ACQUISITION AND PROCESSING OF OCEANOGRAPHIC DATA BY A SEA-GOING COMPUTER: AN OCEANOGRAPHIC TOOL AND A COMPLEMENTARY FACILITY FOR ACOUSTIC TRIALS

by

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1. HISTORICAL DEVELOPMENTS OF SACLANTCEN SEA-GOING COMPUTER FACILITIES

First of all I would like to describe the development of computer application in data acquisition and experiment control here at SACLANTCEN. When a minicomputer was first used as part of the equipment involved in sea-going experiments it was considered by the majority of us simply as a functional substitute for a larger, more expensive, less useful piece of hardware. This happened about 1968 and at that time this was probably the only practical way of using this class of computer.

A good choice of cheap small machines was already available on the market, but most of them were offered with rudimental sets of software. Systems with much better software were certainly available but their price put them outside the area of interest for minicomputer users. (1800 IBM with TSX, 516 Honeywell with OLERT).

However, after our first experiences a strange thing happened, the scientists who first used this new piece of equipment were impressed by its power, its flexibility, its potential space of application, and the computer system started to grow. A paper-tape puncher, a disc mass memory, a CRT display and other peripherals were acquired. This represented an investment of probably more than double the original value, but there was still a lot of space for growing. A recurrent sentence was "If we add this, we could do much more with our computer".

It very soon became clear that if a small dedicated computer system was convenient for data acquisition, a larger one would be much more powerful and desirable. The problem was what to add: memory, number of peripherals, or speed. All of which would open up new possibilities.

We had the feeling that a more complex system would not be so easy to keep under control as a simple one; that is, for it to be efficiently used to its full capacity so as to obtain the expected returns. When we realized this we decided that the computer to be used on board had to be as large as necessary, but it also had to be controlled by a powerful operating system so as to allow the efficient use of all the available resources. Another possibility was to use several small task-dedicated systems. However, this solution is obviously more expensive since a computer alone is worthless and the required peripherals for each system are much more expensive than the actual computer. The only way to acquire efficient use of the peripherals is to avoid prolipheration of the computer system.

For these reasons when international competitive bids were requested for a sea-going computer we emphasized in our requirements the need for a powerful operating system.

In the meantime (1969) Hewlett-Packard brought onto the market the Real Time Executive. This was probably the cheapest computer offered with the required operating system. The next in price was Honeywell with the 316 and 516 both running under OLERT. The OLERT is much more powerful than the RTE, faster in servicing requests and, from a hardware point of view, the Honeywell computers are more powerful than the Hewlett-Packard. However, since our first experience with a sea-going computer was with a Hewlett-Packard, and since they also provide a wider range of hardware and software connections for the instrumentation, and they also made the cheapest bid, we finally ordered the Hewlett-Packard.

We received the first system in spring of 1970, and the second one in July of the same year.

2. THE COMPUTERIZED ENVIRONMENTAL DATA ACQUISITION SYSTEM

The computer may be used for acoustic oriented application as well as for acquisition and processing of environmental data. At present it handles the meteorological data and the TSD profiler data; automatic navigation recordings and sea state recordings will be added later.

Common to all branches of oceanographic data is the relatively low, but continuous, data rate (24 hours on a routine basis). The result of this is that if the computer is managed by a suitable operating system it is possible that only a small portion of the computer's resources are involved in this task thereby leaving the remainder available for more demanding work.

The environmental data acquisition system is composed of several programs (about 10 at the moment) divided into the following groups:

(a) Data Acquisition: These are very small input/output bound, core resident programs. They are only for inputting data which is buffered in the common area or on a disc. These programs now occupy 7% of the available memory (not taking into account the space used by the operating system) and less than 1% of the computer time.

(b) Processors: These are disc resident programs which are scheduled at regular time intervals for "processing" the collected data. Their product is one or more records in the standard format chosen by SACLANTCEN in the common Magnetic Tape Unit. They only occupy the memory for the time strictly necessary since they are not involved in I/O operations. The computer time presently spent in processors is less than 2%.

(c) Background Programs: These are large programs that are not run on a routine basis but on request, generally processing selected sets of data.

The possibility of running off-line programs in the background add to the data acquisition the facilities of a small scientific computer.

The background area may also be used for the full set of acoustic acquisition and processing programs. The background in the operating system used by us does not mean low priority because priority is an independent parameter, it only means a certain core area allocation.

3. CURRENT STATE OF OUR SYSTEM

The system presently run on board consists of the data acquisition programs and two processors.

3.1 The first two data acquisition programs record voltage measurements from a chain of thermistors and other sensors at two different sampling rates. The measurements are then converted by the first processor, averaged, and the result is the following set of meteorological data:

Dry and wet air temperature
Sea surface temperature
Solar radiation
South/north and east/west wind speed

These data are checked by means of several comparisons so that if one sensor should fail an alarm is immediately given.

The data are also stored in row format in the permanent output file (magnetic tape) in order to allow re-processing at a later date if changes to certain parameters are required.

3.2 The third data acquisition program and the second processor take over the control of the TSD profiler. The frequencies sent by the probe are measured, converted, stored, and checked; alarms are given for several error conditions. Upon request, immediately after the end of the cast, the temperature, density and salinity profile may be computed and plotted using a background program. In the background at the moment we have a program that plots the meteorological data as a function of time.

CONCLUSION

Going back to the basic concepts, what I want to emphasize now is not the fact that in oceanography we use a computer for data logging and for directing an experiment but, with a suitable operating system and with an efficient program organization, it is possible to do a lot of things in this direction leaving most of the computer resources available for other applications. This is not a new practice with large computer systems but it has only recently become feasible with mini-computer systems.

There are two major outcomes from our experiments at sea:

(1) Scientists involved in acoustic trials may also have, at no extra cost, descriptions on magnetic tape of the environmental conditions before, during and after the experiments.

(2) Oceanographers may get data out of cruises as a by-product; they will certainly not all be strictly of scientific value, but they will at least be useful in enriching the files of data describing the environment.

The quality of the data collected by this system will be better than data otherwise collected. Processing will be quicker and easier as time-consuming operations such as editing will not be necessary and the results will be more reliable.