Low-budget Hydrography: the hows and whys

Hydrographic Charts as used by seafarers are based on data accumulated over years of professional surveying operations. Standard hydrographic charts either in paper form or as ENC are available for most areas of the world and are quite inexpensive thanks to two factors: government-subsidised hydrographic surveys and the large number of charts printed for numerous users. Dedicated charts, as produced for the offshore oil & gas industry, coastal engineering, cable-laying operations etc. cost a similar amount to produce but are much more expensive to buy due to the limited number of users and additional requirements. For these charts, navigational (safe) depth is insufficient; detailed sea bottom morphology is required.

In both cases the basis for the hydrographic charts, bathymetric survey operations, have been and still are a rather costly affair. In the old days they were costly because the instruments used, lead line, sextant and the like, provided only a sounding every now and then whilst ship-time ticked by. Nowadays bathymetric information is typically gathered from dedicated survey vessels using single or multi-beam echo sounding systems. The prime cost factor in ship-borne surveys is the time and thus the expense involved in conducting the survey and in data post-processing. Delays due to factors such as weather related down time, logistics, red tape and instrument breakdown can cause operational costs to go through the roof.

The execution of a cost-effective hydrographic survey necessitates the use of a package of three: 1. Well trained personnel, 2. Accurate, reliable instrumentation and 3. A suitable survey vessel. How can we save on these? Survey personnel have, historically, not been in the top regions of offshore personnel salary scales. There are signs that this is changing gradually (which is necessary to keep enough people in our business!) and the only way to reduce costs here is to deploy fewer personnel on the job. Thanks to advanced survey systems and computer equipment, this is a possibility, to a certain degree. The other way would be to work longer hours to keep equipment and ship operational for longer periods, but this is done already: for most offshore survey operations, a 24hrs working day is no exception.

The other possibility to optimise survey operations is to deploy more advanced, more productive survey systems. Positioning-wise, we are â€œon dry groundâ€ already. The horizontal positioning world has been turned upside down in the past 25 years by the implementation of GPS and DGPS. Although freely available DGPS has a stated horizontal accuracy of +/-10 meters (95 percent), many mariniers are claiming 3-meter or better accuracy with this system. With selective availability set to zero, the most basic GPS receiver in a non-differential mode may offer 10-15 meter horizontal accuracy. Some sophisticated survey receivers now advertise sub-meter accuracy and with (long range) RTK systems, the cm accuracy levels can be reached for both horizontal accuracy and vertical referencing. What else can we ask for?

For bathymetric measurements, great improvements have been made in the last two decennia. In the past, survey lines were sailed and only the depth directly under the vessel was measured using a single beam echo sounder. Then, multi-transducer systems were developed (Dr. Fahrenholz) whereby an array of transducers was fitted on a pole, fitted perpendicully onto the vessel, giving a swath width of the length of the pole. The system is still very useful for very shallow water. Nowadays, we have multi beam, providing fan shaped coverage of the seafloor similar to side scan sonar, but the output data is in the form of depths rather than images. The multi beam system measures and records the time for the acoustic signal to travel from the transducer to the seafloor and back. For bathymetric purposes, multi beam transducers are generally attached to a vessel, rather than being towed like a side scan. Therefore, the coverage area on the seafloor is dependent on the depth of the water, typically two to four times the water depth. The production rate of multi beam is many times that of single beam and for an increasing number of (larger) surveys, it became a price decreasing survey tool. Post processing of the results of this system has still a considerable price impact due to the vast amount of data which is generated, but new processing packages, such as Triton Imagesâ€™ multi beam software, is quickly helping to overcome this.

The third, but major factor of costs is the survey platform. Indeed, it may be well possible to select suitable personnel and equipment for a reasonable price, but the platform on which these have to be placed to perform the work, a ship, is still the major cost-component of a bathymetric survey. Improved ship design, less shipâ€™s crew, higher survey speed, less fuel consumption and on-board data processing and charting may increase the vesselâ€™s cost-effectiveness, but ships remain expensive. For certain applications such as surveys in relatively shallow, clean water, Lidar solutions with combined RTK-DGPS / inertial systems will provide alternatives. The high speed and enormous amount of data generated enables covering large areas in short survey time. Lightweight Lidar systems (Hawkeye 2) are being developed and smaller airplanes or helicopters can be deployed from remote airfields all over the world to execute such surveys. For large projects, whereby a multitude of sensors have to be deployed over prolonged periods of time, Zeppelin-type aircraft may become a cost saving platform: with payloads of over 35 tonnes, endurance of several weeks in the air and an airspeed of 150 knots, large areas can be surveyed at reasonably low cost.

Another possible cost saving alternative for a survey vessel (or in combination with it) is the AUV. This sensor platform can, in certain cases, be deployed from the shore and execute surveys in a stable (underwater) mode at high speed without on-board
personnel. A study of the broader scope of AUV mission applications for the U.S. Navy was recently completed by a US Navy R&D team. The study, which looks ahead 50 years, provides a roadmap to use in integrating AUV’s into the battlespace of the future.

One of the most significant recommendations in the AUV Master Plan was that many missions could be completed using multiple, inexpensive, small AUV’s rather than fewer large and expensive ones. Nowadays, several research institutes and AUV manufacturers, such as Hafmynd Gavia are working on the development of the deployment of multiple AUV’s from shore or ship. Various operational procedures and survey modes (lawnmower-pattern, Master AUV multiple slave configuration etc.), navigation control, testing facilitation, are under development.

Although survey systems will develop even further, personnel costs can be reduced by deploying less personnel and AUV’s, Zeppelins, Survey Vessels and possible future creations may form a pool of suitable hydrographic sensor/personnel platforms from which the most cost-effective solution can be chosen, it will remain a difficult task to explain why hydrographic surveys are “so expensive”. As I had to point out, years ago to a journalist outside our business: a small B/W paper chart with only few soundings, in the middle of the Indian Ocean, can be thousand times the price of a beautifully drawn multi colour chart of a similar area, with contour lines, coastlines, navigational marks etc near the coast of France which we produced the same time with nearly the same equipment. (And the same salary.)