PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS
TECHNICAL UNIVERSITY OF NORWAY

DATA COLLECTION FROM THE OCEANS USING HYDROACOUSTIC SYSTEMS WITH COMPUTERS

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SUMMARY

Hydroacoustic systems combined with computers open new possibilities for data collection and -integration. Systems for fish identification and abundance measurement, fishing operations, hydrographic surveying and sub-bottom profiling are described in this paper.

1. INTRODUCTION

It is well known that by using acoustic transmitters, receivers and some sort of display and recording equipment, information can be obtained about objects and layers in the ocean and the bottom beneath it. Acoustic methods are widely used for fish finding, bottom recording, submarine and obstruction detection, hydrographic surveying and sub-bottom profiling.

Introducing computers into acoustic systems gives possibilities for obtaining more information from the acoustic signals and also allows for many other parameters to be added into the system to give more integrated information, recording, and display.

Some applications of hydroacoustic systems with computers are described in the following chapters.

2. FISHERY RESEARCH AND FISH SURVEYING

In an ordinary echo sounder or sonar the echo signals are shown on a paper recorder. From the recordings it is possible for a fisherman to qualitatively estimate the fish abundance, and an experienced fisherman can, in many cases, even identify fish species fairly well.

Going from here to measuring fish abundance and perhaps automatically identify the fish schools, would be a great help, and modern technology allows us to do just this.

By using calibrated echo sounders, i.e. sounders which give a known electrical output signal from a defined target, and integrating these signals during a predetermined interval, one obtains a quantitative measurement of the echo sources in the sea, in most cases directly related to the amount of fish and plankton. Various approaches to this idea have been undertaken, from pure analog echo signal integration to digital methods. (Ref. 1. 2 and 3).

Fish identification based on characteristics of echo signals is not an easy task. However, some approaches exist, (Ref. 4) and putting a computer with capability for information processing in real time on to the job gives some interesting possibilities.

Fig. 1 shows a sketch of a system combining fish abundance measurement and identification. A calibrated echo sounder gives fish echo signals as output. These signals are sampled directly by the computer and processed in real time. The echo signals are also integrated in a special echo integrator, the outputs of which are fed to the computer. Ideally the teletype then prints the identified fish species and the fish abundance, e.g. "Cod: 2680 per square mile".

Fig. 2 shows the block diagram of how an actual system might look. This system is installed aboard the Norwegian research vessel "G.O. SARS", belonging to the Institute of Marine Research, Bergen. Here navigational, oceanographic, meteorological and hydroacoustic instruments are integrated into a computer-centered system. (Ref. 5).

Fig. 3 shows a photograph of the hydroacoustic instruments aboard "G.O. SARS". A variety of echo sounders, sonars, echo integrators and calibration equipment are housed in 11 racks.

Fig. 4 shows the computer part of the "G.O. SARS" system.

3. FISHING OPERATIONS

A modern fishing vessel contains equipment for navigation, fish finding and some sort of instrumentation for monitoring the fishing gear. However, it is not easy for the skipper to interprete the information from these instruments in a way that gives him a good general view of the complete fishing operation. The natural thing to do seems to be to integrate the information into one system and display the combined vessel/fishing gear/ fish situation to the skipper. This can be done by using - in addition to the equipment mentioned above - computers and graphic displays.

Fig. 5 shows the underwater picture of the catching stage of a purse seine fishing operation.

Fig. 6 shows how this situation is pictured on a graphic display in an integrated sonar data display system developed by SIMRAD. Here the vessel and its track are displayed in real time together with the fish schools and their movements. The picture shows the situation in the horizontal plane, but the situation in the vertical plane can also be shown. Compared to present methods the advantages of a display method like the one in Fig.6 seem obvious.

Fig. 7 shows the components of the integrated sonar display system. A multibeam sonar stabilized against the vessel's pitch and roll is used to illuminate the target. A sonar doppler log is used to obtain two-component speed of the vessel related to the ocean floor. A computer samples the output of both the multibeam sonar and the doppler log, processes the data, and presents the information on a CRT graphic display.

Similar approaches can be used for trawling operations.

The equipment shown in Fig. 7 is rather space-consuming and can be said to be a first generation of integrated display systems, being based on existing components. Fig. 8 shows the artist's view of how an integrated data display system installed in the wheelhouse of a vessel may look.

In Fig. 8 is also indicated some other applications of an integrated sonar data display system. In addition to fishing operations in commercial fisheries it can be used for fish behaviour studies, e.g. fish behaviour in relation to vessel and gear movements, and for mapping of the topographical conditions of the sea bed. This latter application is of importance to all offshore structure construction work, e.g. for pipeline laying. Further applications of integrated sonar display systems will certainly also be found.

4. HYDROGRAPHIC SURVEYING

For hydrographic surveying one needs to record simultaneously water depth and position information. The conventional method to obtain this has been to write with hand the observed positions on the echo sounder paper recorder. Later the water depth and the position were plotted on to a chart manually. This process is clumsy and time-consuming. In recent years various forms of automatic data logging equipment has been taken into use for recording of surveying information. For chart drawing automatic plotters also have been applied. (Ref. 6).

Fig. 2 shows an automatic system for hydrographic survey work. An echo sounder gives information about water depth to a computer, and a navigation receiver provides position information. The computer controls the data logging and performs data reduction. The data is recorded on a tape recorder. The recorded data can then be used as a data source for automatic chart plotting. The plotting can be done aboard the vessel, or at a shore-based computer centre.

5. SUB-BOTTOM PROFILING

Acoustic methods can be used for getting information about the layers beneath the ocean bottom. Seismic methods are very useful for general sub-bottom geological engineering studies, and oil- and mineral prospecting. (Ref. 7).

The sub-bottom seismic profiling system consists in its simplest form of a power source, e.g. a boomer, sparker or air-gun, which transmits a powerful low-frequency pulse; a hydrophone receiver often in the form of a multielement hydrophone streamer; and a precision graphic recorder. This is illustrated in Fig. 10. More advanced systems also contain digital tape recorders. This tape is used as base for sophisticated data processing in large computer centres at shore. In near future on-line computers can be expected used to a great extent in such systems.

6. CONCLUSION

Hydroacoustic systems with computers will open new possibilities for data collection, -processing, -integration and -display. First generation systems are now coming into use, and a break-through for such systems can be expected in the near future.

7. REFERENCES

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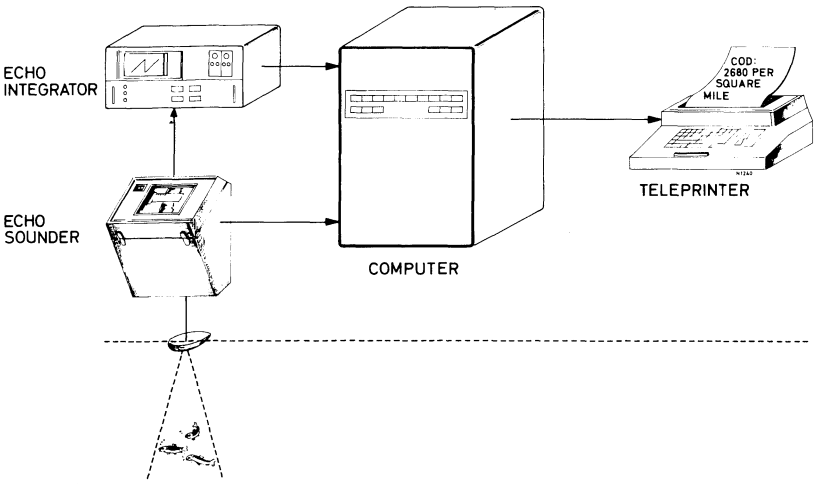

Figure 1. Fish identification and abundance measurement system.

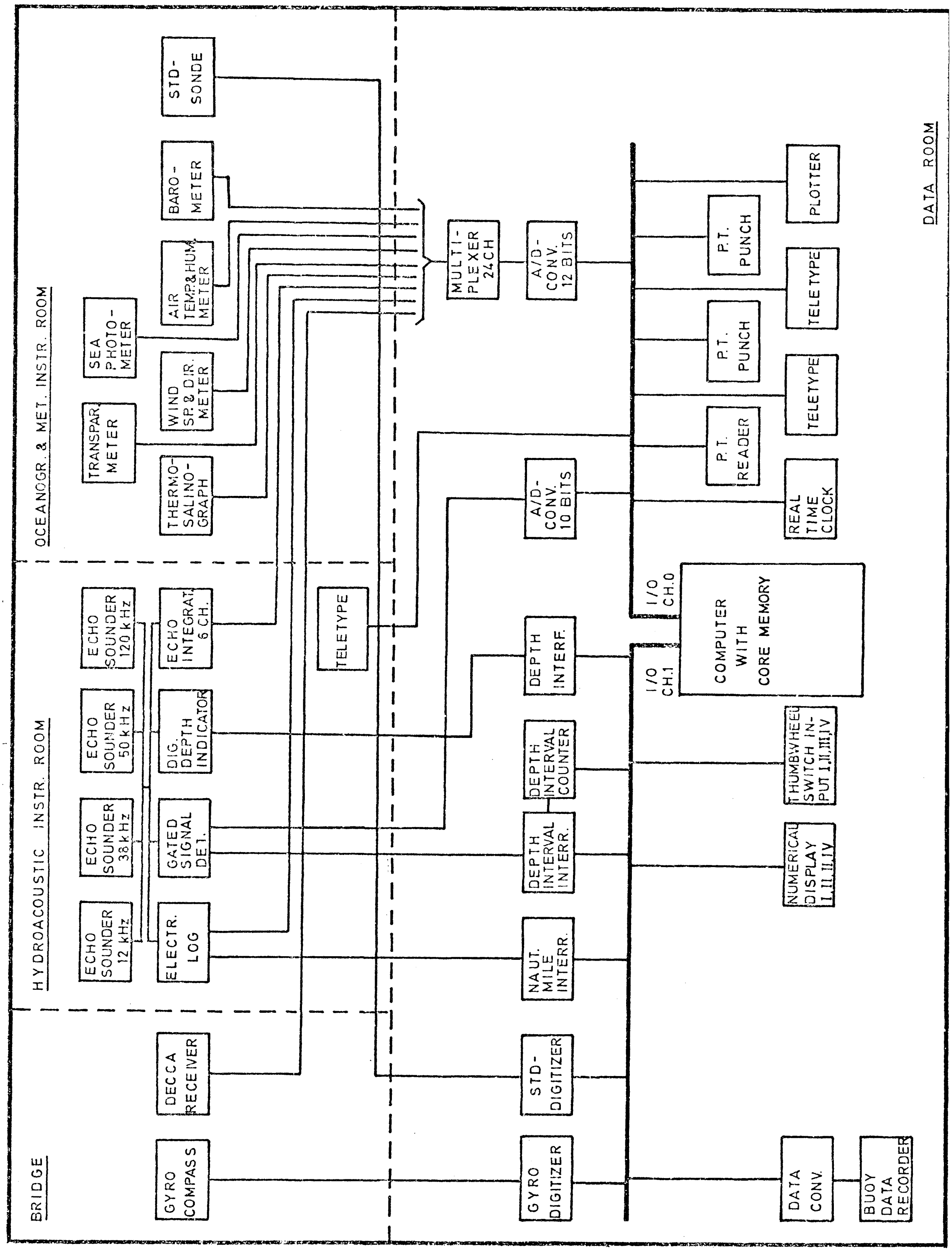

Figure 2. Block diagram of the computer-centered instrumentation system for the Norwegian fishery research vessel "G.O.Sars".

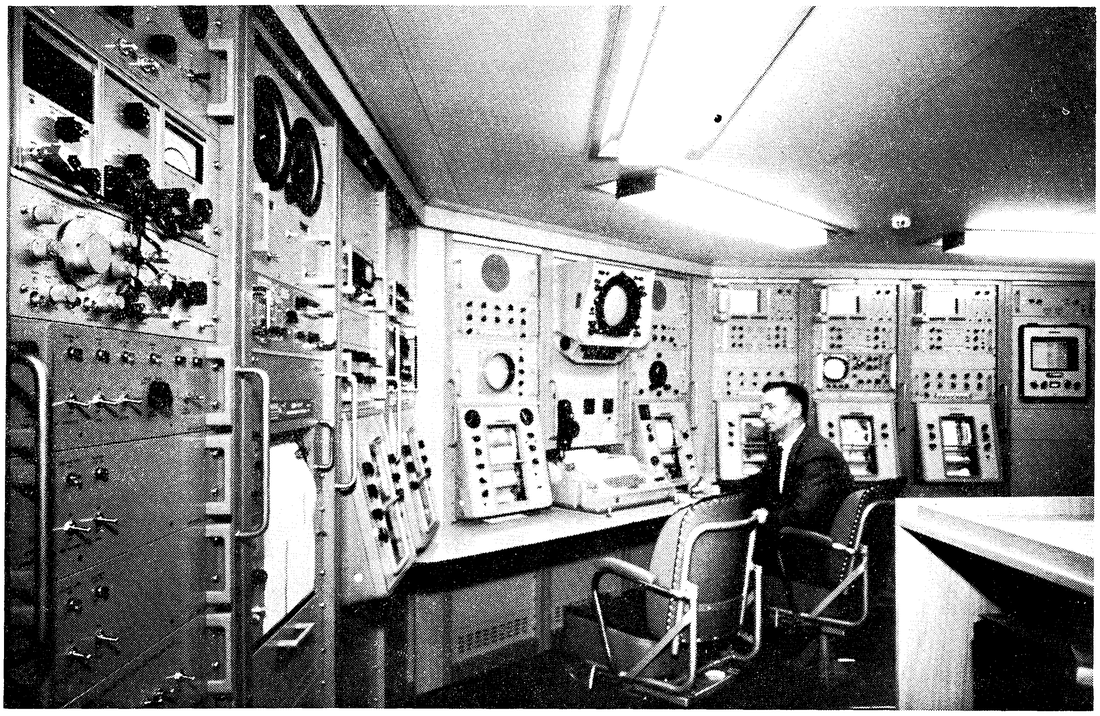

Figure 3. Hydroacoustic instrument room aboard the research vessel "G.O.Sars". The echo sounders and integrators are connected on-line to a computer. The operator controls the computer functions via the teleprinter.

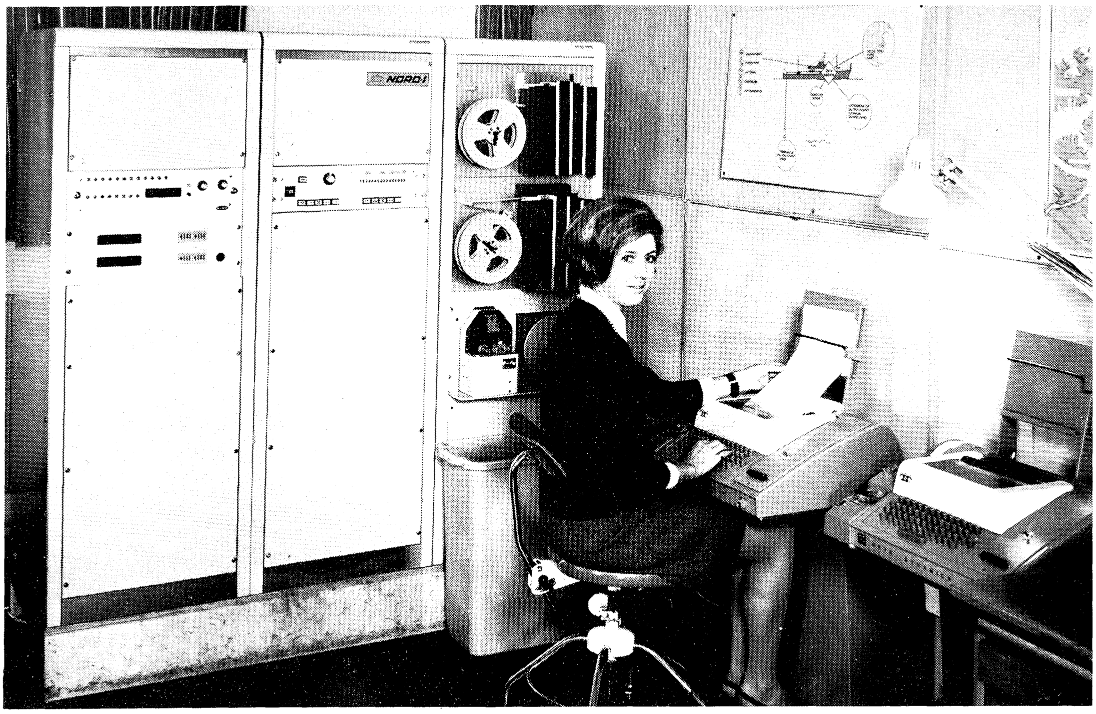

Figure 4. Computer system aboard the research vessel "G.O.Sars".

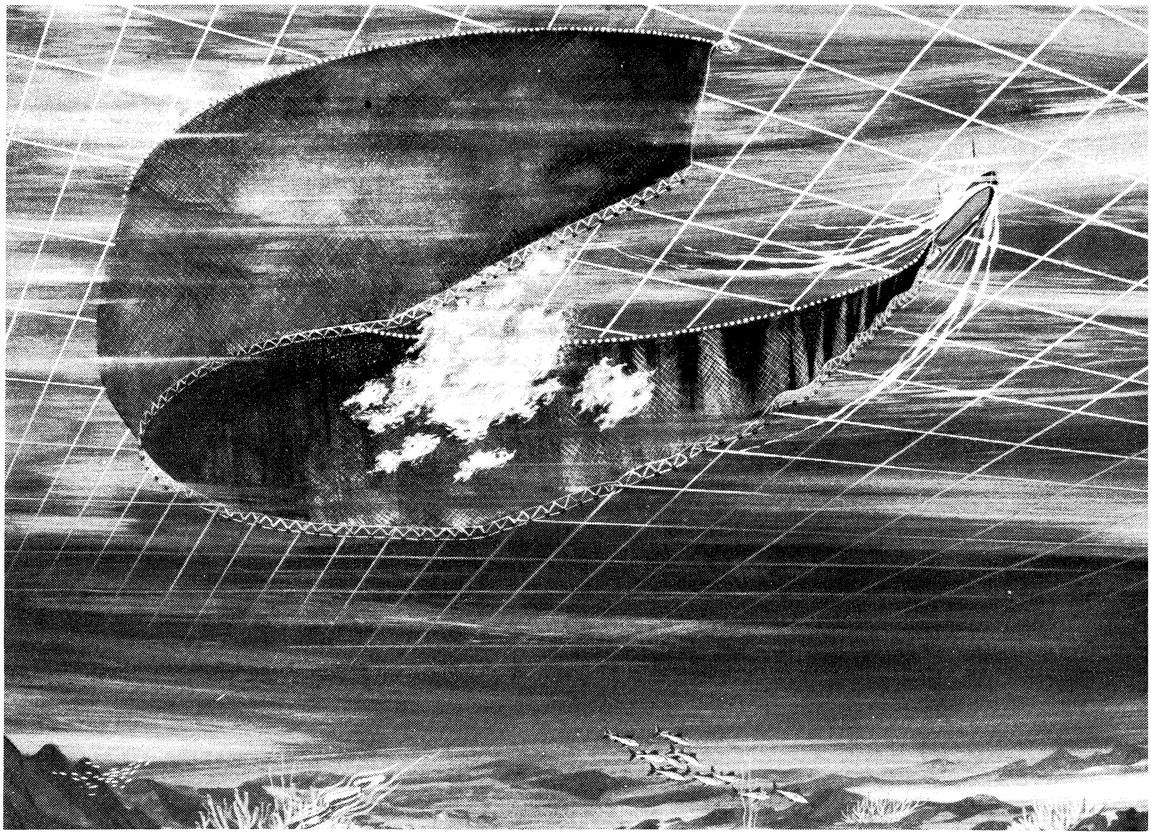

Figure 5. Situation from the catching stage of purse seine fishing.

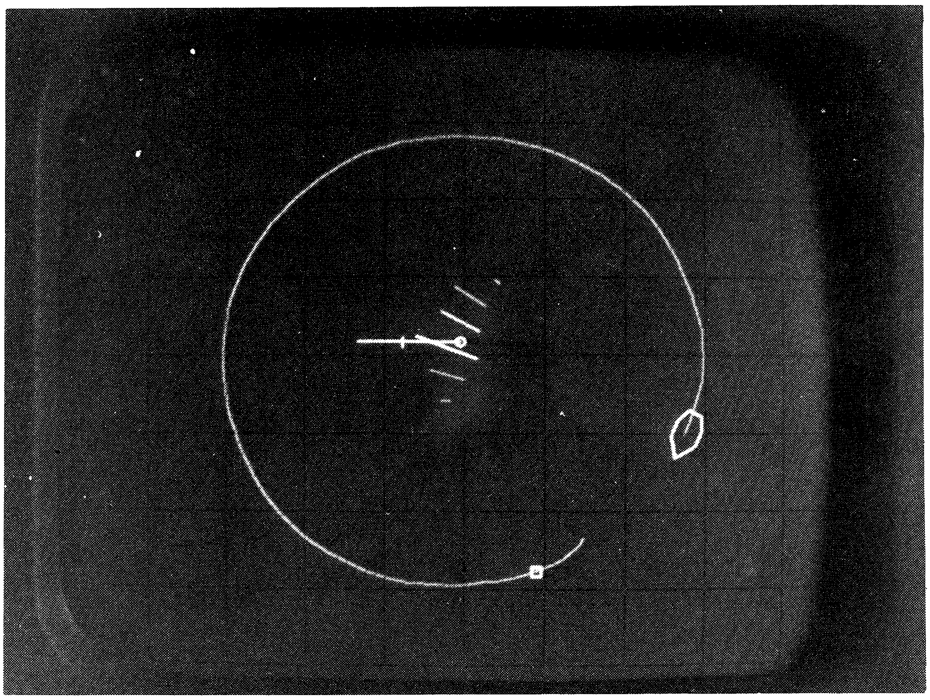

Figure 6. Same situation as in figure 5, presented on the SIMRAD Sonar Data Display.

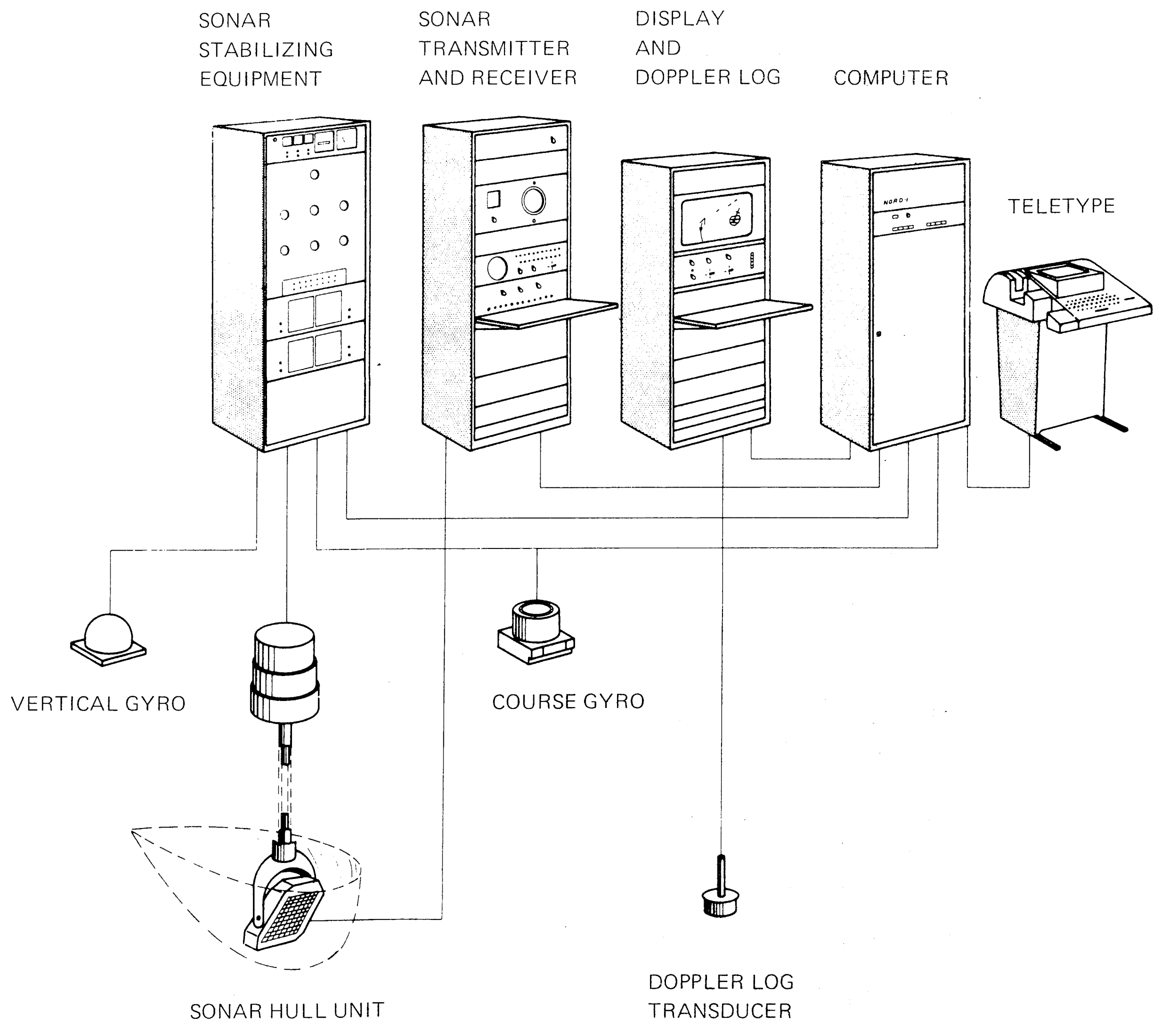

Figure 7. Components of the SIMRAD Sonar Data Display.

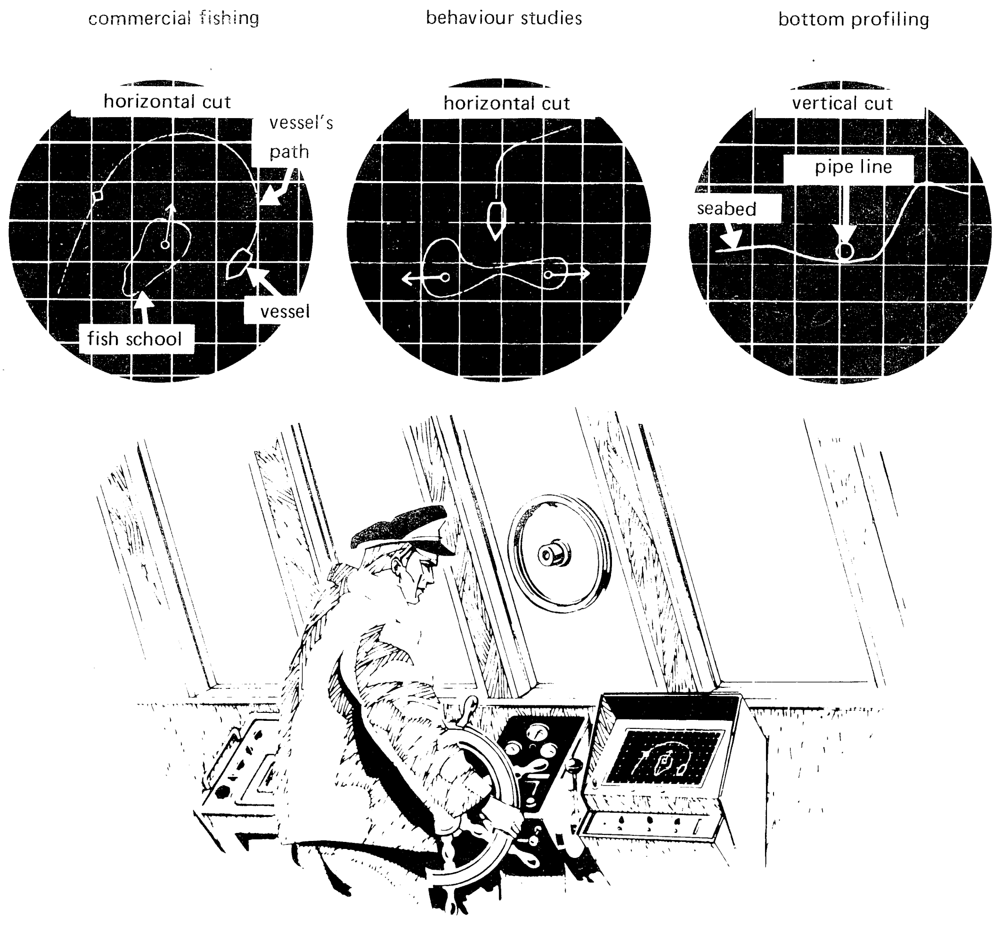

Figure 8. Applications of an integrated sonar data display.

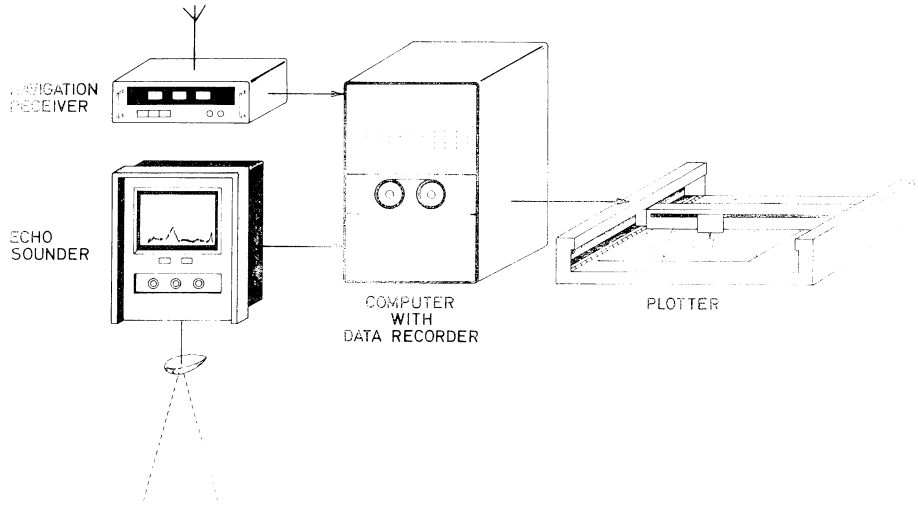

Figure 9. Hydrographic

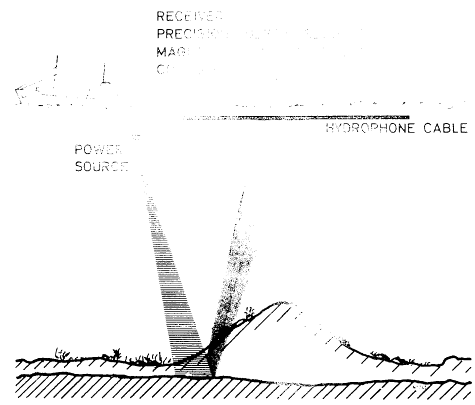

Figure 10. Seismic survey system.