

## **AUTOMATIC DATA HANDLING IN HYDROGRAPHIC WORK**

by A. Raymond BOYLE, B.Sc., Ph.D., A.Inst.P., A.R.I.C.  
of Dobbie McInnes (Electronics) Ltd., Glasgow

---

### **INTRODUCTION**

As in so many other fields of work, which have used traditional manual methods for many years, the use of automatic data handling methods and computers is bringing about changes in hydrographic work.

This description is particularly concerned with automatic methods of reading and drawing — in other words, the analysis of charts and traces and the production of charts or line drawings.

In general, the latter can be carried out completely automatically, but the reading of information normally requires the discretion and assistance of an operator. However, new methods of the recording of basic information are now being developed to make the collection and analysis of information also completely automatic.

### **AUTOMATIC DATA HANDLING APPLIED TO HYDROGRAPHIC WORK**

In hydrographic work, a variety of applications of such equipments is possible and these are generally described in the next few pages. The fields covered in this description are :

- a) The reading of information from charts;
- b) The automatic drawing and printing of information on charts;
- c) The reading of analogue records (e.g. depth recordings);
- d) The design of field recording units, the recording from which is suitable for subsequent automatic analysis;
- e) The transmission of chart information.

#### **a) The Reading of Information from Charts**

During the last few years a system of reading chart information has been developed, which is probably the most simple yet devised. Known as the " Pencil Follower " Automatic Reading System, it uses the services of an operator, but it is only necessary for the operator to pick up a " Pencil "

and place it at a desired position to automatically produce a co-ordinate output in digital form.

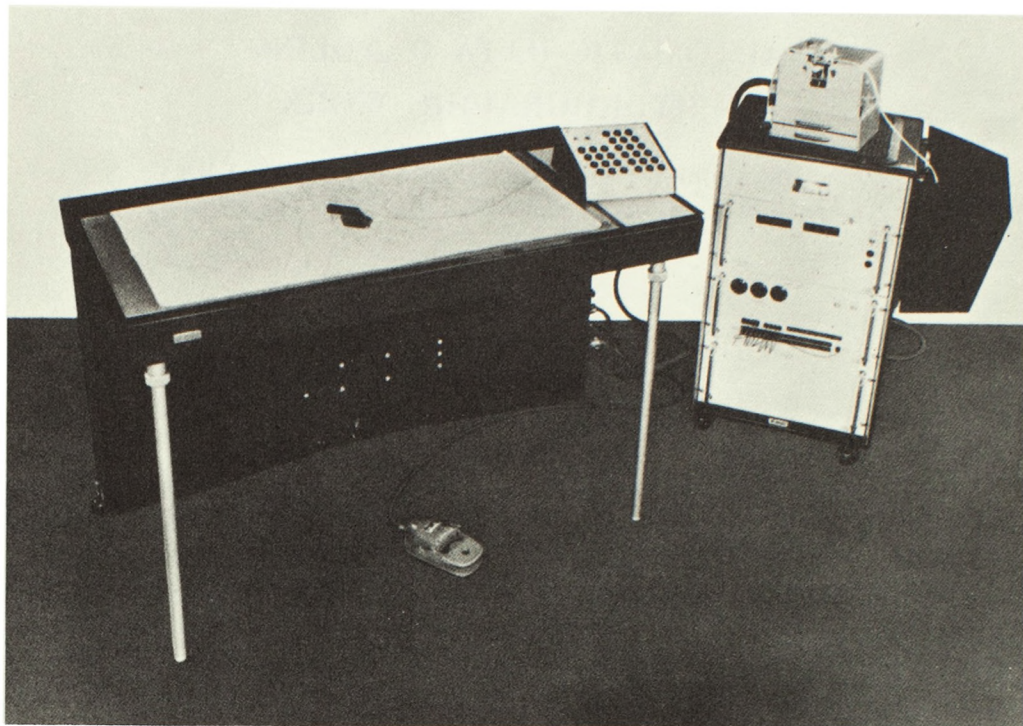


FIG. 1. — Pencil Follower. — For the reading of information from charts

For use in reading hydrographic charts, the pencil is pointed at a particular position and the co-ordinates of that position can be read out. The appropriate symbol or depth information is then added by means of a manual keyboard.

In order to obtain information from coastlines or contours, the "pencil" is moved along a line and a continuous stream of co-ordinates at discrete intervals along the line is then output. The reference value of the contour can again be added by means of the keyboard. The interval between points is normally determined on a fixed time basis, and this is particularly useful as more co-ordinate information is provided when the operator reduces his following speed to negotiate intricate features. The time interval may be varied by the operator to suit his own speed of work and the accuracy required.

Theoretically, the speed of operation is limited only by the speed at which the operator can follow, but in practice the speed of the output device is often the main limiting factor, except for the highest accuracy work.

Types of output fitted to the device include the normal computer media — punched paper tape, punched cards, magnetic tape, — or tabulated outputs may be obtained.

Accuracies of up to one part in 10 000 for each axis length are obtainable, i.e. 0.1 mm over a length of 1 metre.

### b) The Automatic Printing and Drawing of Information on Charts

This type of equipment may be entirely automatic, and consists of the Graphplotting and Line Drawing equipments developed over a number of years.



FIG. 2. — Typical Graphplotting for the automatic drawing and printing of information on charts.

Basically these units consist of a gantry and trolley arrangement which moves over the plotting area. The gantry moves in the X direction, and the trolley travels on the gantry in the Y. Mounted on the trolley is the printing head, which carries out the appropriate functions of printing and line drawing, and is positioned according to the co-ordinate position signals fed to the equipment from the various computer media — punched tape, punched cards, magnetic tape or manually from a keyboard.

The printing head normally carries symbols, in the form of letters, figures, or symbols, which print mechanically in a similar manner to a typewriter. For line drawing functions, capillary pens are used, attached to the printing head.

This type of equipment is used in Sweden by Dr. FAGERHOLM and can carry out the functions of : —

- i) *Graphplotting* — where symbols are used to plot a graph.
- ii) *Straight Line Drawing* — where straight lines are drawn between successive points as they are read by the equipment.

- iii) *Free Line Drawing* — in this method the best curve is drawn through a series of points, the accuracy of the fit depending on the distance apart of the points. This method is widely used for contour drawing in meteorological and mapping fields and has similar applications in hydrographic work.
- iv) *Alpha-numerical Printing* — where a row of letters or digits may be printed at a selected point. This method is ideal for the plotting of depth on standard hydrographic charts.

Equipments of this type, with plotting areas up to  $2.0 \times 2.5$  metres can be supplied, with positioning accuracies of 0.1 mm.

Recently developments in the methods of presentation have enabled this type of equipment to be provided with optical printing. This uses an optical projector to produce the required symbol images (or a light spot for line drawing) on to light sensitive paper. This method gives extremely high quality, and is completely suitable for the direct production of a printing overlay. Speeds of printing of a block of information per second and line drawing speeds above 10 cm per second are normal.

One disadvantage of the above type of equipment is that the speed of operation tends to be limited by purely mechanical limitations of size and weight. In order to overcome these limitations, the latest methods involve the production of complete charts or diagrams on a piece of microfilm, which can be enlarged to the required size when the plot is finished. The equipment is known as the Microfilm Plotter. With this type of equipment, the speed of operation is extremely high and the accuracy, which is better than 1 part in 1 000 is adequate for the majority of applications. Complete blocks of symbol and alpha-numeric information can be printed in approx. 0.5 seconds and due to the low inertia of the moving part and the magnification of the final print, equivalent line drawing speeds of several metres per second are normal.

Normally there is no limit to the complexity of symbol or line information to be presented as the image generating unit is static and can therefore be as large as necessary. Movement in the X and Y axes is obtained by movement of the optical system.

In both methods the input information is in numerical form. For position information this appears as the co-ordinates of a single point and for line information this appears as the co-ordinates of a series of points. Various characters which control mode and symbol selection may also be added.

The input can be from punched paper tape, punched cards, magnetic tape, manual keyboard, teleprinter or similar link, or the equipment can be connected directly "on-line" to a computer.

There is no doubt that the Microfilm method is proving very advantageous. It is somewhat cheaper in construction and gives a very good quality of result, with the added advantages that prints of any size are easily made whilst the original is easily filed.

The process and handling of the microfilm is entirely automatic and a dry print mounted on a standard card is available 50 seconds after the completion of plot. No manual processing or use of dark rooms is required.

The lines produced are always smooth and minor dimensional errors can be corrected in the enlargement processes if calibration lines are added to the microfilm. The small size of the unit and its rigidity facilitate its use in many different locations, including use on board ship, and its speed advantage is very impressive.

### c) The Reading of Analogue Recordings

For many years, Dobbie McInnes (Electronics) Ltd., have specialised in the manufacture of units to analyse analogue traces, and, although direct digital recorders are now increasing in numbers, more and more analogue traces remain to be handled.

Many different types of unit have been designed, and up to the present time one using the cursor method of reading has been most frequently employed. The operator's discretion is most useful and much wasteful information can be left out from the later analysis by examination at this stage. The operator's presence also enables competent information to be taken from traces which are difficult to read. Completely automatic readers have not been popular for general purpose use.

This article is mainly concerned with the latest methods and it is obvious that the popularity of the "Pencil Follower" for the reading of strip charts, as well as area charts, is fast gaining ground. It is remarkably simple to use and it is possible for an operator to use it successfully after only a few minutes introduction — a specially trained operator is not required.

There are many applications of this system, of which one for reading hydrographic charts is mentioned earlier. In this application, recording information of coastlines or contours is by outputting co-ordinates at regular time intervals. It is however, also possible to output Y values only at preselected intervals along the X axis. One such method is to divide any length along the X axis into, say, 100 parts.

This method is obviously applicable to the analysis of analogue charts such as recordings of depth. One difficulty in this particular application, is that during recording, the ship's speed is not necessarily constant and thus the length of chart relative to fixed points on the earth's surface is not constant. This is easily overcome, however, by the use of a small pointer which can be set against each new marker point from the log, enabling the length between markers to be divided into equal increments. The reading is thus automatically taken at fixed intervals of ship's distance.

The combination of the operator and the "pencil" allows the operator to select the true mean reading position as he moves his pencil along the line. An automatic paper advance facility allows him to move the chart automatically on completion of a section.

The output may be in the form most suitable for computer use, i.e. punched tape, punched cards, magnetic tape, or it may be presented as tabulated lists of data. A keyboard is normally provided so that extra information such as scale settings may be noted.

The example given here applies to depth recordings, but the simplicity

and the versatility of the "Pencil Follower" make it suitable for the analysis of any type of analogue recording. Curvilinear as well as rectilinear recordings may be analysed.

**d) The Design of Field Recording Units the recording from which is suitable for subsequent Automatic Analysis**

The advantages of a direct digital recorder for field use are obvious and this field of interest has not been neglected. A small, low cost, self-contained, digital magnetic recording unit, known as the "Limpet Logger" has been recently developed. It is designed to operate from external digital or analogue transducers and as an example, at a recording interval of a reading every fifteen minutes, will operate, completely automatically, for periods of a year or more. The equipment is contained in a waterproof case and is able to withstand severe climatic conditions and operate accurately over a wide temperature range.



FIG. 3. — Limpet Logger — Field recording unit — the recording from which is suitable for subsequent automatic analysis.

Various models of this unit are becoming available and a version is available for sampling up to four analogue or digital inputs.

As mentioned above, the recordings are made in digital form on magnetic tape, which is contained in an easily removable cassette. On completion of a tape, this is placed in a fully automatic Translation Unit, which produces the recording in the form required by the user — either punched tapes or cards for computer use or in tabulated form or pen

recordings for visual use. Facilities are available during the translation for the presentation of accumulated totals and averages completely automatically.

There are many applications for this versatile recording unit and several have recently arisen for use on board ship, for tide measurements, geomagnetic measurements etc.

#### **e) The Transmission of Chart Information**

One problem which frequently occurs in meteorology and also to some extent in hydrography, is the transmission of basic data. The usual method of transmitting a chart from one station to another is facsimile, where the chart is automatically scanned and then reproduced in a comparable way at the other end of the line. Transmission may be by land line or radio, but the disadvantage of the system lies in the fact that times of up to an hour and a half may be taken for a complicated chart if reasonable quality is to be obtained.

Using the line reading and line drawing equipments already described, a system of data transmission has been developed which can transmit the necessary line and position information in a short time. In this case, the system would possibly be a combination of a "Pencil Follower" producing punched tape and a Line Drawing Unit operating from punched tape connected intermediately by Teleprinter or similar unit. Similar systems using radio connections can also be used.

### **FUTURE DEVELOPMENTS**

The above are only some of the ways in which data handling methods can be applied to hydrographic work and special problems in Automatic Drawing and Trace Analysis methods are always being examined.

Amongst current development is the production of equipment for automatic map making, which is expected to reduce the time factor in map production by a factor of 10 and there is no doubt that similar methods can be applied to hydrographic work in the production of charts and similar drawings.

The development of both equipment for drawing and analysis is proceeding at high speed. The next few years will see many interesting further developments.

