

CHARTING HONG KONG - THE WAY FORWARD

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Abstract

Operating in one of the world's busiest ports the idea of setting up a hydrographic survey section was first considered in 1972. The HO proposal was eventually approved by Government in 1991 with funding secured in December 1993. The office commenced setting up in July 1994 and by mid-1996 the HO will be fully functional : trained hydrographic and cartographic staff; first delivery of two fully equipped survey launches; erection of DGPS central reference station and a comprehensive, fully integrated data processing and chart production system installed in the office. With advice from HOs world-wide, the aim has been to achieve a state-of-the-art working environment. We are also firmly convinced that the electronic media revolution will rapidly reduce paper charts to become dusty collectables in ships folio drawers. S-57 and production of electronic charts has thus been in the forefront of our thinking. This paper will briefly present our progress and hopefully provide an introduction to those smaller countries currently considering setting up or modernising their own HO.

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1. INTRODUCTION

"Our essential nature is inherently cautious and careful. As soon as you are lax or lazy, you have lost your essential nature."

NIE BAO (1487-1563)

The Territory of Hong Kong, a British Dependency until the 1st July 1997, when sovereignty reverts to China, includes 235 hilly islands nestled in 2903 km² of the South China Sea (See Fig. 1). A water depth of 40m is reached at the south-eastern corner of the region while a few small channels within reach 60m depth. Over 57% of these waters are shallower than 20m, 30% shallower than 10m, with a generally flat and featureless muddy sandy seabed sloping gently southwards. We have arguably the world's largest container port, with some 41,000 ocean going vessels, 111,000 river trade craft and 64,000 passenger ferries (carrying about 26 million people) using HK waters during 1995. The kernel of the problem for charting here is the spectacular growth rate. For example during the new airport construction at Chek Lap Kok approximately 3/4 of the world's larger dredging fleet were working here. The width of Victoria Harbour between its narrowest points at Tsim Sha Tsui and Central will soon be half of that existing when HK was ceded to Britain in 1841. Even the Government's Marine Department waterfront headquarters has suddenly found itself 200m inland due to reclamation during the last few months. (See Fig. 2)

2. CHARTING HISTORY

One of the earliest charts where recognisable HK names appear, unearthed by Hal EMPSON during his researches, was the famous eunuch Admiral Cheng Ho navigation map of the China Coast, circa 1425. (Ref. 4.) Resembling a motorway gazetteer the rather graphic coastline was drawn from right to left across the top of the chart with a dotted line, representing the ship's course along the coast, drawn horizontally underneath, annotated regularly with Chinese characters specifying water depths, bearings to islands and other pertinent information to the mariner. It is a marvellous and successful example of trying to combine a chart with sailing directions. It was the British Admiralty's first Hydrographer, Alexander DALRYMPLE who first published a chart based on scientific measurements in 1771. The surveys were conducted between 1759 and 1764 while DALRYMPLE was working with the East India Company. Perhaps he had gifted foresight because it is not at all clear that Hong Kong Island is separated from the mainland at Kowloon! But of course the accolade must go to Captain Sir Edward BELCHER's chart of Hong Kong and the surrounding waters published in 1843. This contains numerous soundings that to this day are still used in outlying areas that have never been re-surveyed. It is hard for the modern, mollycoddled hydrographic surveyor to appreciate the work undertaken by HMS SULPHUR during 1841. Such immaculate details resulting from the decks of wooden sailing ships using sextants, compasses and lead lines often



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FIG. 1.- The Territory of Hong Kong.



FIG. 2.- Reclamation in Victoria Harbour.

under arduous conditions and in a climate that most Europeans find particularly enervating. Continuing in the fastidious style of the Royal Navy, back in London, every bit of detail was then manually engraved in reverse directly onto copper printing plates, still kept in pristine condition in their archives. EMPSON noted that DALRYMPLE's chart of 1792 had no longitudes and quipped "*better to omit when not sure?*" BELCHER's chart contains neither latitudes nor longitudes, simply the coastal position of Point Albert -- perhaps again with keen foresight he did not want to confuse those navigating with GPS on WGS 84! Point Albert incidentally is now over 600 metres inland and the intervening space filled with the most expensive high-rise real estate in the world.

Since 1841 numerous sailors have discovered the delights of the Far East aboard naval ships conducting a duty tour in the region, including HMS STARLING, PLOVER, RAMBLER, WATERWITCH, DAMPIER and finally HMS HYDRA in 1972. At that time responsibility for conducting surveys was passed to the HK MD who unfortunately had no facilities available for the work in hand. Rescue was close at hand however with help of the Civil Engineering Department who possessed a fully equipped survey launch. In 1973 the UK-HO in consultation with the HK Government began a thorough modernisation and metrication of charts, including re-scheming

utilising maps, aerial photography, CED surveys and all other available relevant data. The first of these 14 charts (later increased to 15) was published in 1983 with the remaining completed by 1989. Over the last ten years the UK-HO have examined over 1000 surveys and plans received from the Marine, Civil Engineering, and Lands Departments. By the end of 1995, 14 of the 15 British Admiralty charts covering these waters had been updated by New Editions, in the last two years some more than once. However bearing in mind their primary role of conducting pre & post dredging, reclamation and construction surveys, it has not always been possible for the CED to perform the additional work required for the relevant charts.

Figure 3 presents the land reclamation figures since 1887 and amply demonstrates why, despite admirable efforts in the past by all concerned, a local hydrographic office was urgently needed to improve the speed of information flow and data collection.

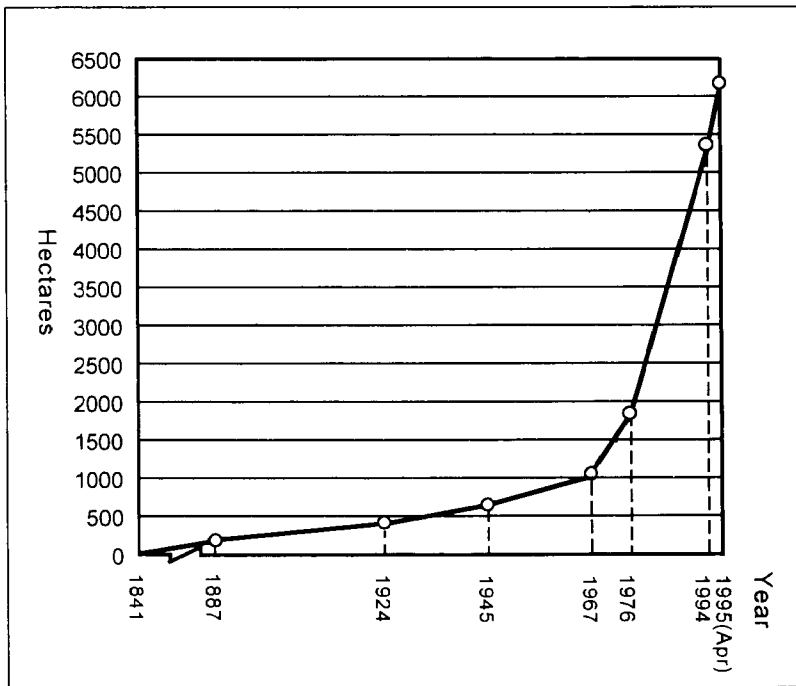


FIG. 3.- Rate of Hong Kong's Land Reclamation.

3. SETTING UP OF THE HK HYDROGRAPHIC OFFICE

The idea of setting up a survey section was first considered in 1972 by the 'Working Group on Hydrographic Development for Hong Kong Waters'. Chaired by the Director of Marine and represented by numerous other Government agencies it was not until 1985 that they agreed an HO was necessary. It was clear to all after signing of the Sino-British Joint Declaration on the future of HK that the British Admiralty's authority to chart this region would cease after July '97. At long last the proposal eventually got through the system in 1991 -- endorsed by Central Government as well as the Sino-British Joint Liaison Group. Funding of HK\$42 million for initial purchases together with recurrent costs for staff (100+) and offices was secured from the Finance Committee of the Legislative Council in December 1993 -- 21 years after the last HMS survey ship visited here. The office commenced for real with the placement of senior staff in July 1994. Besides taking over responsibility for hydrographic surveys the HK-HO will also gradually assume responsibility for updating the navigational charts in both analogue and digital form. With the large increase of resources made available to this office from the Government it is hoped that the surveying work will be better able to keep pace with developments. In this digital era the mariner will thus have up-to-date data readily available to him.

With the Marine Department headquarters already bursting at the seams, we moved to 550m² of refurbished office space at Causeway Bay. As these things go it went rather smoothly and the benefit of computer modelling of space, layout, 3D views, etc. was well warranted. We also have 200m² of workshop space and berths for the survey launches in the new Government Dockyard on Stonecutters Island. The Dockyard is hoping to take over the close-by facilities of the Royal Navy Base in '97 and it is possible that we shall then re-locate there as a complete entity.

4. STAFF

These have been transferred primarily from three Government Departments: 1) Marine -- officers with a Class 1 Masters Ticket who have a good working knowledge of data collation for the UK-HO and Notice to Mariners; 2) Civil Engineering -- Land Surveyors who have extensive hydrographic surveying experience with port works; 3) Lands -- Cartographers who would already be accomplished map makers. The melting pot of staff have blended very well and confirmed our conviction that a better product always results when the data-gatherers can really interact with the processing and chart production sections. The specialisms of marine cartography is one area where we are weak and although 'experience will be a good teacher' we are making up ground fast with training programmes. July will see the fifth marine officer complete the one year hydrographic diploma course at Plymouth University. Two senior cartographers and one marine officer have just finished an intensive six months training session at the Taunton HO

including re-compilation of the less complicated East Coast charts. Survey technicians have been regularly on a four week 'hands-on' training course at the Port of Singapore Authority HO prior to our own equipment and boat arriving. In recent months cartographic trainers from the UK-HO have been seconded here for a few weeks to teach a broader spectrum of junior staff, leaving behind a set of exercises to be evaluated by the next trainer to arrive. Finally wherever possible priority is given to attendance at international conferences. Or if we cannot justify the expense, then in this most modern of worlds we live in, the proceedings on disc plus the video simply arrive a few weeks later (Ref. 6).

5. POSITIONING

A differential correction service for GPS receivers has been installed and is currently on evaluation trials. The manufacturer has quoted us an accuracy of better than one metre (2 Sigma horizontal position error) using our precision survey GPS receivers - and we seem to be achieving it! Although predominantly for use by the Hydrographic Office in their surveying activities afloat, the Director of Marine was quick to spot the obvious advantage for improved general navigation in the Port using corrected GPS positioning. He is currently considering the 'opening-up' of the service, free of charges (presently it is not encrypted anyway). The establishment of the Central Reference Station and the monitoring of system function has consequently taken this into account with a large amount of equipment redundancy. (See Fig. 4).

The Central Reference Station on Kau Yi Chau consists of a 12 channel dual frequency GPS receiver capable of calculating the difference between the observed and true 'range' to each satellite (a pre-requisite is that its GPS antenna has to know exactly where it is - no problem here as it is sitting on top of a Hong Kong primary trig. point). The corrections for each satellite range are then broadcast continuously via an Minimum Shift Keying modulator and radio beacon transmitter on 289.0 kHz. An international standard message (Radio Technical Commission for Maritime Services, Special Committee 104) is used to transmit the GPS corrections which are then capable of being received by any suitably equipped vessels. Kau Yi Chau also has an on-site PC based Integrity Monitor using the RSIM protocol which ensures that the received corrections can be used to calculate accurate positions. If they cannot, RTCM Type 16 error messages will be generated automatically to warn users. All equipment is duplicated such that failures will result in an immediate switchover to the 'hot' spare. The raw, dual frequency satellite data is also continuously logged on the PC and regularly archived to the Hydrographic Office.

The unique feature of the Hong Kong installation is that the Kau Yi Chau site is fully controllable from the Hydrographic Office. Furthermore a separate Remote Monitoring Station is situated on the Marine Department Vessel Traffic Centre where 24-hour manned observation is ensured. The three sites are interconnected by modems via a private microwave link and public telephone dedicated data lines. A Bulletin Board System is also included for other Government users such as the Lands Department to dial-in and download the raw GPS data for post processing of their own geodetic surveying results. Installed sound cards in the PC's

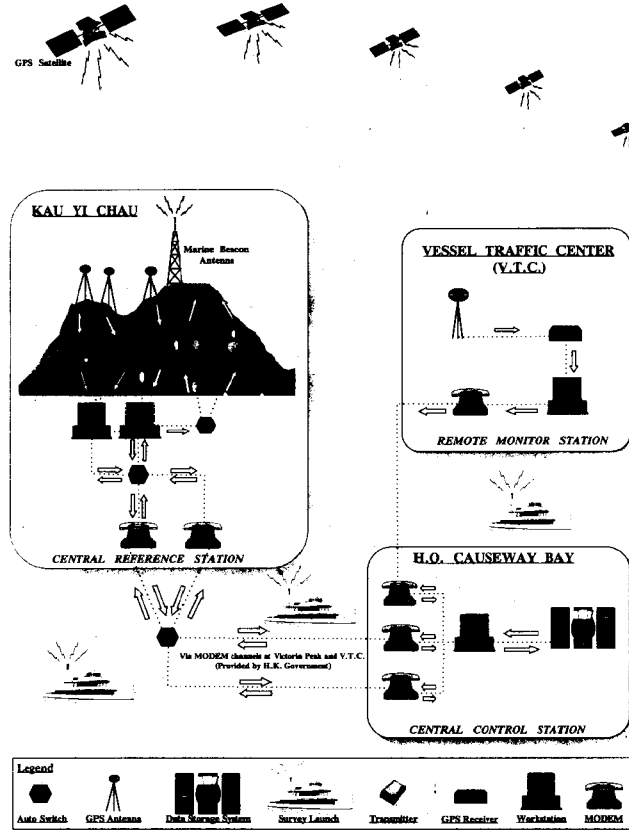


FIG. 4.- DGPS Network.

and a variety of colour & noise co-ordinated alarms ensure that we do not miss an 'urgent' warning. Although designed for use primarily in HK waters, initial measurements of signal strengths at the territories boundaries would lead us to suspect reception will be possible 200-300 kilometres from Kau Yi Chau. The HO surveyors are currently evaluating the overall performance of their DPGS. And how do you check a system that is giving you better than one metre positioning? - not without some difficulty. Some novel approaches will use the open air facilities at Ocean Park, HK's famous family fun centre.

6. SURVEY VESSELS

Our first survey launch, constructed of GRP at Shekou, China, has just entered service. Designed round a standard pleasure craft 12m hull her twin inboard/outboard 160 HP diesels provide a maximum speed of 20 knots. (See Fig. 5)

Although not luxurious she was delivered at a very competitive cost. The contract for our second vessel, a 18m aluminium SWATH design, is well under way with construction about to commence in San Diego, USA. The design (see Fig. 6), similar to the CHS 'SIR FREDERICK CREED' should ensure superior sea-keeping capabilities - history has been dotted with Hydrographers who succumb to mal-de-mer. Although the small survey launch was delivered fully equipped no hydrographic instrumentation has been specified for the SWATH vessel as delivery is not expected until late 1996. We feel that the market is likely to see many progressive developments in that time, particularly in multibeam technology.

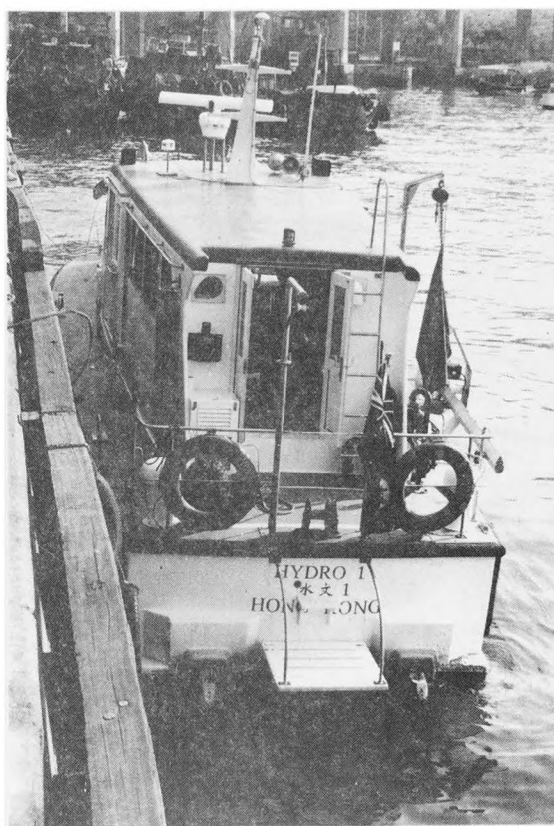


FIG. 5.- 12-metre Survey Launch HYDRO 1.

7. HYDROGRAPHIC EQUIPMENT

The instrumentation on the 12m launch includes a fairly standard array of echo-sounder, heave compensator, DGPS survey receiver, gyro compass, sound velocity profiler, computer data acquisition, seabed classification system, and of course a multibeam sounder (See Fig. 7). Selection of the multibeam specifications

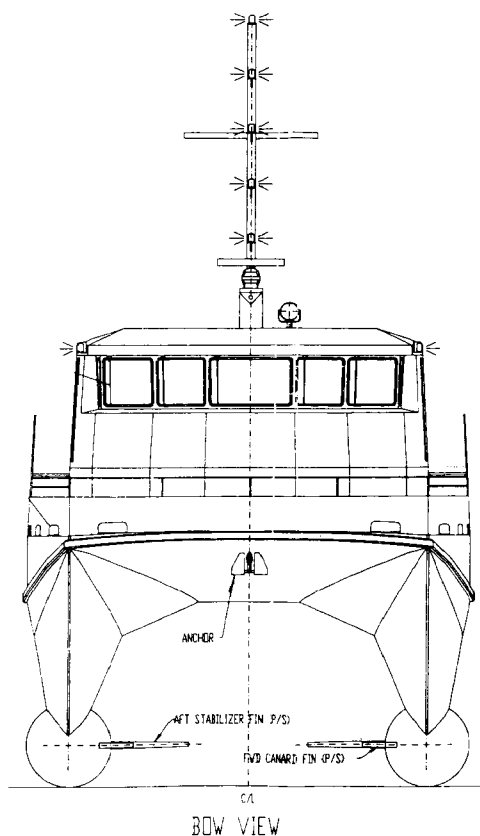


FIG. 6.- 18-m Swath Vessel.

caused many hours of discussions -- what really is 100% bottom coverage? etc, and excellent demonstrations or presentations were given by most of the major manufacturers. It would be fair to say no single unit stood out from the rest; some were obviously not designed for shallow water work; some were still in prototype development stages; some had excellent software but restricted bottom coverage and some could simply not achieve IHO accuracy. We took cognisance of what was happening world-wide including results of the tightly specified NOAA survey for Long Island Sound and comments from the University of New Brunswick multibeam course. (Ref. 2) Only time will tell if our choice was correct and initial results have proved very encouraging. The dilemma we face is simply that of good quality control of the voluminous data sets emerging from a day at sea!

General land surveying equipment including levels and total stations, diving gear and underwater video camera together with a myriad of miscellaneous items needed to kick-start the office have been delivered. An ADCP state-of-the-art current metre has been delivered as updating the tidal stream atlas of HK, last published in 1975, is an urgent priority. Tidal height measurements is one area where we have little work to do as The Royal Observatory maintains a network of 8 electronic gauges all on-line to their main office.

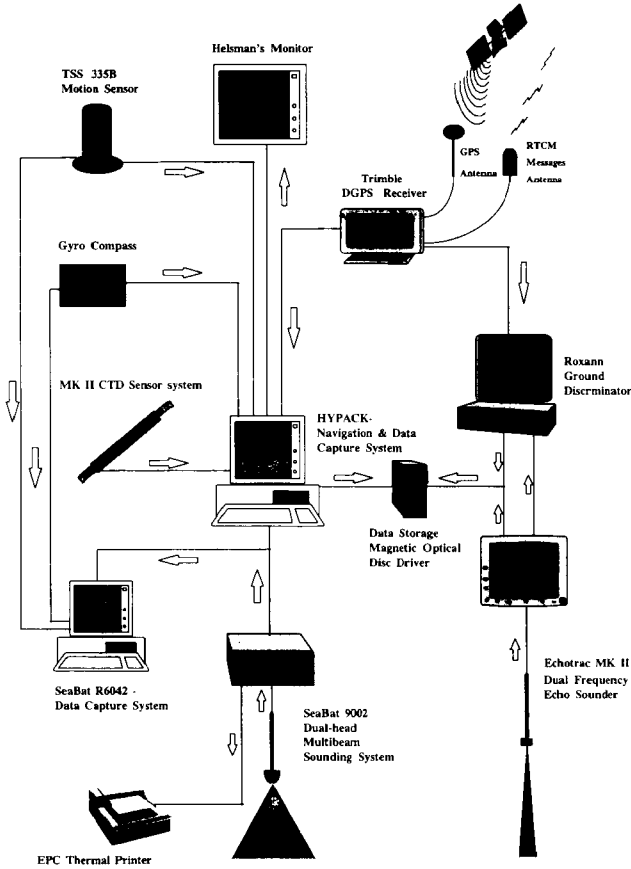


FIG. 7.- Hydrographic Equipment on 12-m Launch.

8. CHART PRODUCTION SYSTEM

The contract for providing a complete hydrographic data processing, database management and integrated chart production system was awarded in December 1995 and office installation is proceeding smoothly. It is expected that the system will be fully functional by mid 1996. The hardware and software suite (see Fig. 8) are able to process raw hydrographic data including the large volumes generated by multibeam and download clean data to the database. This database is used for storing, updating and enabling the retrieval of data for chart compilation and analysis. Cartographic functions provide high quality accurate charts on the graphic displays and output to colour plotters for hard copy proof checking. After necessary revisions the system can output print ready films. Considerable assistance is available from the Lands Department who have a digital database of the territory

at 1:1000, shortly to be generalised to 1:5000. Our efforts will simply involve changing the coastline to reflect the choice of mean higher high water as a datum for detailing land features. One of the first priorities will be to re-evaluate the charting scheme to consider if changes are necessary to reflect the gradual westward movement of port related activities.

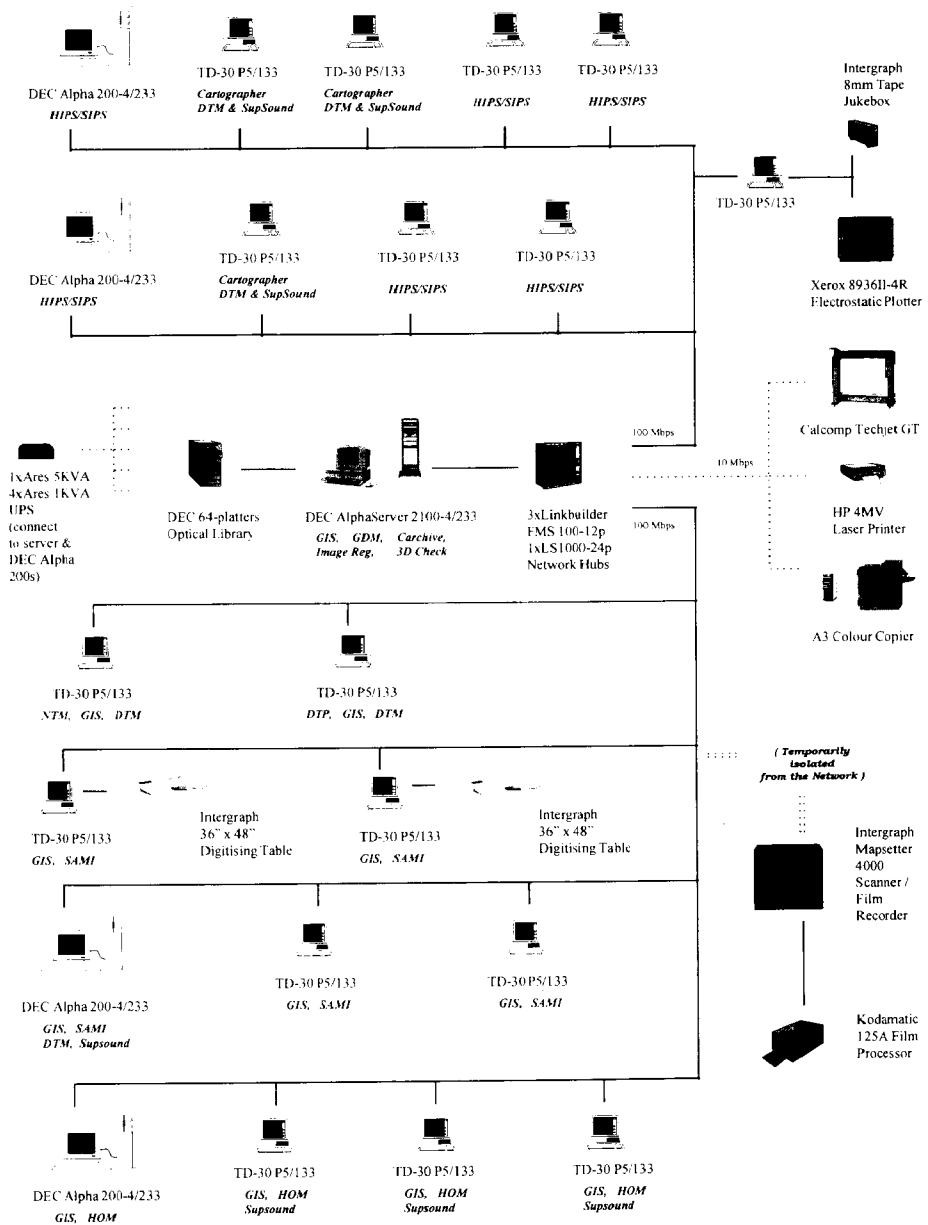


FIG. 8.- Integrated Data Processing and Chart Production System.

The system is seen as a first step towards a primary goal of achieving more print-on-demand applications. The more usual quantity print runs have to be continually corrected for current NM's and other changes. This is accomplished at source (UK-HO), at the chart agents or the laborious task simply left for the second mate during ocean passages. Further we are convinced that the use of Electronic Chart Display and Information Systems (ECDIS) will become very popular in the not-too-distant future. The system is able to provide charts in S-57 (DX 90) format for use by ECDIS manufacturers. And here we have the opportunity to include overlays of sailing directions and other pertinent information to those arriving at the port. We now will have turned full circle -- an electronic version of the 1425 Cheng Ho Chart!

No firm milestone for the transfer of charting responsibility has been laid down yet as the timing will depend on progress of equipment acquisition. Already data examination, the promulgation of NM's, chart compilation and maintenance tasks are under way here. Blue stains of the 'State of Bases' received from the UK-HO allow running compilations to be carried out here, with discussions and mutual agreement on whether to progress new editions. Full quality control will be carried out in Taunton under the direction of Mrs Barbara BOND, Director of Production. One important decision unanimously agreed by all is that any new editions from now on will be published using the WGS 84 datum.

9. NEIGHBOURS AND INTERNATIONAL CONTACTS

Of course a close liaison and good working relationship had already been established with the UK-HO. We have also visited Singapore (perhaps the closest example to our proposed office), Japan (well advanced with ECDIS publication) and one half of the Chinese hydrographic authority, the Maritime Safety Administration in Beijing, Shanghai, Tianjin and Guangzhou. The MSA are responsible for coastal, port, river and inland sea charts for the domestic market while the Chinese Navy is the authority for international shipping charts of Chinese waters. At present HK's shipping tonnage is added to the UK's for calculation of fees and voting rights at the International Hydrographic Organisation. Thus we participate as part of the UK delegation and receive all publications and journals. Unfortunately we have not yet been invited onto the South East Asia Hydrographic Commission, even as observers, which is a great pity given the youthful, dynamic talent available here for joint projects. The world-wide hydrographic fraternity is thankfully a fairly close-knit society and we have received advice from many quarters. Informal visits by Rear Admiral Nigel ESSENHIGH (UK Hydrographer), Adam KERR (Director, International Hydrographic Bureau), Professor Y. C. LEE (University of New Brunswick) and Tom McCULLOCH and David PUGH (Canadian Hydrographic Service) have all been most welcome.

10. THE FUTURE

Well, it does seem strange when most HO's are downsizing that here we are doing exactly the opposite. But then the Marine Department is also undergoing dramatic changes in the lead-up to the operation of a Trading Fund. "Business Process Reengineering, Mission, Vision and Values, Core Competencies, Leading the Change by Seizing the Opportunities" can be distinctly heard in conversations between staff traversing the corridors. It is an auspicious time for us to be setting up the hydrographic office -- hopefully we will find an ancient gold-laden wreck during our re-surveys of HK waters and make the office immediately self-funding!

12. Acknowledgements

The authors would like to thank colleagues here and in the UK-HO for their assistance in the preparation of this article.

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