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THE HYDRAUT AUTOMATIC DATA LOGGING SYSTEM

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INTRODUCTION

The two new hydrographic survey vessels of the Royal Netherlands Navy — H.Nl.M. Ships *Buyskes* and *Blommendal* — are described elsewhere in the present volume. Both these ships and their polyester survey launches (polyboats) have been equipped with an automatic data logging system which has been named the HYDRAUT system, with the processing facilities installed ashore at the Hydrographic Office in The Hague.

The choice for this basic set-up was made in 1971 after trials with a complete automatic system aboard H.Nl.M.S. *Snellius* — where the aim had been to carry out both logging and processing aboard ship — had proved unsuccessful.

The problems that arose during this evaluation period were multifarious. To start with, only two persons had any specialist knowledge of automation in hydrographic work. The time for establishing specifications for the system had, moreover, been less than six months. Furthermore, great problems concerning both hardware and software in the *Snellius* had been encountered aboard ship. A study trip to Canada and the United States in 1971 proved extremely useful gathering valuable information about existing systems.

We tried to combine in one specification those items that had proved successful and reliable. So far as hydrographic work was concerned incorporation of the following features was desired.

(a) A data logging system built around a PDP 8 computer both aboard the ship and in the boats, all further stages of processing up to the end product (the fair sheet) being done in the Hydrographic Office.

(b) Magnetic tape cassettes as the logging medium.

(c) A digital plotter and a teletype on board the mother ship — but not in the polyboats owing to limitations of space — to allow production on-line of the survey track and of a list of soundings.

(d) A compensation system for eliminating the vertical movement (under normal surveying conditions) in both the ship and the boats.

(e) A computer controlled Left/Right Indicator in both the mother ship and her boats.

(f) As many "built-in" quality controls as possible. This was considered essential as ship's time is so very expensive; thus a reliability check on data before being sent ashore for processing was most important.

(g) A variable depth sampling rate of 1-5 times per second, and a constant position sampling rate of once per second.

(h) A single firm that would accept overall system responsibility.

Military specifications were not requested.

A further requirement was that the system should be able to accept data from the following sensors.

For depth : Atlas Deso-10 echosounders in combination with an Edig-10 digitiser and a display unit. Frequencies : 33 and 210 kHz for the ship, and 100 and 210 kHz for the polyboats as well as for the towed echosounders. Ranges : 0-280 m for the ship and 0-100 m for the boats.

For the positioning system : Either Decca Mk 21, Hi-Fix, or Sea-Fix.

The hydrographic operational and technical specifications were put out to tender, the contract being awarded to Rietschoten & Houwens (Applied Dynamics Europe) of Rotterdam who had also manufactured the interface for the system installed in the *Snellius*. This firm has full servicing capabilities and was willing to accept total system responsibility, the processing station ashore included.

Processing and plotting equipment became available for use in the office after the decision to decommission *Snellius* in 1972 was taken. Consequently the IBM 1130 computer, with its peripherals, and the Hagen digitiser were available for integration into the processing station ashore.

THE SHIP SYSTEM

Figure 1 is a block diagram of the data logging system aboard the survey vessel.

The Cartri File cassette recorder, model 4096, manufactured by the Tridata Corporation (U.S.A.), was chosen for logging the data onto magnetic tape. The tapes are in the form of interchangeable plug-in cartridges, each containing one endless loop tape. Photo-reflective "load point" tabs mark the beginning and end of the tape, standard lengths of which are 10, 25, 50 and 150 feet. The tape is in bit-serial format, the bit density being 600 bpi. The recorder is mounted in a standard 19-inch rack, the weight being 16 kilograms.

A Houston Complot DP 3 incremental plotter produces an annotated track plot. The DP 3 uses 22-inch wide Z-fold (fan fold) paper, considered advantageous since the plot remains accessible.

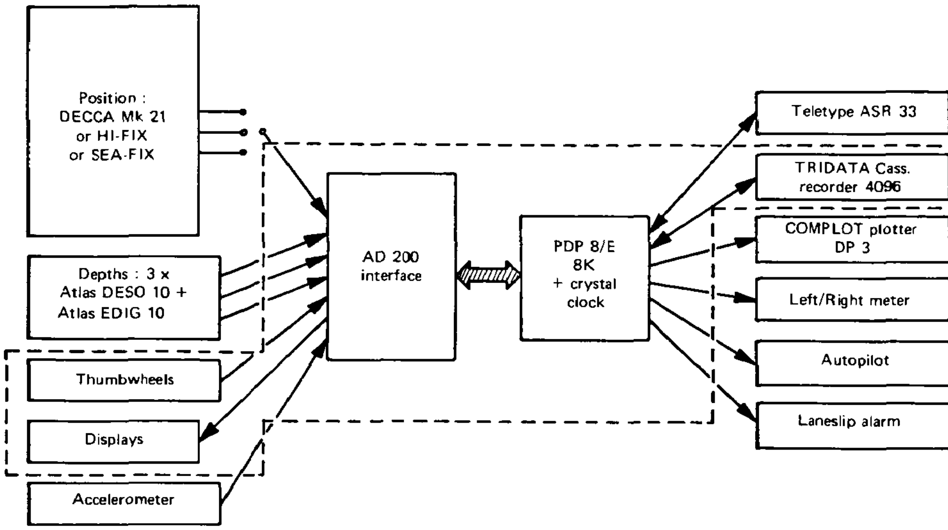

FIG. 1. — The HYDRAUT ship's system.

The modules enclosed by the dashed lines on figure 1 are installed in two enclosed 19-inch cabinets, the displays and thumbwheels being on the front panel. The panel is divided into functional blocks: at the top left the ship's echosounder depths and those of the towed transducers are displayed; at the top right are the displays for the time in hours, minutes and seconds and the readings for patterns 1 and 2 of the positioning system selected. The left-hand centre block feeds the computer, through thumbwheels, the data necessary for computing the positions of the towed transducers, i.e. cable lengths, both to starboard and port; the relative bearing of the floats; and the ship's speed. Here also is the selector switch to indicate to the computer the combination of depth sensors being used. On the right, thumbwheels feed in data for the Left/Right Indicator, i.e. starting point, track/course, distance to the next sounding track; also included is a switch for indicating whether the next turn is to be made to port or to starboard. At the bottom left a thumbwheel selects the depth sampling rate (0-5 times per second) and another selects the fix mark interval on both the echosounder roll and the track plotter, the seven positions being $\frac{1}{2}$, 1, 2, 3, 4, 5 minutes or manual.

The operation mode switch can be set to either sounding or not. In the latter case the depths are not taped and the plotter will produce a dotted line. The last block of thumbwheels (bottom right) feeds the computer an upper and a lower depth limit. This bracket reflects the depths between which soundings are expected to vary in a given survey area. Soundings outside this bracket are periodically printed out on the teletype. The last switch on the operating panel — the up-date button — creates an interrupt and feeds the thumbwheel settings to the computer.

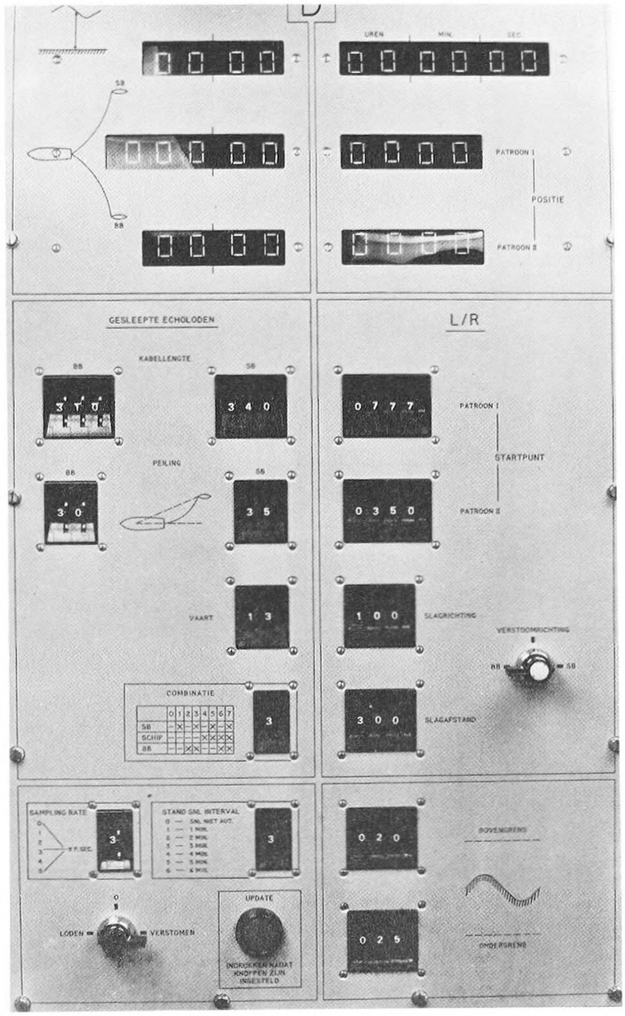

FIG. 2. — Ship's operating panel of the HYDRAUT System.

THE LAUNCH SYSTEM

The HYDRAUT system installed in the launches is a simplified version of the ship's system, having no towed transducers, plotter or teletype. The computer chosen is a PDP 8/M with a 4K memory on account of its small dimensions. The data logger is housed in a closed metal container (48″ long, 30″ high, 22″ deep), weighing 135 kilograms. The container is cooled by means of coils in its upper surface with salt water from the engines. Its front panel has two inspection doors for servicing and starting up the computer; the right hand door houses the operating panel and an opening for inserting the cassettes.

OPERATING THE HYDRAUT SYSTEM

Before surveying can start, the UTM grid, the geographic graticule and the hyperbolic (Decca, Hi-Fix, or Sea-Fix) or circular (Sea-Fix) lattices must be drawn on the construction sheet for both ship and launches. This is done by feeding programs into the computer from cassettes. The plot's North can be skewed.

After initiating the system — starting the computer and setting the panel thumbwheels and switches appropriately — the plotter must be lined up, after which the logging process can start. The plotter is up-dated every second — since the Decca, Hi-Fix or Sea-Fix readings are converted into UTM readings for the plotter once per second — while the plot is marked at the selected fix-mark interval with a small cross, the time and a sounding direction arrow. Simultaneously a fix mark is inscribed on the echogram, and the teletype produces the sounding list together with time, position, depth and any overshoot information. Overshoot is given in three columns: for the port towed transducer, the ship and the starboard towed transducer. Overshooting does not entail elimination from the program: all the original measurements are retained on the tapes. The decision as to whether or not an "overshoot depth" should be ignored is made ashore at a later stage in the processing after comparison with the echogram.

The Left/Right Indicator is also up-dated every second. The helmsman thus has a continuous display of distance off the predetermined track. Even on the first trials this Left/Right Indicator proved invaluable since it leads to unbelievably straight sounding tracks.

The time and position (once per second), depth (1 - 5 times per second) and vertical acceleration (3 times per second) are then fed into a 200-record file: once the file is complete it is put on magtape preceded, every time the thumbwheels are altered and the up-date button is operated, by administrative data taken from the operating panel. When the system is not in the sounding mode (that is when the vessel is proceeding from one sounding track to another) the plotter merely produces a dotted line, and depths are not registered on the tape.

The launch cassettes are plotted out and the upper/lower limits and teletype sounding list are checked off-line aboard the mother ship. After surveying, the cassettes together with plots, sounding lists and echograms are sent to the Hydrographic Office accompanied by special forms indicating which area the cassettes cover and their order for processing, and including information regarding draught, salinity, water temperature, etc.

An additional task is the preparation on board of tidal reduction information; the listed corrections are despatched to the Hydrographic Office.

Remarks on the afloat systems

1. After the system had been set up some modifications proved necessary: firstly a lane-slip indicator was installed in the form of a buzzer to draw the attention of the duty surveyor to the fact that a lane-slip has occurred. Secondly, in addition to the Left/Right Indicator, the Decca/Arkas auto-pilot was connected to the interface. In good visibility and with little shipping traffic the ship can thus be steered completely automatically by the HYDRAUT system, giving the helmsman the possibility of a coffee break.

2. The survey boats have neither a plotter nor a teletype, but this does not mean that these could not be added to the system. With a larger memory and some slight modifications to the software this would be feasible, but in our launches we lacked the necessary space.

3. On the *Buyskes* and *Blommendal* the full HYDRAUT system is sited in the Central Recording Room, and there is no direct connection with the navigation bridge; this proved a disadvantage. A better set up would be to have at least the plotter and a small operational panel on the bridge for the officer-in-charge.

PROCESSING AND PLOTTING ASHORE

Figure 3 is a block diagram showing the configuration for processing and plotting ashore. The various blocks are numbered to facilitate reading of what at first might seem a complicated system.

The first step is to transfer the raw data from the cassettes to a 9-track, 800 bpi TU 10 magtape via a PDP-8/E 16K computer with its OS 8 system and a TC 58 tape control unit (numbered in figure 3 : ① ② ③ ④). This gives the possibility of returning the cassettes to the ship for reutilization.

It is then necessary to wait until both the monitor corrections for position and the tidal corrections become available. On arrival they can be fed into the IBM 1130 computer which will be used for further processing steps.

The raw data is now transferred from the magtape to the IBM computer via the tape control unit, the PDP 8 computer and the interface, (marked ④ ⑤ ⑥ ⑦ in figure 3). The interface — also supplied by Rietschoten & Houwens — enables transfer of the data from the 12-bit PDP 8 to the 16-bit IBM 1130, and vice versa. The raw data is now ready for tidal corrections and then the ship corrections are applied. Next it undergoes a swell compensation program that eliminates the influence of the ship's vertical movement. All this results in "ideal" data relating to Chart Datum and a smooth sea surface.

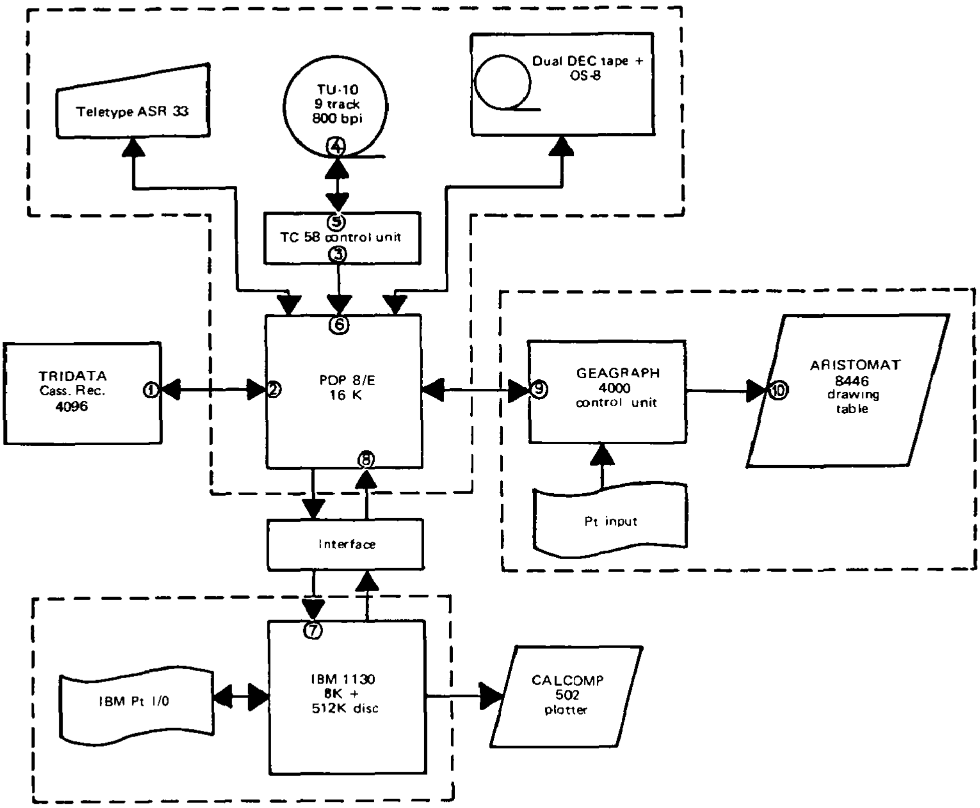

FIG. 3. — The HYDRAUT processing system ashore.

The next step is the depth selection program, yielding those depths to be plotted on the fair sheet. When these depths with their positions have been selected they are fed into the PDP 8 computer (see ⑦ and ⑧ on figure 3) where an Aristo software package enables them to be plotted, via a Geagraph 4000 control unit, on an Aristomat-8446 plotting table. The Aristomat is a highly accurate draughting apparatus with static precision of 0.02 mm and a draughting surface of 1.2 × 1.5 m.

THE SOFTWARE

All programs to be used in the ship system are written in PAL III, a PDP 8 assembler language, the exception being the programs for off-line geodetic computations which are written in Focal — an interactive language. The majority of programs are well documented, and written with modular work in mind.

The three most important operational programs for HYDRAUT are: the mothership program, the boat program, and the quality control and plotting program for data from the boats.

The mothership program

This is written on an "interrupt" basis in such a way that depth, vertical acceleration, position and time are invariably sampled at the correct moment even if the databuffer is "dumping" to the Tridata Cartrifile. To achieve this the sub-routine for plotting the ship's position acts in a main program role; this was feasible because, even when the ship is proceeding at maximum speed and when the plotting scale is 1/1000, the program has plenty of time to complete its task. In fact, it turned out that the program waits for interrupts for about 70% of the time.

The program samples depth and acceleration at the chosen rate; the position is computed in hyperbolic coordinates every second, using the sine and cosine values from the positioning system. For conversion of hyperbolic to UTM coordinates the "small computer method" developed by Lieutenant Commander W.G. van GENT, R.NI.N. (which was described in the Netherlands *Hydrographic Newsletter* of July 1970) is used. The method is an iterative one, and since the ship's position will not change more than 7 metres in a second the computation will take less than 40 milliseconds. The memory requirement is about 2½ pages of memory, i.e. about 350 instructions.

Utilizing the UTM position, the off-track distance from the predetermined track is then computed. This distance is next appropriately converted for the Left/Right Indicator and the Decca/Arkas autopilot. The plotting package used is a modified version of the "John W. Fitzgerald plotting package" (Decus 8-168). Among its modifications it has floating point computing. As the DEC floating point package has non re-entrant subroutines this involves the use of a second floating point package in another memory field.

The program also contains a precaution against laneslip: each second the hyperbolic coordinates are checked against those of the preceding second and if the difference exceeds a predetermined value — expressed not in metres but in fractions of lane — the program will register that a laneslip occurred during that second. A warning buzzer is then activated, the last assumed correct value stored, and the Left/Right Indicator and the autopilot are locked in order to prevent the helmsman from steering wild. Thus, by holding a straight course and creating the possibility of replotting the position, it is possible to find out what has happened. The plot of the ship's track is helpful for this verification. If the coordinate difference remains between set limits then everything continues normally.

Although this is not a perfect solution to laneslip problems it fits about 90% of cases, obviating the necessity for the ship to return to a reference point. The Left/Right Indicator has a logarithmically graduated scale, the value fed to it being adjusted for this scale. In practice the ship is able to hold extremely straight lines due to the high Indicator sensitivity close to the predetermined track.

There are three methods of steering the ship along specified tracks: with a helmsman aided by a Left/Right Indicator; with the autopilot, the course again being adjusted by the Left/Right Indicator; and finally with the autopilot connected direct to the computer. The last two methods appear to yield the best results.

Each time logged data are "dumped" — normally about every 200 words — the record is preceded by an identification word to indicate the variety of data (administrative, sounding or navigational data) and followed by a sequential record number. Each dump is a record on the cassette tape. Every record is terminated by the number of datawords it contains plus a terminal word. Each cartridge starts with a repetition of administrative data in order that the cartridges may be separately processed.

During sounding operations the Update button may be operated at any time either to initiate new thumbwheel values or else to mark a special event such as passing over a wreck. Operation of the Update button has the same effect as a fix mark interval; this means that in addition to the insertion of administrative data on the cartridge a mark is registered on the plot, a line is recorded on the sounding list, and a fix mark inscribed on the echogram.

The survey boat program

This program is very similar to that of the mothership, but fits into a smaller memory (4 K).

Quality control and plotting program for boat data

This program reads the data logged by the boats and performs a quality check. It does not use the "interrupt" facility, but despatches the records automatically one by one. All depths are checked to ascertain that they fall within the preselected upper and lower limits. The hyperbolic coordinates are then converted to x, y coordinates for the plotter, and are plotted in the same way as for the mothership. The plot is marked at each fix, and a new line containing time, position, depth and the number of depth overshoots is added to the sounding list on the teletype. A two-hour period of boat sounding takes only about 10 minutes to process on board the mothership.

A program in the ship's system is used before the survey starts to draw the UTM grid, the geographic graticule and the hyperbolic lattices on the construction sheet. The program has been written partly in Fortran and partly in Pal III; it makes use of the modified plot package mentioned earlier. Moreover it makes possible the skewing of the UTM North in any direction. Each of these tasks is written as a separate program. A "question and answer" routine enables the normal flow of the whole program to be modified or a task to be skipped. There is also an interactive task for plotting alpha-numericals and some specially designed characters. A subsequent modification to this program will add a feature for plotting specific points, such as wrecks, by entering the hyperbolic or geographic coordinates on the teletype.

OPERATING THE SYSTEM

A clearly arranged front panel was of importance, so thumbwheels were chosen for the input of variable constants such as depth limits, and teletype was used for inputting administrative data, scale, etc. As the computer memory is restricted a small preparation program is included for sorting the administrative data into the correct memory locations. This task is in "question and answer" mode, so there is no possibility of something being forgotten. At the same time a hard copy, in decimal notation, is produced for ease of administration later on.

The required inputs are : ship's code, survey area code, julian day, year, reference point of the plotter (UTM coordinates for the lower left hand corner), scale, angle of North skew.

When this has been done the main program can be loaded; this and all other programs are loaded from cartridges. The operator must then set the thumbwheels to their correct values and bring the plotter pen to its reference position — after which the program can be started. After the initial steps the program stops and waits until the ship is in the correct start position. The operator then feeds the thumbwheels the starting time and restarts the program; the system is now in operation. All the operator has then to do is insert new cartridges from time to time — being warned by a printout on the teleprinter when to do so — and to operate the mode switch to indicate either sounding operations or manœuvring. Every time he sets the switch to the manœuvring mode, to indicate the end of that particular sounding track, the computer automatically starts computing the distance offtrack to the next sounding track. Each switching of mode at the start and end of a sounding track thus constitutes a fix-mark interval.

The survey boat program

As the boats have no teletype the following administrative data have to be toggled into the computer : ship's code, survey area code, julian day, and year. A preparation program for the polyboats very similar to the main program is prepared aboard the mothership and produces a hard copy of the decimal values with their octal equivalents to be manually fed into the boat computer.

The quality control and plotting program for survey boat data

The same preparation program for scale etc. as the mothership is used. Thereafter the operator sets the thumbwheels for depth limits, loads the cartridge recorder with the boat cartridges for plotting and then starts up the program. He can change the depth limits at any time if this proves necessary.

The present method for starting the programs, both aboard ship and in the boats, is not very satisfactory due to a misunderstanding in the early stages of program development. Immediately the program is restarted it reads the number of whole lanes from the thumbwheels and the fractions of lane from the navigation receiver, taking this as the track starting point. Later a modification will be introduced enabling the exact starting point to be input by teletype and the program to be started at any point within the diamond limited by the whole lanenumbers selected. The Left/Right Indicator will thus be able to guide the ship towards the start position. Since Hi-Fix and Sea-Fix receivers only give values in fractions of a lane number the " magic " diamond formed by the whole lanes cannot be eliminated.

REFINEMENTS

The HYDRAUT programs have been so written that the ship can still profit from the system even if some of the peripherals become defective. There is a modified program loader, so that in cases of a teletype breakdown the only omission will be the sounding list. While a plotter breakdown will only entail the loss of the ship's plotted track a Cartrifile breakdown means that data cannot be logged onto cartridge tape; however the programs can still be loaded from paper tape. Furthermore the advantages of the Left/Right Indicator are still maintained. If a thumbwheel is out of order the inputs can be made manually.

There is a special program for ascertaining whether or not the sine and cosine values representing the Decca, Hi-Fix or Sea-Fix lane fractions have an offset in phase and/or amplitude, and another for computing any correction factors needed. In the HYDRAUT programs the true sine and cosine values are computed with correction factors. It fortunately turned out that the offset does not change frequently — and the same factors as were determined two years ago are still being used.

Some 20 programs written in the interactive Focal language are available for geodetic computations. Focal was chosen as it is easy to learn, whilst modifications are a very simple matter. The following are some of the programs available:

(a) Conversion of hyperbolic or circular coordinates into rectangular coordinates, and vice versa.

(b) Calculation of the intersection of two hyperbolae, or two circles, or a circle with a hyperbola.

(c) Traverse calculations.

(d) Intersection and resection computations.

(e) Computations of adjustments and equations.

(f) Grid on Grid calculation.

DEVELOPMENT

When about 80% of the HYDRAUT mothership programs had been written the contractor started program tests. Lieutenant van der POEL was then detached for work on this development and took part in all further stages of development and testing of the software. Onboard testing started in April 1973 in an area covered by a highly accurate Hi-Fix chain (Hi-Fix IJmuiden); problems arising from unstable Decca chains were thus avoided. Moreover, IJmuiden has good port facilities and is within reasonable distance from the Naval Base, the Hydrographic Office and the manufacturer's headquarters. Furthermore, when the ship was not being used for trials she could carry out surveying in this same area. After the complete program had been tested using the Hi-Fix chain, trials were carried out with first Sea-Fix and then Decca chains, all with good results. It became evident, however, that in order to obtain such results a stable chain is essential — especially in the case of Decca with its relatively large lanewidths.

All the programs were operational by December 1973.

LESSONS LEARNED

Among the lessons learned from this testing period are :

(a) If a contract firm is designing the software it is very important that a hydrographer who will be using the system should take part in the development of the software right from the early stages — even earlier than was the case with HYDRAUT. He will thus be able to see that the programs are being developed along the right lines as he is himself a surveyor. At the same time he can profit from any new perspectives that become apparent during the development period which had not been known about when the system specifications were established.

(b) The time required must not be underestimated. Our total software package, inclusive of testing and documentation, took some 2½ to 3 man/years to develop.

(c) In the development period the availability of a card punch and reader would save much time. In our case, other than the Tridata cartrifile, we had only a teletype ASR 33 available.

(d) The whole system must first be tested ashore, as ship time is very costly. We lost much time during the testing period through unfavourable weather conditions, and work in the survey boats was often uncomfortable; not everyone has the luck to be a good seaman !

(e) Before starting tests of the software be certain that the hardware is working well. We could have reduced the software testing time by at least 40% if we had not had so many hardware troubles earlier on. In our case the firm's software experts aboard had first to find out the reason why the system had failed. Was it really a software breakdown or was it the hardware ? Incomplete and ambiguous documentation about certain aspects of both the PDP-8 and the Tridata cartrifile also lost us a considerable amount of time.

(f) The time and money needed for good program documentation must not be underestimated, since without this the programs — especially those written in an assembler language — will be worthless.

(g) The proposed modifications must be made as soon as possible since any delays will entail a lot of extra time having to be spent in updating one's knowledge of the program. Alas, budgetary policy can also lead to such delays.

(h) It is desirable to have a small fund from which the cost of small modifications or small purchases can be paid without delay.

Since the system is now nearly operational, the ship's staff must have a fundamental knowledge of the system, as follows :

(1) A general idea of how the programs work.

(2) A basic knowledge of the structure of the PDP 8 computer and its operation, together with some facts about the assembler used.

(3) A good knowledge of Focal, which is a fairly easy language, so as to be able to modify existing programs and to develop further programs.

(4) A clear idea of the programs' capabilities and limitations, i.e. of the hardware used, as this will free the programmer also from such questions as "Why can't the program be changed to do so-and-so ?".

Knowledge of the software can be acquired in a 2-3 days officers' training course being held every year at the Hydrographic Office. As an alternative there is a schedule for study aboard, for almost all the software information is given in the documentation in Dutch supplied by the Hydrographic Office.

MODIFICATIONS TO PERIPHERALS

1. The Houston DP 3 plotter

(a) Both the fibretip and ball type pens gave problems, so they were replaced by Rotring pens fitted into home-made penholders. We use these pens 24 hours a day, obtaining excellent results.

(b) To improve the view of the plot paper the metal bar was replaced by a perspex one.

(c) The coloured pieces of plastic over the status indicators (the Ready light, etc.) were removed to obtain better visibility, and a perspex protection screen was fitted to the operation panel to guard against accidental operation.

2. The Atlas Deso 10 echosounder and the Edig 10 digitizer

(a) The transducers are amidships and flush with the hull. They are thus subject to many false echoes at short range, caused by air bubbles under the keel. To overcome this a special suppressor, adjustable for a range of up to 5 m, was fitted, similar to the seaclutter control in a radar set.

(b) During the dark watches the brightness of the digitiser face proved an inconvenience, so a sheet of red plastic material was fitted over it.

Incidentally we decided to mark the fix-mark lines on the echogram with a number stamp every so often, since not everybody has legible writing.

3. The Hi-Fix or Sea-Fix

To facilitate change over between Hi-Fix and Sea-Fix receivers a Sea-Fix matching box was modified to accept both Hi-Fix and Sea-Fix plugs, while the AD 200 interface remains permanently connected to this matching box.

It was learned later that the Dutch representatives of Decca Ltd had developed a small device which, when connected to a Hi-Fix receiver, simulates a moving antenna; this would of course be of great value during testing periods. We did not use this device simply because at the time we did not know of its existence.

SOME RECOMMENDATIONS ARISING FROM USER EXPERIENCE

(1) Before starting hydrographic automation be sure to talk to those with experience of this field, especially to those who have themselves worked with it. This is often the only way to learn not only the positive aspects of a particular system but also its shortcomings.

(2) Orientation in the field of automation is a lengthy business: there is as yet no organization that can give enquirers a complete and detailed insight into "who offers what".

(3) Automation is definitely not a "one man show"; it requires a team of people, preferably with a hydrographic background. Moreover any change in the team's composition can be costly in terms of time. The maintenance unit must of course be included as part of this team.

(4) Not only is total system responsibility by a single firm most essential, but also very close contact with this firm during the whole of the development and guarantee period.

(5) As full as possible information about the system must be given to those who are to work with it — and the earlier the better.

(6) *Good system documentation, and also a good "trouble shooting list"* cost money but are worth the expense.

The above remarks do not mean that we succeeded in all aspects of operating the system; they are merely points to be taken into consideration by those starting on automation.

TIME TABLE

The time spent on putting the whole HYDRAUT system into operation was as follows:

January-June 1971: Orientation and writing of specifications.

June-November 1971: Discussions with various firms, the order being placed with Rietschoten & Houwens in November.

1972: Design, construction and testing of the system for the two new vessels and of both hardware and software for the dataloggers for four survey boats.

January 1973: Installation of the processing station in the Hydrographic Office.

January-April 1973: Installation of the ships' systems and of the dataloggers.

May-December 1973: Software "debugging" on the motherships.

January-July 1974: Hardware "trouble-shooting" on the motherships.

ASSESSMENT AS AT JANUARY 1975

The ships' systems are now considered to be working very satisfactorily. However, the launch data loggers have suffered from much down-time due to heavy vibration, even under normal survey conditions. It is expected that this will be overcome by the installation of shock mountings during the winter refit 1974-75.

Evaluation of the wave compensation system will continue in 1975. Here also vibration was the reason for difficulties with the system.

The processing system ashore is working very satisfactorily, the depth selection program producing a very realistic picture for the fair sheet.

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An article about some hardware aspects of the HYDRAUT system, written by one of the contractor's Systems Engineers, is obtainable on request from the Hydrographic Department, Royal Netherlands Navy, 171 Badhuisweg, The Hague, Netherlands.

(Manuscript submitted in English)