1997-2007: A Decade of Developments in Hydrography

We all know what is the oldest profession in the world. The second oldest is probably that of land surveyor: Adam undoubtedly wanted to stake out the boundaries of paradise in order to know what was and was not his. Paradise, or the Garden of Eden, was to be found in the land of the Euphrates and Tigris, where these two rivers converge at the town of Qurna in the present Shatt al Arab. And apart from his topographical activities Adam must also have made some hydrographic observations, probably just using a stick cut from a local fruit tree! After all, he had to know the depth of the river if he ever wanted to cross or sail it.

So the third profession and the first marine occupation in the world was probably that of hydrographic surveyor. The first hydrographic survey tool was a pole, maybe even with some depth markings on it. This has not changed much over the years. The ancient Egyptians navigated their cargo vessels, laden with granite from the south, through the shallow stretches of the River Nile with the aid of papyrus charts based on depth soundings taken by measuring pole. Ancient Egyptian hydrographers were knowledgeable navigators: star observations and time-keeping were familiar disciplines to them.

History

Offshore hydrography began with ships and voyages along the southern shores of Europe and the Indian Ocean. As early as 3000 BC, Cretan and Phoenician seamen in the Mediterranean Sea had built up trade and sea commerce, and long before this the Hindus, Chinese and Arabs were similarly engaged in the Indian Ocean and the Far East. When in the fifteenth century the maritime nations of Western Europe became world sea powers they began to take a greater interest in their own hydrography. This was the era in which development of optical survey tools became more and more apparent. Starting with Jacobs Staff, used to measure the inclination of sun and stars, we see the development of accurate optical instruments such as octant and sextant, tools that are still in use today! Depths were still measured the â€˜mechanicalâ€™ way, with poles or lead lines, but there were some precursors of the electronics era. In 1897 USN Commander Tanner invented a shallow-water wire-sounding machine called the â€˜Tanner sounding machineâ€™, along with many other oceanographic instruments. Several variations of this wire-line sounding-machine were developed over the next fifty years, most notably the Lucas Sounding Machine, used primarily on British ships.
Understandably, the most significant changes in hydrography occurred in the latter part of the last century, when electronics made their entry onto the world stage. At the beginning of the Second World War came development of electronic positioning systems such as Loran, with ranges of up to 1,930km and accuracy of some 200m. These were followed by Decca Main Chain, accuracy 50-100m, HiFix (5-10m), SeaFix and HiFix/6 and Hyperfix, all with accuracy in the order of several metres, depending on angle of cut or lane expansion. Most of these systems were hyperbolic and accuracy deteriorated with distance from shore stations or increased lane expansion.
But for depth measurement, too, there was light on the horizon. In 1807 Dominique Francois Jean Arago had suggested that water depth might be measured by sound propagation. After the disaster of the Titanic in 1912, German physicist Alexander Behm conducted some research into detecting icebergs. He discovered the technique of â€˜echo soundingâ€™ and on 22nd July 1913 was granted German patent No. 282009 for inventing â€˜a device for measuring depths of the sea and distances and headings of ships or obstacles by means of reflected sound wavesâ€™. Echo sounding continued to develop over ensuing years, both in Europe and the United States, and there emerged many types and models of device. During the Second World War accurate, reliable echo sounders were available for mapping offshore areas of the theatre of war. In fact, the war gave a boost to the development of a large variety of survey systems now common tools of the trade.

Post-war Innovation
After the war developments in the hydrographic industry gathered pace. Offshore oil & gas and coastal-engineering activities justified the development of more accurate, reliable survey systems. Positioning systems were again developed for military purposes. The Vietnam War brought the development of transponders that were then converted for civilian use in instruments like Miniranger and Trisponder. But other range-range systems like Tellurometer, Syledis and range-bearing systems like Artemis and Polarfix also found their way onto the market. It was not an uncommon sight in the seventies to see several Trisponder and Miniranger remote units, an Artemis beacon and several Syledis stations mounted on one North Sea platform.
But the satellite era was quickly approaching. In 1964 the Transit programme was born with the first Transit Doppler satellite fixed onboard a Polaris submarine, and in 1967 Transit became available for civilian use. By 1973 the system was fully operational and used worldwide for mapping and navigation. The same year, the USA Department of Defense approved the GPS programme and less than twelve years later the system became available and accepted for civilian use.
Meanwhile, development of echo sounders and other hydrographic and oceanographic instrumentation was also progressing. Multi-frequency systems became available for determination of mud and silt layers. With the ever-increasing need for coverage and accuracy, technology advanced to swathe bathymetry systems, introduced in the 1970s. Also on the bathymetric scene, interferometric systems were developed using the phase content of a sonar signal to measure the angle of a wave front. The signal was returned from the sea floor, thus measuring range and bearing to a series of points and producing high-resolution depth and backscatter measurements of the seabed. Parametric echo sounders proved valuable tools for the determination of sub-bottom strata and silt layers.
But these years produced a large variety of other tools, techniques, systems and peripherals which gradually changed the hydrographic profession from one employing mechanical, optical and semi-mechanical/electronic devices to a fast-developing world of electronics, satellites, remote-controlled and autonomous survey tools and sensors. And, of course, computers were now being deployed on a large

scale in hydrography. Large quantities of data could be handled and fast computations were possible, enabling the use of multi-positioning and multi-sensor systems.

New Era, New Voice

And then it was 1997â€¦and the first Hydro International rolled off the presses to find its way all over the world in February. The front cover showed the Trailing Suction Hopper Dredger *Amsterdam*, then the largest of its kind, with hopper capacity of 18,000m3. Now, ten years later, after a thorough shake-up of the dredging industry, the largest of its kind is the 33,000m3 *Vasco da Gama*, nearly twice the size.

In that very first issue of HI the feature article looked at the hydrographic component of the *Amsterdam*: she was fitted out with a SRD multi-beam system in the bow of the ship. Three transducers were flush-mounted behind acrylic portholes in the bow of the vessel. This was the first time a dredging craft had been fitted out with a MBES and it was initially used to survey the dredged profile of a trench for a long pipeline to be laid in the North Sea, on the way back from the dumping area. The Amsterdam, then the largest survey vessel in the worldâ€¦

Also in HI Volume 1, Number 1 came the text of the first â€“ and, up until now, the last - song from a surveyor in Hong Kong awaiting his so desperately needed manual for an echo sounder. Nowadays most manuals can be plucked from the internet, so we wonâ€™t be seeing any more of that kind of nonsense. Nice song though, lots of humour. Perhaps, after all, we could do with some more...

And a drop of nostalgia: there was a feature about Racal Survey and its predecessor Decca Survey, one of the very first commercial survey-companies in the world. Initially based on the success of the HiFix and Pulse/8 chains, the company now deployed several Differential GPS systems like Skyfix and Landstar. And a separate division, Racal TTI, developed and manufactured work-class ROVs in its factory in Singapore. None of this exists anymore under the old name, as the company, like so many others, has been gobbled up by the present largest survey-company.

This same first issue dealt not only with swathe bathymetry but also with SWATH (Small Waterplane Area Twin Hull) vessels. Designed and built by Yarrow Shipbuilders, the Scottish naval shipbuilders, the design promised a large and stable platform for all kinds of survey activities. It is not quite clear what became of the design, whether any were built and what was their performance in reality. Yarrow, after a series of take-overs, now belongs to BAE Marine (YSL).

Another article on swathe bathymetry covered a survey executed by Svitzer Surveys of Denmark, since June 2003 part of the Fugro Group. Systems used were a Seabat MBES with TSS heave compensator and Robertson SKR80 gyro-compass. Horizontal control was provided by a Trimble DGPS system and the reference station was Raugi Lighthouse. The purpose of the survey was to check hydrographic data left behind by the Russians on their departure in 1992, since it was thought that there might be a deepwater channel not shown on existing official charts. A channel in this area could reduce sailing times between Riga in Latvia and Tallinn in Estonia by 25%. The survey results showed that in most areas the Russian data tallied with survey data collected, and after the removal of the wreck of a purposely sunk vessel, MS Zimmermann, the route was free for vessels drawing 7m. Enormous development has taken place in this area over the past ten years: harbour construction, pipeline installation, general increase in trade and traffic, and so on. The area is currently surveyed regularly using the latest versions of MBES, motion sensors and RTK positioning.

Moving On

So what changes have we seen over the past ten years and, more importantly, what changes will we see over the coming decade A guesstimateâ€¦

Positioning. There have been tremendous developments in Differential GPS, satellite-based augmentation systems and the introduction of (long-range) RTK systems. Accuracies of several centimetres in position and height are possible; integration of GPS and Glonass receivers has improved reliability. The coming years will see the introduction of Galileo, receivers capable of receiving fifty satellites or more, and possibly other GNSS systems from China, Japan etc. Accuracy and reliability will increase. But there are underwater developments too. Acoustic positioning seemed to have reached maturity in 1997, with few advances made over early years. Any additional feature threw up repercussions elsewhere in the chain - until recently, when well known manufacturers introduced digital architecture, opening up a wealth of possibilities and update rates not previously deemed feasible. Update rate and reliability, together with the telemetry capabilities of these systems, indicate changes in the way surveys and the installation of structures area carried out offshore. Inertial system accuracy will also improve, triggered among other things by a rising market for AUV and UAVs. Fibre-optics and nano-technology will give us smaller, more accurate and reliable survey sensors at affordable prices.

Echo Sounders. Multi-beam systems have really taken off in the survey business. Initially only government organisations and large survey companies could afford the investment of a small fortune in an MBES; now affordable systems have come on the market. And, of course, clients demand 100% coverage of the surveyed area, with no gaps or uncertainties. The market started out with systems available from only three manufacturers, Atlas, Simrad and Reson; nowadays there are more than fifteen known producers of MBES, some offering products at very attractive prices. It is a growing market and system development over the next ten years will render faster processing times, cheaper systems, very-shallow and very-deep systems, additional features such as bottom classification, silt-layer measurement and sub-bottom profiling capabilities, all thanks to increased data storage space and handling speed. Fifteen-terabyte data storage units come now at the price of a single-gigabyte unit ten years ago.

Oceanographic equipment. Over the ten years since the invention of the Acoustic Doppler Velocimeter in 1993 the product-line has expanded to offer a diverse, multifaceted mix of high-technology instruments designed for a wide variety of applications. ADCPs are widely used for coastal engineering projects, offshore survey, hydrology, river-discharge survey etc. The range is impressive and systems are constantly developing and becoming more accurate and capable of working at great depths. The future will undoubtedly see a further increase in capabilities and applications, such as silt-density measurement.

Lidar. Ten years ago Lidar systems were in their infancy. Nowadays systems provide full-swathe coverage for hydrographic surveys of the seabed from the shoreline to 3x secchi disk visibility. Depths in excess of 30m can be measured and, in optimum conditions, depths to 90m are possible. Increased data storage capabilities and improved positioning (RTK and INS) and ancillary equipment (motion sensors, FOG) combined with accuracy and range improvement in the laser systems will provide great possibilities for Lidar over the coming decade.

AUVs. The first AUVs were developed at the Massachusetts Institute of Technology in the 1970s and they got their first mention in the pages of Hydro International in April 1998. The offshore survey industry uses AUVs to make detailed maps of the seafloor, and a typical military mission for an AUV is mapping of an area for mine detection. Scientists deploy AUVs in studies of the ocean and the ocean-floor using INS, side-scan sonar, MBES, magnetometers, thermistors and other underwater sensors such as AD(C)Ps, water-quality sensors etc. Developments are underway of AUVs capable of subsea intervention and deep-sea mining (manganese nodules), as opposed to fly-by data collection. Most AUVs work in conjunction with surface vessels for support and navigation purposes, although ultra-low-power, long-range variants are becoming capable of operating unattended for weeks or months at a time, periodically relaying data by satellite to shore before returning to be picked up.

AUVs play an increasingly significant role in harbour survey. In regular survey, optionally in combination with MCM for port-security purposes, they carry various sensors, from acoustic and optical-imaging devices to environmental and navigation systems. They are able to survey a small harbour area within hours, at night, and in turbid water. They can inspect shipsâ€™ hulls and harbour walls, providing accurate imagery of the areas covered as well as regular hydrographic survey data. Although AUVs are not yet commonly used in the dredging industry, they will undoubtedly become more popular in the future. Purchasing costs have been quite high, but now low-cost, high-performance AUVs (LCAUV) such as the Hafmynd Gavia (Figure 8) are available at a price considerably lower than conventional survey craft. And because such a vehicle can execute a survey in less time, using fewer personnel and less fuel, the purchase of an LCAUV is becoming more and more attractive. There will be spectacular developments in AUVs over the coming decade due to implementation of nano-technology, increased data-storage capabilities and sensor development.

Concluding Remarks

And so we could go on. However, suffice it to end with the conclusion that the last ten years have shown great improvements in quality and possibilities of the tools of our trade, and that the next decade will bring even more developments at an even faster pace. And all this triggered by a growing survey market caused by the exploitation of smaller oil & gas fields and exploration for new fields thanks to increasing oil prices. Also on the horizon are more large-scale coastal engineering projects, not only in the Middle East but also the Far East and other areas where countries want to invest in maritime infrastructure. The coming ten years will be an interesting decade for our business. Hydro International hopes to report back to you, dear reader, in ten years time, February 2017â€¦