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FROM A CRESTING WAVE TO A CRESTING TECHNOLOGY

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At the request of the Directing Committee of the International Hydrographic Bureau, the author responds to criticism made by RITCHIE in his paper "Hydrography, Yesterday, Today and Tomorrow". In doing so, the author attempts to answer some of the questions raised in the paper, and discusses the reasons why hydrographers must lift their sights from a cresting wave to a cresting technology without losing sight of their primary goal – the collection of complete and reliable data for the compilation of a nautical chart.

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As so often happens when the poet within us takes command, the words flow freely and, so long as they sound good, it is often difficult to critically review what has been set down on paper. If I had been more precise and less poetic, then RITCHIE might not have criticised me in his paper "Hydrography, Yesterday, Today and Tomorrow" when he wrote: "I am not so happy with MACDONALD's statement when, in describing early Canadian adventures in automating hydrographic surveys, he says 'Computer programs were developed to convert electronic positions, to plot soundings, to edit data and to produce field sheets. But, best of all, hydrographers were beginning to lift their sights from a cresting wave to a cresting technology that had possibilities of improving what some thought had already been perfected' ".

However, Rear Admiral RITCHIE, on behalf of the Directing Committee of the International Hydrographic Bureau, has asked me to respond to his criticism. In doing so, I will attempt to answer some of the questions raised in his paper and to clarify my position on automation. RITCHIE poses many questions that I feel need to be asked from time to time, just to keep hydrographers on the right track. For example: How much money has been poured into the search for automated hydrographic systems? How many systems have been built only to be abandoned?

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Have manpower requirements or survey costs been reduced ? Has accuracy or survey speed been increased ? How is automation affecting hydrography ? Why are hydrographers automating ? The answers to these questions should influence the future of automation in hydrography.

What does a hydrographer really mean when he talks about automation ? A dictionary might define automation as a method in which all the production processes are performed or controlled by self-operating electronic or mechanical devices. Automation should eliminate most, if not all, human participation. By this definition, automation for hydrographers will never take place, since there are many subjective decisions that require a hydrographer's training and instinct, and that cannot be left to automation. I do not see a day when the hydrographer will become redundant.

Most hydrographers have a different concept of the term automation. The word "assistant" might be more synonymous. Some piece or array of equipment is assisting the hydrographer. This assistant is often a computer or at least computer-based. It makes few decisions on its own, and does only what it has been directed to do by the operator of the equipment, the hydrographer.

The use of computers began to complicate the hydrographer's life back in the 1960's. A number of schemes were tried, in an attempt to make collecting and processing hydrographic data easier, more efficient and more accurate. One scheme involved mailing echograms to headquarters to be manually digitized and merged with a position file. The sounding plot was returned to the survey. Post Office delays aside, this technique took an important part of the hydrographer's job, data processing, away from him. Another scheme solved that problem. The hydrographer brought a computer with him on his survey, and used it to process the data. But the computer could only read data in a computer compatible format. The most direct way of getting the data into an acceptable format was to digitise and record them in real time on board the survey vessel. The earlier unsophisticated logging systems were not computer-based, and did not always produce reliable results. A new scheme improved the situation enormously. Small computers were brought on board the survey vessel and became an integral part of the logging system. Now the hydrographer could use the computer to monitor the quality of data being recorded and could get some help in conning the survey vessel along a predetermined survey line.

The use of a computer on a hydrographic survey forced the hydrographer to learn new skills and techniques in order to use the new equipment. It was evident that computer programming was becoming a necessary skill, so that the hydrographer would know if the computer was providing the proper assistance. It was also evident that, in order to use the new and more sophisticated equipment effectively, it was necessary to be a skilled hydrographer.

Too often, hydrographic systems have been designed without consulting the hydrographer. These systems sometimes attempted to solve problems that did not exist, and they were the first to be abandoned. Hydrographers, engineers and computer programmers have to work together to implement new survey tools and techniques. The hydrographer has to completely understand the capabilities and limitations of a system before he uses it. The engineer and computer programmer have to understand and respect the requirements of the hydrographer, to ensure that the design of new equipment meets a real need.

The potential benefits of automated systems have been touted by many an engineer looking for financial support for his particular development project: it will make the job easier; it will make the survey more accurate; it will save time and money; it will reduce errors by eliminating the human factor; it will eliminate the need for a trained hydrographer; it will produce a digital data base. Many a hydrographer has heard these arguments only to find: that the equipment works occasionally or not at all; that the equipment is not cheap; that the launches cannot go any faster with the new equipment on board and might even go slower with the extra weight; that the cursed digitizer gives as many bad depths as good ones; that an operator who is not a trained hydrographer is a definite liability. Technological advances are not made in one day. Problems must be solved one at a time and, just as sounders and positioning systems improve with time, so will these computer assistants.

There are many advantages to utilizing a computer assistant. It improves survey efficiency, quality and accuracy. Efficiency is improved because computer-assisted straight-line navigation makes survey planning easier, reduces survey time and increases productivity by as much as 25%. The computer can help con the vessel to a predetermined point, which makes interlining, collecting bottom samples and examining shoals easier. With computers to help process data, the number of processing personnel is reduced because the need to scale echograms, draft boat-boards and ink soundings is eliminated. Data quality is improved because data can be filtered on-line. For many years now, position filters have been used to check for valid distances on range-range systems and for lane jumps on hyperbolic systems; depth filters have been used to improve the reliability of recorded depths. Survey accuracy is improved because each depth is recorded with its own position. The hydrographer no longer has to assume that the vessel maintained a constant speed and followed a straight line between fixes. There is no longer any need to interpolate the position of a depth between two fixes. Computers and accurate plotters have been used for years to produce plots of survey data and lattices faster and more accurately than could ever be done by hand.

With a computer recording positions and depths and providing steering information to the helmsman, the hydrographer is free from the laborious tasks of plotting positions, keeping detailed positioning notes and conning the survey vessel. He is able to raise his sights from the plotting table and look around him. Land features, currents, tide rips, nesting colonies and dense seaweed can be noted. The hydrographer can get a real "feel" for the survey area and with experience may decide to interline or examine shoal areas immediately, or widen line spacing in very deep, flat areas.

A hydrographer can use his computer assistant to improve survey efficiency, quality and accuracy, but the more sophisticated and versatile systems are more complex. As a result, it is easier for the hydrographer to inadvertently enter a wrong navigation value or a wrong filter parameter. So human error is not eliminated by using these systems. The hydrographer must still be as diligent and thorough as ever.

Agatha CHRISTIE once said "Human error is nothing compared with what a computer can do if it tries". This is often quoted by reactionaries who oppose change or advocate a return to the "old" system. The hydrographer should remember that a computer never tried to do anything on its own. It is told exactly what to do by

a human, and it will relentlessly and repeatedly do the job the same way every time. Humans program computers, and sometimes program them in error.

The person who tells the computer how to select soundings for the survey document requires an intimate knowledge of hydrography. Who is more suited for this task than the hydrographer himself? He must not leave this important work to someone else. He cannot ignore his primary task, the collection of completely reliable field data that will be used to compile a nautical chart. At the same time he must not ignore new equipment and techniques, or accept them without question. The hydrographer must lift his sights from a cresting wave to a cresting technology.

The information collected by a computer is only as good as the components of the logging system. Depth digitizers have been a weak link in the automation chain, although improvements are being made all the time. Digitized depths are of prime importance to the hydrographer, who must ensure that each piece of information on his survey document truly represents the facts. Until depth digitizers (and positioning systems for that matter) have proven that they can operate flawlessly, there should be some doubt in the mind of the hydrographer about the absolute correctness of computer-processed data. A thorough check of the selected data is essential. Depth data are logged in two forms; in digital form on a magnetic medium, and in analog form on the echogram. Both data sources should be used by the hydrographer to produce the best possible results. The echogram can confirm the selection of data from a digital source, but should not necessarily be the final authority. The digital data can also be used to confirm what is recorded on the echogram. It is quite possible that the digitizer has picked up the true bottom while, at the same time, the echogram shows no bottom at all because the sensitivity has not been properly adjusted. Should the digital data be discarded because they do not agree with the echogram? If there is any doubt at all then a check line is in order. The data should never be taken elsewhere to be matched by someone else, as RITCHIE suggests has been the case. Technological advances must not usurp the hydrographer's responsibility for ensuring that the survey document is correct and complete.

No matter what other information is archived, the echogram, boatboard and field notes should always be available to reconstruct the survey. This is the primary data base. What about the digital data base? Should it contain the same information as the primary data base, only in digital form? I think not. This information, from which soundings have been selected for the final survey document, will not be needed in digital form by the hydrographer or chart compiler once the survey has been completed. What about potential users such as mapping agencies, oil companies and others in the scientific community? They usually need more data than are shown on the survey document. However, the digital information collected on board the survey vessel is unedited, and is of little value without the echogram. Therefore, these users are likely to revert to the echogram for the additional detail required.

But the selected data, the data shown on the final survey document, must be kept in digital form and should be part of the digital data base that is used to produce a chart. This information becomes part of the digital data base, not because the data base exists and must be filled with digital data, but as a by-product of the data logging and processing process. If the digital survey data cannot be used in chart production, then it is pointless to collect them or archive them. Simply producing a digital sounding data base is not enough. Filed away in archives thoughout the world, there are many tapes that contain only soundings. To be useful in chart

production the digital data base must contain information such as shoreline, contours, bottom samples, foreshore details and aids to navigation.

RITCHIE discusses three technological revolutions in hydrography. He sees echo sounding and electronic positioning as two major technological advances, and suggests that the third revolution is not in automating hydrographic techniques but lies with multibeam swath systems. The real-time plots of contours and soundings over the entire width of the swath, that RITCHIE talks about, are only possible because depths and positions are collected in digital form and processed using computer-assisted techniques. Because such vast amounts of data are collected with these systems, a hydrographer would not be able to process the data by hand. Multibeam systems may be fine for shipboard operations, but what about a small survey vessel ? It will be some time before such systems are used in a launch environment.

When it comes right down to it, the only point on which RITCHIE and I disagree is whether or not depths should be digitized. It should be obvious by now that his third revolution is not possible without digitizing depths and processing digital data with computers. The important thing is not whether depths are digitized but how those digital depths are processed. Selection algorithms cannot be based solely on a "time or distance" philosophy, but must be based on a "keep the shallow at all costs and show the deeps if you can" philosophy. Quality control checks, such as comparing selected digital data to the echogram, are an integral part of the processing procedure. Any advances made in automating hydrographic surveys in general, and in improving the hydrographer's knowledge and abilities in automation in particular, will help bring about, and indeed be a part of, the third revolution.

One nice thing about having a versatile computer assistant on board the survey vessel is that it will do whatever the hydrographer asks. Remember that the goal is computer-assisted hydrography, not hydrographer-assisted computing. If the hydrographer wants to run straight lines using an electronic positioning system, the computer will help. If he needs to log and process manually, the computer can assist. If he wants to record and process digital data, the computer will obey. The hydrographer has a powerful tool at his fingertips; he should use it as he sees fit, but he must not ignore it. He must get to know it; he must understand how it works. It can only be to his benefit. But the hydrographer must not let it do his job for him. To understand how a computer can properly assist him, he must understand all the skills and techniques involved in conducting a hydrographic survey.

I did not say, in the statement that RITCHIE has criticized, or anywhere else, that the hydrographer should revoke any of his old skills, duties or obligations. He must not lose sight of his primary aims, but he must lift his sights to investigate new methods of improving his product. Although many automation schemes have been abandoned with good reason, others have met the needs of the hydrographer. The research dollars that went into these schemes have, besides improving the technical competence of the hydrographer, reduced survey costs and increased survey accuracy and efficiency. The digital data resulting from improved data collection and processing techniques will soon become an integral and necessary part of the chart production process. The result will be a better product, a better navigation chart. That is how automation is affecting hydrography; that is why hydrographers are automating.

BIBLIOGRAPHY

CASEY, M. (1980): The field sheet as an inefficient medium. *Lighthouse*, Journal of the Canadian Hydrographers' Association, Edition No. 22, November.

CZARTORYSKI, J. & C. LEVY (1981): Drafting a chart with computer-assisted techniques. *Lighthouse*, Special Edition, Proceedings of the 20th Annual Canadian Hydrographic Conference, April.

MACDONALD, G. & M. CASEY (1975): Automation – The changing roles in hydrography. Presented at the annual convention, Canadian Institute of Surveying.

MACDONALD, G. (1980). Sounding selection from a digital data base. *Lighthouse*, Journal of the Canadian Hydrographers' Association, Edition No. 22, November.

MACDONALD, G. (1980): The use of microprocessors for track control and data verification on hydrographic surveys in Canada. Proceedings of the Symposium on Position Fixing at Sea, Southampton, U.K. Also in: *The Intern. Hydrog. Review*, LVIII (1), January 1981.

MOBLEY W. & R. HOPKINS (1978): Bathymetric swath survey system (BS^3), an effective bottom mapping survey system for the hydrographer. *Lighthouse*, Special Edition, Proceedings of the 17th Annual Canadian Hydrographic Conference, April.

RITCHIE, G.S. (1981): Hydrography, yesterday, today and tomorrow. *Lighthouse*, Special Edition, Proceedings of the 20th Annual Canadian Hydrographic Conference, April. Also in this issue of *The International Hydrographic Review*.

WATT, J. (1978): Dependable digital depth. *Lighthouse*, Journal of the Canadian Hydrographers' Association, Edition No. 18, November.