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HYDROGRAPHY, YESTERDAY, TODAY & TOMORROW

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ABSTRACT

The President of the Directing Committee of the International Hydrographic Bureau looks back over 45 years of hydrographic experience and takes note of the technological advances which have taken place in this field. He sees the introduction of echo-sounding after World War I and electronic positioning after World War II as two major technological revolutions in hydrography.

He examines critically the present moves into automated hydrography, and poses a number of questions concerning the value of complete automation to the sea surveyor.

He looks to the future and sees the present progress which is being made in multibeam swath sounding as a possible precursor to a third technological revolution in hydrography, solving, as it may, the hydrographic surveyor's major problem of what lies between his sounding lines.

Throughout the paper the author stresses that despite every technological advance the sea surveyor must retain his feel for the environment in which he is working, and that the seaman's eye is as important to the hydrographer today as it was when he joined his first survey ship.

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Forty-five years ago, having volunteered for the Surveying Service, I was called to an interview with the Hydrographer of the Navy at the Admiralty. Awed in the presence of such a senior and, to me, elderly Admiral, I listened to a description of the type of work I should be expected to do. He handed me my personal copy of *Hydrographical Surveying,* written by Admiral WHARTON, who had been Britain's Hydrographer at the end of the 19th century; it was the only manual then available. He also drew my attention to a journal called *The Hydrographic Review* which was supplied to His Majesty's Surveying Ships and which I should read with diligence, for in it I would find articles on the development of modern methods and equipment.

This journal emanated, so he told me, from the International Hydrographic Bureau in Monaco, where, at that time, an even older British Admiral presided over a Directing Committee. My young mind could hardly imagine such seniority and the remoteness of such a post, and I assumed that senility would have taken over.

Today, after nearly nine years as the holder of this same IHB post, I find myself invited to give this paper. I shall probably be stronger on the past than on the future, and if you find my views reactionary you may take comfort from the fact that in a year from now a younger officer will be about to be selected to take over my position in the hierarchy of hydrography.

The Hydrographer appointed me in 1936 to the survey ship *Herald,* on the China Station, and during the six weeks' sea passage to the East I studied 'Hydrographical Surveying'. My attention had been drawn to Admiral WHARTON's 'Preliminary' – the foreword to his book – where I read his views on the Surveying Service of the Royal Navy: "Happily, it is a profession of volunteers, and the author's experience is that in no branch of the public service can the juniors be more anxious to do their duty, not only to the letter, but to the utmost of the spirit, and to such as these no day seems long enough. To them the interest is constantly kept up. Every day has its incidents. The accuracy of the work of each assistant, when proved, is an infinite gratification to him, and he has also the continual satisfaction of feeling that, of all he does, a permanent record will remain in the chart which is to guide hundreds of his fellow seamen on their way".

Victorian in style, perhaps; however, if we change 'hundreds' to 'thousands' in the last sentence, these sentiments first expressed over 80 years ago are still relevant to the sea surveyor's work today. Agreed that hydrographic surveys now also serve the needs of seabed exploitation; nevertheless, the world's navigators remain our main customers whose changing requirements must be constantly and truthfully studied (and never just assumed) by both hydrographers and marine cartographers.

Merry Hampton had been built 20 years earlier as a wartime sloop of the Racehorse class; the change of name, the removal of her guns, and the provision of a survey chartroom were the only outward signs of HMS *Herald*'s conversion to surveying duties. It was not until the mid-1950's that the world's hydrographers began to convince their financial masters that specially built ships most economically and efficiently met their special needs.

As the ship's workmanlike boat brought me alongside, I remember thinking that I had never seen anything that reminded me less of a thoroughbred racehorse than this ageing white vessel swinging to a buoy in Hong Kong Harbour. She was being loaded from a lighter with all manner of spars and timber and the largest

bamboo poles I could ever imagine. The ship was being prepared to sail to distant survey grounds in Borneo at the end of her winter lie-up period.

The surveyors traditionally moved onshore during the lie-up to draw their fair charts resulting from the past season's work. The exercise of their skills of penmanship and water-colour painting, still important in those days, culminated with the surveyors submitting their beautiful work to the Captain for signature.

These pleasureable activites of the sea surveyor (we never called ourselves hydrographers in those days, the word being used only to describe the remote and distant figure in Whitehall) have practically disappeared with the introduction of the transparent plastic materials that so expedite the compilation of charts from fair sheets.

The surveys we made in those days usually started from fundamentals. A position had to be fixed by astronomical observations, and a baseline measured on the ground with steel tapes, from which a triangulation network was extended to the hilltops, and often far to seaward with the aid of moored floating beacons.

Climbing, clearing and theodolite observing occupied the opening days of the survey, while the nights were spent with our "computers" – Bruhn's logarithmic and Shortrede's trigonometrical tables – balancing the triangulation and deriving the grid coordinates of the various stations. Computations complete, the mystic operation of plotting the grid was superintended by the Captain. No air conditioning protected the linen-backed cartridge paper from the vagaries of temperature and moisture so that this operation was best accomplished in one go. The climax was the inspection of the centre intersections of the grid, and the surveyors stood around holding their breath as the Captain crawled to the centre of the chart table to make his inspection with the tripodial magnifying glass. They knew that the quality of the Captain's temper for the next few days depended on whether or not a single prickhole would cover the intersections.

Once the stations had been plotted by their coordinates, field and sounding boards representing portions of the main plotting sheet were made and the survey began in earnest. The ship and her boats sounded from dawn to dusk, whilst coastlining parties walked every yard of the rocky cliffs and sand beaches. The theodolites were returned to their boxes and the sextants and stationpointers became the universal tools.

Underwater acoustic experiments for locating submarines carried out in the closing years of World War I resulted in early developments of echo-sounding on both sides of the Atlantic in the 1920s. Although the progress of this first technical advance in hydrography was chronicled in *Hydrographic Review*, we in *Herald* were still only dimly aware in 1936 that a major revolution was taking place.

True, we had an echo-sounding machine of an early sonic type which had to be listened to rather than read off, but once the ship entered critical depths of less than eleven fathoms the Somerville Sounding Machine was brought noisily into action. By means of a steam-winch on the quarterdeck the lead was hauled forward to a boom abreast the bridge after each sounding and again released. The leadsman, being stationed in the chains near the winch, was able to 'feel the bottom' and call the depth each time the leadline passed vertically beneath him.

In the boats the men still hove the lead and only spot soundings were obtained,

so we learnt to use our eyes between our sextant fixes to search for signs of shoaler water which we might have missed – a breaking wavelet, seaweed near the surface, a change of water colour – all these were vital aids.

By the early post-World War II years, the echo-sounder had come of age as a reliable hydrographic tool. It gave a continuous graphic trace of depths to the seabed as the sounding vessel proceeded. Methods of checking the echo-sounder and correcting it had been devised to meet the different speeds of sound in the water column. Trace reading devices had been developed to enable soundings to be selected from the trace in relation to the 'fix markings'.

Hydrographers were to experience another technical revolution, this time as a result of the Second World War. I recall that as we sailed in towards the Normandy beaches in HMS *Scott* on the morning of D-Day, 1944, a black box, with which the ship had been fitted, came into action. Two dials displayed numerals with which we were able to plot, as if by magic, the ship's positions as we moved in. We were witnessing the first operation of Decca from shore stations in Southern England.

By 1950 the hydrographers had their own version of this navigational aid which they had pressed hard to get. By mounting the master station onboard and placing two transportable slave stations at known positions ashore, a method of constant location in any visibility and at ranges far out of sight of land immeasurably widened the possibilities for hydrographic survey. A second technical revolution was gathering momentum.

There were early difficulties concerning lane slip which took time to overcome, whilst it was necessary to evolve smaller systems for launches and boats. The success stories of a number of different electronic fixing aids are well known, and today surveyors call for higher and higher standards to meet their location needs, both for hydrography itself and the location of oil production installations many miles offshore.

We surveyors are restless beings and, with the establishment of electronic positioning achieved, the mid 1960s saw the beginning of the search for automated hydrography. A new type of surveyor had arrived – we could call him a hydrographic engineer, and from here on one often wonders whether it is the engineer who invents the automation and tries to persuade the hydrographic surveyor he needs it, or whether it is the surveyor who calls the tune.

How many thousands of dollars, pounds, marks, yen, francs and guilders have poured into the sea in search of automated hydrography during 15 years of search ? How many schemes have been devised only to be abandoned ? Have any such schemes reduced survey costs by one iota ? What manpower saving has automation achieved, if any ? Has accuracy been increased ? Has the speed of surveying operations been increased ? What is the purpose of automated hydrography and where is it leading us ?

These questions must be asked as we look into the future.

Well speaks TRIPE [1] in his 'Critical review of automated hydrography within the Canadian Hydrographic Service' when he says in his summary, "From the foregoing it should be obvious that the decision to implement computer-assisted techniques in hydrography must be carefully considered. Planning for such systems must take into account user satisfaction, acceptance and involvement from the beginning – users must understand the system and have a hand in design".

I am not so happy with MACDONALD's [2] statement when, in describing early Canadian adventures in automatic hydrographic surveys, he says, "Computer programmes were developed to convert electronic positions, to plot soundings, to edit data and to produce field sheets. But, best of all, hydrographers were beginning to lift their sights from a cresting wave to a cresting technology that had possibilities of improving what some thought had already been perfected".

I do not want my hydrographer to ignore cresting waves. When he is engaged on a hydrographic survey he should have one over-riding purpose in mind and that is the collection of completely reliable field data for the compilation of a nautical chart and the closely associated sailing directions. Computer-assisted hydrography only serves the surveyor well if it releases him from what might be termed the routine chores of his work so that he is free to pay full attention to his two vital sensors, the echo-sounder and the side scan sonar, to look about him so that he sees the signs of nature proclaiming shoal water or giving evidence of tidal streams and currents, and to note the natural and man-made aids to navigation that his chart must portray. In other words, he must endeavour to get the seaman's feel of the environment in which he is working so that, with the aid of skilled marine cartographers, he can pass on a permanent record in the chart which will guide thousands of his fellow seamen on their way.

I am happy therefore if an onboard computer and data logging system provide automatically the plotting on line of the ship's position on a flat bed plotter readily available to the surveyor; and more particularly if the computer can accept signals from more than one positioning system, so that rejection of redundant data provides a higher standard of positioning accuracy. Any form of steering guidance provided for the helmsman is also useful.

The flat-bed plotter onboard ship must also be capable of accepting off-line work so that survey grids and sheet borders may be scribed for use by the ship and any launches being supported – no longer has the Captain to inspect the centre intersection with a magnifying glass.

In a ship engaged in ocean surveys the facility for processing magnetic and gravity data, for plotting values on drum plotters and storing the data on tape – all of which may be carried ashore to the office – is an admirable way of relieving the hydrographer of some of his chores.

It is only when we come to the soundings that, despite my reading of the work of WEEKS [3] and BROUWER [4] and others, I cannot believe that digitizing and data-logging are ready to take over from the Mark I Eyeball.

The echo-sounder provides the absolute fundamental and all important data required to compile nautical charts, and as such the trace should receive the frequent attention of the hydrographer, although fix marking should be automatic. As soon as possible after sounding operations, the work should be inked in by the hydrographer with the aid of an assistant reading from the echo trace with an echo-reading device. I cannot yet bring myself to surrender this part of hydrographic surveying work to the data logger, to be taken elsewhere and matched by someone else to the fixes marked upon the plotting sheet. I would by no means be certain that those vital shoal soundings would appear, and if so in the right place.

Why, you may ask, am I content to accept automatic plotting but not sounding digitization? A craft steering a course moves in a steady progressive manner,

whereas, as Darwin said 'not even the wind that blows is so unstable as the level of the crust of the earth'. When wrecks and man-made seabed obstructions are added, the recognition of that vital peak sounding cannot be left to automation. It might be the very pinnacle shoal that, unmarked on the chart, brings about disaster.

One of the arguments for digitizing all field data is that it is required for the 'data base' – an almost utopian ideal whereby a bank of data is held in hydrographic offices so that it may be milked by the computer at any time to provide all the data available for any area it is wished to chart.

I would argue that such a data base is not a universal requirement for hydrographic offices, and that hydrographic surveys are made on a given scale to provide data for a given chart, which has been planned for specific, usually navigational, purposes. If a data base must be established, this may surely be done in-house by digitizing and scanning all the charts and survey sheets available in the archives.

Progress in perfecting automation will not bring about a third technological revolution in hydrography. The potential field for a dramatic breakthrough in the future lies in those extensive areas between the lines of soundings where the hydrographer is largely ignorant of what goes on.

According to RUSSELL [5], BRYANT [6], and others, the side scan sonar provides valuable indications of obstructions and shoals to those who have mastered the skills of towed fish operations and sonargraph interpretation, the latter containing far more data than we are yet able to utilise.

The side scan sonar is not a definitive tool and the real breakthrough will only come when a multi-beam swath system such as Seabeam or Bosun is perfected, giving real time plots of contours or soundings over the entire width of the swath; whilst for shallow water operation where such equipment would be most useful the entire package will have to be made small enough to fit in a launch of 9 metres or so in length.

McCAFFREY's recent paper [7] encourages us to believe that a direct descendant of the Harris Array system, the 'B.S.', may be the one to watch.

One of the shortcomings of the world's charts today is widely recognised as being the lack of hydrographic data from many of the remoter parts of the world. It seems to be generally accepted that this situation can only be remedied if the many developing countries with uncharted waters, but no hydrographic potential, are encouraged and guided to form modest surveying units.

The technical skills required to operate and understand the automated systems now being developed, and to deal with the breakdowns to which advanced electronic devices are prone, simply do not exist in many developing countries where surveys are so much required.

My plea, therefore, is that whilst developing Hypos, Haaps, Indaps, Hydrauts, Hydips, Hydas and many others, the advanced industrialized nations concerned should use the great wealth of engineering experience so gained to devise simple reliable standard hydrographic systems for launch installation. Utilise a short range electronic fixing system, with automated plotting and steerage guidance, perhaps, but allow the embryo surveyor to understand what he is about by letting him ink in his soundings from the echo trace in the traditional way.

Automated cartographic systems lie rusting around the world for the lack of technically trained personnel to use them. Are hydrographers going to repeat this folly due to over-sophistication which I see as a very dangerous shoal in the waters ahead of our well-loved ship ?

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FIFTY YEARS AGO

Challenger Rock – See Canadian Chart 4748.

On Friday, 23rd September 1932, HMS *Challenger* weighed and left Ford's Harbour at daylight and steamed northwards at nine knots to land a theodolite observing party on an island about eight miles distant. She was taking a route which she had followed in safety twice previously and where no dangers had been located by echo sounding or by the man looking out from the crow's nest (such a look-out was always posted in these waters). Captain WYATT was alone on the bridge except for the rating watching the echo sounding machine who called out the soundings every 20 seconds. The soundings were between 50 and 30 fathoms, but suddenly a sounding of 21 fathoms was called, and the water then shoaled so rapidly that the echo was momentarily lost, and before another sounding could be called the ship shuddered as she struck a rocky shoal. The engines were stopped and put to full astern with no effect. Abreast the bridge the ship was hard and fast, while at her bows and stern soundings showed deep water; truly this was a pinnacle rock.

This was indeed a serious predicament, the ship firmly aground in a remote part of the Labrador coast with the nearest help over a thousand miles away and the amount of damage done to the ship's hull difficult to assess. Challenger must now rely entirely on her own officers and men and they did not fail her.

A boat having sounded round the ship it was decided to attempt to get the ship off stern first at high water, which was due in about 4 1/2 hours' time, and might give about two feet of water more than when the ship grounded. Time was short and work commenced at once. First the damage was inspected as far as this was possible inside the ship, and then wooden shores were placed against all the adjacent bulkheads, the damaged compartments themselves being sealed off by their watertight doors. It appeared that all the forward oil fuel and fresh-water tanks were leaking and that the large provision room and canteen store were flooded with oil fuel and water, and further, that there was a slight leak in the forward end of the boiler room which was situated abaft the provision room. This damage must be localised as far as possible so that when the ship floated off the reef the minimum risk of further damage might be incurred.

Meanwhile the two ship's anchors were lowered below the water line and slung beneath boats; this was no mean task as each anchor weighed 28 hundredweight. These anchors were disconnected from their cables and when wire hawsers had been secured to them they were laid out astern of the ship and the hawsers brought to the steam trawl winch on the quarterdeck. An amusing incident happened at this point, for when the huge anchors were slipped from beneath the boats the latter regained their full buoyancy with such force that a member of one of the crews was catapulted into the icy water. A smaller kedge anchor was similarly laid out ahead of the ship to steady her.

Just before high water, the anchor cables, now without their anchors, were lowered onto the sea-bed, 14 tons of fresh water and 15 tons of fuel were pumped overboard from tanks in the forward part of the ship and all the crew mustered aft, so that the ship was considerably lightened forward. At about high water the stern hawsers leading to the two bower anchors which had been laid out astern were hove upon and the engines put to full speed astern. It was a tense moment as ever so slowly the ship began to move, and very gently came off the rock. The first part of getting the ship back to port was achieved, but there were many more difficulties to be overcome yet. A hum of eager conversation on the quarterdeck was soon quelled by the Coxswain detailing the men for the task of recovering the anchors. The hawsers running to the bower anchors had now to be led to the forward winch and these anchors hauled up into the hawsepipes once again and connected to the cables. The kedge anchor had also to be recovered before the ship returned to Ford Harbour so that divers could determine the full extent of the damage; meanwhile the pumps were just holding their own with the water in the damaged compartments.

Extract from : *Challenger – The Life of a Survey Ship*, by G.S. RITCHIE, Hollis & Carter Ltd., London.