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## Q1

Selecting a single milestone in hydrography with its long history of innovation is nearly impossible. However, a major step forward which revolutionized the full arc of the hydrographic workflow, including field surveying, nautical cartography, and the use of our data by mariners was the advent of full bottom coverage survey techniques. The ability to fully ensonify the seafloor to produce a high resolution model of the bathymetry and seafloor features completely changed hydrographers approach in the field. While these systems undoubtedly made hydrography more accurate and efficient, they ushered in a new set of requirements for supporting technologies. These dense datasets and the uncertainty estimates possible from multiple measurements of the seafloor in each location gave rise to a whole new class of surface-based products for navigation, modeling, and resource management. The promise of this is realized with the advent of high resolution bathymetric overlays using the S-102 standard. These new products, made possible by full bottom coverage survey methods, are allowing mariners to increase safety, optimize use of available water, and reduce congestion in the world's seaports.

## Q2

Increases in our capacity and efficiency of hydrographic data acquisition, and more importantly, our ability to convey data to stakeholders in fit for purpose format in a timely fashion. In the field, we see the value of uncrewed systems to amplify the effectiveness of traditional platforms. UxS will capitalize on advances in bandwidth, low-latency connections between platforms and shore, quickening data ingestion and product creation. Ashore, AI will aid in analyzing data from a wider range of sources for ingestion into authoritative, current seafloor models like NOAA's NBS. Marine modeling, guided by high-res bathy and other data, will improve our forecasting of water levels, currents, and other marine phenomena. Automation will increase efficiency of transforming data streams into products for users needing authoritative geospatial data for our oceans and coasts. Advances in data models plus next-gen ECDIS and other chart displays, will allow mariners unprecedented use of data to meet their needs, like customized depth curves derived from S-102 overlays. The S-100 model displays these products in a unified operational picture, increasing safety, and efficiency of navigation.

## Q3

The Navigation Surface: A New Database Approach to Creating Multiple Products from High-density surveys by then-LT Shepard Smith, NOAA, Dr. Lee Alexander, and CAPT Andy Armstrong, NOAA (ret.). This article from 2002 set the vision which has guided much of our work over the course of my career. The navigation surface concept was a major shift in hydrography and charting, transitioning from individual depth soundings to a gridded model of the seafloor in which depth estimates and uncertainties went hand-in-hand. This opened the door to the "chart of the future", in which bathymetry, water levels, currents and other data could be combined into a unified picture for the mariner. We've been working toward this vision since this article was published, and our Precision Marine Navigation program and the S-100 framework put us on the cusp of achieving it. Link to article: <https://journals.lib.unb.ca/index.php/ihr/article/view/20584/23746>