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HMS *ROEBUCK* — THE SHIP AND HER SYSTEMS

by the U.K. Hydrographic Department (*)

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INTRODUCTION

HMS *Roebuck* is the Royal Navy's newest coastal survey ship (Fig. 1). Built by Brooke Marine of Lowestoft she was launched on 14 November 1985 by Lady CASSELS, the wife of Admiral Sir Simon CASSELS. *Roebuck* was accepted into Naval Service on 22 August 1986 and was commissioned into the Royal Navy on Friday 3 October 1986, at Devonport.

She is the eighteenth ship in the Royal Navy to bear the name. The first, a ship of 300 tonnes, was part of Sir Francis DRAKE's Squadron that fought against the Spanish Armada. The ninth, a fifth rate ship of twenty six guns, undertook hydrographic surveys in and around the waters of Australia and New Guinea between 1699 and 1701 under the command of Captain William DAMPIER and thus established the connection between the name *Roebuck* and the Surveying Service of the Royal Navy.

SHIP DETAILS

Dimensions and Construction

Roebuck is constructed of a steel hull with an aluminium alloy superstructure located on the forecastle deck. A sonar trunk is incorporated in the hull and extends from the keel through to the main deck. The hull is all welded steel

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FIG. 1. — HMS *Roebuck.*

with transverse frames and longitudinal beams supporting the decks and shell plating. The hull structure is strengthened by transverse main decks, namely the forecastle deck, main deck and lower deck. The build is in accordance with Lloyds Register of Shipping to class 100A1, except where operational requirements necessitate greater strength. The hull is of round bilge form with flared stem and transom stern. Nine watertight bulkheads are fitted and extend from keel to the main deck. The main bulkheads divide the lower deck and a tank top deck into ten watertight sections, two of which form a main machinery space and a generator compartment. Three of the main bulkheads extend through to the forecastle deck to form watertight sectors on the main deck. Areas within the watertight sections are further subdivided by minor bulkheads which in turn form accommodation facilities, various ancillary machinery spaces, offices, storage compartments and workshops. Roll reduction is achieved by means of a controlled passive tank stabilization system.

Principal dimensions:

Length overall	64.0 m
Breadth	13.0 m
Draught	4.0 m without sonar dome
	5.3 m with sonar dome
Displacement	1500 tonnes.

Whilst the construction of the ship is to 'best commercial standards' it must be appreciated that, as a unit of HM Fleet, many naval engineering standards and requirements had to be met. Bearing in mind the role of the ship, these 'Naval Engineering Standards' covered a very wide range of aspects, from standards of pipework to minimum areas for accommodation, and the manner in which compartments are fitted out. Thus in some areas an inevitable compromise has been reached. However, the overall result is a spacious, highly manœuverable surveying vessel, well fitted for her role in the Fleet.

Complement and Accommodation

The present total complement of the ship is six officers, nine senior ratings and thirty one junior ratings. Additional accommodation has been incorporated to allow a total of eight officers, eleven senior ratings and thirty three junior ratings to be embarked. The ship's company are of differing specialisations, as required to operate the ship effectively; thus, of the six officers, five are hydrographic surveying specialists and one of the supply and secretariat specialisation. The Marine Engineering Department is headed by a chief petty officer who has a department of four senior ratings and seven junior ratings. Likewise, the Weapon Engineering Department is headed by a chief petty officer with a senior rating and three junior ratings. The Operations Department comprises a petty officer and thirteen junior ratings, eight of which are trained as surveying recorders. Finally, seven ratings of the supply and secretariat specialisation are borne.

Cabin accommodation and messing facilities for the officers are situated on the forecastle deck. Both double and single cabins are provided and are fitted out to RN standards, which differ depending on the intended rank of occupants. A large wardroom provides ample dining and recreational space for the officers. Accommodation for the senior ratings is provided on the main deck forward, and for the junior ratings on the lower deck forward. The senior and junior ratings have separate messing and recreational spaces on the main deck.

Food preparation is carried out in galley which is located between the senior and junior ratings dining and recreation spaces. This central galley also serves the officers by way of a pantry adjacent to the wardroom. All accommodation areas, and the bridge, are fully air conditioned as are the various offices and machinery control room. Remaining compartments onboard are ventilated by forced and/or natural ventilation systems.

Living and sleeping areas are generally fitted out with modular furniture and fittings designed to minimise the effects of fire, whilst still providing safety and comfort. Throughout the ship, standard lifesaving equipment is provided; this includes an Avon Searider and Swimmer of the Watch facilities.

Storerooms, Offices and Endurance

A number of offices, all fitted out to naval standards, are provided for the administration of the ship and her departments; these are the regulating office, main communications office, combined engineering office, and the victualling and naval stores offices. A large variety of storerooms also exist throughout the ship.

Each department has storerooms allocated for their particular use and a number of general stores are incorporated. Twenty storerooms in total are provided, the more important of which are the diving store and the main survey equipment store. The former is located aft and is fully fitted out to support ship's divers.

The main survey store is situated forward and provides stowage for major items of survey equipment. There is safe stowage for sets of survey beacons and the associated moorings, together with Decca Hyperfix shore equipment. Additionally, bins and racks are provided for stowage of chain and wire moorings, clamps, shackles, radar reflectors, tidepoles and danbuoy drums. Access to this compartment can be provided through a large hatch on the forecastle.

In addition to the many stores, there are four workshops providing facilities for mechanical and electrical maintenance, and the ship's company has the use of a laundry and the facilities of a canteen.

Three refrigerated rooms provide storage space for food. The sizes vary between 10 m^3 and 17 m^3 and can hold sufficient stores for a period of approximately thirty days. Some 80 tonnes of fresh water may be carried in the four fresh water tanks and this capacity, together with desalination plant's capacity to make 14 tonnes/day, provides the ship with ample fresh water. Sufficient fuel is carried for the main and auxiliary engines to give the ship a minimum endurance of 4 000 miles at a speed of 10 knots.

Propulsion and Speed

The main propulsion machinery comprises four medium speed diesel engines (two engines per shaft) which drive controllable pitch propellers through reduction gearboxes and intermediate shafting. The main engines and gearboxes are mounted on engine girders which form an integral part of the hull bottom structure. The main propulsion machinery is capable of sustained running on a single shaft at a reduced speed. Remote control of main engines speed and propeller pitch is provided from the machinery control room, the bridge and both bridge wings. The four main engines are Mirrlees Blackstone, type ES8 turbo charged with a speed of 900 rev./min. The two inward turning propellers are of nickel aluminium bronze and each comprises four controllable pitch blades, each 2300 mm in diameter. With this configuration the ship is capable of a maximum speed of 15 knots. The vessel is steered by two rudders operating in the slipstream of the propellers and controlled from the bridge. Each rudder is a streamlined semi-balanced blade of the hung blade design.

Electrical Systems

Three identical diesel engine driven generator sets, located in the generator compartment, are provided to supply the main electrical power for the ship. Each set comprises a Mirrlees Blackstone Type ES4 MK1 diesel engine flexibly coupled to an alternator having a continuous rating of 266 kW 440V, and distributed by a 440V, three wire unearthed system. In the event of the three main alternators failing, a diesel driven emergency alternator can be selected to start automatically to supply essential 115V services. Emergency battery power is also available for a limited period which will supply power to machinery alarms and controls, low power services and the gyro compass. The electrical system control, instrumentation and distribution is provided by a main switchboard located in the machinery control room, and also by an emergency switchboard located in the emergency generator compartment.

Ship Systems

Roebuck is fitted with a variety of sensors and systems to assist in her surveying role, some are new to the Service, others are not.

Survey Information and Processing System (SIPS)

This recently developed data handling system is described further on.

Sonar 2033BB (Hydrosearch)

A sector scanning hull mounted sonar is fully described further on.

Sonar 2034 (Dual Side Scan)

This towed system, manufactured by Waverley Electronics Limited, has been in service for a number of years and provides a useful means of sweeping an area of seabed to gather the following data:

a. *Bathymetry:* The sonar graphs obtained give the surveyor a good indication of the topography between echo sounder profiles. Variable ranges (75 m, 150 m, 300 m) can be selected depending on the scale of the survey and area of concern.

b. *Wrecks, Obstruction and Pinnacles:* Over the years the system has been in use, the ability to detect such potential hazards has been thoroughly proved. Not only detection but investigation and classification of such features is feasible.

c. *Seabed Texture:* With skillful interpretation of the sonargraphs combined with seabed samples, differing seabed textures can be identified.

Echo Sounders Type 780/778

The Kelvin Hughes type 780 echo sounder is specially designed for hydrographic surveying. The recorder, in conjunction with the appropriate 30 kHz transducers, provide a permanent record of depth measurements. Depths are recorded on dry electro-sensitive paper. Four basic ranges are available (0-20 m, 0-40 m, 0-80 m and 0-200 m). Each range can be phased allowing depths down to 800 m to be recorded during normal transmission. Depths down to 1 000 m can be displayed when the digitiser is activated. A remote numerical display is also fitted presenting a continuous indication of depth to the significance of

0.1 metres. Two of these sets are fitted onboard, one is also fitted in each survey motor boat. For depth data in excess of 1 000 m, the type 778 echo sounder is fitted. With a frequency of 10 kHz, depths up to 7500 metres may be obtained.

Navaids

Several different position fixing systems are available to the surveyor onboard. These are commercial outfits and include:

a. *Main Chain Decca Navigator Receiver Type 80309A* with a maximum range of approx. 320 km, accuracy ± 200 m.

b. *Racal Hyperfix:* A 2 MHz phase comparison position fixing system which may be configured for 'hyperbolic' use (multi-user) or 'circular' use (single user). Maximum ranges of 180 km and accuracy of ± 5 m (on the baseline).

c. *Del Norte Trisponder:* A 9 GHz microwave positioning system. The 540 model is designed for use with a variety of trisponders and provides accuracy of ± 2 m and a maximum range of approximately 85 km.

d. *Satellite Navigator:* Magnavox Type 1107, providing ship's position to within 35 m from a single satellite pass.

These four systems are currently fitted onboard and are interfaced with the SIPS system. Provision has been made to allow Loran C, Pulse 8 and Syledis to be fitted.

Oceanographic Equipment

A limited amount of oceanographic data gathering equipment is currently fitted and is mainly intended for use whilst operating on the continental shelf.

a. *MK 8 Sippican Expendable Bathythermograph:* The system measures and records sea water temperature and sound velocity. A permanent record is displayed. The data is obtained from an expendable probe which is launched overboard, sinking at a known rate whilst transmitting data over a fine wire.

b. *Navitronic Sound Velocity Probe:* This system is designed to measure the actual sound velocity profile in water whilst underway. It is a fully portable, battery operated system which does not require a power or data link between the probe and the surface. When the probe is lowered, sound velocity is automatically recorded and stored in solid state memory which is read on recovery.

c. *Direct Reading Current Meter (DNC-3):* This is a portable system designed to measure and display velocity and direction of currents. The instrument operates by continuously sampling the direction and average velocity, displaying the readings on a surface readout unit.

In addition to the equipment mentioned above, the ship is fitted with an 'A' frame stern gantry and bottom sampling winch both of which may be used to deploy oceanographic sensors.

Boats

Two survey launches are carried in Lum davits, each located abreast of the funnel. The hull, 8.9 m overall length, 3.6 m beam and 0.5 m draught, and the cabin top are of GRP construction with GRP seating arrangements bonded to the hull. Each launch is powered by two Perkins diesel engines with each engine driving an output shaft and propeller. The carrying capacity is for three persons, together with 1118 kg of stores. The boats are fitted out as surveying platforms with a Racal Miniplot system interfaced to Trisponder and Hyperfix; they also have a sidescan sonar and are fitted with a heave filter in conjunction with the 780 echo sounder. An Avon Searider inflatable boat, equipped with a 90 hp outboard motor, is also carried principally for lifesaving purposes; it is launched and recovered using the after deck crane.

Radar

Two navigational radar sets, Racal Decca 16" ARPA display type 65430, and an emergency Decca type 170 set, are mounted on the bridge adjacent to the navigational plotting area.

Logs

Two logs are fitted, the first a Chernikeef Aquaprobe electromagnetic log and secondly an AMETEK Doppler current profiler. The latter not only obtains a current profile in a column of water, but also may be used in a bottom track mode which, by measuring the fore/aft and athwart ship's velocity components corrected by gyro compass, can display the accumulated distance travelled from a designated starting point. This 300 kHz system will typically acquire and track the bottom to a depth of 200 metres.

SURVEY INFORMATION AND PROCESSING SYSTEM

Background

The system is designed to aid all aspects of a hydrographic survey from planning to final fair sheet production. It includes a variety of graphics displays which enables the surveyor to monitor on-line the data being collected. Sophisticated computer processing and cartographic capabilities allow the final data to be presented with a new degree of flexibility in a variety of forms. Initially, the use of automation to assist in the progress of coastal surveys touched only on the areas of position computation and plotting the ship's track. However, with the impetus from oil and gas exploration, a new generation of computer-based navigation and surveying systems has become available in the commercial sector, and has allowed the Hydrographic Department to take advantage of these advances and to install the Royal Navy's first automated logging and processing system for bathymetric surveys. Designated the Survey Information Processing System (SIPS) it has been developed to suit hydrographers' particular needs in association with Qubit UK Ltd as Ministry of Defence contractor.

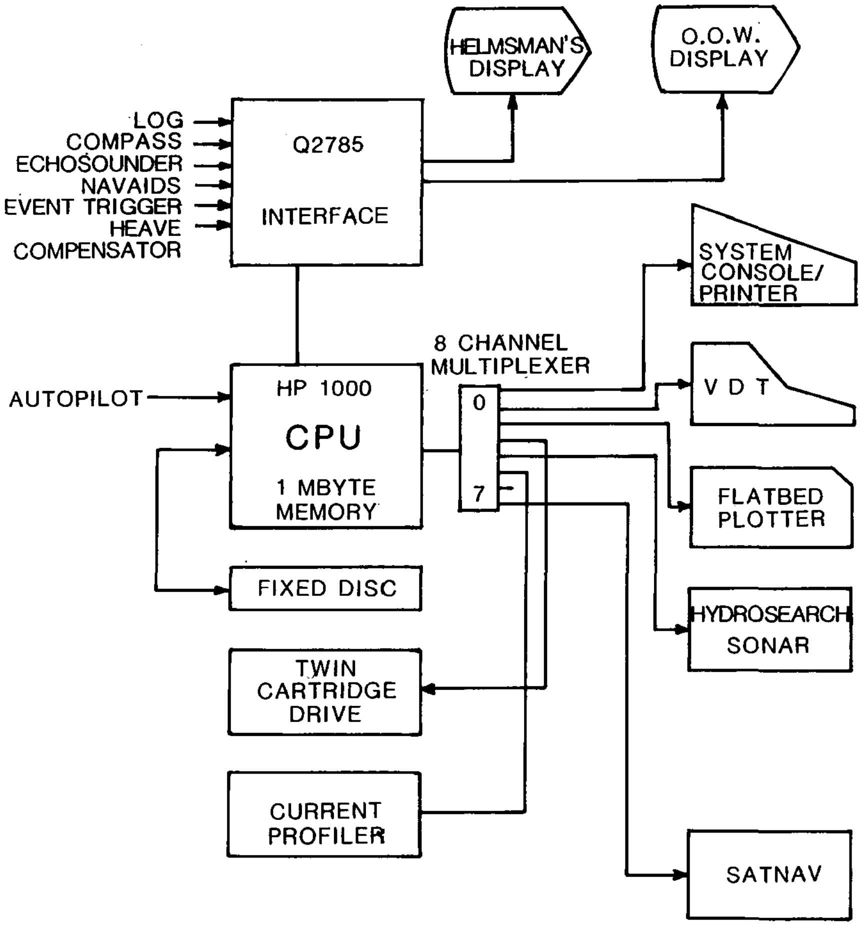

FIG. 2. — Data Logging System (DLS).

The objectives are to improve survey accuracy and presentation, to ease the handling of the voluminous amount of data involved, and to reduce the repetitive aspects, thereby allowing the surveyor to spend more time on the exacting task of quality control of the survey. The following description concentrates on the way the system's graphic and cartographic capabilities help achieve these aims for the surveyor at sea. SIPS is designed to provide a real-time aid to navigation, data logging and onboard processing. To meet this task it is divided into two subsystems, one for data acquisition and one for data processing.

Data Logging System (DLS)

This is located on the bridge and is centered around a Hewlett Packard HP1000 mini-computer. The peripheral equipments comprise an AO-size flatbed plotter, a terminal and two strategically mounted high-resolution colour displays:

one for the officer of the watch, another for the helmsman. The computer is interfaced to a wide variety of navigation and surveying sensors, such as depth measuring echo sounders, heave compensators, gyro compass, logs, sonar and a variety of electronic position fixing equipment (Fig. 2). Observations from all these inputs are logged onto magnetic tape cartridges for transfer to the data processing system.

Data Processing System (DPS)

This is based around a separate but identical mini-computer located in the chartroom. It differs from the DLS in having a faster AO-size drum plotter, a high-resolution graphics terminal and a digitising table (Fig. 3). The outputs are a set of processed data on cartridges and a variety of hardcopy cartographic products.

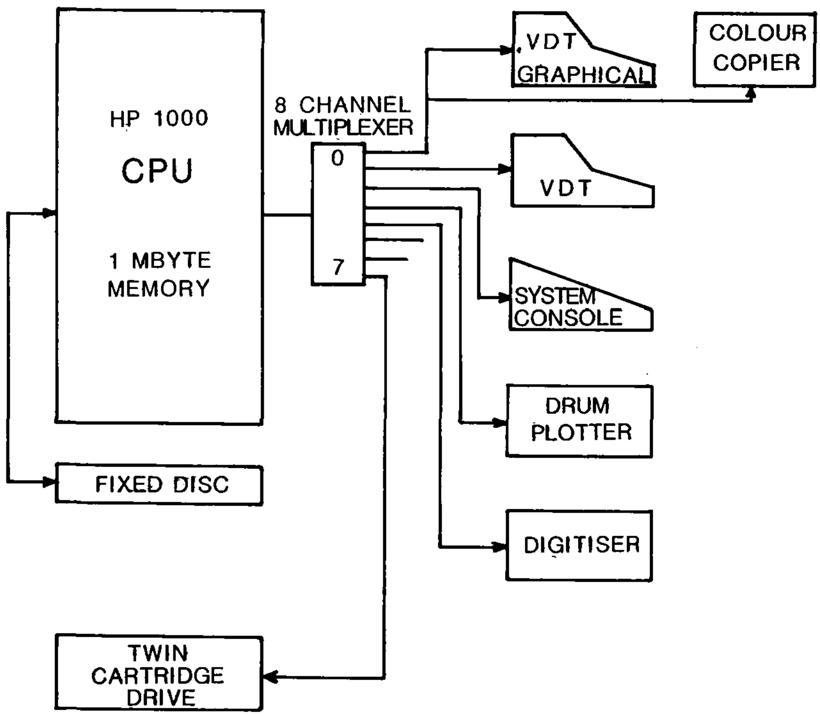

FIG. 3. — Data Processing System (DPS).

System Displays and Output

The use of SIPS divides into four functional areas: survey planning, surveying (real time navigation and logging), data analysis and reduction, and presentation of results. Displays can be either ephemeral on one of the video

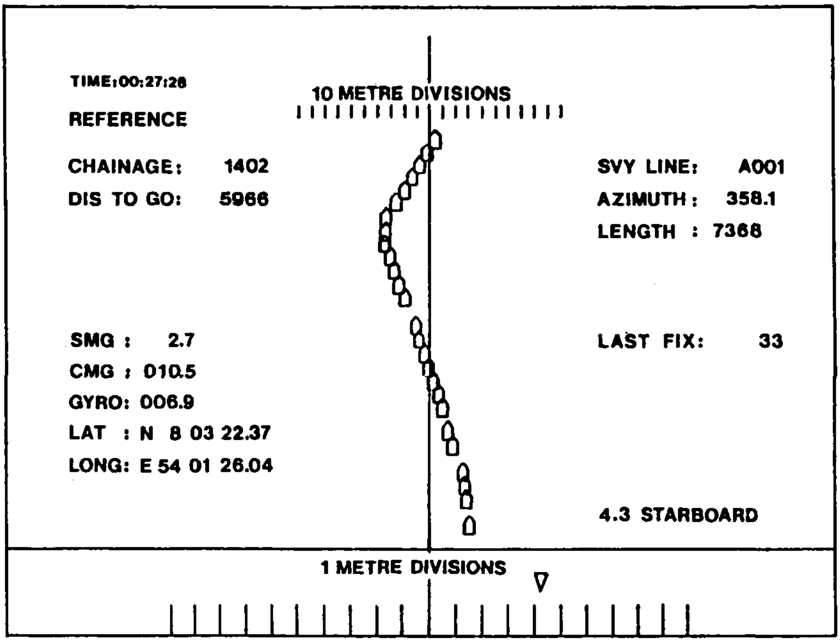

FIG. 4. — Left/Right Indicator Display.

monitors or onto hardcopy. Hardcopy documents can be generated in the planning phase and predominate in the final presentation of the results of the survey. The visual displays are used principally whilst navigating, when constant updating is required, and for interactive editing during data processing.

Survey Planning

The planning phase can be carried out on either system but normally will be done on the chartroom equipment. The lines along which the ship will survey are automatically generated in grid terms, given the area to be surveyed, the spacing between the lines, and the first line to be run. Files are created of, for example, hazards, features requiring investigation, navigation marks and the coastline, using either the digitising table or by keyboard entry. Symbols are drawn from a library of standard Admiralty-style chart symbols. Base sheets, optionally with navigation lattices, can be plotted with this information. Whilst none of this is particularly novel ashore, onboard it gives the ship significant operational flexibility both in the production of planning documents and in the way information can be displayed. Additionally, amendments to the surveying plan can always be made on-line without disrupting the main task of logging.

Surveying: Real-time Navigation and Logging

Data collection for a routine bathymetric survey may well involve the simultaneous collection of data from up to a dozen different sensors. Monitoring the incoming data in the past has been limited to spot checking the reading of an individual piece of equipment and the production of a trackplot on a plotter. SIPS firstly records the raw readings from these sensors for later processing and, secondly, it integrates and processes the data on-line, presenting relevant information to the surveyor. The presentation is achieved by means of a series of textual and graphical displays. Textual displays are used to summarise the data currently flowing into SIPS. A series of graphical displays affords an easily assimilated summary of navigation information, coupled with the more critical data from the sensors such as depth, course and speed.

The principal display that will be used by the helmsman is the left/right indicator (Fig. 4). It provides the ship's track past and present superimposed onto the planned survey line, against which the ship's position can be constantly monitored. Meanwhile, the officer of the watch can be evaluating the accuracy of the position fix using an error ellipse display (Fig. 5) which gives a visual presentation of the lines of position emanating from the various navigational aids. Position fixing remains one of the main problems in hydrographic surveying and demands constant checking. SIPS provides the information for the surveyor to judge its reliability and then to take steps to obtain the best position calculation for the ship.

The information input during the planning stage, such as hazards, the coastline and shoals requiring investigation, can be displayed on the screen, together with the survey lines to be followed or the track already completed. Alternatively, a target display can be chosen centred on, for instance, a wreck or natural submarine feature requiring investigation (Fig. 6). This display includes a series of range circles centred on the pre-selected point at the chosen scale. Again, cartographic information on file can be added to the ship's position. For

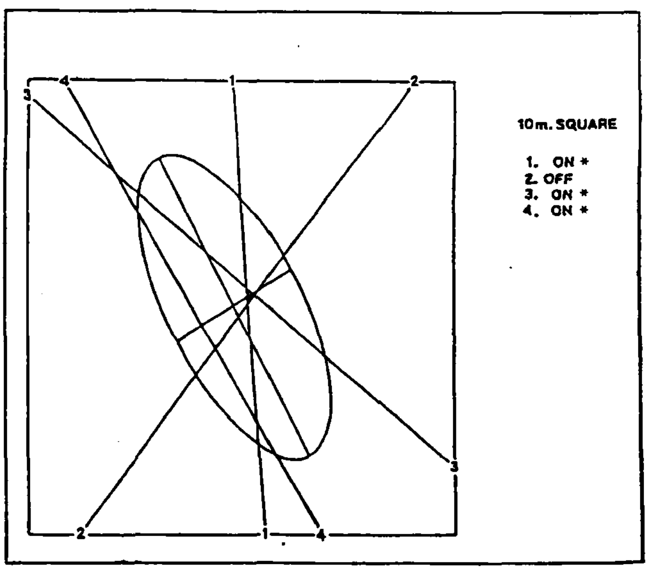

FIG. 5. — Error Ellipse Display.

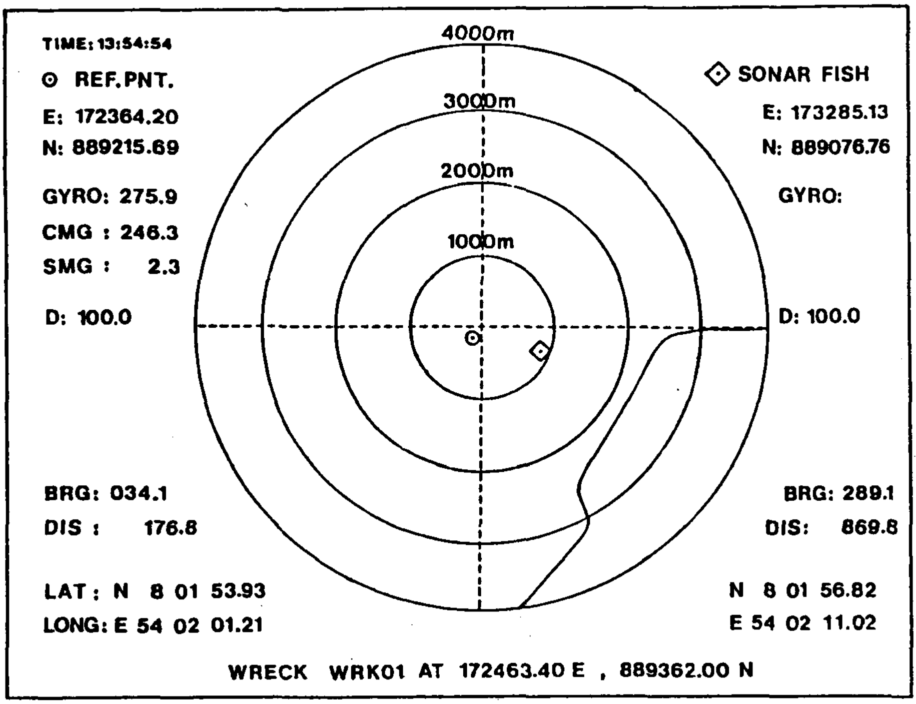

FIG. 6. — Target Display.

investigation of wrecks a very large scale can be selected and, as well as the ship's position, that of a second ship's position (required in wreck sweeping) or a towed sonar can also be displayed. All this aids the precise manœuvring necessary in this type of operation.

In practice, these displays are also backed up by a continuous small-scale hardcopy plot of the ship's track, plotted together with any wreck contacts discovered, but it is the visual display unit that has now become the focal point for the surveyor on the bridge.

Together, these displays provide regularly refreshed information for controlling and scrutinising the survey processes as the survey progresses. The variety of display options enables the surveyor at sea, for the first time, to monitor the quality of his observations properly using quantitative data.

Data Quality Analysis and Reduction

The manual extraction of depths from analogue echo-traces and their reduction to a common vertical datum is exacting and time-consuming. The depths are, in time-honoured fashion, 'inked in', first on collector tracings, then on final 'fair sheets'. Apart from the time these tasks take, a further disadvantage is that there is inevitably a degradation in accuracy resulting from some of the subjective procedures on the manual transcription of data. This can now be eliminated by manipulating the raw digital survey data. With the introduction of computer processing the aim is to remove some of the sources of error and to speed up the production of the final survey results.

Depths may have to be logged at 10 values per second to ensure pinnacles are not missed. The result is a vast amount of data which inevitably contains spurious or redundant information. The object of processing is to produce a reduced, valid, manageable data set. Procedures are still being refined but the underlying philosophy is that they should achieve a balance between software and human intervention. The surveyor has the opportunity to select parameters for the various filters used in the processing, and subsequently has the ability to verify and edit the computer's choice.

The first element to be processed is the ship's position. The values used can be those computed whilst logging but, as all raw data is collected, there is the option, for example, to re-configure or adjust calibration values. Once a 'best position' has been computed the ship's track can be smoothed to remove spikes in the data, for instance those caused by outside radio interference or perhaps the malfunction of a particular shore transmitter. The results are viewed on the screen, checked and, if necessary, interactively edited before the optimum track is plotted onto a base sheet.

Armed with the best ship's track the next stage is to remove erroneous return signals, caused perhaps by fish or aeration, from the logged bathymetry.

This data is processed by viewing the depth profile on a graphics terminal. The horizontal and vertical scales can be adjusted to suit the variation in, and density of, the data. The computer has a 'first go' at finding the errant returns, but the software is not left totally to its own devices. The operator has to set values used in the selection algorithms. This choice affects the effectiveness of the automation and gives the surveyor more control, or at least the feeling of having more control! Additionally, there is the option of editing the automatic selection, by moving a cursor along the profile and tagging or deselecting soundings. At the very least the software draws special attention to areas of data that require special consideration.

At this stage one of the prime objectives has been achieved. A file containing time-tagged accurate positional and valid depth information exists. The bathymetry has been corrected for the ship's heave and the file contains the appropriate tidal values required to reduce the observed depths to a common vertical datum. However, the data has still to be presented in conventional forms for both the end-users and for the surveyor's own use in quality control. The profiles that have been viewed on the screen can be plotted out, either on a large scale to overlay the echo-trace or on a small scale for a whole survey line's worth of data. If the information is required in plan form, the depth data set has to be reduced still further to plot it on a reasonable scale. Chart-making and surveys are based on the principle of presenting shoal depths critical for navigation. This has to be reconciled with giving as representative a picture of the seabed as possible. Further software routines aim to do this firstly by selecting minimum and maximum soundings within a 'window' set by the operator. Having chosen the scale of plot and sounding size, 'infill' depths are then selected, or depths are removed if there is likely to be a clash. As before, the surveyor can view the profiles on the screen (or plot the profiles) and edit the choice of soundings, if necessary.

So far these methods have only dealt with data along individual lines. A normal survey has areas of intense investigation, as well as check lines run perpendicular to the normal survey direction. This extra information may contain critical depths which are required in the final data set. Another software routine compares soundings in two dimensions from adjacent or crossing survey lines, selecting the shoal soundings where there would be a clash at the chosen plot scale.

So we now have the means firstly to achieve valid data, and secondly to reduce the information into a manageable data set. This is the starting point for the conventional cartographic products.

Presentation of Results

The currently accepted international convention on nautical charts is to show depths as individual spot values, supplemented by only a limited number of contours. This forms a constraint within which the presentation of hydrographic survey data must, for the moment, abide, continuing to produce sheets of

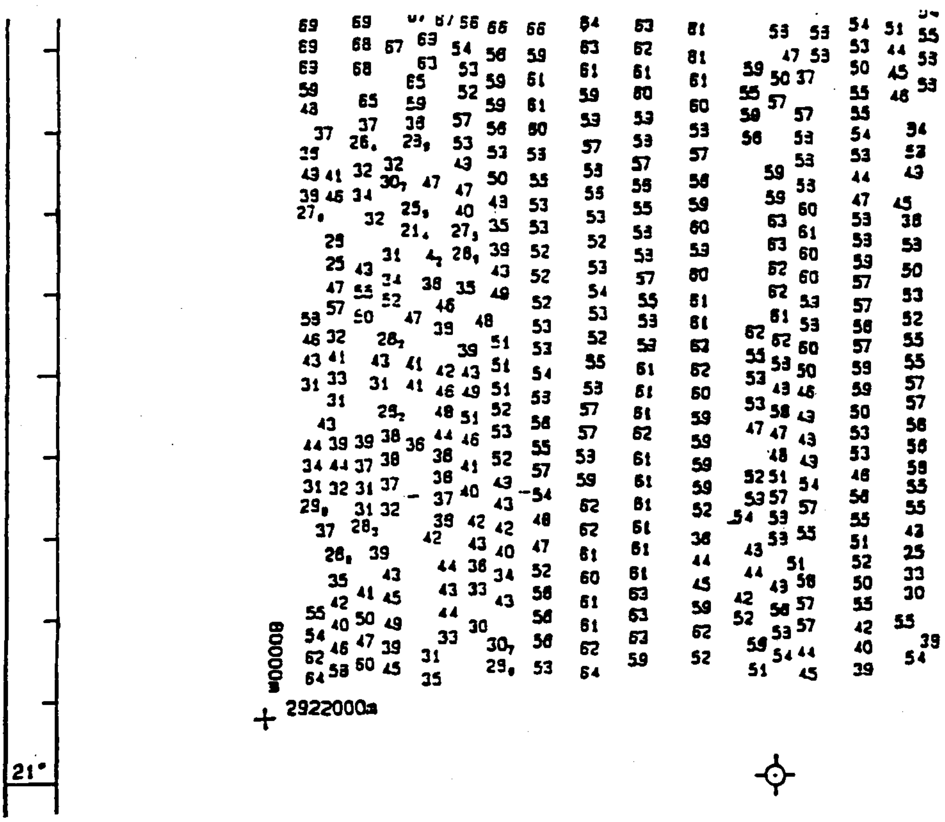

FIG. 7. — Automatically Plotted Survey Fair Sheet.

soundings for a chart compiler to use (Fig. 7). Automated cartographic methods can enhance presentation, speed up production, give more precise and consistent results, and allow much more flexibility in the final product. The starting point is the base sheet which can be generated, as in the planning stage, complete with textual title information and features plotted with a range of Admiralty style symbols. The track of the ship and the projected track of a sonar fish (a body towed some distance behind the ship) can then be plotted, allowing the surveyor, and later the office, to assess the thoroughness of the survey and sonar coverage.

But it is in the plotting of bathymetry where most improvement lies. Depths can easily and rapidly be plotted onboard not only at the required survey scale, but at enlarged scales in areas of detailed investigation, for example. The eight pen plotter allows the depths to be shown in colour bands which can be used to distinguish contours or highlight seabed features. Three-dimensional plots, viewed from whichever direction required, are produced either on the screen or paper. On a practical level these are an excellent 'long stop' for detecting spikes in the depths. At the Hydrographic Department they should aid the chart compiler in assessing the adequacy of his depth selection.

Other options allow surveys to be compared with previous work, plotting the result as a depth-difference choropleth chart; this is particularly useful in the sedimentation studies carried out by the Department. Of more use onboard is the comparison that can be done where survey lines intersect. Cross lines are run as a matter of course to check on the main sounding profiles; the system outputs a plot of depth differences at the line intersections. An excessive value flags the necessity to check, for instance, that the tidal adjustment is correct.

Results of Trials to Date and Lessons Learnt

It was only at the beginning of the New Year that a 'certificate of clearance' was granted, enabling ship's staff to have unrestricted access to the system. All initial trials had been completed by the end of 1986 with promising results. Trials since acceptance have consisted of some 72 hours of data logging and subsequent processing. It would be totally inappropriate to pass judgement on the system after such little experience; however, it is already apparent that SIPS offers a radical change to traditional methods and thinking. There will be enhanced quality assurance and considerable time saving in data rendering even though up to 60 times more data will be collected.

A number of lessons have already been learnt as a result of the introduction of SIPS. Since the whole system is such a large leap ahead from 'traditional' survey methods, the need for preparation in the form of computer familiarisation and training for all operator personnel is of paramount importance. Such a system as SIPS has illustrated how very powerful a tool computer technology is in the prosecution of hydrographic surveying. In the interests of effectiveness and efficiency, further developments must be pursued. The latest lesson learnt so far concerns the time required to process data. The final presentation of data can be achieved particularly quickly, but the time required to process is likely to remain lengthy.

HYDROSEARCH SECTOR SCANNING SONAR (Sonar 2033BB)

Sonar Type 2033BB is a Hydrosearch sonar designed to incorporate changes in technology that overcome operational shortcomings found in the earlier system 2033AA installed in HMS *Bulldog*. Changes have been made in areas such as data presentation, operator control and the stable platform.

Major Features

The equipment takes the form of a within-pulse sector scanning active sonar working at 180 kHz, designed specifically to meet modern hydrographic requirements. The sonar system comprises of:

a. Hull mounted electrically stabilized array head containing the transmitting and receiving transducers, stabilization being achieved by reference to the ship's gyro platform.

b. A transmitter and receiver located in the sonar equipment room which is situated above the sonar trunk.

c. A computer controlled display and control system located on the bridge.

The operator is provided with a real time processed visual display of seabed topography. Recording equipment is supplied as follows:

i) Video display unit (with printer) which displays and/or prints as required the system data and parameters.

ii) Video cassette recorder which records the processed sonar signals as seen on displays, in TV format.

iii) Hard copy unit — installed in the survey chartroom, which permits single sheet hard copies of selected display frames to be taken on demand.

The array head has two basic modes of operating:

i) Horizontal, for sweeping 7° beam width.

ii) Vertical, for height finding.

In each mode the array may be trained 270° in either direction from ship's head to give full azimuth cover. The array housing is mounted in gimbals on the stable platform. The gimbals are maintained in the horizontal and vertical places by reference to the ship's compass input and to the vertical reference gyro which forms part of the equipment.

The platform is housed within a pressurized 1.5 m internal diameter trunk passing up from the keel to the Sonar Equipment Room (SER) located on the main deck. The trunk is sealed and pressurized during operations. A powered winch is used to raise and lower the platform between its operating point at the bottom of the trunk and its stowage/maintenance position within the SER.

A hemispherical terylene fabric dome with an internal PVC lining is fitted to the bottom of the trunk and pressurized to shield the transducer housing and the platform. A steel blanking plate is provided as a closure to the bottom of the trunk as an alternative to the dome.

Operational Aspects

The equipment is designed for one man operation with facilities available for a second observer; 'Offline' independent playback facilities are available in the survey chartroom. The system represents a significant advance in surveying techniques, the surveyor is now able to obtain 100% coverage of a designated area of seabed combined with a high probability of detecting all possible navigational hazards within that area. Furthermore, the nature of such hazards can be assessed and their dimensions determined. The design makes provision for a comprehensive range of recording/replay facilities which enable a permanent record of information gathered to be retained.

Due to the nature of the dome, the ship's speed is limited to 10 knots through the water when it is deployed. If the array head is withdrawn and a negative pressure is created within the trunking, the flexible dome may be withdrawn, thus reducing the ship's draught. The equipment is capable of operating to a water depth of 120 m under all bottom conditions and up to sea state 6 and, although 10 knots is the maximum ship's speed, variations may be necessary to cope with difficult conditions combining a high sea state and difficult seabed topography.

Sonar Quality and Trials

Currently the system is subject to a programme of initial trials and thus has not yet been accepted into Service. However, there is every indication that the following prediction performance will be achieved.

Target	Prediction Range (m)
Sphere 1 m diameter	475
Sphere 0.3 m diameter	405
Icosahedron	545

Detection ranges are subject to many variables such as depth of water, propagation loss, background noise and seawater conditions and only after future trials can a full evaluation be made.

Integration with SIPS

Perhaps one of the most significant features required of the system is the integration with SIPS. The system is designed to transfer relevant contact data to SIPS which in turn transfers data to Hydrosearch. The resulting exchange of information permits contact range and bearing to be recorded and plotted in real time together with height, length and beam. Thus the flow of information available to the on-watch surveyor is greatly enhanced and the sonar information immediately becomes an integral part of any survey.

Evaluation and Trials Programme

An extensive programme of evaluation and trials is currently in progress; it should be appreciated that any such programme involves every aspect of the ship, not only her surveying capability, but also that of ship handling and manœuvrability, main machinery performance and a host of miscellaneous items, including such evolutions as 'Dress Ship'. The specialist surveying aspects cannot be entirely divorced from 'whole ship' aspects for, whilst the Hydrographer of the Navy has issued his trials requirements, the ship as a unit of HM Fleet must undergo a package of trials and evolutions common to all naval vessels.

This package, consisting of some 90 trials, was compiled by Hydrographer. The length of trials varies considerably from the 1/4 day to the three week hydrographic survey. The entire package spans a time scale of approximately 9 1/2 months to which can be added the inevitable delays for bad weather and defects. The trials are sub-divided into four main sections:

a. General Ship
b. Surveying Systems
c. Sonar Systems
d. Boats and Integration.

To oversee and co-ordinate these trials, a Hydrographic Trials Officer (HTO) was appointed to Hydrographer's Staff at Taunton on 1 July 1986. Apart from the co-ordination of all defined hydrographic trials, he is also responsible for analysis of each activity, establishing the necessary documentation for operator procedures/checks and the conduct and rendering of surveys in the light of new equipment. Thus a hydrographic specialist is in a position to devote time to trials and evolutions without compromising the tasks of ship's officers.

Summary

Roebuck and her systems without doubt represent a significant advance in surveying techniques within the Royal Navy. Undoubtedly SIPS will improve the accuracy of surveys and greatly improve the feasibility with which data can be presented. It is expected that certain time consuming tasks will be reduced allowing more time to be spent on quality control as well as speeding up the rendering of data. The final product will now include digital data ready for potential future exploitation, and will be more accurate and error free than hitherto.

The real-time video graphic and cartographic presentation of information is drastically changing life at sea and for the Royal Navy surveyor. For the first time he will be provided with a proper measure of control over both the observations and the way in which they are presented.

Roebuck is continuing her programme of trials and evaluation and is shortly embarking on a comparison survey of an area surveyed to modern standards off the UK South coast. Shortcomings are inevitable, and some have already been identified, but by the late summer of this year it is envisaged that this surveying platform will be engaged in the production of original surveys to standards hitherto unachieved.