MARINE TECHNOLOGY REPORTER

July 2018

White Papers

A special content edition of MTR

Hydrographic edition

The Maritime Industry's Largest
Social Media Presence

Maritime Reporter is a member of the Marine Media Network of websites, publications, and social media sources for news, editorial and information including the Maritime Network, the commercial marine industry's largest dedicated Linkedin group.

63,523
Facebook Page Likes

MARITIME REPORTER AND ENGINEERING NEWS

130,096
Linkedin Group Members (industry's largest)

THE MARITIME NETWORK

31,453
Twitter Followers

@ShipNews

All stats from 01/02/2018

Also part of the Marine Media Network

Page	Likes
Marine Electronics	33,528
Marine Technology Reporter	55,692
Maritime Global News	26,157
Maritime Jobs	46,011
Maritime Logistics Professional	30,947
Maritime Propulsion	22,477
Maritime Reporter & Engineering News	63,515
World Energy News	49,498

MTR White Papers / No. 1

Contents

ON THE COVER

Hurst Spit surveyed by 4D Ocean using a SeaRobotics ASV (“Harry”) in combination with a UAV. Data collected and Processed using QINSy and Qimera.

Image courtesy of Channel Coastal Observatory and the Maritime & Coastguard Agency.

NEW YORK
118 E. 25th St., New York, NY 10010
Tel: (212) 477-6700; Fax: (212) 254-6271

FLORIDA
215 NW 3rd St., Boynton Beach, FL 33435
Tel: (561) 732-4368; Fax: (561) 732-6984

www.marinetechnologynews.com

PUBLISHER
John C. O’Malley
jomalley@marinelink.com

Associate Publisher & Editor
Gregory R. Trauthwein
trauthwein@marinelink.com

Managing Editor
Eric Haun
haun@marinelink.com

Special Projects
Gabby DelGatto
delgatto@marinelink.com

Contributing Writers
Capt. Edward Lundquist, USN (Ret.)
Elaine Maslin, Aberdeen
Tom Mulligan, Ireland
Claudio Paschoa, Brazil

Production Manager
Irina Vasilets
vasilets@marinelink.com

Production & Graphic Design
Nicole Ventimiglia
nicole@marinelink.com

Corporate Staff
Manager, Marketing
Mark O’Malley
momalley@marinelink.com

Accounting
Esther Rothenberger
rothenberger@marinelink.com

Manager, Information Technology Services
Vladimir Bibik
bibik@marinelink.com

CIRCULATION
Kathleen Hickey
mtrcirc@marinelink.com

ADVERTISING
Vice President, Sales and Marketing
Rob Howard
howard@marinelink.com
Tel: (561) 732-4368 • Fax: (561) 732-6984

Advertising Sales Manager
Mike Kozlowski
kozlowski@marinelink.com
Tel: (561) 733-2477 • Fax: (561) 732-9670

Ping and Done: Evolving QPS Technology for the new Era of Autonomous Hydrography

Authors: Chris Malzone and Matthew Wilson, QPS, Inc

The implementation of autonomous technology in hydrography has seen steady evolution for 20+ years. The initial developments focused on deploying large diameter (0.5 to 1m) vehicles (AUV's) at great depths. AUV's have quickly proven to be cost-effective solutions for obtaining high resolution bathymetry, imagery and photographic images in environments where preceding technology fell short. The most recent innovation surge is focusing on autonomous surface vessels (ASV's) where organizations have found great gains to be made by removing personnel from the vessel altogether. Since 1997, QPS has provided options for the user to minimize the interactions with the surveyor and the system by automating key functionality. The combination of QINSy's automation and Qimera's data processing innovations (Wilson et al., 2018) provides a tightly integrated solution for organizations to embark on this new era of Hydrography.

Introduction

One of the challenges posed to the autonomous hydrographic workflow are issues arising from the incorporation of a variety of software solutions with non-seamless linkages. Many autonomous operators are incorporating separate solutions for; mission planning, sensor control (navigation, sonar settings, etc.), acquisition, systems monitoring (QA/QC), data fusion, data processing and final product deliverable. For a single mission this can lead up to eight (8) different software solutions from four (4) or more vendors. A non-seamless workflow leads to increases in error due to a heavy reliance on human interaction (Wilson et al., 2018). QPS has successfully decreased error and improved efficiencies by automating the tasks best suited by computing technology. Since 1997, QINSy has had the ability to provide all eight of these requirements for surface (ASV) applications. For subsurface applications (AUV), QINSy is scheduled to be fully compliant with the incorporation of mission planning functionality by the end of 2018. This paper will outline the history of QPS's commitment to autonomous applications and how these requirements are paving the way for this new era of hydrography.

Early Real-time Innovators

The QINSy software solution has been a market leader in flexible, stable and reliable hydrographic operations for well over two decades. Initially implemented as a software solution for complex positioning projects (rig moves, marine construction, etc), QPS implemented its hydrographic functionality beginning in 1996. By 1997, QINSy had already laid the groundwork for autonomous applications through the introduction of auto-logging; real-time data processing (including ray-tracing, height compensation - RTK, tides); multibeam filtering (depth, range, sector, quality, TPU, etc); grid generation; systems monitoring alerts (satellites, standard deviations, proximity/ collision alarms) and the Remote Display Client (low to high bandwidth remote access). By 2002, real-time sidescan and backscatter mosaicking (with or without normalization) was added, and by the end of 2006, magnetometer grid generation, autopilot interfaces, generic/user configurable output drivers and advanced survey planning features were released. In 2015, QPS introduced Qimera and shortly thereafter released Qimera Live which provides near real-time processing of multibeam data regardless of platform and data format. Beginning in 2017, QPS has responded to market demands by providing fully automated functionality specific to several key ASV manufacturers, including but not limited to; SeaRobotics, ASVGlobal, Seafloor Systems, IxBlue, Maritime Robotics. Across all of these platforms QPS provides a tightly integrated Five-Point solution which includes:

- Mission Planning
- Automation
- Systems Interfacing & Control
- Systems Monitoring
- Post-Acquisition

The QPS solution ensures 100% survey coverage, tight quality control and fully corrected data products upon vehicle retrieval.

Simplifying Planning and Ensuring 100% coverage

A common challenge amongst autonomous operators is the ability to ensure 100% survey coverage in regions of varied slope. This challenge is exacerbated by lack or complete absence of historical bathymetry data essentially making survey planning a futile exercise. In response, QPS introduced "AutoSurvey" (demonstrated at OI2018), a real-time intelligent line generation tool that utilizes the most recently collected multibeam data to generate a line that accounts for variation in slope (Fig 1). Unlike prior solutions, the success of QINSy's AutoSurvey is the result of having highly reliable and fully corrected real-time multibeam data to generate a line that will prevent gaps or "holidays" in the data by providing course corrections to follow along bathymetric contours. Another unique feature is that AutoSurvey is tightly integrated with QINSy's Autopilot (serial or network) driver to provide accurate navigation data for vessel control. The "turning track" may also be customized to ensure proper lead-in to the survey coverage and/or to ensure proper positioning of a towed object relative to the vessel. Line planning is now reduced to a single line as a starting point to begin the autonomous survey.

While tight integration between line planning and contoured guidance is an idealized real-time scenario, several operators utilize "way point" navigation for their systems. To ensure all requirements for navigation are met, QPS provides direct integration with Control software and direct import of L84 formatted line plans. Direct integration includes driver interfaces with autopilot systems, such as the AutoNav MavLink that is utilized in manned and unmanned maritime, aerial and terrestrial operations. If issues arise due to interface complications or users wish to utilize a pre-planned mission, QINSy line plans may be exported via L84 and uploaded directly to the Control system software (e.g. ASView software by ASV Global).

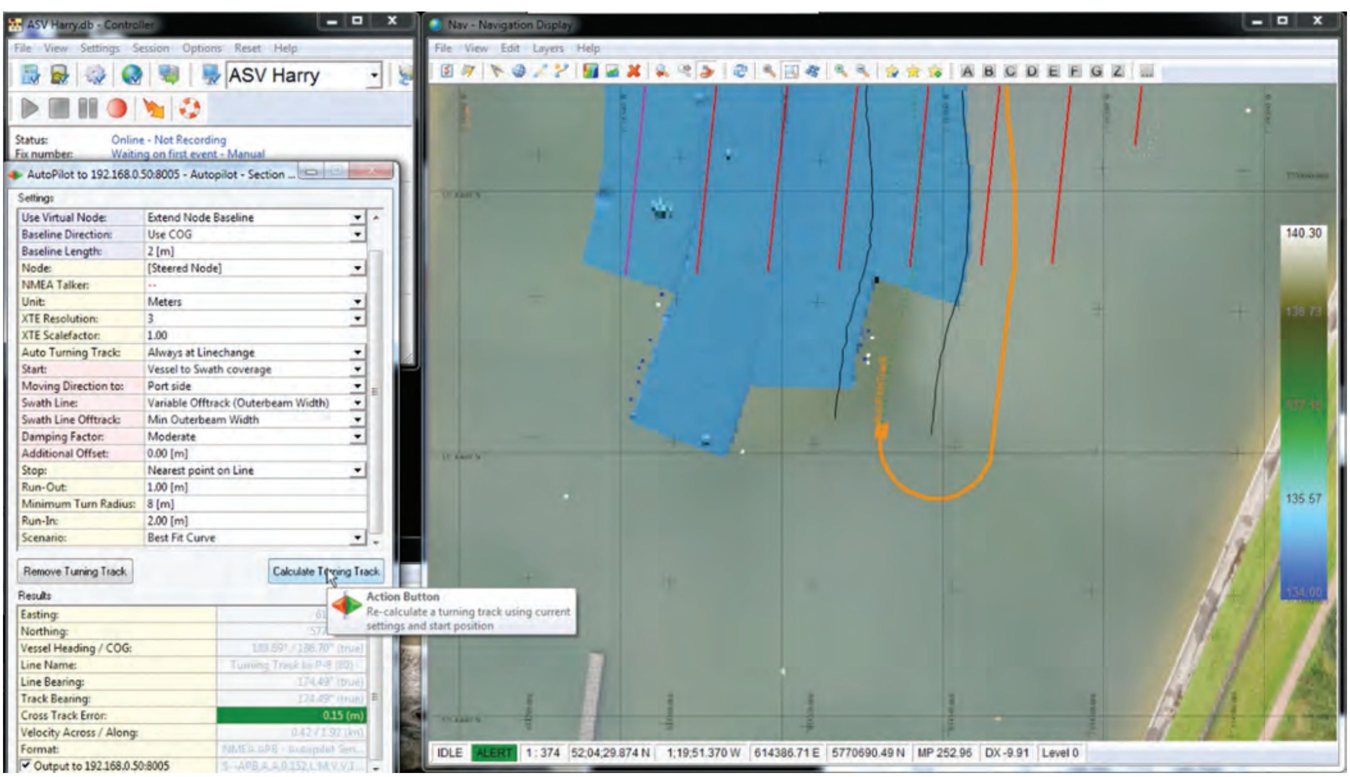
Despite extensive planning, one must expect the unexpected: storms arise, sensors fail, collisions occur, power is lost. QPS is in the process of implementing "Murphy" Planning which integrates with QINSy's on-line systems monitoring to provide system recovery options. Murphy planning is simple and straight forward but requires real-time logical reasoning by the software itself and taps into QINSy's innovations in automation to ensure proper execution.

Innovations in Automation

A mundane truth about hydrographic surveying is that the majority of the time is spent behind a computer initiating start/stop logging sequences and configuring file management. QINSy provides several options that may be preconfigured to automate both processes. Auto-logging functionality may be initiated based on distance to start/end of line, distance from swath coverage or distance to predefined survey area. QPS implements a file structure that is automatically configured during installation. Raw data (.dB & .xtf) and processed (.qpd) file names can then be defined based on a user defined name, date (julian day, month-day-year, year-month-day, etc), time or a combination of all options in order to fit the most complex client requirements. Furthermore, eventing and/or fixing (dynamic or passive) may be automatically generated based on time, trigger, distance (sailed, along, seismic, preload). All events and fixes are stored raw data files.

Further, QPS has removed the necessity to create a predefined grid area allowing for attributed grids (SBES, MBES,

Figure 1. QINSy autopilot setup window with AutoSurvey dynamic line planning functionality with turning track (left) and the QINSy Navigation Display showing the result (right).



Sidescan and magnetometer) and dynamic surfaces (DTM-based related to processed qpd files). Users also have the option to include ancillary data files (e.g. sound velocity) in the real-time processing such that the information contained in the resulting grids and processed point files are fully refracted and corrected. If the ASV has the ability for continuous sound velocity profiling, raytracing corrections can be implemented based on the most recently available profile in QINSy. It should be noted that Qimera has several additional raytracing options for concurrent processing including nearest in time and nearest in distance.

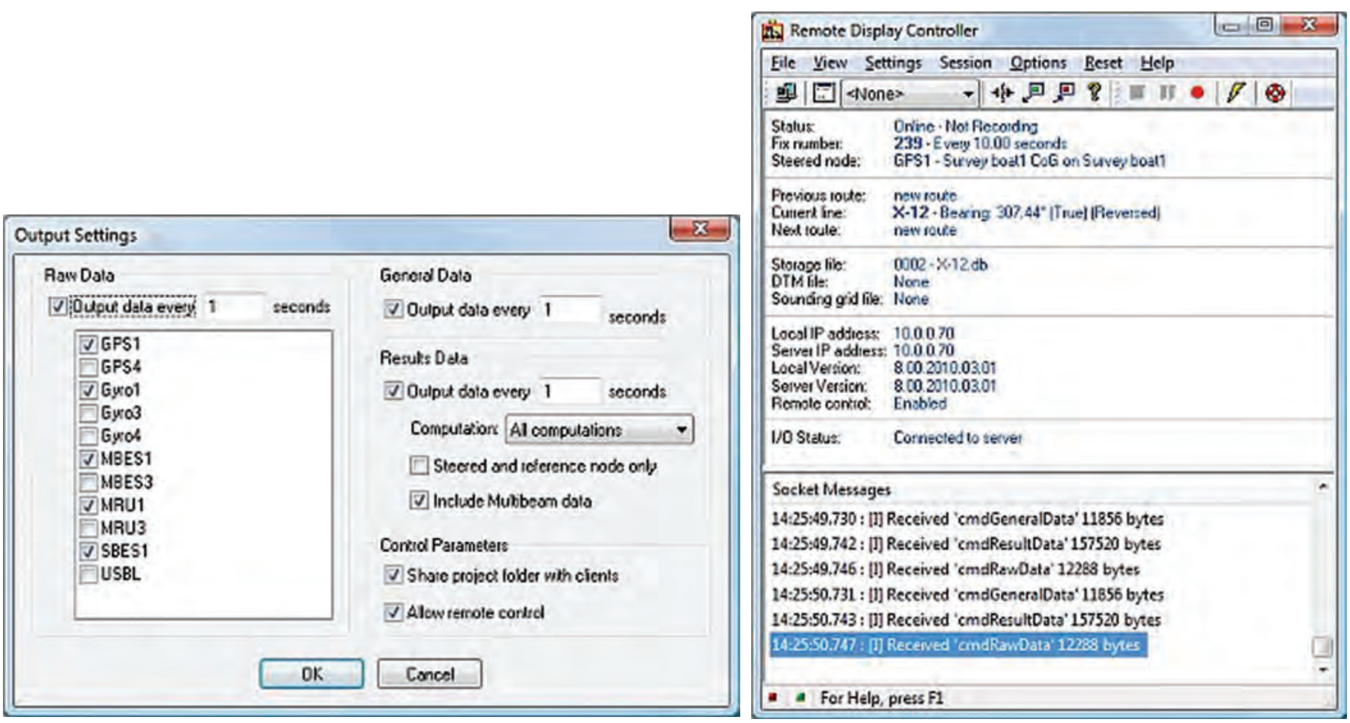
Systems Control

The overall purpose of unmanned versus manned surveys is to provide fully automated processes with minimal human interaction. However, it is recognized that operators need confidence in their ability to have the system self-monitor and react, be customized based on variable payloads, remotely interact with the 3rd party control systems (if needed) and provide the option to manage data from multiple sources and vessels simultaneously. QINSy currently provides over 2000 interface drivers, making it one of the most flexible and readily deployable software solutions on the market. An emerging trait of success for autonomous systems is the ability to rapidly change payloads based on mission requirements. Since these requirements may take place "on the fly", customizations may be required to accommodate varying sensor inputs and outputs. QINSy satisfies both requirements through a generic user defined ASCII driver which is often used to send out basic ASCII string (serial, UDP, TCP/IP) to monitor ASV position or to control other devices.

Monitoring your System

In response to market demands for low graphics load monitoring options, QINSy provides two options; a TCP server based Remote Controller and the Remote Display Client. Remote controller is used to send commands over a network to start/stop logging or to shut down QINSy. This functionality also provides the operator the ability to set or redefine the file naming convention and obtain an overall status of the I/O as well as logging (storage, memory, etc.). The communication can take place internally with an AUV/ASV controller and/or externally to provide remote operator access. For those operators focused more on the later, the Remote Display Client (RDC) (Fig 2) provides the ability to receive settings (computations, current line, steered node, etc.), raw data and positioning results over a TCP/IP network from a Socket Server running under the on-board system. The RDC can set

Figure 2. Remote Display Client output settings (down) and Remote Display Controller (right). The RDC controller mimics what is running on the AUV/ASV and allows full remote access and configuration of the system



up independent displays (navigation, swath, alarms, etc.) and, if permissions are set, remotely change online settings. Furthermore, QPS provides sonar controllers for several major manufacturers including R2Sonic, Kongsberg and Edgetech. While most of these systems have fully automated sonar control functionality already incorporated, QINSy RDC provides the option for settings to be monitored and changed if necessary.

Regardless of the chosen monitoring option, the QPS alerting system has the ability to monitor all aspects of the integrated system and trigger alarms if acceptable tolerances have been exceeded. Of notable importance is seabed collision avoidance, a critical feature for manned and unmanned surveys. Collision avoidance is set up prior to survey and is based on current 3D position and speed over ground. When the seabed is at the same depth or shallower than the defined object (e.g. ASV, AUV or towfish) and within the maximum amount of time, an alarm is generated. The defined seabed may be a model, active grid or real-time observation (Fig 3).

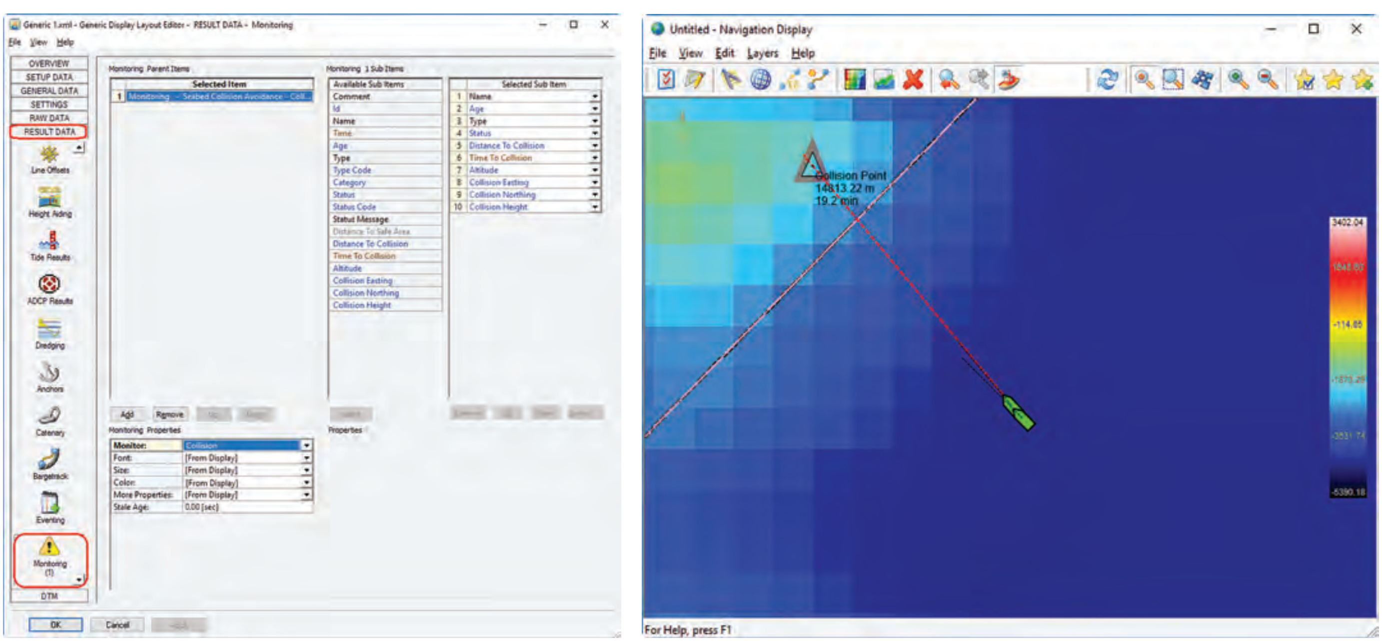
Force Multiplier

Force multiplier technology is another significant advancement in autonomous operations. For Hydrography, running in parallel with other autonomous vehicles and/or alongside manned survey vessels, operators are covering far greater ground while minimizing logistical overhead. QPS is committed to improving the Force Multiplier concept through advances in both real-time data acquisition and processing as well as during post-processing in Qimera. For real-time, QPS is developing technology that will allow for scalable approaches for multiple systems to populate a single grid in real-time. Unique to Qimera, Cooperative Cleaning and Production Line Processing functionality provide seamless workflows highly relevant for the post-production and validation portion of the autonomous workflow.

Cooperative Cleaning – Making the unmanageable manageable

For large data sets, cooperative cleaning allows multiple users to clean and validate large survey projects by dividing into smaller, more manageable projects while maintaining data integrity. This allows multiple processors to work on the same project simultaneously, greatly increasing efficiency. Because the subprojects are entirely encapsulated (i.e. they can exist independently from the main project), further efficiency can be gained by creating the subprojects locally, which therefore reduces or completely eliminates the near constant network transactions that are normally required when point editing. Data processors work within their subprojects and, once complete, introduce their efforts back into the main project. In parallel, the main project may have ancillary data processing completed (e.g., SBET, SVP, height corrections). The edits from the subprojects may be incorporated back into the main project without affecting the overall progress of the entire

Figure 3. QINSy Alert System for Seabed Collision Avoidance. A collision point is detected and the estimated time to contact is calculated.



project but enormously increasing efficiency (Fig 4).

Production Line Processing – Unifying separate projects for a common goal

Production-line processing allows for multiple projects to be treated as stages and encapsulated under a single, much larger effort. These stages can be done based on survey days, survey segments, survey vessels or, in this case, autonomous systems. The processing for a stage (e.g., a day, vessel/vehicle, segment) of data is handled in its own processing project. Further, if real-time processed data acquired by QINSy is present, these outputs can be aggregated into a master project for review. During review, the stage may be accepted and immediately incorporated into the master project or sent back for additional processing. This is done repeatedly and combined with other stages within the master project. The net result is the integration of multiple smaller projects processed in the exact same manner that can then be seamless integrated into the QPS hydrographic workflow.

Integrating into an already Seamless Workflow

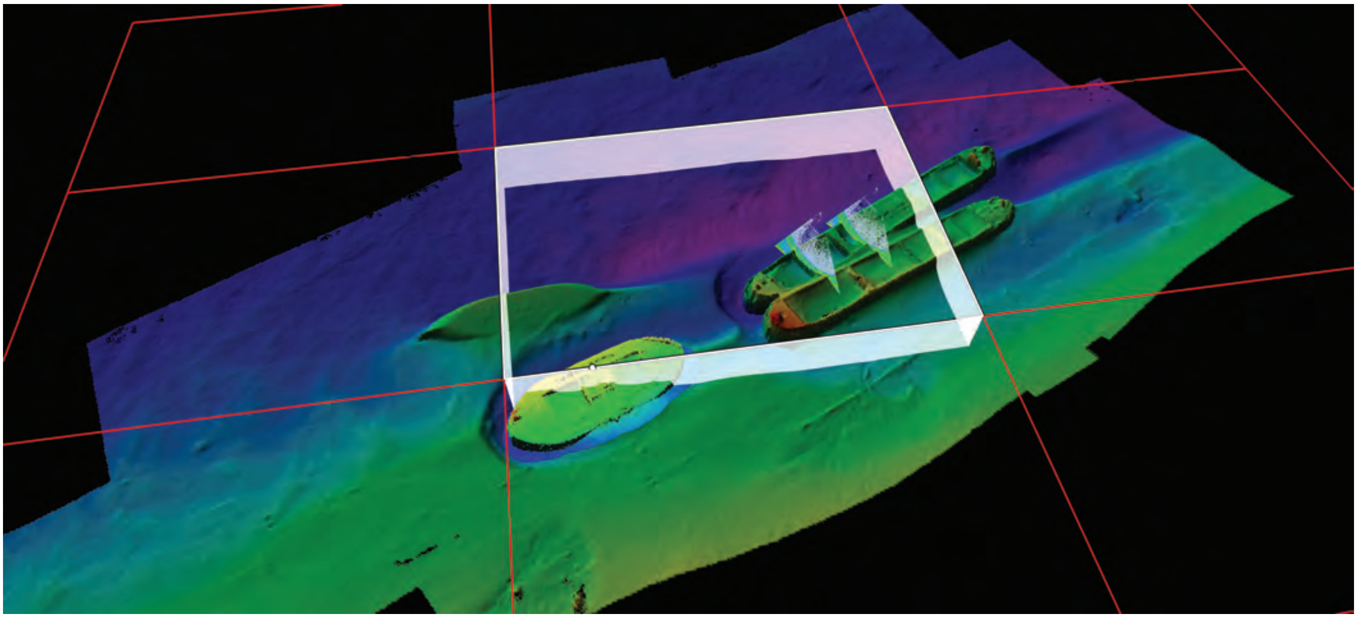
Despite the presence of automated real-time solutions, tedious and manual processes continue to persist in many of the post-acquisition steps of many hydrographic workflows. As previously outlined, human interaction in the workflow is a highly prone to error (Wilson, et al, 2018). These errors are also quite costly, as they have been proven to dramatically increase the time required for data throughput to chart. Qimera is designed to provide a higher return on investment by minimizing the opportunities for human operators to make mistakes. This philosophy stands true whether the data is collected from a manned or unmanned system.

Real-time processing as outlined above is often referred to as “pre-processing” where all of the mathematical operations for data fusion, filtering and surface generation have been completed on-board prior to ASV/AUV retrieval. The unique integration between QINSy and Qimera provides a rapid linkage for final quality checks or to revisit the raw data to troubleshoot, utilize Qimera’s problem solving tools or to reprocess all-together (Fig. 5). Care has been taken to simplify reprocessing by linking the proper metadata (including operations performed) to the raw (regardless of data format) and the processed data.

For non-QINSy users, QPS introduced an automated standalone solution called Qimera Live. With a single command, the “Live” functionality automates the guided workflow such that by the completion of every survey line, pre-flagged data files create and/or update a fully georeferenced gridded surface. The surveyor may choose to use Qimera Live to immediately identify problems in post-processing or have a completely autonomous processing solution that can deliver a final product upon hitting the quayside. Qimera Live is a part of the standard Qimera installation and is maintained through the standard release cycle. It may run on a separate computer or on the acquisition machine, allowing maximum flexibility for implementation in autonomous operations, remote vessel operations and/or multivessel surveys.

Once within Qimera, there are several QC tools available to either move towards product deliverable or fix any problems that may be present. Three of these tools are the implementa-

Figure 4. For Cooperative multi-user cleaning, Qimera breaks up the project based on user-defined parameters. This example shows a simple grid of 9 subprojects.



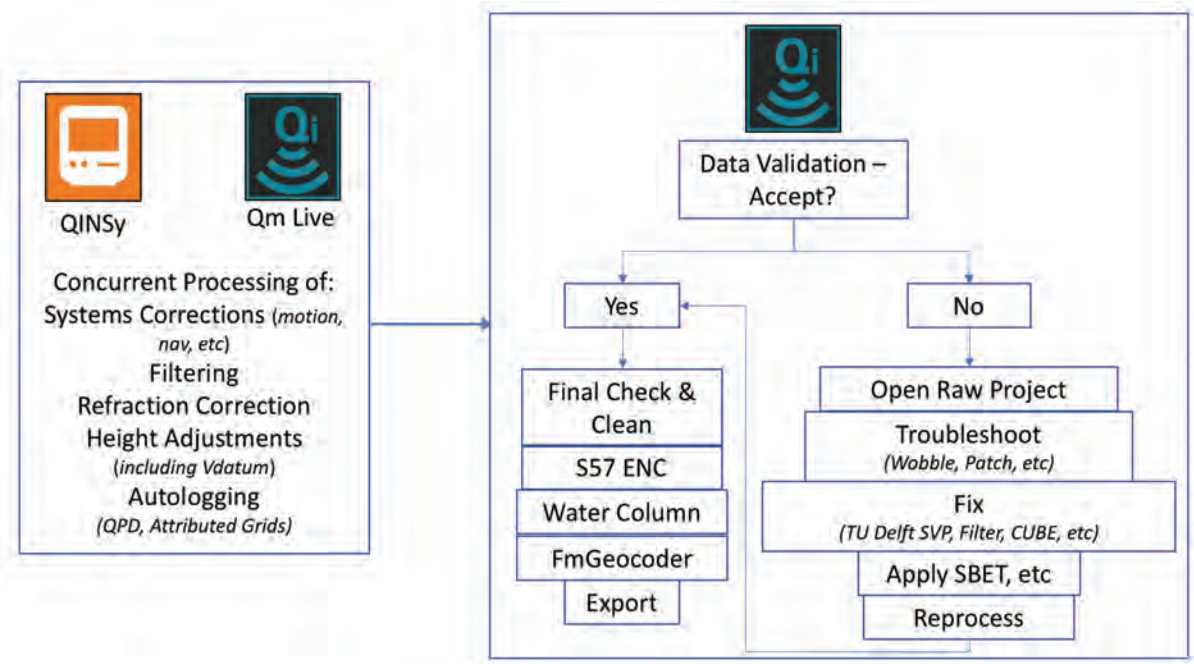
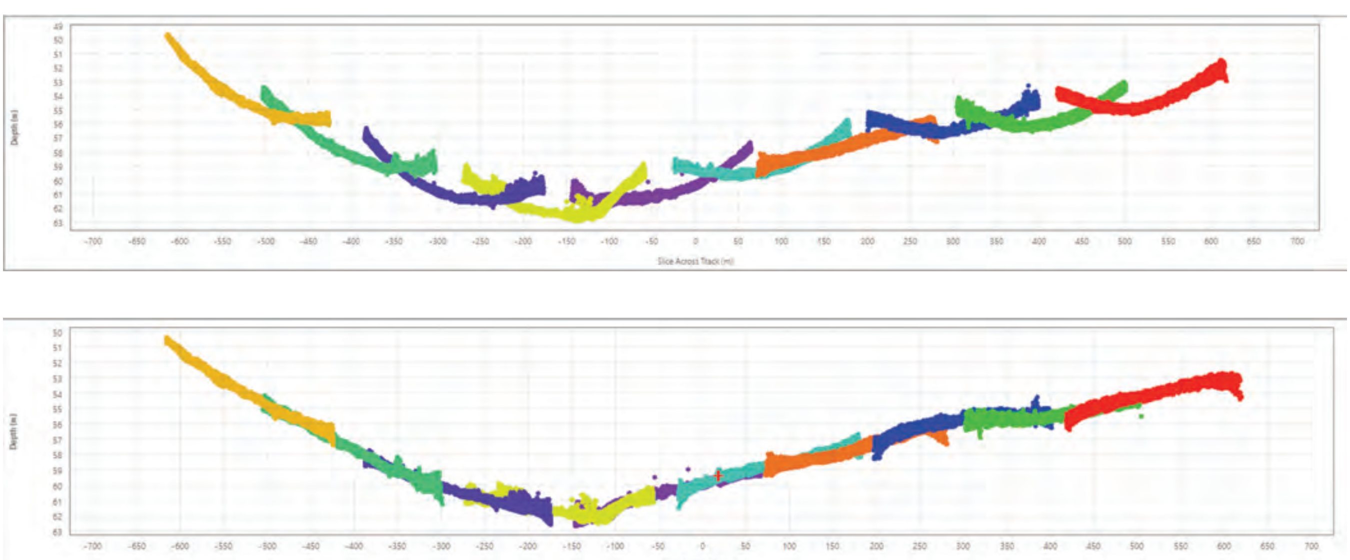


Figure 5. Simplified workflow for QPS's concurrent (real-time and/or near real-time) processing. QINSy may be utilized as a comprehensive autonomous solution. Alternatively, for non-QINSy users, Qimera Live may be utilized for near real-time data processing.

tion of many years of academic research to address common problems found in multibeam data; Wobble test, ENC Plus and TU Delft SV Correction. The TU Delft SV Correction tool is particularly important for autonomous surveys as relevant and reliable sound velocity profile information is often not available. This tool fixes data errors caused by sound velocity issues that are not fixable within an available set of SVP measurements. This physics-based approach takes advantage of the overlap between survey lines, harnessing the power of redundancy of the multiple observations. For a given

Figure 6. Slice Editor view, colored by file, showing the smile effect, before (top) and after (bottom) running TU Delft Sound Speed Inversion Tool

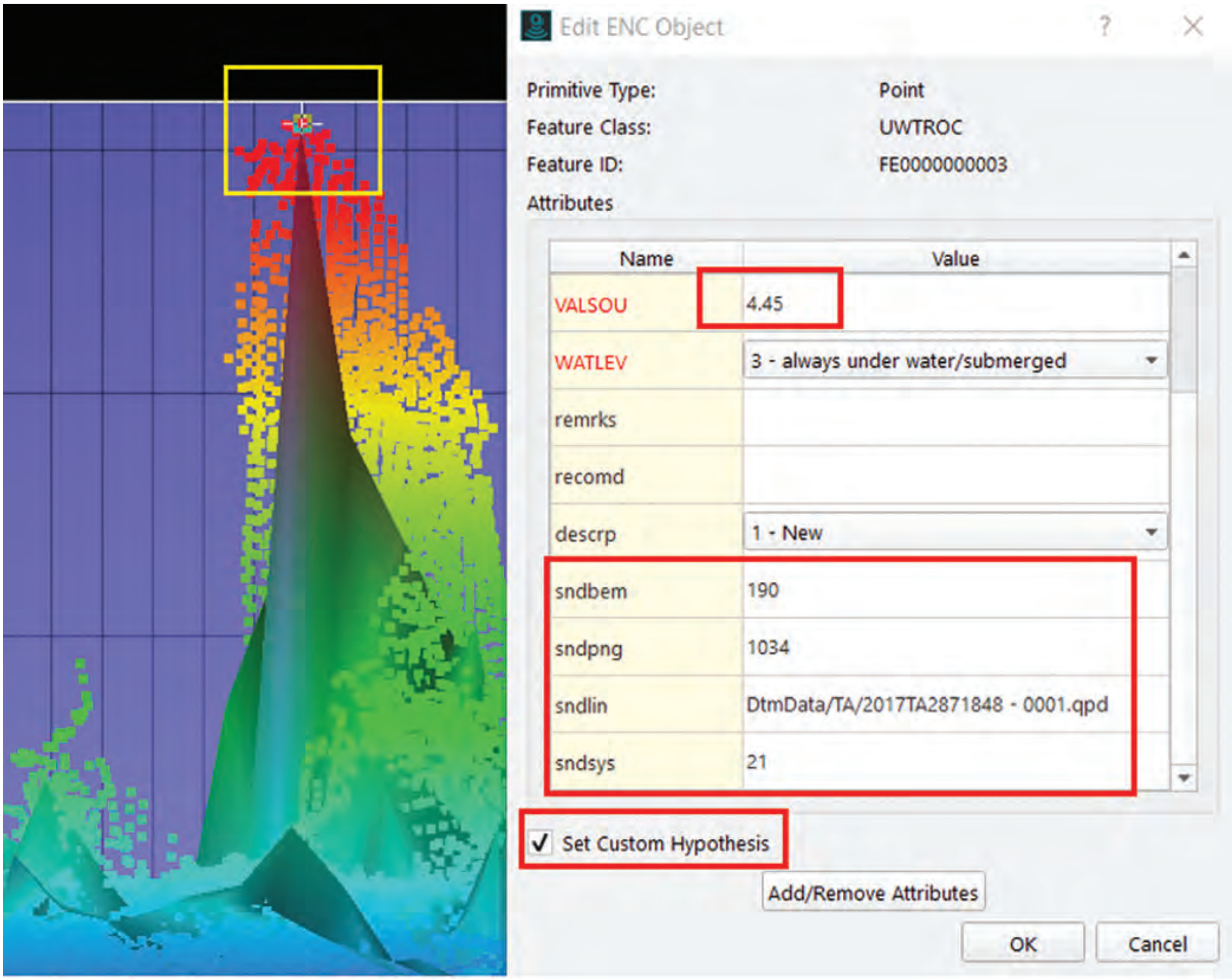


set of pings, the algorithm simultaneously estimates sound speed corrections for the chosen pings and their neighbors by computing a best-fit solution that minimizes the mismatch in the areas of overlap between lines. This process is repeated across the entire spatial area, allowing for an adaptive solution that responds to changes in oceanographic conditions. For accountability, the algorithm also preserves the output of the inversion process for review, vetting, adjustment and reporting (Fig 6).

Artifacts associated with autonomous installations may also be an issue for the new era hydrographer. To correct these issues during post-acquisition, the Wobble Test is designed to dynamically adjust the echosounder and/or motion sensor configuration in a trial-and-error method to isolate causes of integration errors resulting in so-called "wobbles" in the sounding footprints. Finally, to comply with the deliverable requirements for Hydrographic Offices, the ENC Plus tool in Qimera features a built-in linkage between S57 features and the corresponding bathymetry (Fig 7) to ensure parity between these data submissions.

Further production can be done through QPS's "one button" mosaic tool in FM Geocoder or utilizing Qimera's built-in water column processing tools. Both tools have been successfully deployed for hydrographic based projects ranging from

Figure 7. Qimera seamless ENC S57 functionality allows for features to be added regardless of view, editor (swath, slice, 3D), etc. Qimera automatically updates the wrecks, rocks, and obstructions on a corresponding S57 feature file. This is accomplished via a link between the S57 attribute value of sounding (VALSOU) and either a particular sounding or grid node.



substrate identification with least depth determination to seep hunting activities. All water column detections processed utilizing Qimera are fully corrected and raytraced requiring very little interaction from the user aside from identifying what it is they wish to add to the processed data files (Fig 8).

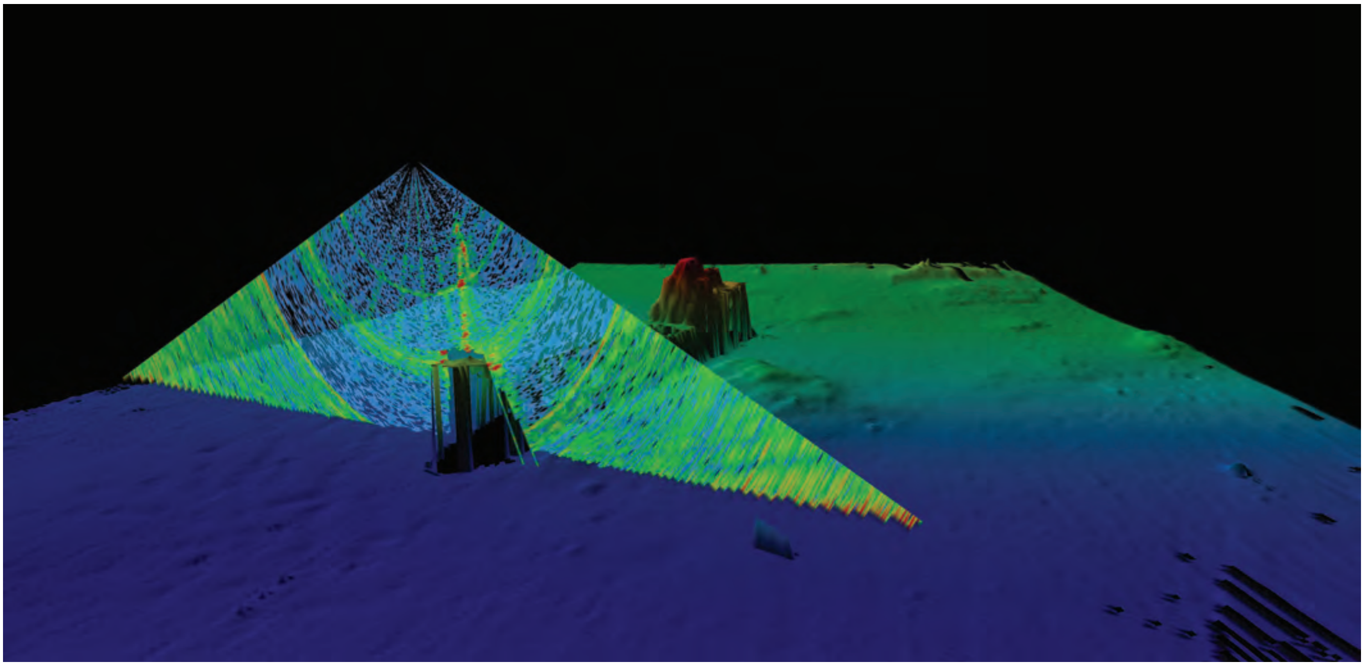
Summary

Since its entry into the hydrographic market in 1997, QPS has strived for minimizing error due to human interaction by automating the mundane tasks which can best be achieved through computing automation. A byproduct of this early innovation is the foundation for QINSy to become a comprehensive autonomous solution suitable for both subsea and surface applications. It's real-time processing functionality paved the way for new innovations that simplify in mission planning and provide dynamic line guidance tools that ensure 100% survey coverage. Since the data processed during survey are fully corrected and refracted, the positions on the seabed can be utilized to improve systems control and monitoring through QPS's Collision avoidance tools. QINSy is also highly flexible tool to implement into existing systems through a wide range of systems drivers, customizable generic drivers and options to interface directly to systems control software (remote control). This flexibility is scalable allowing for users a wide range of options to fully control the system remotely (RDC) or, when something is wrong, have the system alert the user and allow them to respond (e.g. the "Murphy" plan). This scalability is now allowing for multiple vessels and/or vehicles to be incorporated into a single project. These Force Multipliers are expanding the concept of autonomous hydrography and Qimera provides the unique functionality to either break up large projects into manageable sections or to consolidate several small projects (e.g. multiple vehicles/vessels) into a common space. The seamless integration between QINSy and Qimera is providing options for users to simply QA/QC data at the end of the day or tap into the most recent innovations in post processing to identify problems, correct them, reprocess and confidently deliver.

References

Wilson, M., and Nijsen, F., 2018, "QPS Nautical Charting Workflow: Walking a ping from the surveyor all the way to the pilot", in Proceedings Canadian Hydrographic Conference, Victoria, BC, Canada, 2018.

Figure 8. Water-column processing above a wreck reveals a mast with a more accurate least depth to be incorporated into bathymetry, ensuring the utmost in safety of navigation for those nautical charting products later derived.



Qimera

A simple to use and advanced multibeam processing software solution with autonomous near-real time data processing capabilities.

- Qimera Live Near Real-time Compatibility
- Compatible with major data formats
- Processing State Configuration
- Wide array of additional post-processing and quality control options
- Seamless integration with Fledermaus Geocoder Toolbox for backscatter processing

Aiding AUV Operational Decisions with CARIS Onboard

Author: Travis Hamilton, Teledyne CARIS Product Manager for CARIS Onboard, HIPS and SIPS

In April 2017, **CARIS Onboard**™ Product Manager, Travis Hamilton, was onsite with the Japan Agency for Marine-Earth Science and Technology (**JAMSTEC**) to conduct a CARIS Onboard installation and trial. JAMSTEC is an organization committed to supporting ocean research and development activities which covers a broad spectrum of marine science and technology. With several institutions located across the country, their mandate is to contribute to the creation of a holistic understanding of global concepts surrounding the ocean.

While survey operations were managed from the R/V Yokosuka, CARIS Onboard and the survey sensors were installed on JAMSTEC's AUV "URASHIMA" which is capable of deployment in depths of 3500m and allows for high resolution mapping in deep waters. The trial was organized to demonstrate how CARIS Onboard may be used to help improve efficiency for AUV surveys by providing quicker access to results, and supporting more efficient decision making around the redeployment or movement of the AUV to its next survey location.

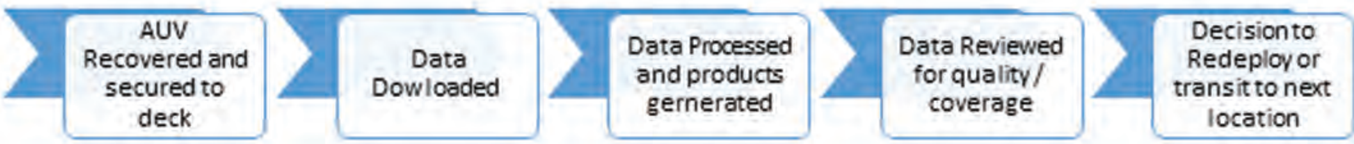
The trial began with installation and system familiarization on April 20th and 21st. On the morning of April 22nd the vessel departed for the survey area in the Sagami-nada Sea. Following a three-hour transit, the AUV was deployed and

R/V Yokosuka stationed at Yokosuka Port prior to departure for the trial survey

dove to a depth of 1000m to conduct a trial survey to test all the vehicle's sensors and systems, including CARIS Onboard.

JAMSTEC's AUV URASHIMA is designed for deep-sea exploration. The AUV is depth rated to 3500m and has a range of greater than 100km in a single dive. Due to its large size (i.e.1.3m wide and 10m long) URASHIMA has a payload capable of housing a large array of sensors. One of the sensors of interest for this trial was the Teledyne Seabat 7125 Multibeam Echosounder. Surveying at approximately 100m above the seafloor, the AUV can map an area of 5km2 at high resolution during a single deployment. Once URASHIMA has completed a mission, there is a standard set of procedures which are put into action to prepare it for its next dive. Once the AUV is recovered and secured to deck, the raw data collected by the multibeam is downloaded from the AUV to a processing station in the control room. The data is then converted using **HIPS and SIPS** data processing suite, and processed into a point cloud and bathymetric surface. The processed products are then reviewed to ensure that the mission successfully surveyed the target area, and that the quality of the

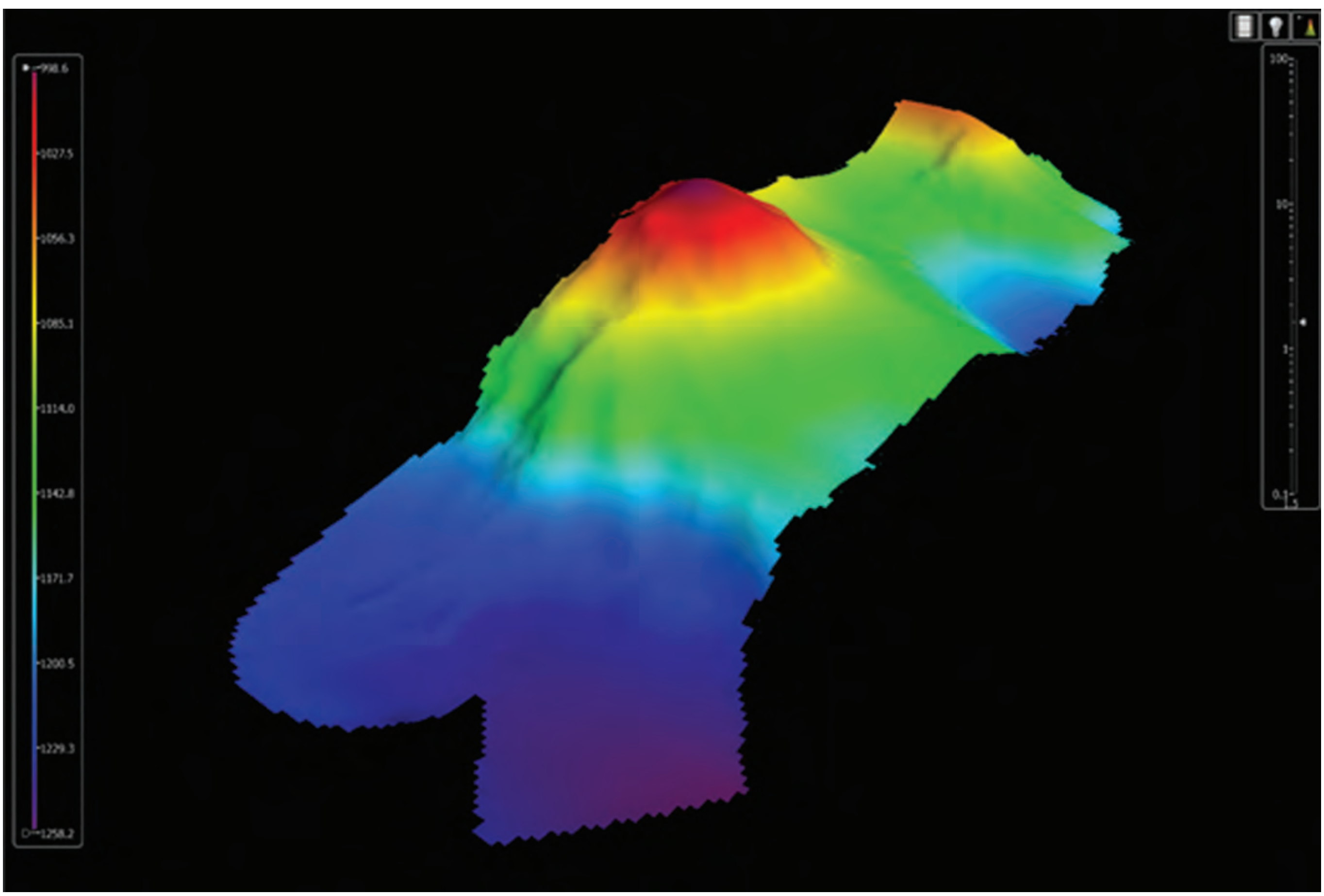
JAMSTEC's AUV URASHIMA being recovered by the R/V Yokosuka following a successful trial



data met the survey requirements. Once the survey coverage and quality of data has been reviewed, the decision can then be made to transit to the next survey location, or to redeploy at the current survey location to gather additional data. (The figure above shows the traditional timeline.) Given the size of the datasets, collected by URASHIMA, the time from the AUV being recovered to making a decision that the survey was successful is normally several hours. The goal of the trial was to demonstrate how CARIS Onboard could process the raw data and generate products automatically on the AUV while the survey was underway rather than after recovery, allowing for faster, and more efficient operational decisions which, in turn, reduces the overall survey time.

Prior to the survey, CARIS Onboard was installed on URASHIMA and configured to process the raw sonar files from the multibeam as they were being acquired. A processing workflow was designed to import the raw sonar files into a HIPS project, apply sound velocity corrections, filter the attitude and soundings, and produce a georeferenced bathymetric surface. As soon as the AUV was recovered it was connected to the ships network, at which point the HIPS project, and processed surface could immediately be accessed from a laptop in the operations room. Within a fifteen minute window, a bad line had been identified by the data processor tasked with QC and was removed from the surface. With the bad line removed the data processor provided confirmation that the target was surveyed within requirements, allowing transit to the next survey location to commence.

Bathymetric surface produced by CARIS Onboard for quality control purposes



AUTOMATION FOR BATHYMETRIC DATA PROCESSING.

CARIS Onboard 2.0

Bringing efficiency to survey

Survey operations can be complex and costly, demanding many resources. Why not leverage the near real-time processing power of CARIS Onboard to safely increase bathymetric production? Reduce overall cost and allow skilled workers to focus on the tough stuff. What are you waiting for? Start the process today.

Get more CARIS Onboard details
www.teledynecaris.com/onboard

TELEDYNE CARIS
Everywhereyoulook™
Part of the Teledyne Imaging Group

Using CARIS Onboard to process the raw sonar data on URASHIMA during the survey removed the time-consuming steps of downloading and processing raw sonar data from post survey procedures. This meant the time from recovering the AUV to being able to transit to the next survey location was reduced from several hours to just a few minutes, ultimately saving valuable ship time and operational costs, allowing the R/V Yokosuka and URASHIMA to operate together more efficiently.

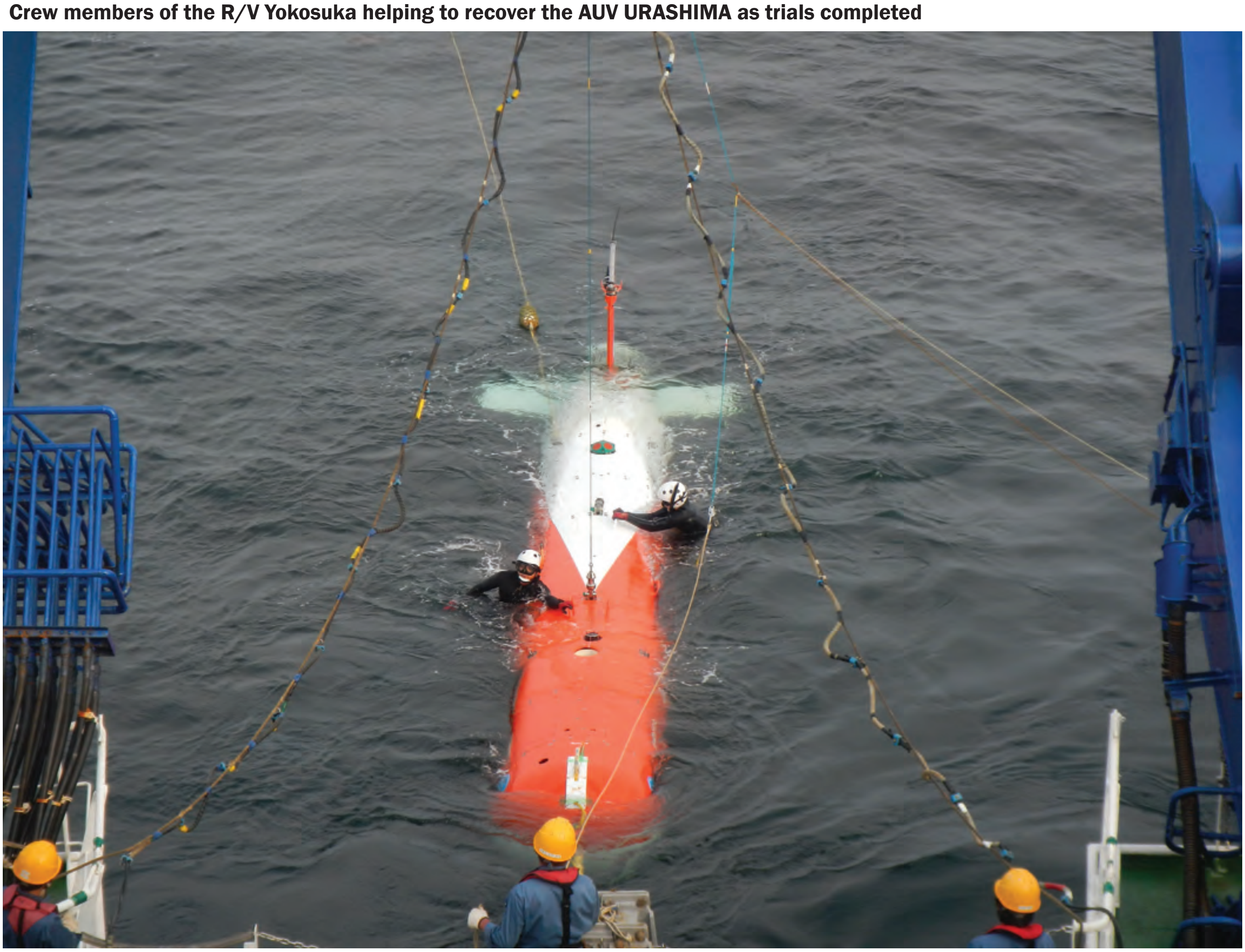
The trial also provided a unique opportunity to gain firsthand experience of the practical challenges of executing a deep-water AUV survey. This has resulted in practical software improvements in CARIS Onboard. One such example relates to pre-programming CARIS Onboard to ignore certain raw data files during processing. This capability would have eliminated the need to remove the erroneous line during QC in this trial. It was discovered that the multibeam is on and logging for the entire mission including the dive, and the recovery resulting in the collection of non-useful data.

Based on this survey, a simple but powerful feature was added to CARIS Onboard to control which lines are submitted for processing based on the time they were collected. With this feature, JAMSTEC engineers can program Onboard to ignore sonar files collected during the dive and ascent, allowing only the survey lines to be processed. Going forward the data processors will no longer have to remove non-useful survey lines during QC gaining further efficiencies in their AUV survey operations.

About the Author

Travis Hamilton has been with **Teledyne CARIS** since 2015 and is the Product Manager for CARIS Onboard and HIPS and SIPS. Prior to this, he spent several years working in research and industry, gaining experience with the operation of, and processing data from, AUVs, subsea positioning systems and swath sonar systems.

Crew members of the R/V Yokosuka helping to recover the AUV URASHIMA as trials completed



Bristol Port – Profiling with the SWiFTplus and Connect Software

By Jim Gardiner, Research Scientist, Valeport

With tidal ranges up to 14m and extremely high sediment loads Bristol Port was an ideal location to test Valeport's new SWiFTplus profiler with an integrated optical sensor, in this particular case turbidity.

In early march 2018, an opportunity arose to join the Bristol Port survey team on a survey of the entrance to the city docks. Surveyed twice a year to monitor dredging requirements it gave Valeport the chance to collect sound velocity and turbidity profiles in the lower reaches of the Avon river as it joins the Bristol Channel and further up river where there is a much stronger fresh water influence.

Figure1: Deploying the SWiFTplus with the Clifton Suspension Bridge in the background

SWiFTplus

The SWiFTplus takes the proven platform of the Valeport SWiFT SVP and adds a state of the art turbidity sensor designed and manufactured by Valeport. The new sensor incorporates a Nephelometer(NPH) and an Optical Backscatter Sensor (OBS) in a compact and robust package that is seamlessly integrated into the main body of the SWiFT housing. The turbidity sensor is also available as a standalone unit for use with 3rd party systems.

Figure 2: The Valeport SWiFTplus

Optical Backscatter vs Nephelometry – which is best?

Nephelometry (NPH) is the technology of choice for low concentration suspended sediment measurement. Up to ~1,000 normalised turbidity units (NTU) the SWiFT's turbidity sensor's response is linear in nature and a robust calibration procedure to traceable standards can be carried out. At higher concentrations the sensor becomes increasingly nonlinear with the effect at high concentrations (>2,000 NTU) of suspended particulate matter (SPM) the observed turbidity values start to roll over and decrease despite the increasing sediment concentration.

Optical backscatter measurement (OBS) is less reliable in low concentration of SPM but remains linear up to ~10,000 NTU and reliable at concentrations up to 20,000 NTU.

Combining the two types of optical turbidity sensor into a single sensor provides a truly versatile instrument that can provide a unique insight into the optical properties of the water column and its relationship with suspended sediment. For both parameters, a local site calibration is essential if quantification of the sediment load is required. Particle albedo and grain size distribution of the local sediment can affect the intensity of optical returns, combining the two measurements into a single sensor with the same water volume being simultaneously sampled opens up a number of possibilities for data processing and sample characterisation.

Connect Software:

To coincide with the launch of the SWiFTplus, Valeport has released a new software package.

Connect has been designed and developed with the requirement of the online surveyor in mind. Available on Windows PC and iOS portable devices, Connect streamlines the acqui-

Figure 3: SWiFTplus, Connect PC and IOS applications

sition, download, assessment and conversion of sound speed profile data files for onward use in all major hydrographic processing packages.

Using the coordinates and UTC time stamp from the integral GPS receiver, profiles can be filtered and selected by position or date and time as well as the instrument used to record the data. Selected profiles can be viewed individually or as a group, as shown in Figure 6, for quality assessment before being exported in industry standard data file formats.

A major feature of Connect software is a fully automated download function. Recognising industry feedback about the repetitive nature of acquiring sound velocity profiles as part of survey operations, when operating in a 'Smart Profiling' mode, it is possible to deploy the SWiFTplus, record profiling data and on recovery to the surface, Connect will automatically establish a Bluetooth connection to the SWiFTplus, download the profile data, and convert the file into a user selectable file format ready for immediate use. In most cases, the profile will be downloaded and converted within 60 seconds of recovering the SWiFTplus to the surface. While initially developed to reduce the load on the online surveyor, automating this process has opened up possibilities for machine-to-machine communication and control with automated vehicles and deployment systems.

Results:

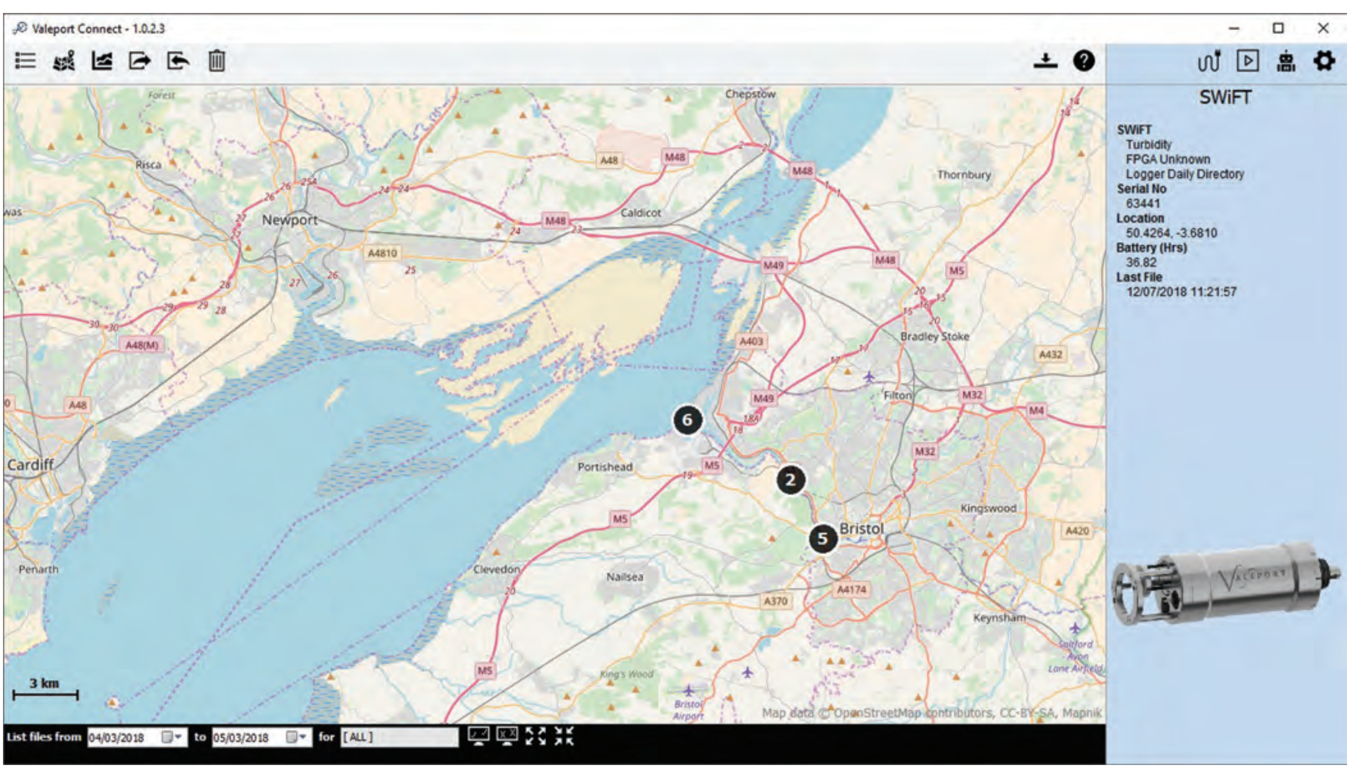
Water column profiles of sound velocity, temperature, pressure, NPH &OBS were taken in a number of locations in the estuary, see Figure 4. At the survey area, near the inner harbour entrance a number profiles were collected in the 30 minutes before slack water.

In the absence of a site calibration from filtered sediment samples, the OBS data has been corrected to the NPH data with a linear fit below 1000 NTU. A laboratory calibration of the NPH and OBS sensor in ***AMCO Clear***®, sets the relationship to 1:1 below 1000 NTU. Field observations in the rivers Avon & Severn showed this relationship to be closer to 1:0.7, this is most likely due to the lower albedo (reflectivity) of the sediment type compared to ***AMCO Clear***® and highlights the importance of site calibrations.

At the entrance to the city docks, significant stratification was apparent with a ~15 m/s difference in sound velocity between the surface and seabed. This is caused by the fresher river water overlying the more saline waters from the estuary. The fresher surface layer shows much lower concentrations of SPM. In the lower half the water column the turbidity increases significantly in the more saline water travelling upstream from lower in the estuary. Below 6m the NPH and OBS sensor start to diverge, this is due to the non-linear behaviour of the NPH sensor, with the OBS sensor showing the true profile in high concentrations of SPM. Using only a NPH sensor, it would be easy to underestimate the sediment load present within the water column, especially at higher concentration in the deeper estuarine water. The OBS sensor provides invaluable information at higher levels of SPM to understand the sediment dynamics within the Avon estuary.

In Figure 6, a Density profile is plotted. Density can be seen to steadily increase with depth in the warmer freshwater and then at a maximum and consistently through the estuarine water below. Density, in this case, has been calculated using

Figure 4: Connect Software: screenshot showing locations where profiles were observed



Serving the world of Hydrography & Oceanography

Tide Gauges

Telemetry

Optical Sensors

Wave Recorders

CTD & Multiparameter

Current Meters

Ocean Engineering

Echo Sounders & Bathymetry

Sound Velocity

VALEPORT in our element

Tel: +44 (0) 1803 869292
sales@valeport.co.uk
www.valeport.co.uk

ISO 9001
ISO 14001
OHSAS 18001

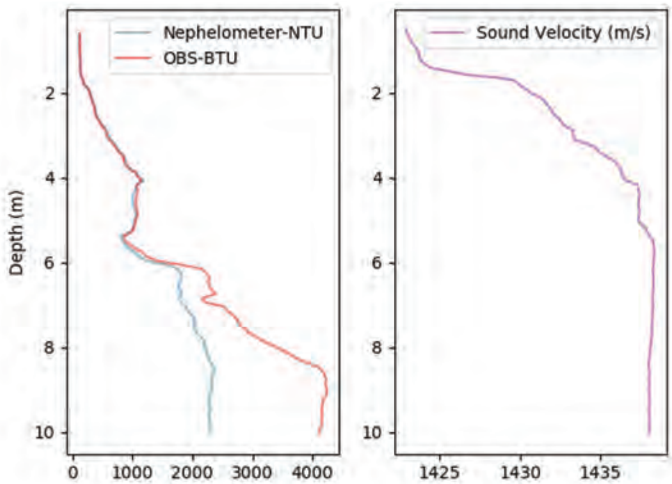


Figure 5: Turbidity Profiles – Nephelometer and Optical Back Scatter

Valeport's DASH formula where Sound Velocity, Temperature and Pressure are used in the calculation.

Summary:

The SWiFTplus with integrated turbidity sensor, combined with the Connect software package offers the Surveyor and Hydrologist alike further opportunities to better understand the water column by monitoring additional factors, synchronously giving a true snapshot of the water column. In operations where turbidity is a contractual parameter to be monitored this can be achieved as part of a standard profiling activity for Sound Velocity, for example, Density is calculated from observed data with no additional overhead. Connect has streamlined the data collection process allowing more data to be collected more efficiently and made available more quickly.

Valeport

Valeport has led the way in sound velocity technology for more than a decade and our latest addition to the portfolio, the SWiFTplus, was designed from the outset with customer feedback front of mind and a practical understanding of what customers actually want from an instrument.

Valeport is a leading British manufacturer of oceanographic, hydrographic and hydrometric instrumentation.

Valeport designs and manufactures instrumentation for a worldwide customer base that includes: defence, environmental, oil and gas, renewable energy, construction, dredging and civil engineering sectors.

Valeport has supplied the subsea sector since it was established in 1969, now an independent, family owned business, Valeport designs and manufacturers instruments from their base in Devon, in the south west of the UK and works with a global network of agents to ensure a responsive and efficient worldwide service.

For further information please contact:
Kevin Edwards, Valeport Head of Sales
kedwards@valeport.co.uk
Jim Gardiner, Valeport Research Scientist
jgardiner@valeport.co.uk
+44 (0) 1803 869292 • www.valeport.co.uk

Figure 6: Connect Software - Density Profiles