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NEW METHODS IN HYDROGRAPHIC SURVEY

by Anthony G. STEPHENSON
Gardline Hydrographic Surveys, Inc.

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An ambitious engineering project to lay pipelines across the Straits of Florida from West Palm Beach to the northwestern tip of Grand Bahama Island required a detailed survey of the Bahamian Trench and of the very steep fall-off into it from the Grand Bahama Island.

The initial approach was to obtain a very perfunctory knowledge of the general trend of the slope off the bank from Freeport to the northwest tip of the Grand Bahama Island and northwestward for 8 miles to Memory Rock. These lines were to be used primarily if the optimum area showed no promise of even slopes off the bank (fig. 1).

Following the coarse survey the plan was to run sounding lines perpendicular to the contours at approximately quarter mile spacing and compare the records to observe gradient changes.

These lines would be supported by side scan sonar lines parallel to the contours to develop a sonic picture of slope variations, outcrops of rock or coral, or cliffs. Should areas of lesser gradient or smoother surface be located by this tool, detailed bathymetry was to be undertaken in the areas of interest.

On the basis of all this information a route would be selected and used to take a visual look at the conditions of the seabed.

The horizontal control for the survey was complicated due to, firstly, the wide area over which control was required and, secondly, the lack of suitable land areas north of the island. To control the survey by the conventional range/range method would have required lengthy search for very old triangulation monuments and a subsequent land survey to develop suitable points on which to locate the shore stations. Though arduous and time-consuming, this could have been achieved along the southerly coast of the island, but was not possible north of the island without using a small boat to gain access to the small islets.

These problems were recognized prior to mobilization and it was decided to use a Hydrobar, a range/azimuth positioning system that was originally developed for the control of hydrographic surveys in narrow waterways, in order to reduce the large amount of shore control required when using

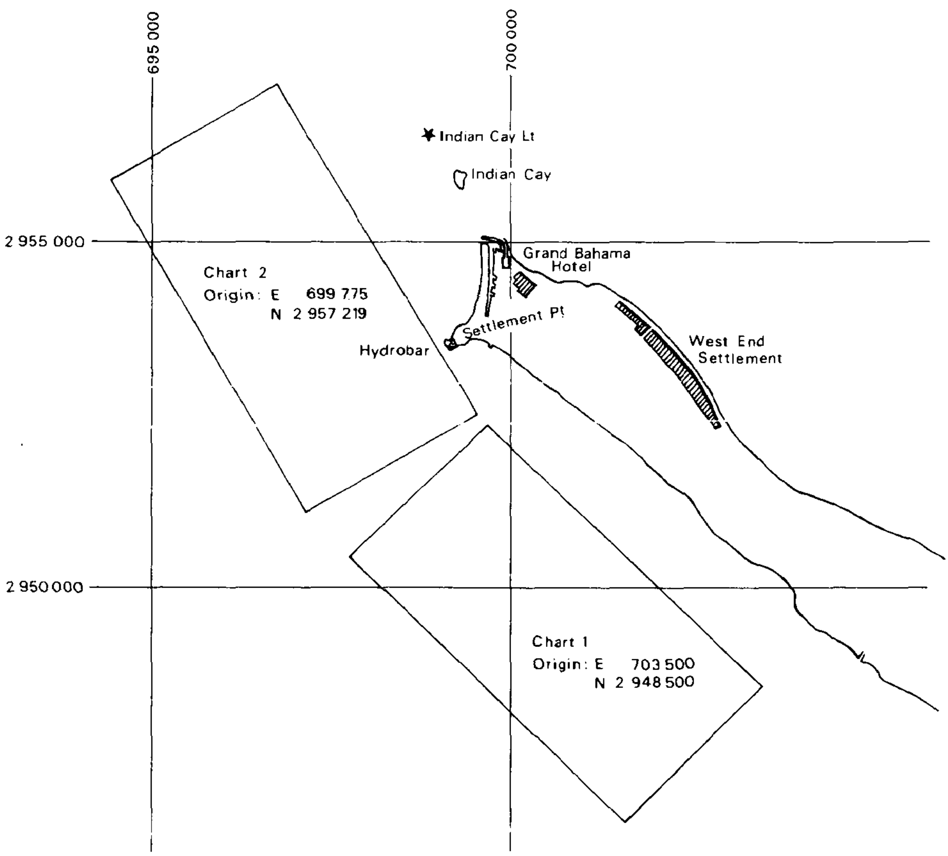

FIG. 1. — Detailed survey charts of the area. Scale 1/100 000.

range/range positioning. Hydrobar is a semi-automated system in which the angle measured by the theodolite is transmitted to a receiver onboard the vessel. The observer first zeroes the instrument on a reference object of known bearing and then, as he tracks, the bearing of the vessel is transmitted to it, either continuously—twice a second—or on command, as he presses a pushbutton at the moment of the fix.

Range is measured independently, by any of the common microwave systems, to a shore station placed over the same survey monument as the theodolite tripod, so that aboard the vessel both the range and bearing from a single point are available. One range of a Trisponder system was used for the survey. The bearing discrimination is 0°0'.01—better than 1 foot per mile—and the position lines always cut at 90°, so that at short ranges the system gives better accuracy than any other electronic system. There was, however, considerable software manipulation required to achieve the inherent good accuracies. This was due to the fact that the range bearing and depth arrive at the receiver asynchronously and have to be married to the true time of transmission. The method was ideally suited to the area to be surveyed in the Bahamas as the whole survey area could be controlled from one point.

The Hydrobar system was used in conjunction with Hydrocarta, a fully automated hydrographic data acquisition and plotting system. Following each day's work, it was essential to plot up the data so that decisions could be made on the area to survey the next day. The Hydrocarta system accepts most positioning systems including the range/azimuth Hydrobar; the position values are read as often as they are available, typically once a second, and converted into x and y coordinates. These positional updates are used to plot the boat's position continuously on a previously prepared chart which may be on any scale. The Hydrocarta plotter is shown in fig. 2, and peripheral sounding and side scan equipment with it in fig. 3.

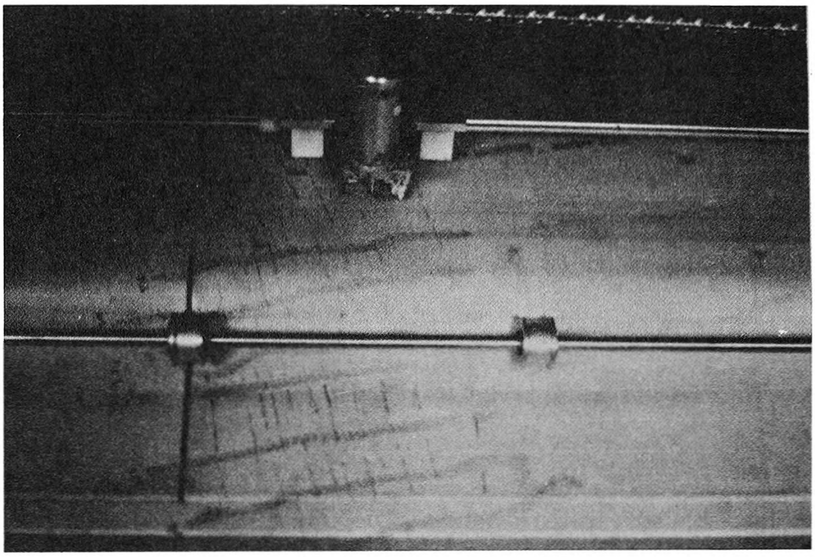

FIG. 2. — Hydrocarta plotter.

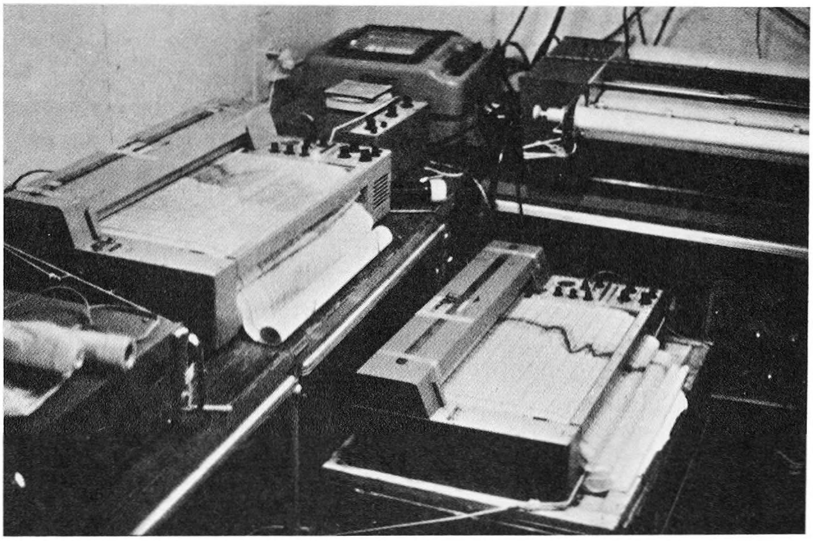

FIG. 3. — Plotter (upper right) with peripheral survey equipment.

The remote left/right display gives guidance to the helmsman, also being updated on each computed postplot. The system is interfaced to an echosounder through a digitizer and records every depth, with time and position once a second, on magnetic tape. At any interval of time or distance a fix is generated, drawing a cross on the chart and printing out the time, fix number, range, angle, x-y position and depth. Simultaneously, event marks are drawn automatically on the echosounder and side scan sonar analogue records.

At the end of the day, after the observed tide readings are available, an offline program reduces the depths to chart datum, selects soundings and plots them in their true position to any scale, with options as to the form of editing required and the size of soundings. Since every depth is available to the computer at this stage, it is able to distinguish between bottom echoes and false echoes with high reliability and the resulting chart has a greater accuracy than can be obtained by hand.

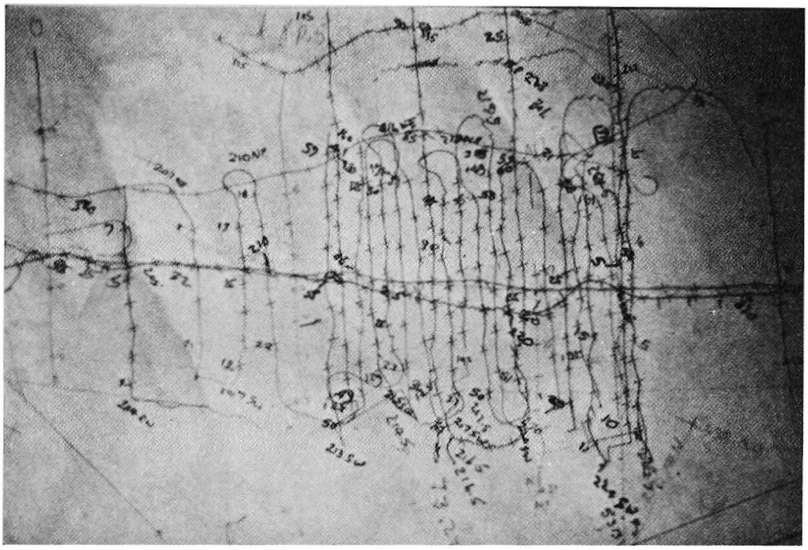

FIG. 4. — Real time track chart, hand annotated, Crosses are keyed to automatic printout of survey control and depth data.

While mobilization of the equipment was being undertaken onboard a chartered boat (fig. 5), a search for an established control monument was made in the Bahamas. A mark was located at Settlement Point that had the advantage of seeing all of the area of priority, but it was only just above sea level. To obtain a greater line-of-sight, a wooden tower 16 feet high was built over the mark and completed prior to the survey vessel's arrival in Freeport (see fig. 6).

The sophisticated combination of positioning and data collection, however, was of little avail when out of visibility range. Thus the initial reconnaissance lines run into the coast, working north from the south of the area, were controlled by sextant, radar and azimuth circle, plotting

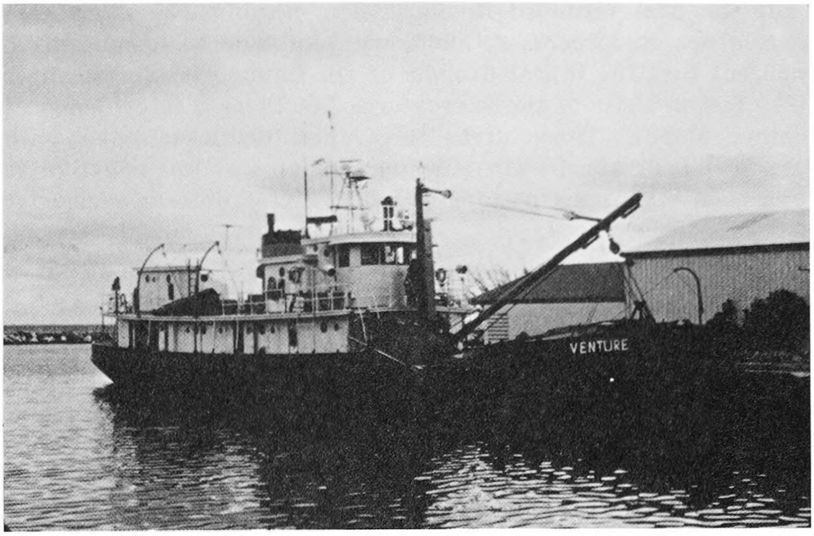

FIG. 5. — Chartered ship utilized in survey.

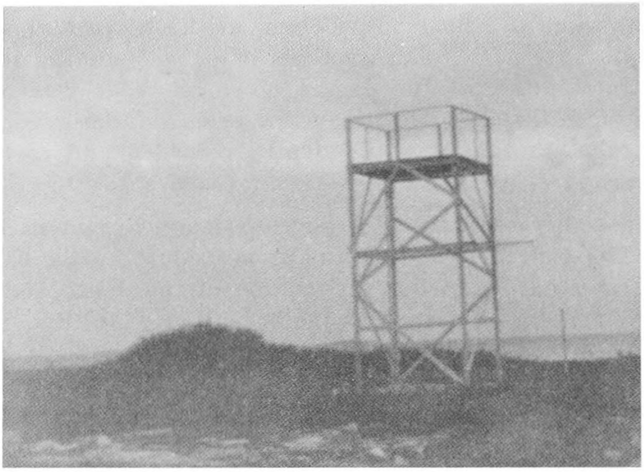

FIG. 6. — Survey control tower.

by hand on the largest scale hydrographic chart until approximately 5 miles away from the control station, when the vessel became visible. This first day of sounding ended at the commercial dock of the Grand Bahama Hotel at West End.

The next day the work continued north at one mile and 1/2 mile intervals to 8 miles north of Settlement Point.

These long distances made apparent the variable visibility conditions from day to day. The observer on the tower could only see the boat about 5 miles on the first day, though range and azimuth transmissions were received 17 miles away, but on the second day he had no trouble in seeing the boat at 8 miles.

While the boat returned to dock each evening, the day's soundings were plotted up and processed, along with the side scan runs. It became very apparent that the initial dropoff of the bank was almost sheer from 150 to 270 feet in most of the survey area but there was evidence of areas of smoother slopes. These areas were then detail sounded with lines 50 meters (164 feet) apart. The side scan sonar was less effective over the slope area than where the bottom was flat, but it did show clearly where the cliffs were to be found.

The project to this stage included nearly 100 survey lines and nearly 50 miles of side scan lines, and had taken eight days on site. All information had been plotted and contoured.

The final stage for this investigatory survey was to bring in the submersible to take video pictures of the areas of interest down to about 1,000 feet. The survey vessel returned to Miami to mobilize the submersible while the survey data tapes were taken to the office in Houston for preparation of the final charts.

The client required both a conventional hydrographic chart and cross-sections from which he could compare the bottom slope on different lines. It was difficult to do this on the echosounder records because variations in the current, wind and boat speed changed the horizontal scale. It was decided to draw up true to scale sections of each sounding line to obtain a realistic understanding of the degree of slope. This was done directly from the data tapes through another offline program, designed for dredging surveys, that takes the position and depths recorded and plots the profile to any combination of vertical and horizontal scales (see figs 7 and 8).

More than eighty sections were developed and drawn in India ink on plastic film. The general trend of the slopes could easily be seen but it was also apparent that erroneous digitization of the depth had occurred in some areas. This was due to two factors. Firstly, although as can be seen in fig. 9 the outboard mount for the echosounder transducer was gimbaled to reduce errors as the boat rolled, the narrow 7 ½° beam of the transducer was sweeping up and down the steep slope as the boat pitched, causing a ragged seabed appearance, and secondly the side lobe of the sonic beam from the transducer was periodically digitized causing a sudden reduction in depth, though still following the seabed profile. This was not so evident in the bathymetric charts, due to the editing process and the smaller scale.

The section, however, drawn at a scale 1 : 2 000 plotted all soundings returned, 4 per second, showing all the imperfections actually received. Fortunately, the human eye can do its own editing and draw a line through the serrations of the swinging transducer beam and perceive the true trend below the side lobe effect.

When laid in order on top of each other, the sections can be seen successively through the plastic film and yield a three dimensional effect. In this way, it was noted that even in locations that appeared to have little or no sudden drop, profiles close by showed evidence of steeper slopes. It was thus proven that though some areas had smooth slope conditions, they were very localized.

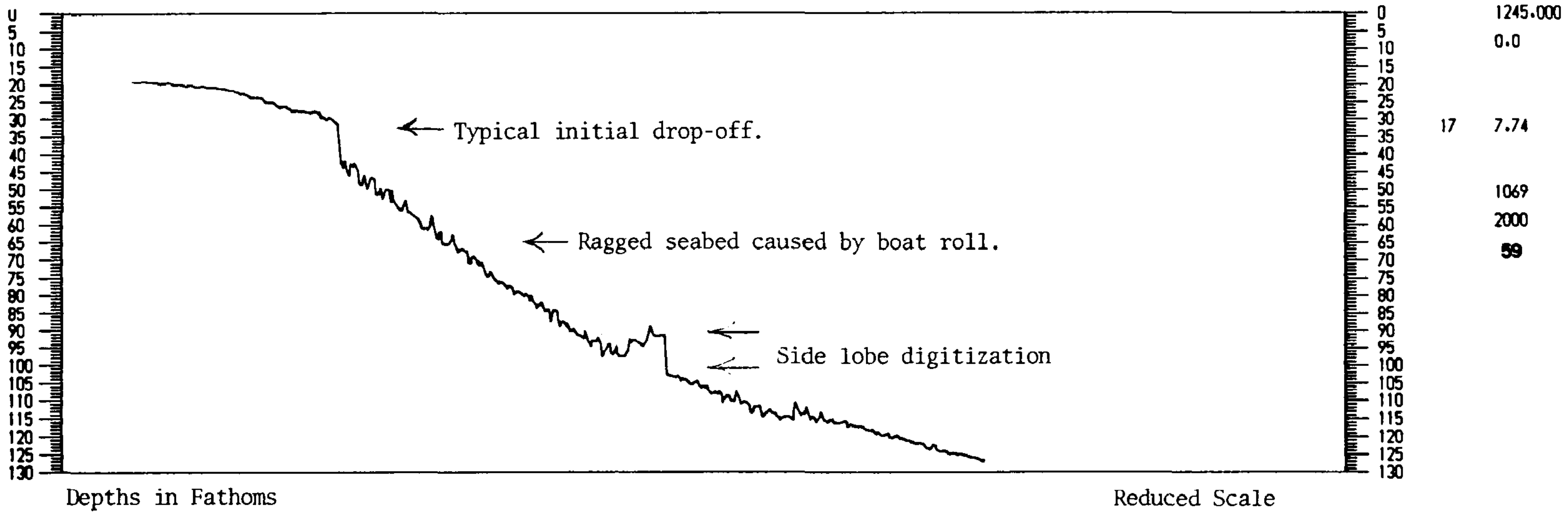

FIG. 7. — Section showing the ragged seabed and side lobe digitization.

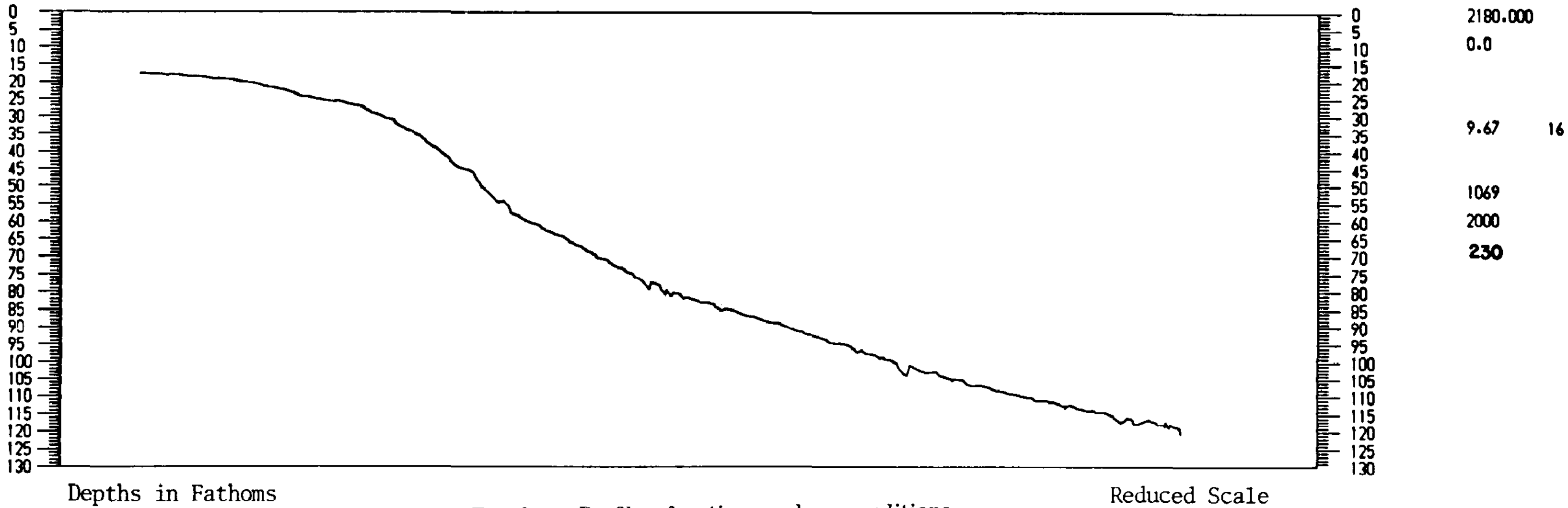

FIG. 8. — Profile of optimum slope conditions.

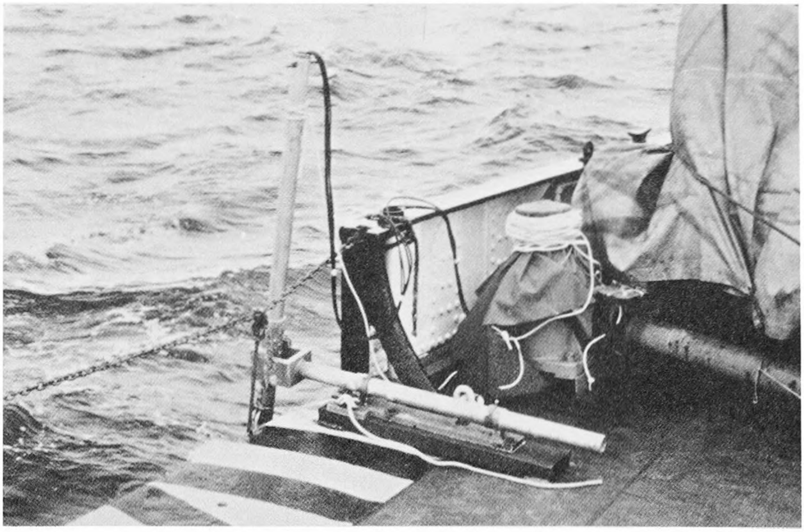

FIG. 9. — Outboard mount for echosounder transducer.

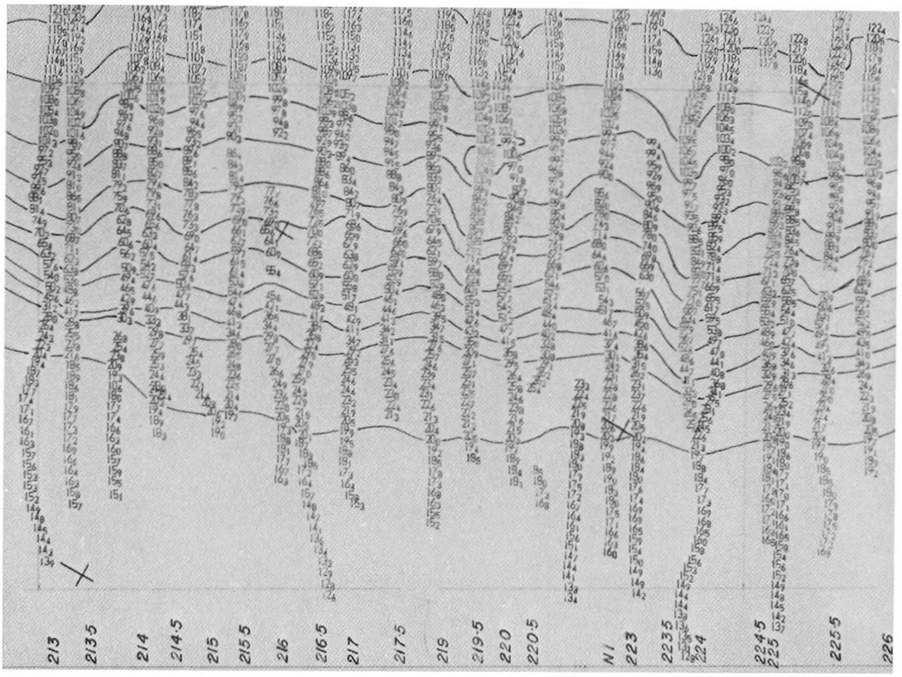

FIG. 10. — A portion of a chart drawn by Hydrocarta. Scale is 1/5 000. Depths in fathoms and tenths of fathoms.

While this fact was being observed in Houston by the drawn sections it was also being proven by the submersible in the Bahamas. Diving in the selected areas, it recorded smooth to steep variations in the bottom slope. The submersible also noted coral outcrops of up to 10 feet in localized areas.

The bathymetry and positioning was undertaken by two hydrographic surveyors onboard one vessel and the Hydrobar station was manned by a local surveyor. Other personnel onboard in charge of the sub-bottom profiling and side scan sonar were under a separate contract. No draftsman or hand plotting by the surveyors was required. The preliminary charts for each day's work took approximately one hour to draw up automatically (fig. 10).

This survey operation showed that modern survey equipment, with the capability of providing a variety of data presentations for onsite decision-making, adds a new dimension to site surveys. It also showed, however, that a high degree of professional judgment, with awareness of each piece of equipment, is also necessary if the best use is to be made of the information obtained.

A QUESTION OF VALUES

The increase in man-made disasters on a worldwide scale highlights that technology has raced ahead of common sense. The word "technology", as used today particularly in political corridors, came from the 17th century Greek signifying art, shape and construction.

What skilled carpenter would send a truck carrying tons of volatile explosives down a country lane to save a $ 15 toll at the expense of 200 lives? Who is there to evaluate the total lack of common sense surrounding movements of similarly dangerous substances all over the globe? We have become spectators of tragic events that will jeopardize the existence of our great grandchildren.

Look at the values in the oceans, where millions of tons of hydrocarbons are carried from place to place and where the word "bonanza" is used for oil discoveries. The extraction of fossil fuels is pressed forward at a rapid pace by profligate waste, both in unproductive energy expenditure and in pollution caused by so-called "accidents".

"Accident" is defined as "an event without apparent cause", but the causes of most catastrophes at sea are too human and all too apparent. This repetition and proliferation will continue if the laws of maritime countries remain unchanged.

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The game of roulette played by vessels carrying lethal cargoes will soon reach a crescendo if nothing is done to change the present chaos. Marine insurance knows it too well, and a study of ship casualties becomes a chilling chore.

(Continued on page 40)

A QUESTION OF VALUES

(continued from page 39)

The ultra-rapid building of ultra-large tankers was not followed by ultra-efficient training of men to man them. This paucity of good seamen is compounded by boredom at sea where many duties traditionally performed by men are now automated. If one adds to this lamentable chain of events that only a small portion of world waters have been surveyed since the days of leadline, one begins to comprehend the urgency of early action.

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The skill of a master and his officers is judged by people with minimal knowledge of the seas and who rely on insurance policies to keep them financially buoyant. The well-managed fleets with experienced masters and crew suffer competition from ill-trained foolish ones.

Both on land and at sea transportation of dangerous chemicals should be prerouted and escorted by police, Coast Guard or military when in congested waters into their ports of destination.

So it is a question of values — of order of magnitude. How many more tankers carrying oil are to spew their cargoes into the already polluted oceans for want of ordinary commonsense precautions? How long must hydrographers facing a mammoth task contemplate grossly unseamanlike navigational practices costing billions, when they are starved of millions to do their vital work?

We have only a short time to learn our values.

Excerpts from a contribution by James DAWSON, a London Insurance Broker, to *Sea Technology*, September 1978, by kind permission of the Editor.