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SOUNDING DATA PROCESSING BY MINI-COMPUTER

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ABSTRACT

The French Lighthouse and Buoyage Service (Service des Phares et Balises) and the Port Autonome de Bordeaux developed in 1980 an original method for the processing of hydrographic sounding data by the use of a desk-top mini-computer.

This method uses the DALI 2 programme for the automatic plotting of the sounding sheet as well as for the calculation of volumes which are essential for the planning of dredging and the study of changes in the bottom topography.

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The experience gained over the last five years by the Lighthouse and Buoyage Service and the Port Autonome de Bordeaux in reconnaissance hydrographic surveys and automatic plotting of sounding sheets has led these two organizations to design a data-processing method, combining their knowledge of the problem with recent great advances in mini-computerized and electronic equipment.

Thus the Port Autonome de Bordeaux which, from 1975 onwards, had used the DALI 1 programme (Automatic plotting of isobaths) written in FORTRAN and designed to be run on a high performance computer, has used, since September 1980, a DALI 2 version written in BASIC language and specially designed to be utilized with a desk-top mini-computer.

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This paper, the aim of which is to explain the new version of the DALI programme, also shows, in the first part, how the equipment that was installed for the DALI 1 system (*) has been added to, modified or adapted so that the DALI 2 system can operate.

ON SITE

1) Naval Equipment

In addition to the small 33 m survey vessel *Gardour* and the 17 m sounding launch *Biganon*, already described in the *I.H. Review* of July 1977, the naval sounding equipment now includes a small unit which was commissioned in January 1980 (fig. 1) and designed to carry out the following:

- hydrographic reconnaissance surveys:
  - in port areas (quays, docks, basins, piers),
  - in the estuary in sheltered areas,
  - on the Atlantic coast in summertime, in very fine weather, no further than 20 miles from the nearest land;
- the lowering of small hydrographic or oceanographic measuring devices weighing not more than 150 kg;
- the fight against pollution by the spreading of a dissolvent on small oil slicks.

FIG. 1. – Sounding launch *Cailloc*.

(*) *I.H. Review*, LIV (2), July 1977, pp. 61-86.

Its main specifications are:
- overall length: 9.25 m
- moulded breadth: 3.50 m
- draught loaded: 0.90 m
- speed: 12 knots.

2) Electronic positioning

The radio positioning of vessels in the estuary of the Gironde is carried out using the following systems:
- a Toran radiopositioning system set up between 1967 and 1973 which covers the lower part of the estuary from BXA to the northern point of Ile Verte;
- a Syledis radiopositioning system installed in 1976, covering the area from Pauillac to Bassens in the upper part of the estuary;
- a portable Syledis system intended for positioning in places not adequately covered by the fixed radiopositioning installations.

The simultaneous use of both systems, Toran and Syledis, has highlighted the indisputable advantages of Syledis, namely:
- ease of use, without any adjustment,
- improved accuracy at least by a factor of 2,
- greater simplicity of shore stations,
- easier accessibility,
- simplified maintenance,
- no calibration on site,
- single network with multiple mobile stations.

In view of the very high level of performance of this new system, it has been decided to progressively replace Toran chains by Syledis.

The objectives to be achieved are as follows:
- the coverage of the entire Gironde estuary from Bordeaux to the sea (isobath (– 30 m)),
- an accuracy better than 10 m probably 95 % of the time over the whole area covered,
- the possibility, if specific action is taken, of locally improving the accuracy of positioning to less than 2 m.

At the present time, seaward from Ile Verte, the network operates in the hyperbolic mode. This enables more than 4 ships to work simultaneously.

Upstream from Ile Verte, the network operates in the range-range mode, which does not allow more than 4 ships to work simultaneously.

Shipboard equipment is not affected by the mode. Consequently, the same mobile equipment can operate in either a hyperbolic or a range-range mode.

In the near future (late '81, early '82) a single network comprising 7 or 8 beacons operating in hyperbolic mode will cover the whole of the estuary and the mouth of the Gironde.

3) Tide gauge network

Consisting of 8 remote-controlled tide gauges plus one remote-controlled tide gauge buoy, this network, which, since its implementation, has proved to be extremely reliable, has undergone very few changes.

The logging system on punched cards has been replaced, for the purpose of the DALI 2 programme, by an HP 9885 (Hewlett-Packard) computer connected to the receiver unit responsible for checking the validity of signals received and the identification of the transmitting stations (fig. 2). Magnetic cassettes directly compatible with the system of processing the sounding data are used for storage.

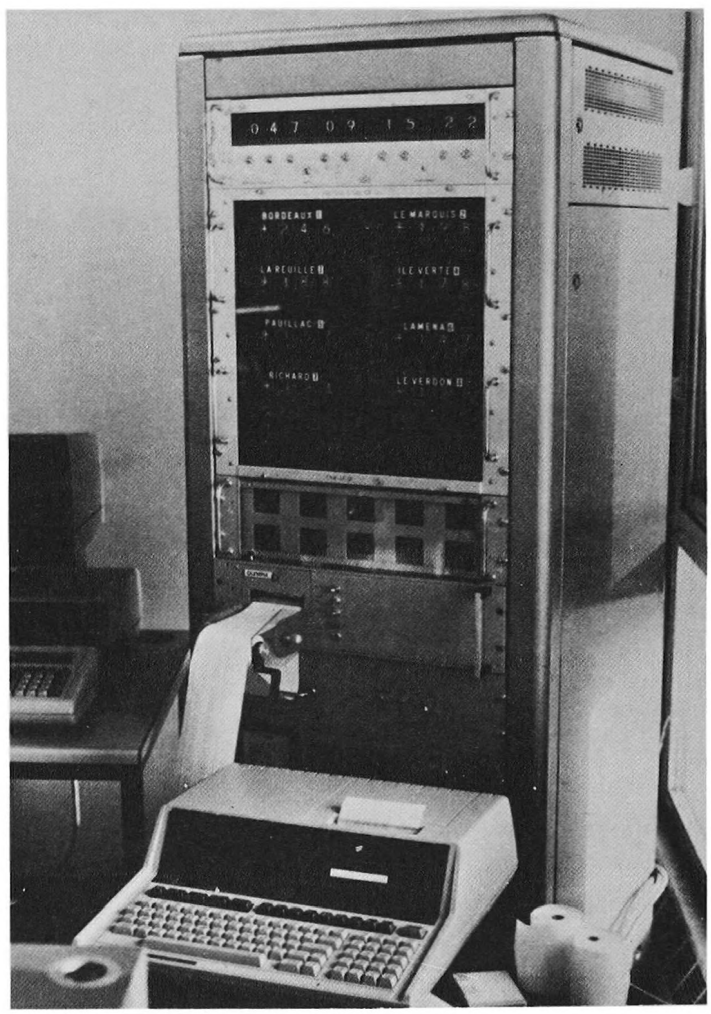

FIG. 2. – Tidal heights/recording system.

4) Shipboard equipment

The basic principle on which the system of acquisition of sounding data is based, and which corresponds to the standard configuration of the equipment as it can be envisaged today, is illustrated in figure 3.

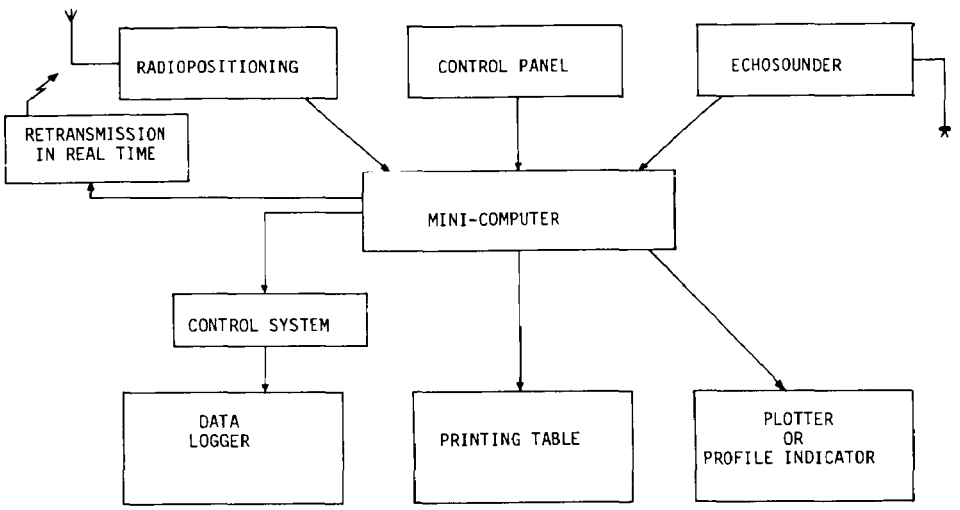

FIG. 3. – Standard equipment of a sounding launch.

The equipment onboard (fig. 4) comprises:

- a DESO 20 echo sounder (30 and 210 kcs) with its sounding digitizer,
- a radiopositioning receiver (Syledis),
- a microprogrammed computation unit (M.C.U.) for:
  - checking the validity of positions and soundings,
  - converting the circular or hyperbolic coordinates obtained from the radiopositioning system into geographical coordinates,
  - processing tidal information semi-automatically, if necessary, in order to correct raw sounding data from the echo sounder,
  - controlling the plotter or the position indicator;
- a keyboard to enter manually various items of information such as codes for the beginning and end of the profile (*), the beginning and end of the sounding operation, erroneous profile, which are essential for subsequent data processing,
- a plotter or profile indicator to plot the ship's track,
- a magnetic tape unit (HP 9875) for the archiving of information on magnetic cassette directly compatible with the processing system. This unit receives data from the M.C.U. through a controlling device, the functions of which are given below:
  - sorting of useful information,
  - temporary storage during cassette handling,
  - correction of errors.

(*) Profile is the term used for the track followed by the vessel when sounding.

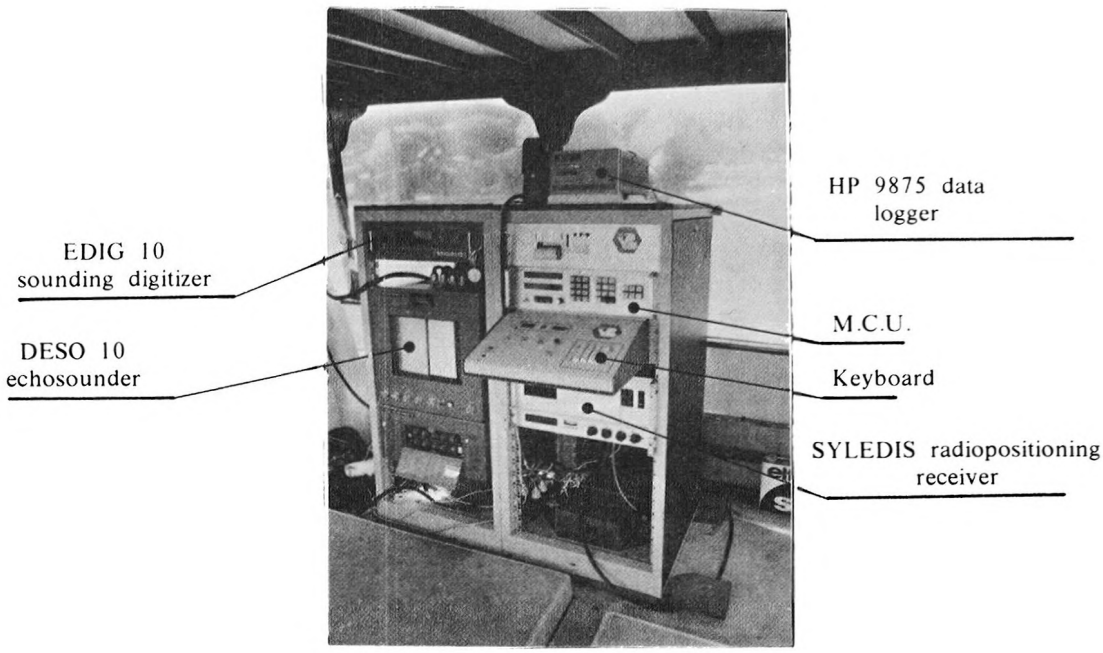

FIG. 4. – Shipboard equipment.

One of the characteristics of the system used by the Port Autonome de Bordeaux is the possibility of retransmission of the information obtained onboard the ship in real time to the data processing centre at Bordeaux via a Post Office telephone line or telex. This information is received and validated by a mini-computer, HP 9845 (Hewlett-Packard) and recorded on magnetic cassettes. Thus, the data required for plotting are available immediately upon completion of sounding.

We have just reviewed all the equipment which is used on site for data acquisition. Let us now examine the processing of these data and the results obtained in the different phases of processing.

ASHORE

1) Data processing equipment

The processing unit is composed of a desk-top mini-computer Hewlett-Packard 9845, the maintenance of which is available in most countries. This computer, fitted with light peripherals (display screen, thermal printer, cassette and flexible disk units), is directly connected to an automatic BENSON drawing table (fig. 5).

The general operating principle and the results offered by DALI 2 are given in the diagram shown below (fig. 6).

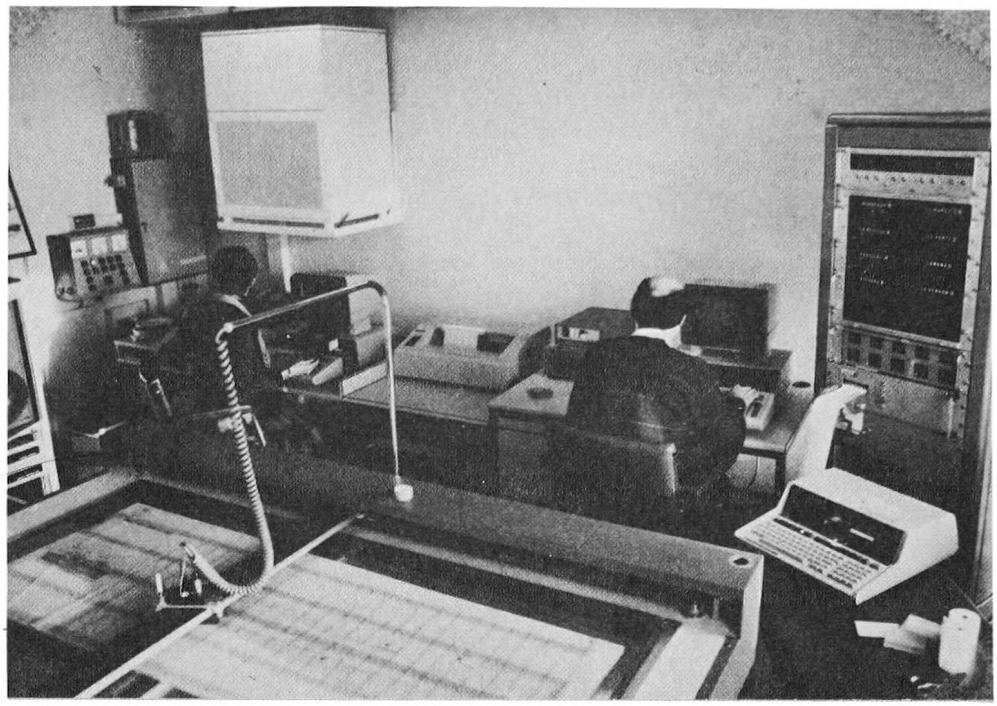

FIG. 5. – System of processing and automatic plotting of the sounding sheets.

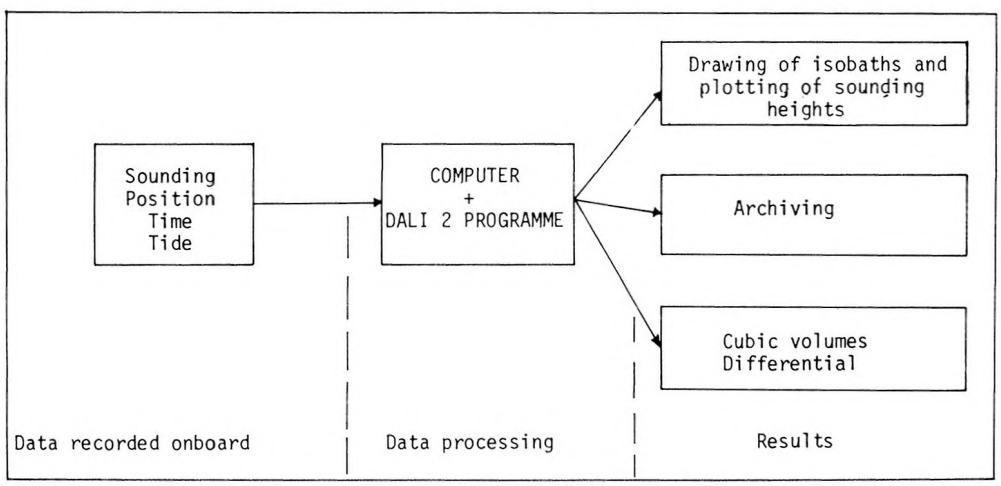

FIG. 6. – General operating principles of the DALI 2 system.

2) DALI 2 programme

After a preliminary phase of tidal correction, the processing by the DALI 2 programme consists of three steps:

1. The isobath chain comprises 4 phases:

- *The first phase* consists in reading the sounding data. Each data block (sounding, position, time, tide, miscellaneous) is examined in terms of the parameters which characterize the survey area:
  - slope of the channel sides,
  - range of soundings (maximum and minimum),
  - anomalous positions,
  - smoothing in order to eliminate the swell effect,
  - tidal correction.
- *The second phase* consists in selecting, from amongst the soundings considered correct in the first phase, a limited number of soundings on each profile according to criteria based on safety of navigation and control of dredging operations. This phase is completed by the setting up of a file of selected depths, called the "apex" file.
- *The third phase* of the isobath chain consists of selection from the "apex" file of two soundings from one profile, along with the two opposite soundings from the following profile, in order to determine a basic (paraboloid-hyperbolic) surface which will be cut by horizontal planes corresponding to each level of isobath which it is desired to portray; the intersections will be portions of isobaths. The whole surveyed area will therefore be composed of a mosaic of small surfaces within which the isobaths will be determined.
- *The fourth phase* is the plotting of the isobaths determined in Phase 3, of the "apex" file, and of the reference border and graticule.

During this first stage, the quality of processing can be checked at any moment. In fact, the operator, when he deems it necessary, can view on the graphic screen or the thermal printer incorporated in the computer:

- the points of soundings obtained by the boat when sounding,
- the points of apexes, or shoals,
- the outline of natural bottom slope along the profile of soundings or apexes with the possibility for the operator to change manually any anomalous sounding.

2. The archive chain comprises two parts:

- The first part is the *establishment* of a screen which will cover the whole area to be archived. This screen, composed of meridians and parallels, each intersection of which is called a "node", is determined by its limits and the dimensions of its rectangular grid.
- The second part is the *integration* which consists in calculating the theoretical sounding at each intersection of the grid, thus establishing the archived "apex file" from which the isobaths and the heights of apexes can be plotted.

In addition to safeguarding the information, this stage allows for:

- updating a sounding,
- printing-out an overall sheet from individual soundings, and
- extracting an individual sounding from an overall sheet.

As during the first stage, the visualization of the cross-sections along a meridian or a parallel enables the operator to evaluate the processing.

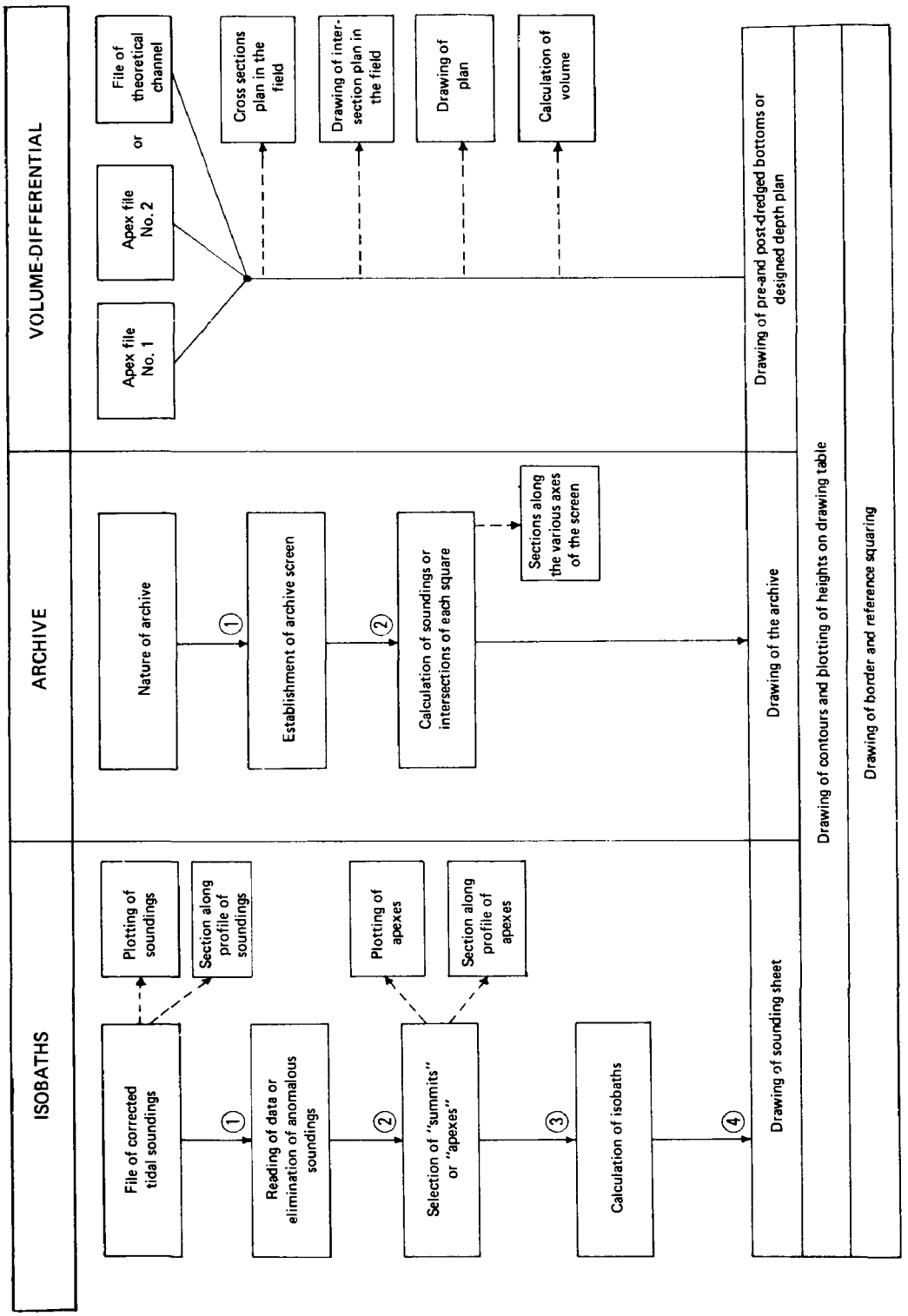

FIG. 7. – DALI 2 programme. General flow chart.

3. The cubic volume chain

With the recorded information, many calculations are possible, such as:
- comparison of two recorded sounding intersections to observe the decrease or the increase in depths between the two positions;
- in defining a model of a theoretical channel within a survey area, computation of volumes to be dredged is possible.

The general arrangement of the different phases of processing is shown as a diagram in figure 7.

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The originality of this system, simple in conception and one which can be operated by hydrographic personnel who are not computer experts, lies in the following characteristics:
- as far as the carrying out of sounding is concerned, flexible organization of work (profiles of unequal lengths, not necessarily parallel, with slight overlappings, taken in any order or direction);
- as far as data processing is concerned, the possibility of:
  - being operated in a conversational mode, a series of questions and answers between the operator and the machine,
  - graphic display allowing continuous checking of the quality of the data processed.

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Amongst the future developments already envisaged by the Port de Bordeaux for this system, may be mentioned in particular:
- the preparation of a sounding sheet from scattered random soundings where the site characteristics do not permit the conducting of a reconnaissance survey by "profiles" (due to numerous obstacles),
- the plotting of isocurves by the analytical method with a view to better "smoothing".

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The use of these modern techniques, in particular by port authorities in estuary and river ports, not only improves the safety of navigation but also allows more effective deployment of suction dredgers and a thorough study of sediment transport and of improvement schemes for approach areas.

However, the application of such a system is not limited only to harbour requirements. It is possible, for instance, to envisage its use for surveys of the continental shelf during hydrographic missions, or by research organizations, fisheries departments and dredging services of States having extensive areas of territorial sea.