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RACAL SYSTEM 960 AND THE ROYAL NEW ZEALAND NAVY'S HADLAPS PROJECT

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INTRODUCTION

The Hydrographic Surveying Service of the Royal New Zealand Navy (RNZN) has always followed the traditional path of acquiring, reducing, drawing and rendering surveys from the survey ships at sea, rather than by forwarding raw or semi-processed acquired data ashore for processing.

The RNZN's first automated system for the acquisition and processing of survey data at sea was commissioned into HMNZS MONOWAI in 1977. This was the Marconi HYDROPLOT, an advanced variant of the system still in use in the Royal Navy's HECLA class ocean survey ships.

In 1985, moves were commenced to procure a modern system to replace HYDROPLOT in HMNZS MONOWAI and to provide an automated capability for the smaller survey vessels and MONOWAI's survey motor boats. For this project, MONOWAI, the RNZN's principal survey ship, was designated a Class I vessel, lesser units being designated Classes II and III. Details of the RNZN's survey fleet are in Appendix 1.

The project was called 'HADLAPS' (Hydrographic Automated Data Logging And Processing System). The coincidence of name with the Royal Australian Navy's HYDLAPS project - which commenced at about the same time - was unfortunate since inevitably some companies became more than a little confused!

Basic Requirements

Based upon the experience with HYDROPLOT at sea, the RNZN had certain basic requirements of any new system:

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- The new system would need to be as simple as possible to operate for those with little or no computer experience.

- Redundancy and compatibility in hardware over the various system classes was a MUST - not least of all because New Zealand is an isolated country and previous experience has shown that support of specialised equipment can take considerable time and effort and can be expensive.

- In the same order, it was decided that equipment and software types overall must be kept to a minimum for reasons of operational efficiency, spares backup, and to ease the training load.

- The selected supplier would need to demonstrate that his software development standards and documentation were of a high standard since the RNZN required that source code be delivered so that further in-house software development would be possible if necessary. Source code on its own is worse than useless.

- Throughout the consideration of the various contenders, the needs of the operator and the importance of improving his -or her - lot with a new system were kept firmly in mind.

The RNZN sought to procure an off-the-shelf system with minor modifications as necessary. Ultimately this was not the track followed. Three competing systems were viewed in operation in the UK and Canada and Racal Positioning Systems Ltd (Racal) of the United Kingdom was selected as the supplier.

HADLAPS Project Management

The project-proper commenced in the middle of 1989. With the RNZN's agreement, Racal had decided to commence from scratch, building upon principles developed for, and demonstrated in, that company's System 900 series (currently in operation in Japan, China and Brazil). Since the RNZN was now involved in the development stage of a new system (termed 'System 960' by the company), a senior hydrographic surveyor was posted to the United Kingdom by the RNZN for the duration of the project.

This arrangement proved to be a cost-effective means of ensuring that the customer got what he actually required rather than a company's interpretation of the need. System 960 is now a commercially available off-the-shelf system which has a great deal of in-built flexibility to make it attractive to civilian and military hydrographic organisations with little modification. The joining of minds in what became an RNZN-RACAL team development effort appears to have resulted in a product that meets the requirements of the customer and the desire of the company to develop a competitive commercial system.

This is not to say that there were not disagreements between the RNZN's representative and the company from time to time! However, ultimately the development project served to deliver a system which met the needs of both customer and supplier.

Hardware

A total of 15 operational workstations were supplied under the HADLAPS contract along with the various peripherals and spares.

Each workstation is configured around a 'core' workstation which is identical whether it be fitted in a ship, a boat, or ashore. Each 'core' workstation consists of:

- Hewlett Packard Model 360C+ CPU
- 16" Colour graphics monitor
- Keyboard and roller-ball unit
- HP Quietjet printer
- Combined 40 Mbyte hard-disc/3.5" floppy drive
- 650 Mbyte IEM optical disc unit

The system classes are named I, II, III. They are mainly distinguished by the peripherals attached and the number and configuration of the workstations as shown in Figure 1.

There is no networking. This is perceived to be a major strength of the system, since there is no reliance upon a central processor and the system is resistant to power failures without the need to ensure a maintained supply. Instead, magneto-optical drives are used and the data is hand carried between workstations if required. (This has been termed in some quarters as the 'SHOENET').

HADLAPS (System 960) is thus not only a multi-user system in the survey ships, but it is capable of multi-task (i.e. survey) processing as well. The optical discs provide a cheap and effective 'directory' structure as well as a highly retentive archiving medium.

Perceived Strengths of the System

System 960 is seen as having a number of strengths:

- All HADLAPS system classes use identical hardware and common peripherals. This results in a number of benefits in terms of support and on-board flexibility, since degraded capability can be accepted to keep the survey going. There are, however, some minor disadvantages, for example the exposure of the equipment in the motor boats. Prophylactic precautions are being taken and the RNZN is investigating more permanent protection. The problem was identified at an early stage in the project but it was decided that operating experience would be gained before a solution was settled upon. It is understood that Racal are offering a specialised demountable rack system as an option in future System 960 installations.

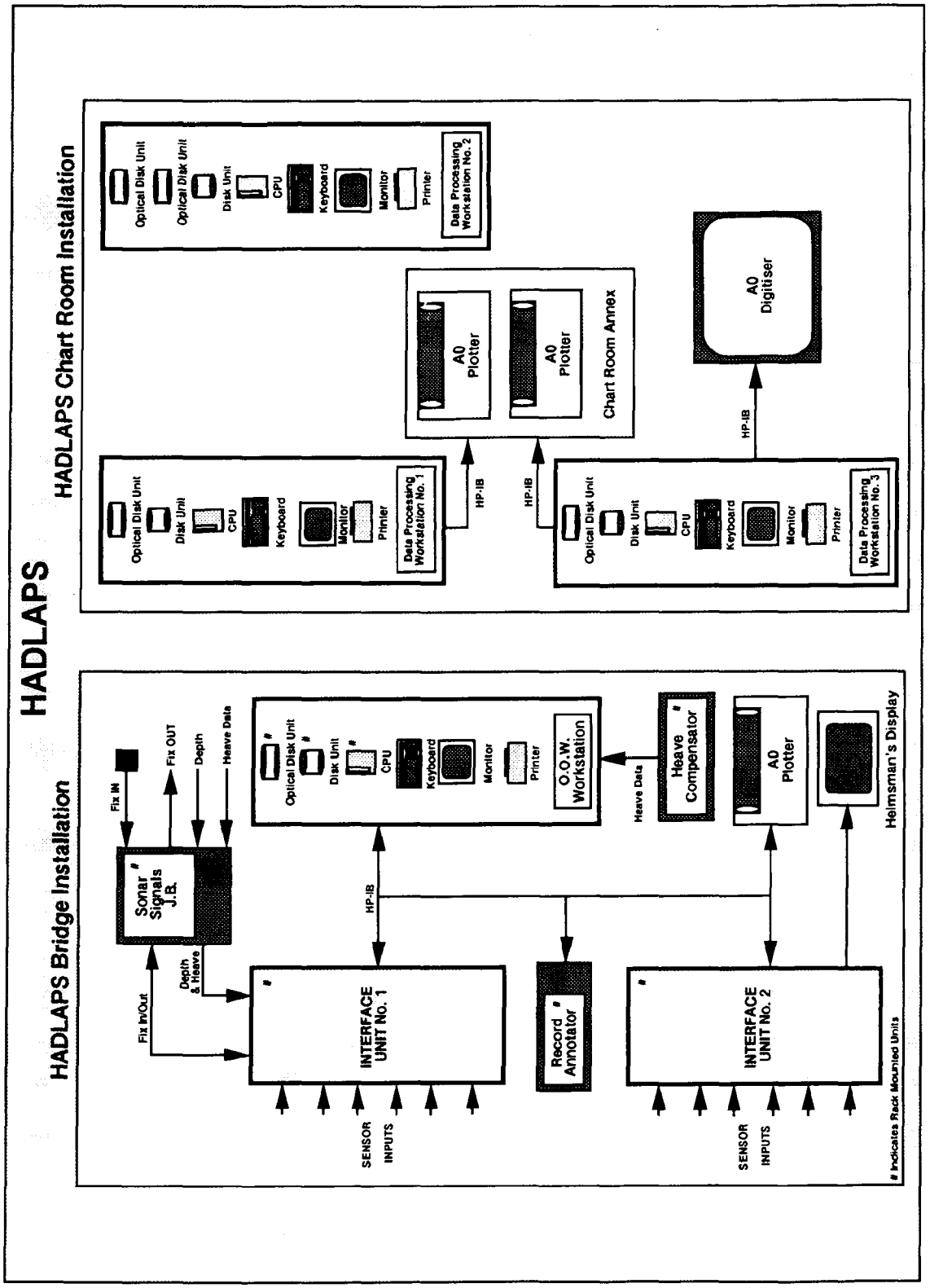

FIG. 1.- Class I (MONOWAI) Block Diagram.

- No matter what its intended purpose (What Class it is, Whether it is an Acquisition or a Processing Station and so on), each workstation is installed with the same software suite. Training therefore need only be conducted in the operation of one type of software, discs and data can be interchanged between all units without any problems, and workstations principally employed for acquisition can be pressed into service as a processing station if required.

- Acquisition files are automatically related to vessel and time and are not sounding line based. This gives numerous advantages for example: it reduces the number of files to manage; it makes the files very readily identifiable; data from adjacent lines may be reviewed at an earlier stage than otherwise possible etc.

- File types - tidal files, velocity files, data base files etc - are identified by the system and the utilities provided by Racal with the system, for file and data management, sort them into types for copying, archiving, etc. Whilst the file name is provided by the operator, it means that the file type is readily identifiable and the RNZN's developing SOP's specify a naming convention to avoid file names that are decipherable to only the originator.

- Frequent operations are initiated by as few key strokes as possible. Line changing, for example, is effected by as few as four keystrokes.

- The software has been designed to be flexible enough for future hardware enhancements to be readily incorporated. The addition of extra sensors or peripherals merely requires an amendment to the 'Device Control' file through menu choices provided and, of course, the provision of the appropriate interface.

- Geodetic facilities have been designed to allow great flexibility. They are clear and instinctive to use. The system stores positions in cartesian coordinates. The software readily allows additions to Grid, Datum and Spheroid data and changes to Datum Transformation parameters are readily incorporated. HADLAPS only caters for Transverse Mercator and Mercator projections (in accordance with RNZN requirements), but Racal are understood to be planning to offer other projections as an option with System 960.

- The flexible geodetic facilities enable the operator to enter stations, sounding lines, waypoints, etc, on a variety of coordinate reference systems and provided that the datum transformation parameters have been specified, the system converts on-line. No off-line computations are thus required, though such facilities are also available as part of the software suite if required, and transcription mistakes are avoided.

- There is no networking, apart from what has been termed 'SHOE-NET' - hand-carrying the disc and walking from workstation to workstation. This makes System 960 (HADLAPS) rugged, reliable and removes the dependence upon a central file server. HADLAPS is thus both a multi-

user system and a multi-task system in the strict sense. To test the system during sea-trials, HMNZS MONOWAI was effectively working on six surveys at any one time.

- Power supply is always a problem in ships. The system essentially looks after itself and returns to its previous state when power is restored. The Officer of the Watch can thus concern himself with the care of the ship. These facilities also enable quick resumption of a survey from its lastest state -for example if the boat's system has been turned off overnight. (MONOWAI actually has a maintained power supply for its workstations since that provided for HYDROPLOT was retained, although this was not a design feature of the installation)

- Optical discs give large amounts of flexible and very cheap storage and an effective and simple 'directory' structure. They have magnificent archiving properties and the portable medium allows the immediate change from working on one survey to working on another. Access time is only slightly slower than from Hard disc.

- Acquired data may be recorded straight onto any medium and a survey may be conducted from parameter files stored on Hard or optical disc. This enables, for example, the operator to prepare survey data in the comfort of MONOWAI's chartroom and take it straight into the boat or up to the bridge for immediate use with no copying required. If data are recorded on Hard disc, one can 'archive' them into optical and purge the acquired data file on the hard disc without interrupting the survey. The loss of a minimal amount of data, due to buffering, which results from a fast echo-sounder rate of acquisition, can be avoided carrying out the procedure above described whilst turning at the end of line.

- The operator can inhibit data recording if required. If inhibited, and a line is commenced, the system will automatically turn recording on.

- No requirement exists for operators to learn any operating commands, since HADLAPS (960) is menu-driven. Throughout the development, the needs of the operator were kept firmly in mind. HADLAPS is truly user-friendly though its capabilities naturally incur some complexity of operation.

- All screen window layouts were generally made to conform to a standard pattern to aid operator familiarity, and a standard menu structure was adopted across the various program modules. Common 'library code modules' are used to ensure that algorithms used in different areas of the programs are the same and render the same degree of precision.

- Personnel of many rank and experience levels can take an active part in acquiring and processing data. This leads to a more active interest in the task in hand and provides a graduated learning path for our junior personnel as they progress upwards. There is, of course, the penalty of ensuring adequate supervision.

- Processing ratio targets established by the RNZN as part of the specification - a target of 6 man-hours processing for 24-hours worth of data - are readily achievable and should, indeed, be bettered given 'normal' amounts of editing. The RNZN sees no need for a processing watch to be established to keep up with data rates, although this is possible if required (for example in a military survey or in a survey for a proposed cable-lay where immediacy is a requirement). Similarly, the progress of data from reduced raw data to its output on 'paper' or in digital form is very much less labour demanding and is very much quicker than using traditional or some automated systems.

- HADLAPS permits the configuration of two separate fixes using a wide variety of positioning fixing methods, from GPS to Horizontal Sextant Angles (HSA). Different fixing methods may be combined into the one fix, although of course one must be very sure of the relative weight of the equipment. The author is not totally convinced that this would necessarily be valid or good practice, except perhaps in combining an HSA into a Trisponder fix so that when the fix degrades down to one LOP in a bay, one can take an HSA LOP to keep the fix valid. The RNZN is, however, a military organisation and requires the ability for fixing without transmitting or having stations up ashore. Should the operator make a mistake in fix configuration or LOP changes during acquisition, these can readily be remedied during processing since all raw data are filed.

Project Progress

The development was planned for a two year period from 1 July 1989 and Factory Trials commenced on time on 1 July 1991. These trials ran a little over-time, but the systems were installed and commenced sea trials in New Zealand to the original timetable. As the software is identical in all system classes, the bulk of the sea trials (approximately nine days worth) were carried out in MONOWAI with functioning and 'Class-specific' trials being carried out in the other vessels over a three day period.

The systems were accepted by the RNZN in November 1991 and, as this paper is being written, the RNZN now has a year's operating experience with the system in the various units.

Two major surveys have been completed with the systems, the predominate survey being of the Bay of Islands (BOI) in the North Island of New Zealand. The BOI was surveyed as part of the RNZN's ongoing programme of updating surveys, but a more testing area could hardly have been chosen! The BOI, whilst very scenic and an attractive place to work is a very complex area of bays and inlets. The surveys involved work by all three classes of vessels, but principally with the Inshore Survey Craft and MONOWAI's boats.

Thus a wide number of operators gained experience of the system and, along with an impromptu survey task close to Auckland investigating an abandoned minefield from the last War, HADLAPS has undergone rigorous testing during the year's warranty period.

Operational Experience

The system has generally stood up well. There are, naturally, some areas which do not suit all operators, but there have been no major deficiencies identified in the design or the implementation, apart perhaps from the fact that the ability to remedy lost LOP's is buried a little deeply in the menu structure.

The topographical features of the Bay of Islands survey area lead to numerous shadow areas and loss of Trisponder ranges with frequent LOP loss. This was a problem not evident under simulation at the factory and is one being addressed between the RNZN and Racal as a possible modification.

Various other defects have been notified to the company, although some may be attributed to operator error or misconception. At the time of writing, the revised software which addresses the bulk of these defects has been received and is being evaluated.

Both Racal and the RNZN believe in rigid configuration management of the software. One of HADLAPS additional strengths has been that it is very easy to ensure that all workstations are maintained with the current software version.

During the course of the HADLAPS development project, moves commenced to procure an automated system for cartographic purposes in the Hydrographic Office. This project has been named SEACARTIS, the first stage of which has recently been completed. It is proposed that a hard link between the HADLAPS system established at the Hydrographic Office and SEACARTIS may be developed in the longer term.

In the short term, the RNZN is purchasing a comparatively simple software modification to allow the RNZN's GEBCO/OSS data to be digitised and better managed using HADLAPS in the Hydrographic Office. This modification will also allow such data from the IHO GEBCO database at Boulder Colorado to be received on disc in MDG77 format and read into HADLAPS for manipulation and editing, as HADLAPS offers more versatility in this area than SEACARTIS and the data may be readily passed to or received from the survey ships undertaking passage sounding. Likewise the RNZN's data may be converted into the MDG77 format by HADLAPS for transfer to Boulder.

CONCLUSION

In HADLAPS (RACAL System 960) the RNZN has a powerful and up to date surveying tool. System 960 is an off the shelf system which is flexible and versatile and will meet the RNZN's needs into the next century.

References

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[2] ROBBINS L.: The Development of a Hydrographic Automated Data Logging and Processing System (HADLAPS) for the Royal New Zealand Navy Hydrographic Service. *Proceedings of the Second Australasian Hydrographic Symposium* (Hydrographic Society), University of NSW, 9-12 December 1991. pp. 63-80.

APPENDIX - THE RNZN SURVEY FLEET.

HMNZS MONOWAI

Tonnage	- 3900 tonnes load displacement
Length	- 90.8 metres
Breadth	- 14 metres
Draught	- 5.2 metres
Complement	- 130 (12 officers)

Survey Equipment

2 Racal/Decca Hi-fix/6 receiver
1 Trisponder DDMU 542
1 Magnavox 1107RS Satellite Navigation Receiver (Transit/GPS)
2 Atlas Deso 20 echo-sounders (1 fitted with deep-sea unit)
1 Raytheon PDR deep echo-sounder
1 Ametek Straza 2-axis doppler log
2 Arma-Brown Mk5 gyro compasses
1 EG&G 159 sidescan sonar (Note 1)
1 Klein 531T sidescan sonar (Note 1)
1 TSS 321/320B Heave Compensator (fitted as part of the HADLAPS outfit)
1 TSS 312 Record Annotator

Survey Motor Boats	- ASTROLABE	(7 tonnes, 10.5m)
(Note 2)	- PELORUS	(7 tonnes, 10.5m)
	- SEAGULL	(5 tonnes, 8.9m)

HMNZS TARAPUNGA/HMNZS TAKAPU (THE 'INSHORE SURVEY CRAFT')

Tonnage	- 105 tonnes load displacement
Length	- 26.8 metres
Breadth	- 6.1 metres
Draught	- 2.1 metres
Complement	- 12 (1 officer)

Survey Equipment

1 Trisponder DDMU 542
1 Magnavox 1102 Satellite Navigation Receiver (Transit/GPS)
1 Atlas Deso 20 echo-sounder (1 fitted with deep-sea unit)
1 Marioka III/V EM log
1 Arma-Brown Mk5 gyro compass
1 EG&G 159 Side Scan Sonar (Note 3)
1 Klein 531T Side Scan Sonar (Note 3)
1 TSS 321/320B Heave Compensator (fitted as part of the HADLAPS outfit)
1 TSS 312 Record Annotator

Notes: 1. Side Scan Sonars are interfaced to HADLAPS, receiving 'fix-mark' input only.
2. Each SMB is fitted with HADLAPS interfaced to Trisponder DDMU 542, Atlas Deso 20 echo-sounder, TSS 312 record Annotator.
3. Klein is fitted in TARAPUNGA, EG&G in TAKAPU.