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HYDROGRAPHY FOR THE YEAR 2000

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1. INTRODUCTION

Any paper which deals with the future is open to criticism and skepticism by traditionalists. The only comforting fact for authors of futures papers is that recent history has shown the skeptics have an equal chance of being wrong. Regardless of the odds in the prediction game, every discipline or organization must attempt to determine the influences and pressures that will ultimately determine future directions. Hydrography is no exception !

To address all of the influences and pressures that bear on the hydrographic community would be an onerous task. Therefore this paper will address only a small number of factors which the authors feel are the most important in revealing the direction of hydrography to the year 2000. While these factors place a major emphasis on technology, their impact on society and the economy must also be considered as "there are significant human problems in all countries that can be mitigated to some extent with the results of marine research. The ocean is already a source of extractable resources, living and non-living, and additional resources remain to be developed. The ocean provides a medium for shipping, communications and national defence. It modulates the climate, receives the wastes of domestic, agricultural and industrial activity and welcomes those seeking recreation. In each case too little is known about the relevant phenomena and process to permit accurate forecasts of the consequence of alternate use strategies or management measures. Without that knowledge, resources may be wasted, used inefficiently or inadvertently destroyed. The cost of ignorance is often high and the investment in reducing it can produce large dividends" [1].

2. TECHNOLOGY

A recent report in Canada dealing with technology and federal policies defined technology as "tools and the capacity to create and use them" [2]. Further,

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it is "not just about machines; it's about the skills and knowledge and ability of people to develop and use tools which make their lives more enjoyable and productive. Technology, in other words, is "know-how and know-why". As such, it's a social, cultural and educational phenomenon which cannot be considered in isolation from its human context" [3].

The history of technological advancement can be summarized as a series of push and pull cycles. The pull of demand has created many great technological changes but the push of new technology has created changes of a fundamental nature which have repeatedly altered the world in which we live and the way in which we carry out our daily lives.

Demand is the great pull for technological change. It was demand that created the machines of the Industrial Revolution. But demand pull involves simply the application of engineering knowledge and innovation — not the genius of invention. Invention is the pushing force which prods society forward. It is within the framework of technology change that the effect of the following factors on hydrography are discussed.

3. SOME FACTORS TO BE CONSIDERED

The factors considered for review in this paper are not meant to be exhaustive but to give some feel for what may happen in the future as a result of various technical thrusts. Five factors encompassing computers, remote sensing, communications, navigation and positioning, and platforms for surveys have been selected.

3.1. Computers

Although the past 20 years have seen a dramatic increase in computer performance, the number of users and the difficulty and range of applications have been increasing at an even higher rate, to the point that demands for greater performance now far exceed the improvements in hardware. The result is that difficult problems are typically undercomputed relative to the scientific requirements.

One solution to these requirements may be the new vector processors which are being designed to achieve speeds of 800 million floating point instructions per second. This tremendous speed is achieved by dividing problems into parallel operations. Currently IBM researchers have developed an experimental 512 microprocessor system called the Yorktown Simulation Engine while Intel Corporation has announced a new computer utilizing 128 microprocessors.

A development concurrent with parallel processor research is the new breed of machines known as reduced instruction set computers or RISCs. Although RISCs are far from being universally accepted in the industry, there appears to be significant gains in speed and operating simplicity.

In addition the next (fifth) generation of computers will likely employ Artificial Intelligence (AI) and be able to emulate human thought processes such as deduction, inference and comprehension. This will permit natural language interfaces, knowledge bases, machine vision and computer-aided teaching.

What does this new direction in computer technology mean for hydrography ? It means that systems which generate large amounts of data, such as side-scan sonar, multibeam sonar and laser depth finding systems will be able to process the information to a meaningful state, without compromise, in a very short time. These systems will become inherently more useful and improve the quality and coverage of the surveys as the capability to process the data in a rapid manner is reached.

3.2. Communications

In 1985 there are approximately 25 communications satellites serving North America. By the year 2000 this capability is expected to increase by a factor of six. Solutions to the problems of congestion in the allocated frequency bands and the geostationary areas, as well as the inherent shortcomings of satellite communications such as weather-induced attenuation, are likely to be found in the near future. The need to establish earth stations remains a major drawback to such systems; however, even partial solutions to this problem are already being addressed. GINGRICH, in his futuristic book, *Window of Opportunity* [4], predicts a dramatic increase in communication capacity once the problems of assembling satellites and antennae in space are solved.

What does this new tool mean to hydrography ? It means that data can be moved about very rapidly and very reliably. Indeed, it may have a centralizing effect on the processing and archiving of data being input to a data base. It is not difficult to envisage data from a survey vessel or aircraft being directed to a centralized processing system through satellite or surface microwave/satellite links. Dissemination of data from the data base to a user is also entirely possible now and, of course, this is one feature that will eventually play an integral role in the development of the Electronic Chart.

Much of the technology presently exists to implement data links via satellites with the result that many of the ideas discussed will be commonplace. The technology currently available to transmit chart data from one location to another is already well advanced. A typical chart which contains approximately 25 megabytes of data can be transferred from one location to another in about 2 minutes.

Projecting the potential gains in the use of advanced communications systems, GINGRICH suggests that people engaged in certain data-intensive tasks will work at home thereby reducing the need for large offices and highways. It is not difficult to envisage a marine cartographer contracted to produce a certain number of data points per week on an interactive graphics system from a simple work station in the home.

3.3. Remote Sensing — Satellite and Aircraft

For purposes of discussing remote sensing in this paper, the term is meant to cover parameters remotely sensed from aircraft as well as from satellites. Indeed for the more traditional parameters of hydrography, remote sensing from aircraft may be the most important to consider.

The sensing of water depths from aircraft by laser systems, multispectral scanners, electromagnetic systems and other hybrid systems is in its infancy. The system that holds the most potential is the laser-based system. Laser technology is being intensely pursued by military researchers and many spin-offs from those investigations are likely to have a significant impact on the present system.

Considerable effort has been exhausted on the application of photogrammetric techniques for determining water depths. It is the feeling of the authors that these techniques will continue to be applicable to delineating the high and low water line and foreshore detail; however, it is unlikely that the photogrammetric approach with interpretation by analytical plotter methods will succeed as a method of consistently measuring water depths in a cost effective manner. The lack of contrast between bottom features on much of the sea floor precludes the consistent use of this approach. Indeed it is felt that the combination of active systems such as the laser system, complemented by the large footprint passive systems such as the spectral scanning system will, in the end, be the most effective. In addition electromagnetic systems, while currently in their infancy, appear to show considerable promise for areal measurements.

Remote sensing of hydrographic parameters from satellites is under development as an additional small scale aid; however, it has suffered from the excesses of technology push. Often sensors were designed, built and implemented with little input from the potential benefactors of the new technology. There are, nevertheless, clear signs that this situation has changed for the better. A new generation of space-borne sensors has been designed with very specific application-orientated goals. For example, sensors with specific application to the shipping industry include those for sea surface wind measurement, ocean wave height measurement and sea ice concentrations.

One important consideration in remotely sensed observations is the quantity of data collected. On a recent survey using the Larsen 500 laser system, 200,000 soundings were collected in 2.5 hours of flight time. By the year 2000, the processing of this data in a non-compromising manner should be routine.

What then is the future of remote sensing in hydrography ? In general, remotely sensed data will continue to increase in popularity as a new tool for the chartmaker. These data will be used to meet very specific requirements such as the rapid survey of selected inshore areas and macroscale views of specific parameters. The notion that remote sensing will remain as a complementary technology will likely continue; however, as the technology continues to improve, the requirement for more traditional platforms and sensors will inevitably decrease for shallow water applications. This decrease will, at the same time, be more than compensated for by an increasing demand to carry out detailed swath mapping at all ocean depths.

4. THE TECHNOLOGY FORCES ON MANAGEMENT

The quantum leaps in technology have generated tremendous forces on the style and practices of program management. Many managers have not grown up in the "high tech" environment and, consequently, are often faced with the difficulty of utilizing the potential that the technology is capable of providing. Many businesses as well as hydrographic offices have partially responded to the technology pressures but find themselves in a two-tiered, inefficient management process with some of the old and some of the new. The problem is really one of second and third generation management practices trying to integrate with fourth and fifth generation technology [5]. Unfortunately, there appears to be little cause for optimism as the technology is progressing at a much faster rate than the human response to these changes. It can only be hoped that the new thrusts in information management and data base design will bring the technology and management into line.

5. INTERNATIONAL CONSIDERATIONS

The hydrographic community is fortunate to have initiated work on a common exchange format for digital data as a result of a resolution adopted through Decision No. 31 at the 1982 Quinquennial Conference of the International Hydrographic Organization [6]. It is felt that well before 1995, countries will be exchanging data in computer-compatible form and by the year 2000 this will be the standard format for data exchange.

The easy exchange of digital data will greatly facilitate an accelerated production rate for International Charts at medium and large scales because it will provide printer nations with the hydrographic data in a form that can be easily manipulated to their exact requirements.

In addition, by the year 2000 ships will be fitted with receiving systems to receive hydrographic and other data at high data rates from regional distribution centres. Ship operators who will be using the Electronic Chart on a routine basis will be able to verify Notices to Mariners action, chart updates and, if necessary, check their digital data base for a particular area against the data held in a hydrographic office. Such will be the situation for the hydrographic community in the year 2000. Are we as hydrographers preparing ourselves and our organizations to meet the challenges and the opportunities ?

6. TRAINING

The personnel required to understand, operate and maintain the technological developments of the next fifteen years will be significantly different from the more traditional approach of today. It is likely the hydrographic community will be forced into developing staff with distinct areas of specialization. The generalist of today will, in all likelihood, become a rarity and will probably be replaced by a team concept. The specialization categories that make up the hydrographic team will likely include data collectors and processors, data managers, software and systems analysts and mission specialists. While these categories are not new in concept or operation, they do emphasize the greater degree of specialization that can be expected.

To prepare the hydrographic office of the future for the anticipated changes in personnel requirements, the training of future staff must be considered today. The hydrographic community has advanced a great deal with the development of the Standards of Competence for Hydrographic Surveyors [7]; however, the authors believe a re-examination of those Standards must begin now to ensure that we have adequately trained staff to meet tomorrow's challenges while at the same time preserving those attributes that ensure the production of quality products.

7. SUMMARY

Some of the reasons for preparing this paper :

i) This paper has been written as a stimulus for the hydrographic surveyor to consider the future. It is hoped that the thoughts presented will serve as a forerunner to more detailed futuristic papers.

ii) It is felt that it is necessary to assess the technological framework in which we work and to see what mechanisms must be set in place to achieve optimum benefit from technological change. For example, what digital data bases should be constructed, what data should they contain, and how should they be structured to present hydrographic data to all clients in the most easily accessible format, be they mariners, oceanographers or developers.

iii) The time has come to begin to sensitize the marine community to the rapid technological change that is taking place in the hydrographic process. Hydrographers are no longer just producers of traditional navigational charts and other publications. They are slowly becoming members of a volatile and important information society.

iv) Government Services in many nations and in particular hydrographic services are in a period of restraint. With decreasing resources, the question is : how can the increasing number of clients who depend on our services best be served ?

v) There was a time when hydrographic operations were carried out only by the national charting agencies. As hydrography becomes more and more a private sector task, then national hydrographic offices must prepare their future organizations to ensure the integrity of their data which is their lifeblood and "raison d'être".

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