

MAXIMUM MOBILITY SURVEY TEAM

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ABSTRACT

Although Ireland has a long seafaring tradition and has produced many famous sailors such as Commodore John Barry, "Father of the U.S. Navy", many of the charts of Irish coastal waters are out of date and there is a constant need for their revision and updating.

The Office of Public Works is a government body which carries out a wide variety of engineering work and for some of this a certain amount of inshore hydrographic surveying is required. For various reasons, the team that carries out most of this surveying is very small but is also highly mobile. This mobility is essential as the surveys are spread around the entire coast as well as on some rivers. To aid rapid deployment, the equipment has been kept to a minimum and all mounting hardware has been so designed that it can easily be transported to difficult sites, such as small islands, and mounted on whatever boats are available locally. Position fixing is usually carried out by the fixed transit and cut-off angle method, although electronic or resection methods are used when conditions require them.

A considerable amount of post-dredging surveying is carried out and for this a Raytheon Channel Sweep System is used. The mounting equipment for this has also been designed for ease of transport and flexibility of attachment to local boats.

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HISTORICAL NOTE

Ireland has a maritime history which goes back more than 1,500 years. There are records of Irish ships sailing across to Wales to attack the Roman garrisons. Because of successive occupations by foreign powers, beginning with the Vikings in the 9th century, Ireland did not have its own navy until the foundation of the present State in 1922. However, being an island, from the earliest times the sea-going tradition was strong and dependence on the sea was strengthened by laws discriminating against land ownership by the natives, which made fishing vital to the populace, particularly on the western sea-board.

Tariffs imposed on imported goods provided an impetus for smuggling and this was rampant in the 17th and 18th centuries, France and Spain being the main sources of supply. Such was the volume of illegal trade that some merchants in northern Spanish ports learned to speak the Gaelic language to expedite their dealings with the smugglers. Seamen who had learned their trade on the smugglers' ships were much in demand by foreign navies. Many of the ships of the Spanish Armada were piloted by expatriate Irishmen. These "pilots" were effectively the masters of the galleons; the "captains" were noblemen who had little or no sea-going experience. From the latter half of the 18th century onward, the British Navy regularly sent press-gangs to Cork and Kerry, but it was not unknown for the crews so recruited to seize the ships and operate as corsairs in the St. George's Channel.

During the American War of Independence, a blockade runner, John Barry from Tocomshin, Co. Wexford, was the first serving officer of the embryo United States Navy and was later made its first Commodore. The Argentinian Navy was founded by William Brown from Foxford, Co. Mayo. The Chilean Navy was organised by Bernardo O'Higgins, although as a general in the army and first President of the Republic he did not actually command the fleet. What was probably the first practical working submarine was designed by John P. Holland, a schoolteacher from Liscannor, Co. Clare, who emigrated to the U.S. in order to develop his design. Another who left his mark on maritime history was Robert Halpin from Rathnew, Co. Wicklow, who was captain of the Brunel-designed cable-laying ship *Great Eastern*. He laid a total of 26,000 miles of submarine cable, linking Brest with Newfoundland, Bombay with Suez, Madeira with Brazil and Australia with New Zealand. The first ship to cross the Atlantic by steam was a small paddle steamer, *Sirius*, which sailed from Cork to New York in 1838 under the command of Lieutenant Richard Roberts.

As mentioned earlier, Ireland did not have a Navy until the early part of the present century. Consequently, all charting of Irish waters was done by foreign ships. Some was carried out by the French and the Dutch, but most was done by the British Navy. Quite a lot of surveying on the east coast was done in the early years of the 19th century by William Bligh of "Mutiny on the Bounty" fame.

THE OFFICE OF PUBLIC WORKS (O.P.W.)

The Office of Public Works is a government body which was founded in 1831. Among the responsibilities of its Engineering Section are :

- Maintenance of State Harbours. These are Dunlaoghaire, Howth and Dunmore East. The main ports such as Dublin and Cork have Harbour Authorities and are outside the jurisdiction of the O.P.W.
- Development of Fishery Harbour Centres. These are ports now being developed as major fish landing and distribution centres, and are being designed to cater for the large modern inshore trawlers which may now reach about 50 m in length.
- Improvements to small fishing harbours.
- Coast protection work.
- Arterial drainage of rivers.
- Maintenance of and improvements to navigation on the River Shannon.

These works give rise to a need for a considerable amount of hydrographic surveying and most of this is done by the Site Investigation Section of the Marine Division, the exception being the River Shannon, for which there is a separate section which carries out its own surveys. Most of the surveying done by Site Investigation is in connection with engineering work rather than navigation. For this reason the areas surveyed are usually small and the required accuracy high.

The O.P.W. does not have its own budget to carry out marine engineering works; it acts mainly as a consulting and/or contracting agent for other Government Departments who provide the funds.

HYDROGRAPHIC SURVEY TEAM

In the last few years there have been swingeing cuts in all public expenditure and one of these has led to an embargo on the replacement of staff leaving the service. This has resulted in some sections being understaffed and one of these is Site Investigation. As a consequence of the understaffing, the number of people available for hydrographic surveying has been restricted to two or, at times, three. This small team has to carry out surveys around the entire coast.

There were two ways in which the hydrographic survey team could have been organised. The first alternative would have been to have used the resources of a central engineering workshop which provides transport for the various works sites. A small launch could have been purchased and permanently equipped with survey gear. This could have been moved from place to place by means of a Landrover provided by the workshop. A driver would have been provided and extra labour could have been borrowed from the nearest works site to assist in manhandling the

boat on and off the trailer. This system would have resulted in a rather inflexible operation for the following reasons :

- Several days' notice would have been necessary to secure the use of a Landrover with driver. This would have precluded any sudden dashes to sites to take advantage of good weather.
- As it is impossible to estimate accurately the time which small surveys take, the vehicle and driver would have had to remain at the site for the duration of the survey, thereby tying up valuable transport.
- The security of the boat would have been a problem, unless a full-time boatman was employed.

As flexibility is considered important it was decided not to pursue this course.

The other alternative was to make the team entirely self-contained by keeping equipment and transport to a minimum and hiring boats locally. Such a team could reach any site in the country, given twenty-four hours notice. It was decided to take this option.

EQUIPMENT

The equipment carried to all surveys, except post-dredging surveys, is :

- 2 Raytheon DE719 fathometers with transducers, assorted clamps and packing pieces to attach the transducers to any boat
- 1 bar check plate
- 1 hand sounding line
- 1 12V battery with charger
- 1 theodolite
- 2 sextants
- 1 levelling staff of the metal telescopic variety
- 3 hand portable radios with rechargable batteries
- 1 cassette recorder
- rolls of paper, spare parts, tapes, note books, etc.

All this can be carried in one saloon car along with the personal luggage of the survey party. Almost any combination of breakdowns can be overcome with what is available. Since we own two Raytheon DE719s, and as they are neither large nor heavy, bringing both to all jobs eliminates the need to carry out any repairs on site should one break down (in fact this model is very reliable and seldom does). There has been no incidence of both sounders giving trouble on the same survey. A second transducer is carried in case one is lost overboard, an event which also has never taken place. The theodolite and two sextants allow some form of fixing to be carried out even if one of them gets broken. In fact, a theodolite has been blown over and damaged on a pier only several hundred metres away from where the survey boat was operating quite comfortably in sheltered water.

BOATS

Most survey boats are hired locally. Apart from the convenience already referred to of not having to bring one to the site, this also gives the advantage of having a boatman who is familiar with local conditions.

The sort of craft most suited to our work is an open boat about 5 m long with a 6 h.p. outboard motor, or a small half-decked lobster boat with inboard engine. Small trawlers are frequently unsuitable, as their superstructures make optical position fixing difficult and their draught prevents them from approaching beaches and rocky shores. In practice we suffer more from boats being too large than from their being too small.

In some of the western areas such as the Aran Islands, the indigenous type of small boat is the currach, which is a timber-framed canvas canoe. Although very good sea boats in skilled hands, they make terrible survey boats, as they blow off line due to their light weight and high freeboard. They also engender an uneasy feeling that the sounder or battery may disappear through the canvas bottom.

There is no hard and fast hiring procedure. A deal is done on the spot and local supply and demand dictates the price paid.

FIXING

Fixing is normally done by the fixed transit with cut-off angles method. In this, an operator sets up a theodolite on each of a series of points along a baseline on the shore, and directs the boat towards him on a known bearing by means of a hand-portable radio. The other operator on the boat takes cut-off angles with a sextant at regular intervals along the transit. The cut-off angles are the angles subtended at the boat by the theodolite and some other convenient fix point on the shore whose position is known. If sheets of "Dayglo" paper are taped to the legs of the theodolite and to any features used for fixing, these can be seen in the mirror of the sextant at a distance of at least 1 km in any reasonable light.

The reasons for mainly using the transit and cut-off angle method are :

- It is very accurate. An experienced theodolite operator can anticipate leeway of the boat and order corrective action before the boat actually gets off line. In this way the transducer can be kept within 0.5 m of the intended line.
- Because the sextant is pre-set to the same whole angles for each line, the event marker button can be pressed at the exact instant that the image coincides with the object. There is no tracking with the tangent screw involved as in the resection method.
- Any line can be repeated very accurately should it be necessary to drop a buoy on an obstruction.

- It is quick to plot. This is particularly important when checking dredging so that the dredger can go back to any high spots before leaving a particular area.

A variation of this method is to sound along radial transit lines around a convenient fixed point such as the nose of a pier. The benefit of this system is that sounding can commence almost immediately after arriving on the site with a minimum of preliminary preparations, and this can be vital when trying to take advantage of any break in bad weather, or if it is anticipated that the area to be surveyed will be occupied by trawlers returning to port in a short time. Another benefit is that the tide gauge can be sited near the theodolite and one surveyor can double as instrument man and gauge reader. The disadvantage of sounding in radial lines is that the spacing of the lines becomes unnecessarily close near the instrument. Although this can be overcome to some extent by shortening some of the lines, a considerable amount of oversurveying is inevitable. However, in some circumstances, such as those mentioned above, the advantages compensate for this oversurveying.

For large area surveys a Motorola Mini-Ranger is hired. As this is only needed for one or two jobs a year, it is more convenient to hire than to buy. On the other hand, if one were bought it would probably be used more often than at present. When using this equipment it is usually necessary to draft in help from other sections of the organisation to assist with battery changing, etc.

If local conditions require it, the resection method of fixing can be used as two sextants are always available. However, we use it with reluctance for two reasons :

- (a) The areas to be surveyed are usually inshore and contain piers and headlands. These frequently preclude the use of lattices of constant subtended angles, as it is often impossible to get three shore marks which do not become unsighted on parts of the line due to the piers and other features. It would be very difficult to change from one lattice to another in the middle of a line when these are relatively short.
- (b) The team is too small. This means that a person is not available to plot the angles with a station pointer on the boat. Consequently, the angles have to be recorded on a cassette recorder and transcribed and plotted later. A rough plot of the first and last fix for each line is done before leaving the site to ensure that there are no gaps in the coverage of the survey area.

A subtense board is not usually carried unless it is known beforehand that it will be required. If a need for it arises unexpectedly, it is usually possible to make one from materials either borrowed or purchased locally.

TIDE RECORDING

Because of the shortage of personnel, we try to combine the functions of theodolite operator and tide gauge reader. As mentioned earlier, this is easily done

if the boat is sounding radial lines about a fixed theodolite station, as the gauge can be sited there. However, if the theodolite has to be moved to a series of stations, a number of gauges can be set up in the area and these can still be read by the instrument operator without too much loss of time. These extra gauges can be levelled in quickly from a master gauge by using simultaneous water levels transmitted by radio.

For surveys lasting only one day, we find that a "Brookeades" metal telescopic levelling staff functions quite satisfactorily as a tide gauge and does not come to much harm from immersion in salt water. It can be lashed securely to a ladder on a pier or to some such vertical face.

The O.P.W. has a hydrometric section which maintains a number of recording gauges situated at the larger harbours, and when surveying in these areas the records from these gauges are used.

The areas surveyed by us are seldom of such size as to have any significant difference in tide heights from one side of the site to the other.

The tidal ranges for most places around the Irish coast are about 2 m at neap tides and 4 m at spring tides.

POST-DREDGING SURVEYS

Post-dredging surveys are carried out using a Raytheon Channel Sweep System (Raytheon DE719CSS). For those who may not be familiar with it, this is a modified sounder with four transducers which give four traces on the recording paper. The traces are separated on the paper by fixed distances so that the depths can be read off for each. The transducers are mounted on vertical tubes which are clamped at equal spaces along a beam which is fixed transversely across the boat (Fig. 1). The spacing of the transducers along the beam is adjusted according to the depth of water so that the insonified areas on the sea-bed are contiguous. Thus a band 8 m wide can be "swept" with one pass of the boat in water 7 m deep.

In common with the ordinary DE719, the Channel Sweep System has a facility for moving the traces up and down the paper to accommodate changes in the tide. By keeping radio contact with the tide gauge, the traces can be continuously adjusted so that four specific graduations on the paper always represent the proposed dredged levels for the four traces. In this way, high spots can be recognised instantly while the sweeping is in progress. If there is any dispute about these with the dredging superintendent a second run can be made over the area in question and, because of the accuracy with which the lines can be repeated using the fixed transits, the high spots can be demonstrated and, if necessary, buoys dropped on them.

Although the DE719CSS was purchased specifically for post-dredging surveying, many engineers now ask to have areas swept for other purposes. Consequently, the equipment gets quite a lot of use. For this reason, the 7 m beam to which the transducer uprights are clamped is made of aluminium and breaks down into four sections which can be carried on the roof-rack of a car (Fig. 2). The

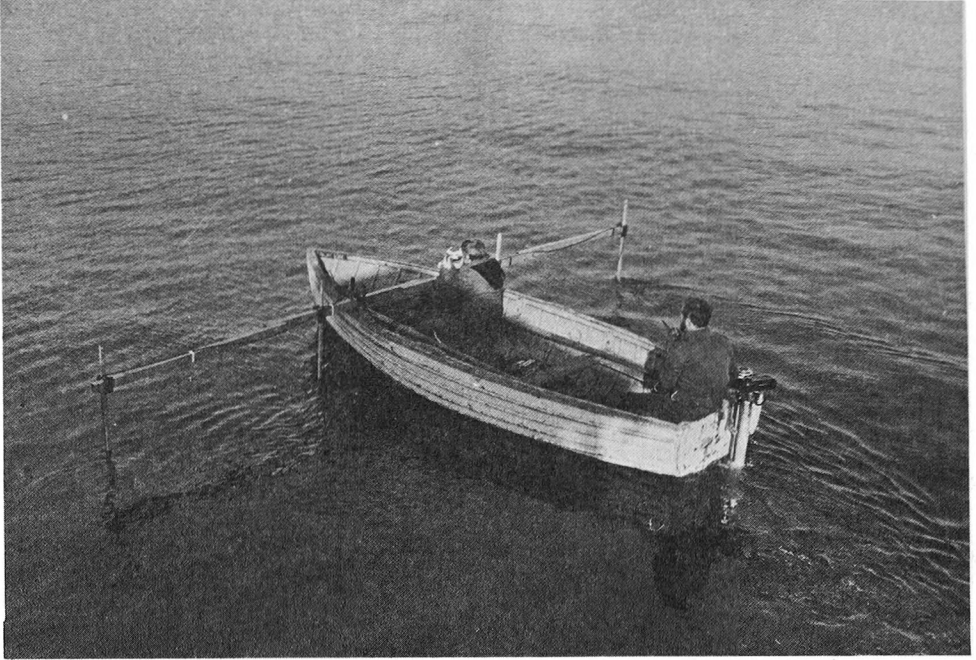


FIG. 1. — Raytheon Channel Sweep System mounted on a small boat



FIG. 2. — Equipment for post-dredging "sweeping" dismantled for transport by car

equipment, including the beam, can be carried in the small aircraft which service some of the islands off the west coast. Everything has been kept as uncomplicated as possible. The transducer uprights, also of aluminium, are clamped to the beam with simple friction devices made from two plates which are tightened together by means of four bolts. When the bolts are slack the transducers can be moved vertically as well as laterally. The beam is clamped to the gunwales of the boat with woodworkers' clamps. A "fail safe" element is incorporated in the mounting by deliberately making the clamping arrangements rather weak so that if the beam accidentally catches in the piles of an open-work structure it pulls off its mountings before any serious damage is done to either boat or beam. The principal difficulty in using the Channel Sweep System is that with the beam clamped across it the boat becomes rather difficult to manoeuvre near piers or quays.

Small boats about 5 m long, as described earlier, are the most suitable craft for operating the Channel Sweep System in confined waters such as harbours. Larger boats are too wide amidships, with the result that the two middle transducers are so far apart that their insonified areas no longer meet on the sea bed. If, in an effort to overcome this problem, the beam is mounted at a narrower part near the bow, the free-board here tends to be so great that it creates other problems. To reach the water here, extra long transducer uprights have to be used and the water resistance at the ends of these long lever arms causes severe overturning movements at the beam. To counteract these, the whole set-up has to be made of heavier sections, which means that it is no longer easily portable. Also, the beam must now be clamped firmly to the boat so that in the event of a collision the boat or beam will get damaged. Another problem with larger boats with the beam clamped across them is that they get trapped in windward corners of docks. On one occasion, a skilled skipper in a powerful tug took twenty-five minutes to manoeuvre out of such a situation.

PLOTTING

The plotting is usually done back in head office, except for post-dredging surveys, which are plotted in the site offices so that instant decisions can be made concerning their results. Memory plays a part in any hydrographic survey. In our case, because of the smallness of the team, it is difficult to keep comprehensive notes and records. For this reason, it is important that the surveyor does the preliminary plotting. A draughtsperson then takes over to finish the drawing. Because of the small areas involved and the "one-off" nature of the jobs, no attempt has been made to automate the plotting.

CONCLUSION

While the smallness of our operation has been largely forced on us by financial constraints, it can be argued that a very small team has advantages over

a larger one in certain circumstances such as those described earlier. Undoubtedly, such a team is very cost-effective. We, of course, have the advantage that all our surveys are done for our own internal use and, therefore, we can alter our program to suit any change in priorities. We never find ourselves in the position of trying to do two surveys at the same time, as a contract surveyor might.

From a social aspect, there is the disadvantage that the surveyors spend a considerable number of weeks in the year away from home, and this gives rise to a certain amount of dissatisfaction, particularly as Civil Service conditions make it impossible to offer inducements such as bonus schemes or project leave. However, when the present recession ends it is hoped that staff will be increased. Should this happen, we would probably continue very much as at present but with two small teams working on a rota system, thereby retaining the operational flexibility.

Finally, I would like to thank the Commissioners of the Office of Public Works in Ireland for their permission to present this paper. I would like to take the opportunity also to acknowledge the assistance which I have received from my colleagues in the Site Investigation Section in preparing the paper.

REFERENCES

- LAWLOR, Anthony T. (1945) : Irish Maritime Survey, The Parkside Press Ltd.
PETERSON, Basil (1962) : Turn of the Tide, Irish Shipping Ltd.
MCNEILL, D.B. (1971) : Irish Passenger Steamship Services, Vol. 2, Newton Abbot, David and Charles.
INGHAM, A.E. (1974) : Hydrography for the Surveyor and Engineer, Crosby Lockwood Staples.