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THE ROLE OF THE CONTRACT HYDROGRAPHIC SURVEYOR

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The past fifteen years have seen a marked increase in the number of hydrographic surveyors engaged in providing services under contract. To a large extent this expansion has been created by the needs of the offshore oil industry, and much of it was concentrated between the years 1970 and 1974. The consequent training load on the responsible organisations providing these services has been heavy indeed; there have just not been enough experienced men to go round. Over a twelve month period in our own company school alone, 1,500 man/weeks of instruction were completed with a pupil-to-staff ratio of less than 7 to 1.

The number of ocean-going vessels regularly employed on contract survey work around the world is difficult to quantify; not least because surveyors themselves would disagree on the scope and limits or the types of activity that constitute hydrography. In the context of contract work, classical hydrography often becomes inextricably mixed with other aspects such as field development of equipment, "positioning", geophysics, inspection and maintenance work, or the collection of data for engineering projects.

But, in order to get some idea of the international scale of the effort available, and assuming that it was all to be concentrated on producing a "harvest of soundings" over the continental shelves around the world, then we estimate that the offshore contract surveying industry would be capable of deploying not less than 20 survey ships at any one time, each ship supported by the necessary shore organisation and equipment, and with manpower of sufficient experience and training to produce data to a standard acceptable to international charting authorities.

These notes comment on a few aspects of the organisation of a large survey company. Also, with a few examples, they show how equipment

and techniques first developed to solve problems encountered in contract work are being used to the benefit of all branches of hydrography.

QUALITY CONTROL

The control of quality of survey work in groups such as the Surveying Service of the Royal Navy poses no organisational difficulties. There, responsibility for both the management of the project and the quality of the result rests squarely with one man — the Commanding Officer of the survey ship. This simple and logical arrangement is rarely practicable in commercial work.

In survey companies, there is invariably a preoccupation with trying to maintain a reasonably steady flow of work; the natural order of things appears to impose a "feast or famine" tendency. Contracts are generally awarded only days before the due date for mobilisation, and the majority of single tasks employ a ship for less than one month. Consequently, we must arrange for our capabilities to be available in as many parts of the world as our resources will allow.

Since it is useless to try to control the quality of such widespread work from a central headquarters, and since only a portion of our field-work is centred round the operation of our own ships, only two methods of control are open to us.

Firstly, overseas work can be organised on a project-by-project basis whereby a senior surveyor (or party chief in the parlance of the oil industry) with his team of specialist assistants and all his equipment are deployed by air to the work site. The party chief is then responsible for all aspects of the control of the project until his return to the United Kingdom, where headquarters staff can assist with the preparation of the final report. This method has the advantages of low overhead costs and economy of personnel drafting from a central pool, but the disadvantages of high mobilisation costs and slow reaction time to unexpected or emergency requirements or to changes in plan.

Secondly, a permanent overseas base can be established, with full responsibility for its own affairs. This entails heavy investment in equipment, workshops, ships, draughting and computing facilities and many other items; but above all in key personnel who must not only be of sufficient calibre but must also have enough experience of company standards, methods and objectives to operate on the end of a very loose corporate rein. Even to maintain one man and his family in an overseas posting in an oil exploration country will now cost his employer not less than £ 25,000 per annum; if this man is to be employed as base staff, this cost will have to be borne as an overhead, and the whole scale of the operation must therefore be adequately forecast.

At the time that the decision is taken to set up an overseas base (which will be months before the operation becomes effective) there may well be not one penny of contracted income for the following financial

year. This is the nature of the business, but there is not much room for wrong decisions in such matters.

Once established and operating successfully, the overseas base has obvious advantages — better communication with the client, a more flexible and efficient service and job satisfaction for one's own staff, etc.

SHIPS AND THEIR MANAGEMENT

The contract surveyor looks with envy at the fine modern ships operated by the government survey agencies.

Time and again we in commercial groups have been through the exercise of costing the building of a ship designed to meet our own requirements — which differ in many important respects from those of a public service ship. The exercise has never yet got very far before the economics have indicated clearly that it would be pointless to proceed with that line of thinking.

In our own group we have now had twelve years' experience of operating ships; there are currently 15 of them — most of them owned and the remainder on long term charter. Whilst all ships, whether specifically designed for their intended purpose or not, are a compromise between conflicting needs, our own ships must in addition be adapted from the most suitable of those already available on the open market.

The many factors to be considered in making a good choice and an economic conversion form a separate subject in themselves, and the hydrographic surveyor who is also an experienced seaman certainly has a big contribution to make in these matters. But once the ship is operating, the hydrographic surveyor will not normally find himself appointed as captain, officer, or crew member of the survey ship even though he may be fully qualified to act as such under the relevant national regulations; nor, if he is in a shore appointment, will he become involved to any great extent in the many affairs of ship's business and management.

This arrangement therefore requires a shared responsibility. Whilst the Captain (a certificated Master Mariner) remains fully in charge of his ship, the proper conduct of the survey is the concern of the party chief. This potentially difficult relationship has not caused nearly as many problems as those of us trained in the naval tradition might have expected. On the few occasions when there has been friction, the reasons have not been difficult to identify and the situation has been quickly corrected.

THE NATURE OF THE WORK

From what has been said so far it might appear that national survey organisations possess all the advantages over their commercial counterparts. This is far from true. Whilst national organisations act with the full weight of government authority behind them, changes in policy also incur

the full weight of a governmental decision-making process, and this is usually relatively slow to take effect. The client/contractor relationship cuts across national boundaries with a greater facility than provided by diplomatic channels in many cases — despite difficulties of customs regulations, authorisation of radio transmissions, visas, work permits, and other matters.

Survey firms usually employ staff with a number of differing specialist skills all connected with survey : electronics engineers, underwater acoustics engineers, geologists and geophysicists for example, in addition to hydrographic surveyors. These will work in close cooperation and almost daily contact. Some of these survey firms have a large investment in research and development of survey equipment.

Through clients and sub-contractors the surveyor also gains first hand experience of dredging, deep seismic ships, deep diving, sea-bed coring, marine pipeline construction and many other industries.

All this places the surveyor in a large and complex framework of activity in which he not only exercises his particular skills, but has the opportunity to relate them directly to the needs of the client through his personal experience.

Over the past decade many large and important hydrographic surveys have been completed by commercial firms under contract; these have been commissioned mostly by government agencies or by the oil industry. In total they have already made a significant contribution to the data available for the compilation of published charts. Following the explosive rate of expansion in the years 1970 to 1974, and the further training and experience gained since then, the potential in the industry for further contributions in this field is now greater than ever before.

But the main cause of most of this expansion has not been hydrography as such. The work has been paid for by the engineer rather than the navigator, or by the oil industry rather than the shipping industry. Presumably this is because the needs of shipping are already largely catered for by the national survey organisations, and because where there are many users of one piece of work, as for instance a survey of the approaches to a large port, it is difficult to get those users together to pay for the cost of the survey on a equitable basis.

As a result, much of the contract work is carried out in great detail, at very large scales, in areas where there may be no danger to shipping. The future sites of drilling rigs, gravity structures or submarine pipelines are examples. This type of work may be of only limited interest to the chart maker.

Many quite major tasks in which the surveyor fulfils a key function may not produce a single sounding. Examples are the guidance of an oil rig into its predetermined location using Hi-Fix or Pulse/8 type systems, sea-bed acoustic systems or satellite receivers — or an appropriate combination of these; the continuous control of position of dredgers, seismic ships, lay barges, bury barges, heavy lift ships and diving vessels; the inspection of a main trunk submarine pipeline by acoustic sensors such as sidescan sonar and the high resolution sub-bottom profiler.

THE CONTRACT

Hydrographic surveyors have done well in making their services known to the oil industry. They have become widely accepted as a necessary part of the team of experts required to "bring oil into town" from under the sea bed — along with the drillers, geologists, geophysicists, engineers and others. Many major oil companies now employ hydrographers in a supervisory or quality control function. This is welcomed by the contracting organisations in that it improves the channelling of information between the two parties and helps to avoid misunderstandings.

A vital requirement for providing an efficient survey service is that the work should be conducted under the general guidance of a well and appropriately constructed contract. The surveyor should have an important part to play in ensuring that this is the case. In this, he has not yet achieved very much. Some large and reputable groups of consulting engineers persist in issuing contract survey documents which purport to be professional, but succeed only in demonstrating the author's abysmal ignorance of what is required in matters of marine survey to serve the client's best interests. Specifications and "Scope of Work" may be dangerously inadequate, or may impose a ludicrously expensive way of acquiring quite simple data — or both.

Putting matters right is going to depend mainly on the surveyor himself — by continuing a long process of education of the client and of the consulting engineer whenever he gets the opportunity to do so. It is in the common interest of surveyors working in the public and private sectors, as well as of the general public, to ensure that he succeeds.

A striking example of this educative process within the experience of many contracting surveyors is that as little as ten years ago very few of the Exploration Managers who were then involved in the North Sea oil boom realised that to specify a precise latitude and longitude alone did not define a location on the earth's surface. Now all of them do. A general awareness that the solutions of problems of spheroid and datum shift are not academic, but can mean the difference between success and failure in finding oil, has brought along with it a realisation that this is one of the reasons why the surveyor is there to help.

THE SURVEY REPORT

Every field operation completed by a survey company should be the subject of a survey report, even though the work may have been undertaken to collect data for the company's own purposes, or where the client may have said, as occasionally happens, that no report was required. This full documentation is necessary to ensure that any future disputes arising from the work may be satisfactorily resolved, in addition to the usual needs for survey data storage and retrieval.

The report is compiled by the surveyor in charge, but it may incorporate specialist reports such as geophysical interpretation of records, analysis of sea-bed cores and samples, and divers' reports, in addition to a range of hydrographic data. Each of these specialist reports may have resulted in a mass of detailed information in diagrammatic or tabulated form, and yet to collect these individual sections together, bind them in an outer cover and present them to the client will not help him very much.

Were this to be done the client's reaction might run something like this: "I have told you that my organisation is going to have to invest one million dollars per kilometre run of pipeline to transport oil along the seabed from Point A to Point B. I have asked you to advise me on whether any diversion from the great circle route might be necessary. In reply you have given me 300 pages of figures, but nowhere can I find the answer to the question. What is the answer ? Yes or No ? ".

Whilst the answers in such cases are rarely quite as simple as that, the example does indicate how the reports should be written. The senior surveyor must correlate the data contained in each specialist section, and consider its combined implications for answering the question. The report must then begin with presenting his conclusions! These must be in as concise and unambiguous a form as possible and, where appropriate, should contain recommendations for further action. These will be followed by all the detailed data, mostly in appendices to the main report. In the example above, for instance, these appendices would be used by the pipeline design and construction engineers to plan the next stage of the project.

Problems of this sort are frequently encountered by contracting organisations. They raise important questions. Should the company only undertake work where data collection under contract has been clearly separated from data interpretation, and the implication of offering professional advice based on this data? If it is to undertake these advisory responsibilities, which are the technical matters in which it is competent to do so? How is a client to be persuaded that a company with contracting interests is also going to offer good professional advice? As members of a professional body of Chartered Surveyors, would the companies' surveyors be acting outside their terms of reference in offering advice in the particular field being considered?

The way in which each company answers these and similar questions will colour the whole style and scope of its work, and will influence investment, recruitment and training programmes.

EQUIPMENT DEVELOPMENT

Surveyors in large companies will find themselves employed for some of the time on aspects of that activity which led their organisation into providing offshore survey services in the first place. In the case of the Decca Survey Group this was the manufacture of a range of survey positioning systems.

Operational reports on equipment performance from our own field engineers and surveyors form a valuable link with the laboratories and help to speed up the process of improving existing systems. At an earlier stage surveyors have their part to play in the development and field evaluation of prototype equipment. At an earlier stage still, surveyors help to identify new problems and can discuss with the engineers the line of development most likely to provide a solution.

Many of these developments first receive attention in an attempt to solve one specific but urgent problem, and subsequently become useful in a much wider context.

Some examples of these types of work are given below.

Fixed Error Data

Wherever survey positioning chains, such as Hi-Fix or Trisponder, are temporarily established around the world in places where Decca Navigator Chain cover exists, our ships have been fitted with Main Chain receivers for simultaneous recording with the survey readings, even though the former may not have been specifically required for the survey. This data is analysed by field surveyors and office staff to provide reliable fixed error data of Decca Navigator Chain coverage out of sight of land. This routine has added significantly to the quantity and quality of such data published in the "Data Sheets" used by thousands of seamen around the world.

The accumulation of such data for purely survey purposes, by comparison of one survey system against another, has been a major task in areas such as the North Sea. Many months of ship time, numerous aircraft sorties, specially-fitted vans deployed at key points along the continental and United Kingdom shores of the North Sea, Sat-Fix receivers around the coasts and on fixed platforms offshore, have all been involved. The resulting mass of data has required a great deal of computer time in its analysis, and a number of key staff in its handling and publication.

The establishment of any new positioning system on a service basis, such as the new Pulse/8 chains (see fig. 1), further increases the amount of data handling. This work is now centralised in a separate department. Surveyors have a key role to play in all this.

This work is expensive and its cost has to be borne out of company resources, but without it correlation between positioning systems would have been poor, and the problems of oilfield exploration and development would have been compounded.

Aqua-Fix

One of the many new positioning problems that has followed offshore oil development into deep water over the last few years has been that of a requirement for relative and repeatable accuracies as stringent as $\pm$ 1 metre within an area of perhaps 1 square kilometre; and this area might be 300 kilometres offshore and in a depth of 150 metres.

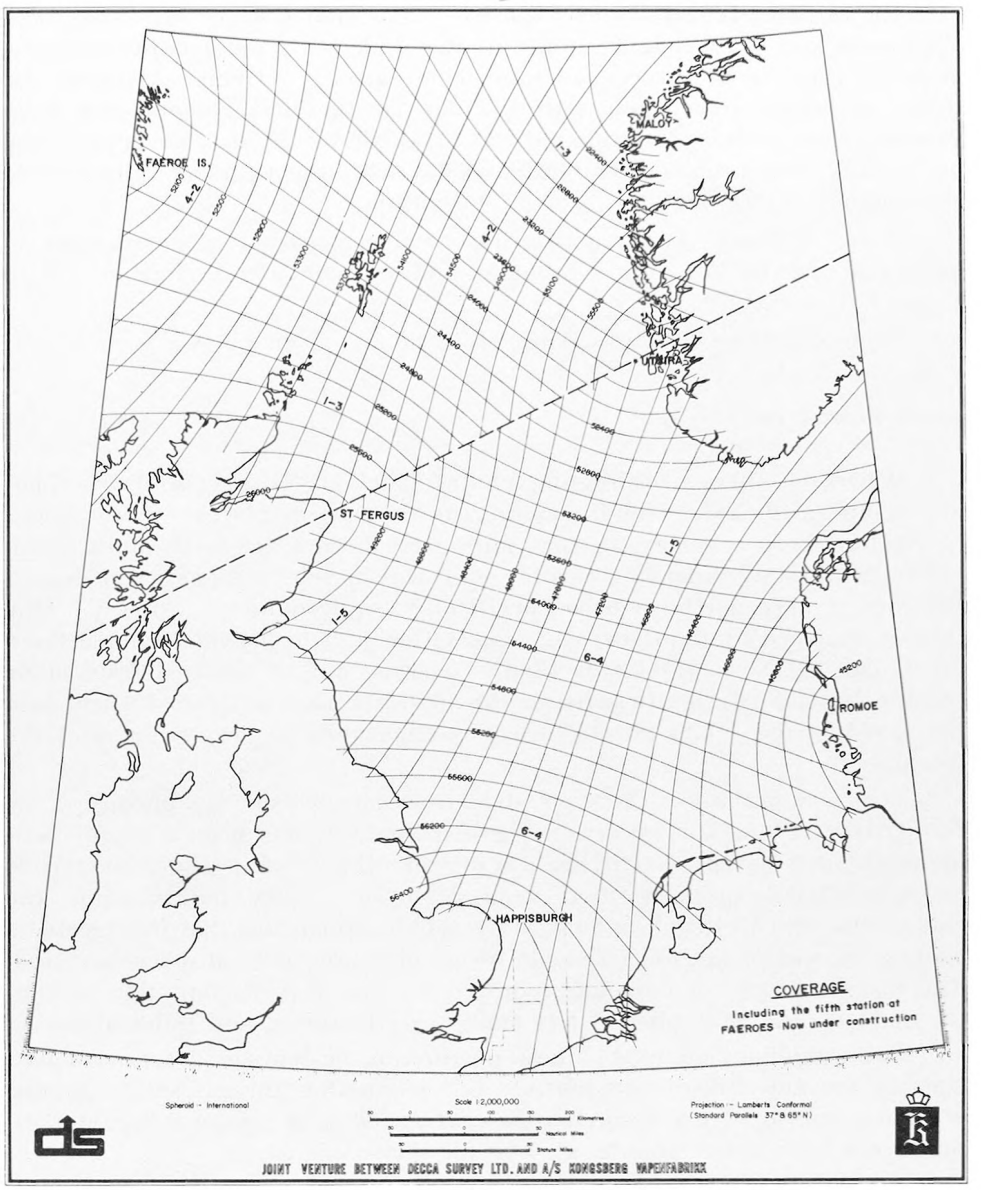

FIG. 1. — North Sea Pulse/8 planning chart. (This diagram indicates the best two patterns from those available for position fixing. In *all* fixing an additional position line should be observed).

The problem has arisen in such activities as the detailed coring of a small area of seabed where it is intended that a gravity structure should be placed in the following year; or the setting out of a precise pattern of anchor piles for a single buoy mooring.

The solution has been the development of acoustic ranging devices which interrogate small seabed transponders. Development has been rapid through a succession of prototypes until now Aqua-Fix production systems

are in reliable operation under very testing conditions in the North Sea. The data is displayed to the user on an *XY* plot, having been processed through an HP-9810 computer. The programme first orientates and trilaterates the seabed array and then displays ship's present position on the plot — plus, if required, the position of one mobile submerged object such as a towed or a manned submersible.

Such systems would now appear to have their place in more conventional tasks such as the drift sweeping of wrecks or the close examination of vigias.

Again, surveyors have had their part to play in the development of hardware and software for these systems. Indeed, their involvement in underwater acoustics goes much further than this. It is the surveyor more than anyone, for example, who is interested in the interpretation of high-resolution sidescan records for such engineering purposes as pipeline maintenance. Much has been achieved in this technique already and further developments are in hand.

Sat-Fix

When our Sat-Fix receivers became available for our own use in the field in 1973, they were first deployed in various field trials to test reliability, repeatability and comparative distance measurement against primary coordinated points. Soon afterwards they were in operational use. The quality of results to be expected, given proper observing and processing routines, for either single point or — preferably — translocation work, is now well documented in numerous survey reports of major operations. Four of these are referenced [1], [2], [3], [4].

In the North Sea, in consultation with government authorities, Sat-Fix receivers were placed at key points in Scotland, Norway and other North Sea coastal countries. The purpose was to chek on the strength of the connections, mainly between Norway and the North of Scotland, which would directly affect the baseline length of our Pulse/8 system. We had already been affected by the Ordnance Survey of Great Britain Scientific Network (1970), which had "moved" Scotland by 20 metres or so. This had caused us to recompute a mass of simultaneous readings from our Scottish and Norwegian Hi-Fix chains and to change our published fixed error data accordingly — and incidentally to achieve better consistency in the process. In the next few months we look forward to the results of the readjustment of Block V of the European Network, which will give us revised E.D. coordinates for our Norwegian stations.

In the Arabian Sea/Persian Gulf, Sat-Fix operated in the translocation mode is being used to coordinate Trisponder and Sea-Fix stations on offshore islands where the geodetic connection with the mainland is known to be weak.

In the heavy bush of the Niger Delta, Sat-Fix derived geodetic control is proving invaluable in the preliminary stages of installing the Decca Navigator chains in that area.

REMARKS

In this short paper it has been difficult to give a fair impression of the tremendous variety of work now experienced by the offshore surveyor in contract work, and it seems that nearly every day new problems arise in new parts of the world. Our field staff are now providing services in all five continents. Inevitably, there are patches of tedious, repetitive and yet responsible activity, but these are far outweighed by the more interesting work.

Finally, perhaps a word of warning. The rapid rate of expansion and consequent recruitment over the past few years has been referred to above. If civilian training and educational establishments project the same rate of expansion into the future and plan their staffing and student intake accordingly, we feel they would be wrong. It will be necessary for education and industry to continue a good liaison to get things right in this all-important forecast.

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