Opening up the Seas

The resolution of object detection in the worldÃ¢â‚¬â„¢s oceans has increased exponentially during the past century, supporting engineering design of complex seafloor structures and leading to new scientific understanding of Earth features and global climate. Now repeat surveys and ocean observatories provide detection of events in the fourth dimension, time.

This issue of Hydro International touches on fascinating aspects of recent advances in our ability to detect, identify and map objects in the worldÃ¢â‚¬â„¢s oceans. Prior to the late 1930s, knowledge of the ocean floor was defined by about 20,000 poorly positioned lead-line soundings. Trans-oceanic telecommunications cables, arguably the most ambitious deep-seafloor installations between 1850 and the Second World War, were established using only widely spaced lead-line soundings. Then, as the ability to collect acoustic soundings developed into widely-spaced continuous bathymetric profiles, researchers in the mid-1960s were able to assemble maps of the shape of the seafloor that contained enough information to help guide the understanding of plate tectonics and the evolution of the surface of the Earth. But it would be another ten years before the US National Geophysical Data Center archived its millionth sounding!

When multi-beam echo sounders became available for research and commercial use in the early 1980s we experienced another quantum advance: the ability to detect football stadium-sized objects on the seafloor. Combined with side-scan sonar data, large shipwrecks could now be detected in the deep ocean. Continuing improvement of swath-sonar acquisition and processing technology means we are now able to acquire bathymetry with an accuracy of about 0.5% of water depth, and detect objects of similar dimensions. In deep water this means resolution the size of a house, but in shallow water the resolution becomes proportionally finer. There are now over a thousand multi-beam sonar systems across the world, most capable of acquiring many millions of soundings per day.

We are now moving our mapping sonar close to the bottom to obtain very high resolution in deep water; essentially making deep water shallow. This has progressed from deep-towed systems to ROVs, and now to AUVs. The most recent AUVs now provide decimetre-accuracy bathymetry and detect objects with dimensions of a few tens of centimetres in water depths of 3,000 meters or more. We have the ability to provide detailed engineering maps of the seabed in any water depth.

Arguably, the next big advances in study of the seafloor will come as we begin to detect objects in the fourth dimension, time! Long-term seafloor sensors monitoring geological activity, oceanographic change, and biological activity are now being installed and connected by cable to shore. These seafloor observatories will provide continuous detection of events in the ocean that have direct and powerful consequences for terrestrial areas. We know that ocean currents and temperatures are driving and defining global climates; now these oceanographic conditions can be continuously modelled, even in critical and barely understood areas such as the Beaufort Sea.

As another example, it has been shown that by combining ultra-high resolution AUV survey and precise location of seafloor reference navigation beacons we can use modern technology to make sub-decimetre-accuracy bathymetric maps of large areas of seafloor in deep water. In a place like the seismogenic inner wall of the Nankai Trough, where huge subduction-zone earthquakes have recurrence rates of tens of years, this would allow monitoring and detection of seismic strain before and between earthquakes.