des Barres* (Toronto: University of Toronto Press, 1969).

> entific gentleman for which I ever hold myself indebted to Capt. Cook. I remained that night on board, in the morning landed to continue my survey at White Point, attended by Capt. Cook and two young gentlemen. . . . During our stay in Halifax, whenever I could get a moment of time from my duty, I was on board the *Pembroke* where the great cabin, dedicated to scientific purposes and mostly taken up with a drawing table, furnished no room for idlers. Under Capt. Simcoe's eye, Mr. Cook and myself compiled materials for a chart of the Gulf and River St. Lawrence, which plan at his decease was dedicated to Sir Charles Saunders; with no other alterations than what Mr. Cook and I made coming up the River. . . . Mr. Cook frequently expressed to me the obligation he was under to Captain Simcoe and on my meeting him in London in the year 1776, after his several discoveries, he confessed most candidly that the several improvements and instructions he had received on board the *Pembroke* had been the sole foundation of the services he had been able to perform. . . .[8]

Cook was clearly giving credit to both Simcoe and Holland as his teachers and acknowledging that the hard winter of 1758-1759 was a vital period in his apprenticeship as a sea surveyor.

Simcoe and Cook were clearly unaware of the plane table until they met Holland in 1758, although its use for land mapping had been demonstrated in the *Connaissance des Temps* (The French Almanac) in 1683.[9] I believe that Cook developed the concept of the plane table method in making running surveys of a coastline, as I shall attempt to show later. Cook's surveying activities during the British attack on Quebec are well known. After the fall of the city he was transferred to the *Northumberland* under the Command of Lord Colville.

The *Northumberland* entered St. Johns, Newfoundland,. on 20 September 1762 after a military force under Lieutenant Colonel Amherst had recaptured the place from the French. Here in Newfoundland a second meeting between Cook and a military surveyor took place when

[8]R. A. Skelton, "Captain James Cook as a Hydrographer," *The Mariner's Mirror,* 40, No. 2 (May 1954), letter reprinted on pp. 97 and 98. Holland's letter to J. G. Simcoe was first printed by H. Scadding, "A Notice of Samuel Holland," *Canadian Magazine,* October, 1895; reprinted by Willis Chapman, "The Life and Times of Major Samuel Holland," *Ontario Historical Society, Papers and Records,* 21 (1924), 11-90.

[9]*La Connaissance des Temps ou Caledrier et Ephemerides* (Paris, 1683), published annually.

Colville sent his master fo accompany J. F. W. Des Barres, an engineer on Amherst's staff, to survey Conception Bay, where British fisheries were to be reestablished and extended.

Des Barres, of a noted Huguenot family, was educated at Basle Bay by the Bernouilli family, well known for their study and teaching of mathematics. About 1752, he went to England to enroll as a cadet in the Royal Military Academy at Woolwich and received a commission in 1756 in the Royal American Regiment.[10] Whilst at Woolwich he would have been able to apply his knowledge of mathematics to surveying which, particularly in its application to the construction of fortifications, was taught at the academy.

Whilst Des Barres surveyed the fortifications of Carbonera Island, Cook made plans of Harbour Grace and the Bay of Carbonera. It seems probable that Des Barres learnt as much about hydrography from the practical seaman as Cook learnt about survey control from the military engineer. We have clear evidence that within three years of this meeting Des Barres had become a competent hydrographic surveyor working in North America under the general direction of the Lords of the Admiralty.[11]

In 1762, the *Northumberland* returned to Spithead. The declaration to the cessation of hostilities with France was read to the ship's company and the ship paid off on 8 December. Lord Colville, who had been promoted to rear admiral in October, wrote to the secretary of the Admiralty on 30 December concerning his master for the last three years:

> Mr. Cook late Master of the *Northumberland* acquaints me that he has laid before their Lordships all his Draughts and Observations, relating to the River St. Lawrence, Part of the Coast of Nova Scotia, and of Newfoundland.
>
> On this Occasion, I beg leave to inform their Lordships that from my Experience of Mr. Cook's Genius and Capacity, I think him well qualified for the Work he has performed, and for greater Undertakings of the same kind--These Draughts being made under my own Eye I can venture to say, they may

[10]Evans, chapter I.

[11]Evans reprints on pp. 13 and 14 a report made by Des Barres to his Superior, Lord Colville, in May of 1765, describing his method of hydrographic surveying. The original is to be found in *Admiralty Secretary in Letters*, Adm. l/482, in the Public Record Office, London.

> be the means of directing many in the right way, but cannot mislead any.[12]

From this moment the avid learner became a gifted teacher.

The Treaty of Paris concluding the Seven Years' War was signed in February 1763. France lost most of her North American colonies but was to reoccupy the islands of St. Pierre and Miquelon off the south coast of Newfoundland.

In April 1763, at the request of Captain Graves, the governor, Cook was selected to survey the coasts and harbors of Newfoundland. He was able to engage a military draughtsman and obtained a theodolite and a brass quadrant fitted with a telescope made by John Bird. Here were the two instruments necessary for extending a triangulation from a baseline and observing for meridional latitudes, which indicates that Cook intended controlling his surveys on the Murdoch Mackenzie pattern.

On arrival in Newfoundland, Cook's first task was to survey the islands of St. Pierre and Miquelon, a sensible military precaution decided upon by Graves before handing them back to the French. Whilst Captain Douglas in HMS *Tweed* delayed the landing of the French governor designate, much to the latter's annoyance, Cook under great pressure from Douglas completed the work by the end of July. Surveys made in such circumstances are anathema to hydrographers, but the requirement for speed wonderfully concentrates the mind on introducing new methods and on streamlining. Cook would have benefited from such an experience as many surveyors have done since.

Graves had bought a small Massachusetts-built schooner for survey work on the Newfoundland coast. Renamed the *Grenville,* she carried Cook as a supernumerary to the northern tip of Newfoundland to commence the surveys in the late summer of 1763.

For the winter of 1763-1764 Cook and his military draughtsman returned to England in HMS *Tweed* to draw the fair charts of their surveys. By spring, Captain Palliser had taken over as governer of Newfoundland and, with Cook's advice, more satisfactory and permanent arrangements were made for the manning and operation of the *Grenville.* Cook was placed in command, whilst his master's mate was chosen for his navigational and mathematical knowledge and became vir-

[12]J. C. Beaglehole, *The Life of Captain James Cook* (London: A. & C. Black Ltd., 1974). A letter from Lord Colville to Mr. John Cleveland, Secretary to the Admiralty, dated 30 December 1762, is reprinted on p. 59 (Adm. l/482).

tually the assistant surveyor. The military draughtsman passed from the scene. The ship, now with a permanent complement of seamen, could operate independently and sail to England each winter to refit at a naval dockyard in the Thames.

William Parker was the first master's mate. When he was promoted to lieutenant during the winter of 1766-1767, Michael Lane, a naval schoolmaster and former scholar of Christ's Hospital Mathematical School ("Blue Coat School"), succeeded him.

After working under Cook on the Newfoundland surveys during the summer of 1767, Lane assumed command of the *Grenville* when Cook was selected to command the *Endeavour* during the early spring of 1768. Lane, with his basic mathematical training, had acquired from Cook in one summer season sufficient knowledge to become a sea surveyor in his own right. He continued in command of the *Grenville,* surveying the coasts of Newfoundland and Labrador until the schooner was broken up seven years later. He was then appointed as mate of the schooner *Lion* which was employed surveying under the command of Lieutenant Pickersgill, who had learnt his chartmaking from Cook in the *Endeavour* and the *Resolution*. Lane eventually commanded the *Lion* for surveys in North American waters. Cook's influence was spreading.

During the five years when Cook was charting the Newfoundland coasts he used the good weather of the summer to work in the field with the ship and her boats; in the winter he was far away, drawing his charts on shore while his ship was refitted in the Thames. He established a naval pattern, largely followed to the present day, whereby an approximately eight-month good weather "surveying season" is followed by the "lie-up" period.

After his first season on the *Grenville,* Cook soon established the British naval practice whereby the man who is making the surveys is also in command. The surveyor thus assumes the responsibility for risks to his vessel, so that a practiced seaman may press forward the work of charting unsurveyed waters with a vigor which divided control can never permit.

Foolhardy risks Cook did not take. During the first lie-up he had the *Grenville* converted from schooner rig to a brig so that he had a square sail on the main topmast which could be rapidly laid aback to stay the vessel's progress when meeting unexpected dangers. He also arranged whenever possible to carry on board local fishermen who frequently have knowledge of uncharted submerged shoals and rocks.

The ability to be both a bold and a prudent seaman when exploring unknown seas was part of Cook's nature. This intangible gift has ever since been recognized as a priceless attribute in a sea surveyor.

Cook's interest in astronomy, aroused by Simcoe, alerted him to an opportunity which he seized avidly. He observed with Bird's brass telescope quadrant the beginning and end of an eclipse of the sun from the Burgeo Islands off the south coast of Newfoundland on 5 August 1766. This eclipse had also been observed at Oxford, and the results enabled an FRS named Bevis to calculate the longitude of the Burgeo Islands from London and to communicate these results to the Royal Society.[13] This achievement brought Cook to the attention of the world of science and was certainly a significant factor in his favor when the Admiralty and the Royal Society were considering the appointment of a commander of the expedition to be sent to Tahiti to observe the transit of Venus.

When Cook sailed in the *Endeavour* in 1768 he had on board the *Nautical Almanac,*[14] first published in 1766, giving tables of angular distances of the moon and a limited number of the brighter stars from the sun at Greenwich at three hourly intervals. These tables enabled the longitude of the ship's position to be found by observers using a quadrant to measure the actual lunar distances, together with some fairly extensive mathematical reduction.

It is doubtful whether Cook was proficient at reducing lunar sights when he sailed from Plymouth. What is quite clear is that he very soon attained proficiency in the art with the advice of the astronomer Green who sailed with him. He quickly thereafter taught his officers and midshipmen. Wales, the astronomer of the second voyage, wrote that "there were few, even of the Petty Officers, who could not observe the Distance of the Moon from the Sun, or a star, the most delicate of all observations, with sufficient accuracy."[15] A lieutenant, the master and the master's mate would join the astronomer and the captain in making these lunar observations; the mean of their results provided the accepted longitude.

Although the new timepieces, including particularly Kendall's No. 1, enabled Cook on his second and third voyages to observe equal morn-

[13]J. Bevis, *Phlosophical Transactions,* Royal Society, London, 57 (1767), 213-216, reprinted in full by Beaglehole. See footnote 12.

[14]*The Nautical Almanac and Astronomical Ephemeris* (London: Commissioners of Longitude, 1767), printed annually.

[15]G. M. Badger, ed., *Captain Cook Navigator and Scientist* (Canberra: Australian National University Press, 1970), ch. 4 by Sir Frederick White, "Cook the Navigator."

ing and afternoon altitudes of the sun to find longitude by time differences from Greenwich, regular observations of lunar distances were also continued. Numerous lunars were observed both afloat and ashore, the instruments being set up at such stations as Point Venus, Dusky Sound, and Nootka (where 137 lunars were taken). These places were thus fixed with increasing accuracy whilst the gaining or losing rates of the timepieces whilst sailing from one station to another could be found and appropriate corrections made to the longitudes observed on board.

Cook learnt much from Green and Wales the astronomers, and he and Lieutenant King were themselves appointed as the astronomers on the *Resolution* for the third voyage. Cook's superb mastery of the sextant, the chronometer, and the *Nautical Almanac,* and the sheer pleasure he took in the effective use of them, inspired his successors.

The French Senator Gregoire, speaking in the year after Cook's death, recognized Britain's supremacy in this field, a state of affairs which Cook had done so much to bring about. *"Les succes des Anglais, spécialement dans la quèrre de 1761--la guèrre de Sept Ans--n'ont que trop prouvé que la supériorité de la marine decide souvent du sort de la guèrre. . . . Or, les Anglais, bien convaincus que sans astronomie, on n'avait ni commerce, ni marine ont fait des dépenses incroyables pour pousser cette science vers son point de perfection."*[16]

Cook was keenly aware of the changes in technique he had to make as a surveyor to adopt his methods to the needs of an explorer. When making a running survey through the New Hebrides he wrote in his journal "The word survey, is not to be understood here, in its literal sense. Surveying a place, according to my Idea, is taking a Geometrical Plan of it, in which every place is to have its true situation, which cannot be done in a work of this kind."[17]

Cook developed the plane table concept to meet the requirements of his "running surveys." He and his officers observed for latitude and longitude at intervals as the ship sailed along offshore, the resulting positions forming the terminals of a number of traverses. Each change of course, necessitated either by the changing direction of the shoreline or a shift in the wind, was carefully recorded, as were the times when azimuth compass bearings were taken to fix features on or near the coast, or distant inland peaks. Intervening coastal detail was sketched in from

[16]Frédéric Marguet, *Histoire générale de la Navigation* (Paris: Société d'éditions géographique, 1931), p. 80.

[17]J. C. Beaglehole, ed., *The Journals of Captain James Cook,* 3 vols. (Cambridge: The Hakluyt Society, 1955-1967), II, 509 n. 4.

the deck, whilst the log was frequently streamed to keep a record of the ship's speed.

Darkness or foul weather would oblige Cook to leave the coast, only to return at dawn or when better weather prevailed, to take up the survey again where it had been left off. Cook's success lay in great attention to recording courses, speeds, and intersecting compass bearings, and above all in the importance Cook attached to completing the work while fresh in the mind; which often necessitated working far into the night. Such dedication to the tasks, so difficult to pursue by candlelight in a heaving vessel, was assimilated by his officers. There were a few opportunities for detailed surveys and these he gave to his officers to complete according to his geometrical plan, resulting in charts by Clerke, Pickersgill, Bligh, Roberts, Molyneux, Gilbert, and Riou.

Cook's methods were used and passed on by those of his officers who subsequently sailed on their own voyages, and in this respect Vancouver (A.B. on the *Resolution* on the second voyage and midshipman on the *Discovery* on the third voyage) and Bligh (master of *Resolution* on the third voyage) are the most prominent.

Roberts (A.B. on the *Resolution* on the second voyage and master's mate in the same ship on the third voyage) was an excellent draughtsman and was employed from 1781 to 1784 drawing the fair charts of the third voyage for the engraver. In 1789, he was appointed to a new *Discovery* for a survey in the northwest Pacific, with Vancouver as his first lieutenant. However, during the excitement aroused by the "Spanish Armament" the ship was put to other uses, and it was not until 1791 that the expedition finally sailed. Vancouver was then placed in command of the *Discovery,* with Lieutenant Broughton in the tender *Chatham,* a two-masted brig, to accompany him. Vancouver was able to select some excellent officers; Zachary Mudge was his first lieutenant, and under him were Peter Puget and Joseph Baker, with Joseph Whidbey as master. James Johnstone was Broughton's master on the *Chatham.* All of these learnt to lay down a coastline and sound the adjacent waters and are commemorated by named features on the west coasts of Canada and the United States.

Vancouver began his work on the west coast at 30° north and on reaching Cook's Cape Flattery he entered the Strait of Juan de Fuca in search of a passage to the Atlantic; and here, as Vancouver worked eastwards, we can see how he developed Cook's running survey into something more detailed.

Inside the. strait a new and more detailed survey technique was developed as the expedition charted the southern shore.

> Both vessels were anchored when suitable shelter offered and a tented observatory set up ashore for obtaining the gain of losing rates of the timepieces by daily comparison with the passage of the Sun across the meridian at noon, and for the fixing of geographical position, and determining of the local variation of the magnetic compass with reference to a true bearing of heavenly bodies. Meanwhile two or more boats, each with an officer in charge, were provisioned for three weeks or so and were despatched along the unexplored coastline ahead. Thus the boats took up the running survey of the intricate coast, proceeding steadily under oars that they might follow closely the trend of the coast, upon which, from time to time, the officers landed to take hand-compass bearings of the direction of the coastline, both forward and back, and of the sides, or tangents, of off lying islands so that a number of such bearings would determine their positions relative to the shore. The courses and distances covered by the boats were carefully assessed and recorded, so that on return to the ship after a week or two's absence, the work could be transferred to the fair drawing sheet which was kept up-to-date by Lieutenant Baker working steadily away on board. The vessels weighed anchor and moved forward to the next observatory position which had been selected by the boats, and then another boat party was sent ahead.[18]

Vancouver had a diplomatic task to perform when he met the Spaniard Quadra at Nootka which need not concern us here, except to note that, in order to report to the British government a stalemate in his negotiations, he dispatched first Zachary Mudge westabout via Macao, and then Broughton eastabouts from the west coast of Mexico.

These officers reached England three years before Vancouver's return, just when Bligh was arriving home on the *Providence* from his second and successful breadfruit voyage from Tahiti to the West Indies. The *Providence,* a copper-sheathed sloop well suited for cruising in uncharted waters, was recommissioned under the command of Broughton, with Mudge as his first lieutenant, and sailed for the Pacific in 1794 to continue Vancouver's work.

Calling at Nootka, Broughton found a message from Vancouver indicating that surveying of the east side of the Pacific had been largely

[18]G. S. Ritchie, *The Admiralty Chart-British Naval Hydrography in the Nineteenth Century* (London: Hollis and Carter, 1967), pp. 41 and 42.

completed; accordingly Broughton and Mudge, "second generation" Cook surveyors, as we might term them, embarked on charting the coasts of Asia and Japan, and employed the methods they had learnt from Vancouver.

Bligh's achievement in taking the *Providence* through the dangerous and uncharted Torres Straits in nineteen days demonstrates something of what he had learnt as Cook's master on the *Resolution.* He later carried out coastal surveys including those of Dublin Bay and Dungeness.

Accompanying Bligh on the *Providence* had been a young man of eighteen, Matthew Flinders. He had been placed in charge of the timekeepers and had learnt from his Captain how to navigate through dangerous waters. His long voyage with Bligh developed in Flinders an intense ambition to chart unknown seas himself. From then on Flinders devoted his life to exploration, and in 1801 he sailed from England in command of the *Investigator* for his great Australian surveys. In his journals he makes reference more than once to the methods of "the great Captain Cook" which he was successfully following."[19]

In 1771, Murdoch Mackenzie was relieved as the Admiralty surveyor by his nephew of the same name; the old man settled down to write his *Treatise on Maritime Surveying,* published in 1774."[20]

In 1773, Graeme Spence was appointed as assistant to Murdoch Mackenzie, Jr., and they worked together along the south coast of England. In 1788, the Admiralty ceased the permanent employment of civilian hydrographic surveyors and Spence thereafter worked both for Trinity House and the Admiralty as required until his retirement from active fieldwork in 1803.

In his *Treatise* Murdoch Mackenzie, Sr., refers to an instrumental solution to the resection problem which would enable the surveyor to plot the position of a sounding vessel using horizontal sextant angles observed from the boat between three triangulated stations on shore. Robinson demonstrates that Murdoch Mackenzie, Jr., and Graeme Spence developed the station pointer, which was being manufactured by Troughton, the instrument maker, by the turn of the century.

The station pointer was not available to Cook, and almost certainly not to Vancouver, Bligh, Broughton, or Flinders. However, station pointers, together with improved sextants, both benefiting from high

[19]Matthew Flinders, *A Voyage to Terra Australis* (London: G. & W. Nicol, 1814).

[20]Murdoch Mackenzie, *A Treatise on Marine Surveying. Corrected and republished with a supplement by James Horsburg* (London: Black, Kingsbury, Parbury, and Allen, 1819).

quality angular division of the arc (made possible with Troughton's dividing engine which he had developed from that of Rawsden), were ready in time to revolutionize hydrography when the British naval surveying service came into being during Captain Hurd's term of office as hydrographer of the Navy 1808-1823.[21]

Had he lived to return from his third voyage to the Pacific, Cook might well have become the first British hydrographer of the Navy; as it was, a talented civilian, Alexander Dalrymple, already serving as hydrographer to the East India Company, was appointed to the newly established post in 1795. His terms of reference directed him to review all existing hydrographic information in order to supply selected material to the commander of English ships, rather than commissioning more fieldwork. This work he performed to the best of his ability with the very small staff allocated to him.[22]

A naval officer, Captain Hurd, took over from Dalrymple in 1808, the first of the long line of twenty naval hydrographers up to the present day. Hurd's early hydrographic training is obscure. His obituary in the *Gentleman's Magazine* of 1823[23] read in conjunction with Dawson's *Memoirs of Hydrography*,[24] and a reference in Professor Evan's *Uncommon Obdurate*[25] leads one to believe that he had learnt surveying from Samuel Holland in North America in the years 1771 to 1774. He was appointed surveyor general of Cape Breton sometime after 1780, a post from which he was dismissed by Des Barres, who had become governor of Cape Breton in 1784. By 1788 he was commencing a remarkably detailed survey of Bermuda and remained there to establish a base for the Navy. During the first ten years of the new century Hurd was often on the enemy's doorstep, surveying the Bay of Brest in support of the British blockading forces.

As a young man surveying in North America, Hurd would have learnt Cook's hydrographic methods from Holland, probably from Des Barres, and possibly from Lane. As one of the few naval officers em-

[21]Robinson, pp. 60-70.

[22]Sir Archibald Day, *The Admiralty Hydrographic Service, 1795-1919* (London: H. M. S. O., 1967). Order in Council "Establishment of an Hydrographic Department dated 12 August 1795" is reprinted in full in Appendix Al, pp. 334-335.

[23]Obituary of Captain Thomas Hurd in *Gentleman's Magazine,* 93 (1823).

[24]Llewellyn S. Dawson, *Memoirs of Hydrography,* 2 vols. (Eastboume: H. W. Keay, 1883-1885). Facsimile reprint with four-page Errata was published by Commarket Press, London, 1969. Hurd referred to p. 45.

[25]Evans, p. 96.

ployed in chartmaking he would certainly have studied Captain Vancouver's *Voyage of Discovery to the North Pacific Ocean and Round the World* (published in London in 1798), and Captain Broughton's *Voyage of Discovery to the North Pacific Ocean* (published in London in 1804). Both these explorers were employing and developing Cook's methods. From 1810 onwards, Hurd was closely associated with Captain Flinders, who was preparing the manuscript and charts for his *Voyage to Terra Australis* (published in London in 1814). Even if Hurd never met Cook he would have been aware of the broad pattern for chartmaking set by the great sea surveyor before his untimely death only thirty years earlier.

In 1814, Hurd made a report to Their Lordships detailing the many areas of the world's oceans which should be surveyed to meet the fleet's charting requirements. The introductory and concluding paragraphs of this report read as follows:

> The return of Peace to this Country makes me consider it as an official duty to represent to the Lords Commissioners of the Admiralty the great deficiency of our Nautical knowledge in almost every part of the World, but more particularly on the coastline of our own Dominions, and also with the hopes that the present favourable moment for remedying these evils will be made use of, by calling into employment those of our Naval Officers, whose scientific merits point them out as qualified for undertakings of this nature--of which description of Officers there are I am happy to say many who stand eminently conspicuous.
>
> In acquiring the Nautical knowledge here recommended, much good might also result therefrom in other points of view as an excellent opportunity would thereby be afforded for the exertions of abilities both scientific and commercial, by uniting as Companions of their researches, persons of the description who of course would become accountable to the Nation for all the knowledge they might thereby acquire. At all events such an undertaking would keep alive the active services of many meritorious officers whose abilities would not be permitted to lie dormant, whilst they can be turned to National benefit and would also be the means of acquiring a mass of valuable information that could not fail of being highly advantageous to us in any future War, and would otherways redound to the Credit

> and Glory of this great Maritime Empire, whose flag flies trumphant in every part of the World.[26]

A corps of officers, selected for their mathematical and navigational abilities to carry out the hydrographer's instructions worldwide were gradually built up by Hurd. The founding of the Royal Naval Surveying Service may be taken as 7 January 1817, when a board minute established special rates of pay for officers specializing in hydrography. These "Companions of their researches" as Hurd called them, hardly ever exceeded sixty in number, have remained as a coherent body of chartmakers to the present day, whilst a number of Commonwealth navies have formed similar if smaller corps.

The civilian hydrographers had been active since the beginning of the century; the methods described in Murdoch Mackenzie's *Treatise*[27] had been assimilated by Cook and others and extended to meet the needs of ocean and exploration surveys. Cook did not live to write a manual but Hurd established the new body of specialists on Cook's principles, and these were passed on traditionally by surveying captains to their surveying assistants who in their turn gained command.

One may follow many such lines of descent, one only of which is given here as an example. John Franklin served with Flinders on the *Investigator* during the surveys of Australia and was associated with Flinders when he returned to England from Mauritius in 1810.

Beechey accompanied Lieutenant Franklin on Captain David Buchan's expedition towards the North Pole in 1818 and later commanded the *Blossom,* in which he waited in vain off Icy Cape in the Bering Sea for the planned arrival of Captain Franklin's overland expedition in search of the Northwest Passage. On board the *Blossom* was Lieutenant Belcher, who surveyed Chamisso Harbour during the long wait.

Belcher later claimed that he had learnt nothing from Beechey and was self-taught; but we have learnt to take Belcher's statements with a "pinch of salt." After having commanded the surveying ships *Aetna* and *Sulphur,* he published in 1835 a treatise on nautical surveying.[28] Although this treatise was rambling and diffuse, it served a useful purpose until Captain Beechey's admirable section of "Hydrography" was pub-

[26]Day, pp. 27, 29.

[27]Mackenzie.

[28]Sir Edward Belcher, *A Treatise on Nautical Surveying* . . . (London: P. Richardson, 1835).

lished in the *Admiralty Manual of Scientific Enquiry* in 1851.[29] Belcher's First Lieutenant on the *Aetna* was Kellett, who later, as a captain, commanded the *Herald* surveying in the Pacific, with Lieutenant Chimmo as one of his assistants.

In 1864, Commander Chimmo was in command of the *Gannet,* a surveying vessel on the North American and West Indies Station, in which also served Lieutenant Wharton, who became, twenty years later, the eighth hydrographer of the Navy.

Rear Admiral Sir William Wharton served twenty years as hydrographer, into the twentieth century. In 1882 he published his *Hydrographical Surveying,*[30] which remained, with new editions, the standard English language work on hydrography for the next fifty years. Aware of Cook's continuing influence upon the Royal Navy's hydrographic services during the nineteenth century, Wharton edited and published for the first time in 1893 Cook's own journals of the *Endeavour* voyage exactly as Cook had written them.[31]

What were Cook's contributions which have continued to influence hydrography during two centuries? An attempt will be made to enumerate them:

Firstly, his attention to the good health of his ships' companies without which no hydrographic venture can be successful. He fought scurvy incessantly, imposing by personal example a wholesome diet which he had devised, whilst his forethought prevented his men from ever being seriously short of food or water. In his early days on the *Grenville,* he realized the necessity, sometimes denied even today, of carrying a doctor on board a working vessel when far from her base.

Secondly, we note his obvious desire, at a time when new instruments were being rapidly introduced, to have on board the latest and best when he sailed. He ordered the instruments himself and he and his officers soon mastered them: the most carefully engraved sextants, the newest timepieces, up-to-date azimuth compasses; he never missed purchasing these for his voyages.

[29]Sir John F. W. Herschel, ed., *Admiralty Manual of Scientific Enquiry* (London: J. Murray, 1851). Reprinted and published by William Dawson and Sons Ltd., Folkestone, 1974. This edition includes an introduction by David Knight which reviews the relationship between science and the Royal Navy during the nineteenth century. Section III, *Hydrography* by Captain F. W. Beechey is reprinted on pp. 52-107.

[30]Sir William J. L. Wharton, *Hydrographical Surveying* (London: J. Murray, 1882).

[31]Sir William J. L. Wharton, ed., *Captain Cook's Journal during his First Voyage Round the world . . . 1768-1771* (London: E. Stock, 1893), reprinted Adelaide: Libraries Board of South Australia, the Australiana Facsimile Editions No. 188, 1968.)

Thirdly, there is his feeling for science; although he sometimes found the presence of scientists on board tedious, his association with Banks, Solander, and the Forsters undoubtedly broadened his mental horizons far beyond those of a practical seaman. His ever-widening interest in the natural sciences--meteorology, oceanography, anthropology, and biology--and his habit of continual inquiry during his voyages constituted a precedent. Hydrographic surveyors have remained alert to take advantage of their opportunities of adding to the general scientific knowledge of the world. Hydrographers and scientists have sailed together on many subsequent voyages, of which Fitzroy and Darwin on the *Beagle,* Owen Stanley and Huxley on the *Rattlesnake,* and Nares and the *Challenger* scientists are only outstanding examples.

Fourthly, there is his close attention to what is today known as forward planning. This is evident in his organization of the good-weather-season concept when working in Newfoundland, which evinced itself in a grander manner when he came to plan his great exploring sweeps through the Pacific, within an ocean-wide meteorological pattern which was only gradually becoming apparent.

Finally must be listed Cook's absolute dedication to chartmaking which still motivates us today. The search for the cartographic truth despite fatigue, foul weather, and often shortage of time cannot be successfully concluded even with the most sophisticated instrumentation in the modem ship unless the surveyor has inherited that sense of complete determination which Cook so clearly possessed.

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