THE NEW DANISH DK/SQN-1 ECHOSOUNDING AND DATA PROCESSING SYSTEM

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Paper presented at the 10th International Hydrographic Conference in April 1972.

The steadily growing demand for close hydrographic surveys has made it necessary to increase the number of echosounder bearing vessels considerably in order to enable the hydrographic services to conduct the required surveys within a reasonable period of time.

To keep expenses at the lowest possible level, a system of parallel sounding has been introduced in which one large survey vessel, acting as leader, is supplemented by a number of small fast launches running sounding lines on parallel courses at pre-determined distances. The system, however, necessitates a crew of one or two men per sideboat.

With the object of saving manpower the Royal Danish Hydrographic Office has developed an array of towed echo sounders for parallel sounding. As a result, five sounding lines, instead of only one, can be run by a single survey vessel, or launch, with a normal crew.

For the sideboats and for the towed array we used ATLAS echosounders, type 658, rebuilt for these surveys with the addition of rotation counters, position markers and external scale shift controls.

The use of five echosounders aboard one vessel meant that a lot of space was taken up, and it was very difficult to supervise five recorders at the same time.

1. As there was so much mechanical detail in these echosounders, they were already nearly worn out after four seasons' work. We therefore wanted to obtain new ones, more suitable for our surveying system, and especially to acquire echosounders suitable for towing. Furthermore, we wanted to be able to digitize all data on board, and to have it on punched tape for producing the fair sheet on our automatic plotter later on.

It was not possible to find an echosounder constructed exactly as we wanted. We therefore asked our Naval Electronic Department if they could help us. After we had made out a specification of our requirements they became interested in the question and started research on a very

flexible echosounding and data processing system which was to be divided into modules in such a way that it could be used in various combinations in different classes of ship, from small motor launches to large survey vessels.

The following were the modules envisaged : digital echosounders; an indicator unit able to present the profile from at least five echosounders simultaneously; a data logger for collecting the data from the five echosounders, the chronometer, and the navigational system (Decca, Raydist, etc.); channel space for other kinds of digital data, and the means to route these data to a paper tape punch recorder.

To reduce the amount of data, the data logger should be able to select the minimum depth in a chosen time interval.

After some years' experimentation, the Naval Electronic Department began a collaboration with the engineering firm of Lindholst & Co., and a prototype of this echosounder and data collecting system has now been developed.

We should maybe have waited a year or two before putting the system on public show, because up to the present the new echosounder has only been tested a few times at sea, but we thought that as there are so many new ideas incorporated in this equipment it might be of interest to the participants to this Conference, and we did not want to wait until the next I.H. Conference.

2. *Description.*

The whole system is contained in one rack, and consists of :

(a) a ventilation module;
(b) an analogue recorder unit;
(c) a data logger and control unit;
(d) a digital clock;
(e) a high speed puncher;
(f) a power supply for the six echosounders;
(g) an echosounder with digital readout.

As many controls as possible have been made automatic and as they have been removed from the front panel attention can be concentrated on the remaining controls there. Incoming echoes, together with the resulting data, are displayed on the recorder unit so that the performance of all digitizing circuits can be checked. The recorder scribes automatically the time position marks on the echogram, thus reducing manual notation. The system requires only one operator, and his main duty will be to reload the paper and the tape.

3. *Echosounder.*

Depth is read on the front panel, and can be compensated for transducer depths of up to 9.9 m. The lefthand button can be switched to compensate for heave (up to $\pm$ 3.2 m). The sounding range is 1-3200 m, depending on the frequency used. All the circuits have printed circuit cards to facilitate repair work. The echosounder contains no mobile mechanical units.

FIG. 1. — The rack containing the whole system.

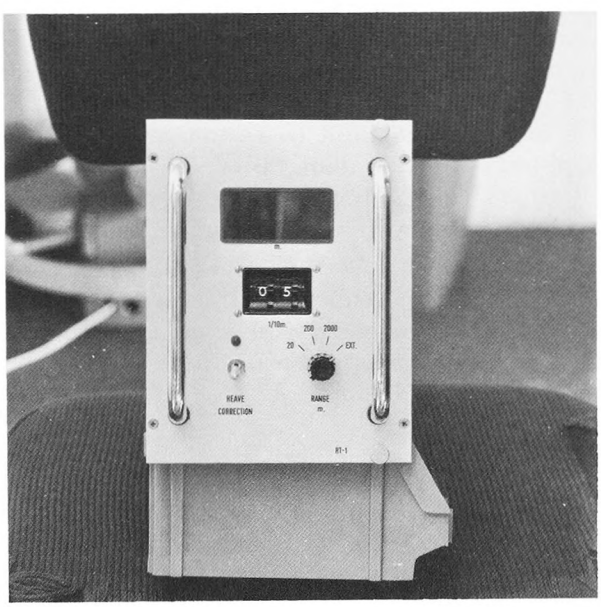

FIG. 2. — The echo sounder.

The equipment can be operated with most the transducers found on the market. It can be coupled internally to operate between 10 kHz and 300 kHz. Either single or double transducers can be used. The pulse length for the transmitter is adjustable. It is also possible to pulse-code the echo signals to allow for simultaneous operation of several transducers of the same type.

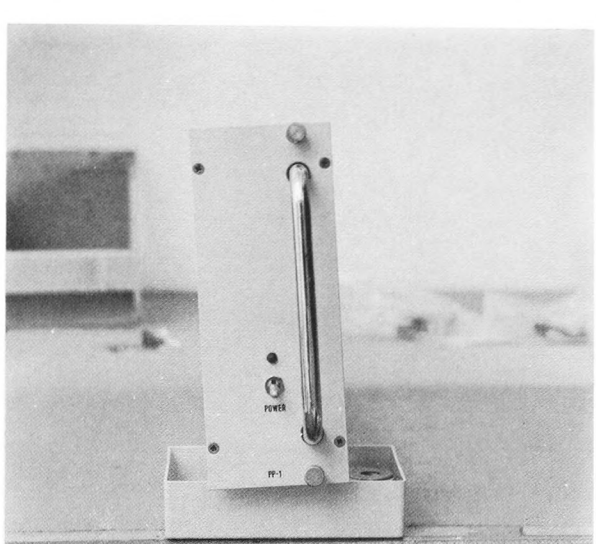

FIG. 3. — Power supply unit for the echosounders.

The echosounder has an automatic sensitivity control which means that the receiver's transmitting power and sensitivity can be automatically adjusted. Maximum transmitting power is about 1.5 kW, depending on the transducer. The echosounder's receiver and transmitter have been very specially studied in order that the true bottom will invariably be indicated. Fish and other objects will not show up on the display as the system will immediately eliminate such echoes. Spurious echoes will not be shown, but in this case the display will show a blank.

It should be mentioned that this echosounder has been tested in a large steel water tank where echoes from a second reflection or multiple reflections were found to be of nearly the same amplitude as the true echo. The echosounder worked perfectly during these tests.

4. *Data Logger.*

The data logger is designed to collect data from equipment consisting of up to six echosounders, a chronometer, and an electronic positioning system, with channel space for other kinds of digital data, and to route all these data to a punched paper or magnetic tape recorder, and then to display the results on the recorder in a suitable form for judging the quality of the incoming data.

Utilizing the switches provided on the front panel, the time interval between pulses can be regulated. It is also possible to modify the signal frequencies, and thus acoustical interference between the various echosounders will be minimized.

The logging unit is also provided with a facility for automatic changes of the sounding range, and thus the surveying can be performed almost unattended.

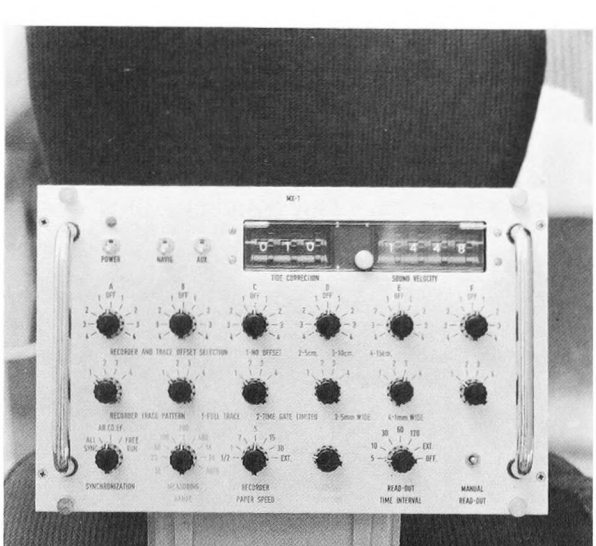

FIG. 4. — The data logger.

This unit furthermore produces the pulses for the echosounders. The sound velocity selector switch is calibrated in metres per second in steps of 1 m/sec. It has an accuracy of better than 0.1%.

The data logging unit is not adapted for use with any particular navigation system, as existing chains need elaborate interfacing. Such interfaces will be constructed as separate units.

If desired, the data logger can also control two recorders at a time, thus enabling each to register three traces simultaneously.

The unit generates calibration lines on the recording paper, as well as the traces reported by the echosounders. It then displays the results in a final stage before punching them a little distance above the real trace. Experiments are being carried out with other kinds of marking.

This unit also controls the paper speed which can be adjusted at will so that the trace displayed will be to scale.

A switch for selecting the tide correction is provided to enable the data to be corrected before punching. This permits direct recording of the depth contour intersection positions. Normally, the data selected will show the minimum recorded depth in a chosen time interval, together with the positions of the soundings.

The punched paper tape provides all the depths and positions for all the contour lines intersecting the survey lines. The positions are converted ashore to X and Y coordinates on a computer which yields the information necessary to an automatic plotter. We are thus able to draw up a fair sheet that contains all the sounded depths and all the contour line intersections. It will then be an easy matter to draw in the contour lines by hand.

5. *Chronometer.*

A digital clock is required for the tidal corrections when it proves possible to do this work in the field. This clock also generates 10 Hz pulses for the data logger where, after conversion to a frequency proportional to the chosen sound velocity in water, the pulses are used for regulating the frequency of the echosounders. The sounders thus require no separate calibration.

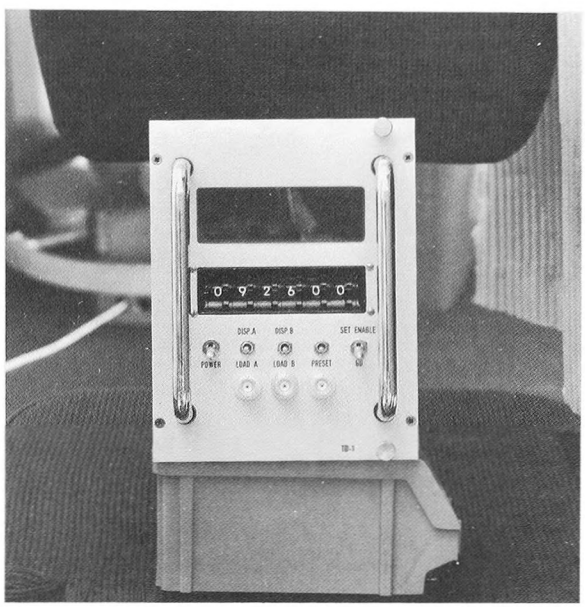

Fig. 5. — The digital clock.

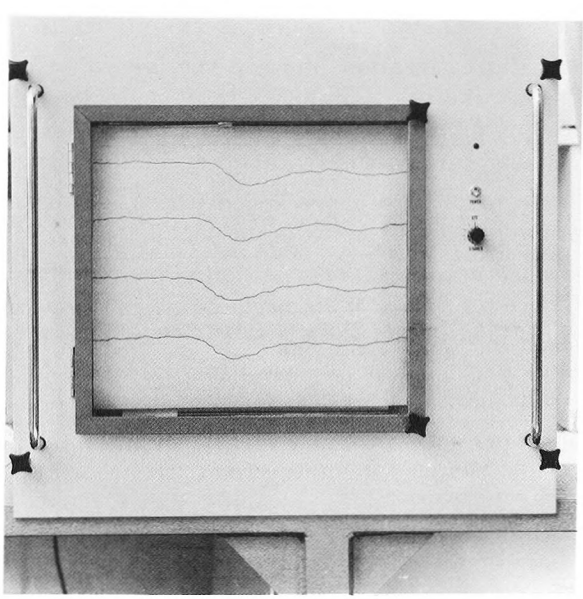

Fig. 6. — The recorder.

6. *Recorder.*

The main purpose of the recording indicator is that it permits on-line control of incoming data for quality. If this form of record is not required, the unit can be entirely removed. If the paper runs out during a survey, it can be reloaded without interrupting the measurements as only the presentation of a few minutes of punched data will be lost. The echosounder's pulse frequency is in no way dependent on the speed of the needle movement.

The recorder uses dry paper of width 10 inches (250 mm). There is full remote control for both paper speed and trace intensity or "blacking". It is programmed for 10 shades of blacking, and the picture can also be shown in negative for better presentation when used with a side scanning sonar.

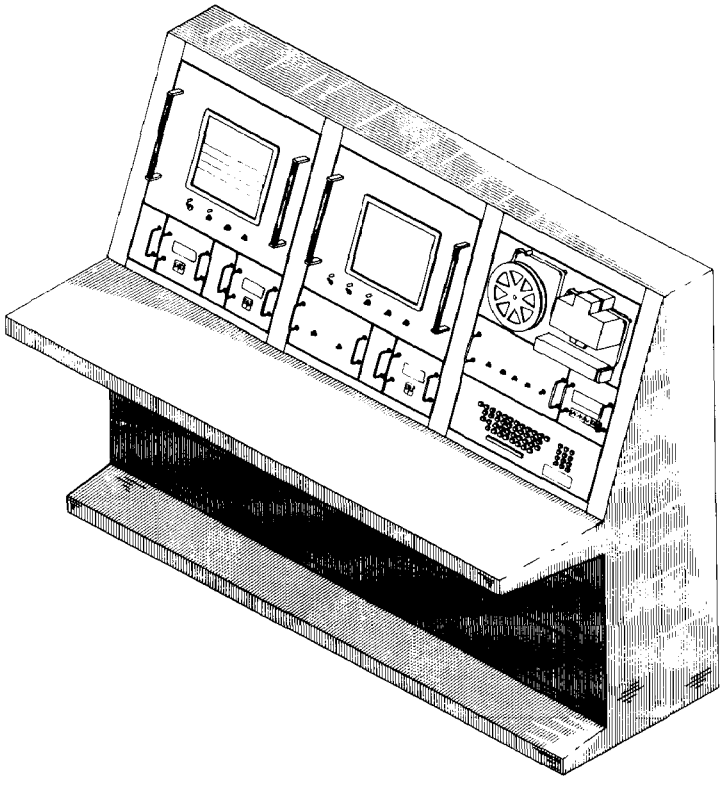

FIG. 7. — Another form of rack for the system.

7. This then is a brief description of the equipment in the configuration that we wished to have constructed for our towed echosounder system. However, the system is so flexible that other configurations are possible; for example another rack could be envisaged which might comprise :

(*a*) an analogue recorder;
(*b*) three echosounders;
(*c*) a side scanning sonar display (with possibility of negative picture — see above);

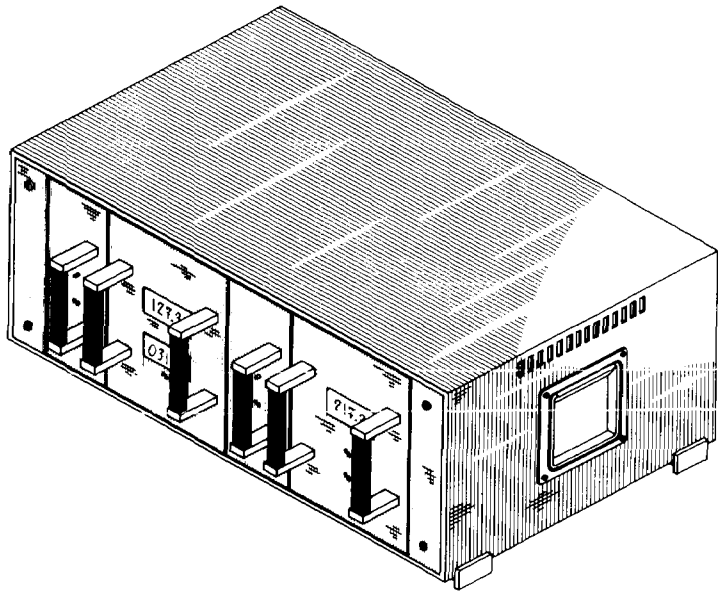

FIG. 8. — A system for measuring distance, speed and acceleration, using a horizontal beam echosounder.

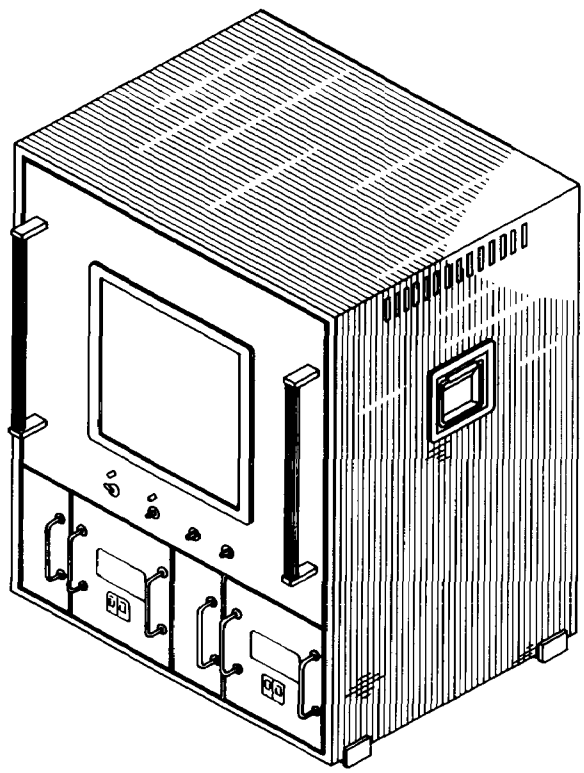

FIG. 9. — Two echosounders and a receiver.

(*d*) an interface for a side scanning sonar;
(*e*) a keyboard with digital readout;
(*f*) a digital clock;
(*g*) a digital data logger;
(*h*) a high speed puncher.

8. A distance, speed, and acceleration measuring system with a horizontal echosounder provided with digital readout would be of great help to the giant tankers.

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None of the above described equipment has yet reached the stage of final development, but further units could be added as the need manifests itself. It is thought that the electronics firm will be able to produce the items required by customers wanting more specialized equipment.

During the summer of 1972 the Danish Hydrographic Office will be putting the system I have described under extensive trial, and so later in the year I hope we shall be able to make a statement about the evaluated system.