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Image courtesy: binnenvaartkrant.nl

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Innovative Hydrography; delivering a workflow for Acquisition, Processing, Visualization and Sharing for all modalities of today's shallow water multibeam echosounders

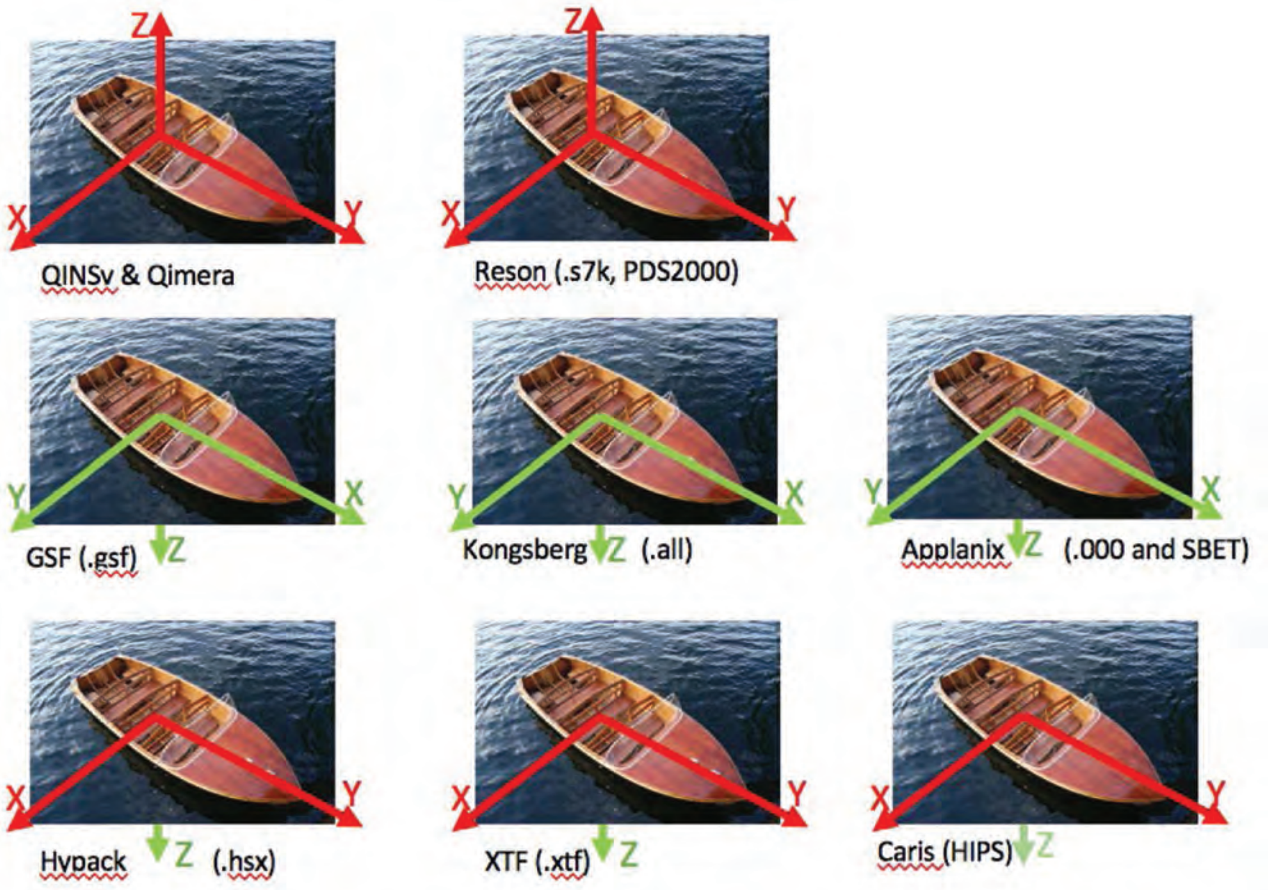
Authors: Richard Hill, QPS bv and Frans Nijsen, QPS bv

Today's shallow water multibeam echosounder are capable of efficiently delivering bathymetry, backscatter and water column data types. To benefit from this technology, Hydrographers are having to adjust their data collection and data processing workflows to deliver detailed and accurate information in an effective manner to a wider variety of End Users. Issues usually arise when there is the incorporation of software products from different vendors within a single and non-seamless workflow from acquisition through data delivery. This can result in an accumulation of human error which in turn leads to inaccurate final products and/or poor decisions with undesirable consequences. Advancements in the Hydrographic workflow by researchers and engineers at Quality Positioning Systems (QPS) have wherever possible automated the mundane, human-error prone tasks and the QPS workflow offering guides the user through the steps needed to get from sensor data to processed deliverables. This workflow removes redundancy and capitalizes on advanced computing technology to provide a dynamic multidimensional user interface that allows those even with a low knowledge threshold to deliver high-quality final products.

Introduction

While software generally keeps pace with the advancements in hardware and processing methods, many of the frustrations are present because human operators must connect all the pieces together to come up with a final processed solution (Beaudoin, 2016). A paradigm shift is currently underway to isolate and minimize the human error in the modern day Hydrographic Workflow while maximizing advancements in

Figure 1. Sample of the variation in coordinate frames found within any given hydrographic workflow



computing technology to automate the mundane, error prone tasks.

Uncertainty

To obtain a single, accurate sounding on the seafloor, one must account for error sources associated with the likes of: position (XY), draft, squat, load, tide, geoid model, bathy depth, node offsets, timing offsets, speed, gyro heading, vessel motion (HPR), mounting offsets, beam range, beam angle, beam width, beam steering, sound velocity at transducer head, sound velocity profile. Within the integrated hydrographic survey system, uncertainty accumulates within your setup which is known as Total Propagated Uncertainty or TPU. The Total Propagated Uncertainty (TPU) of a sounding is a measure for the accuracy to be expected for such a point, when all uncertainty sources are considered. The TPU can be computed statistically using the well-known Law of Uncertainty Propagation. Hence the indication "Propagated". The TPU value thus results from the combination of all contributing uncertainties. Hence the indication "Uncertainty".

What is not considered is the "human uncertainty" in any given workflow. Quality controls are imposed that minimize error however errors still do occur and their cumulative totals result in what is now referred to as "human induced TPU". During data acquisition, we maybe utilize Survey Logs to note line names, positions, start/stop times, features (shoals, wrecks) and unique observations that may pertain to any survey line. During data processing, we incorporate check lists to ensure proper application of such things as tides, sound velocity, post-processed heave, etc. The common denominator with survey logs and check lists is that they require manual (analog) input with cognitive feedback to ensure quality. Unlike systematic TPU which can be calculated human TPU is generally unpredictable (a function of each different operator) and is difficult to measure. Typical areas for Human TPU include:

- Transcription: There are 3 different coordinate frame conventions that may exist within a single installation spread across a minimum of 8 software interfaces. An error transcribing a vessel configuration from the logging solution to the processing solution results in large, very cumbersome errors (Figure 1)
- Importing Ancillary data then failing to apply it to the correct data files
- Changing processing configurations and then not completing the appropriate reprocessing of the data to account for the new settings

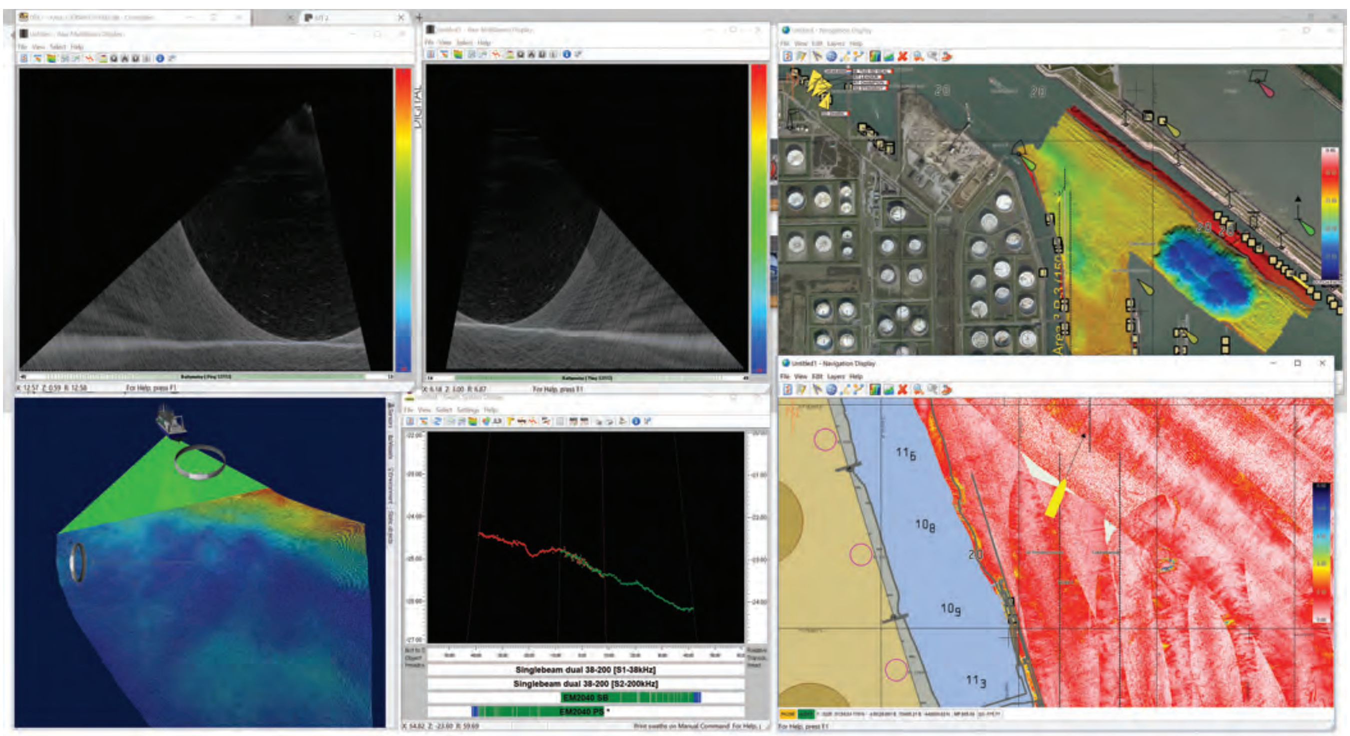
Minimizing TPU, both systematic and human represent a logical evolution in the Acquire – Process – Visualize – Share workflow.

Guiding the User

Real-Time Improvements

Standard hydrographic software solutions are governed by menu-driven Graphical User Interface (GUI) that reference files structured through a "Folder" organization scheme that

Figure 2: Typical QINSy display typical during data collection showing a multi-attribute dynamic surface and plentiful MBES QA/QC indicators.



reside within the computer hard-drive. In the year 2000, Quality Positioning Systems (QPS) introduced the guided workflow to their QINSy software to assist their users in the setup process. The process includes a guided "Wizard Based Setup" for Project Preparation including: automated folder creation; Template Database Creation including guided Geodesy, Vessel Setup and hardware interfacing; On-line preparation including; data recording setup, On-The-Fly data filtering, Calibrations & Field checks.

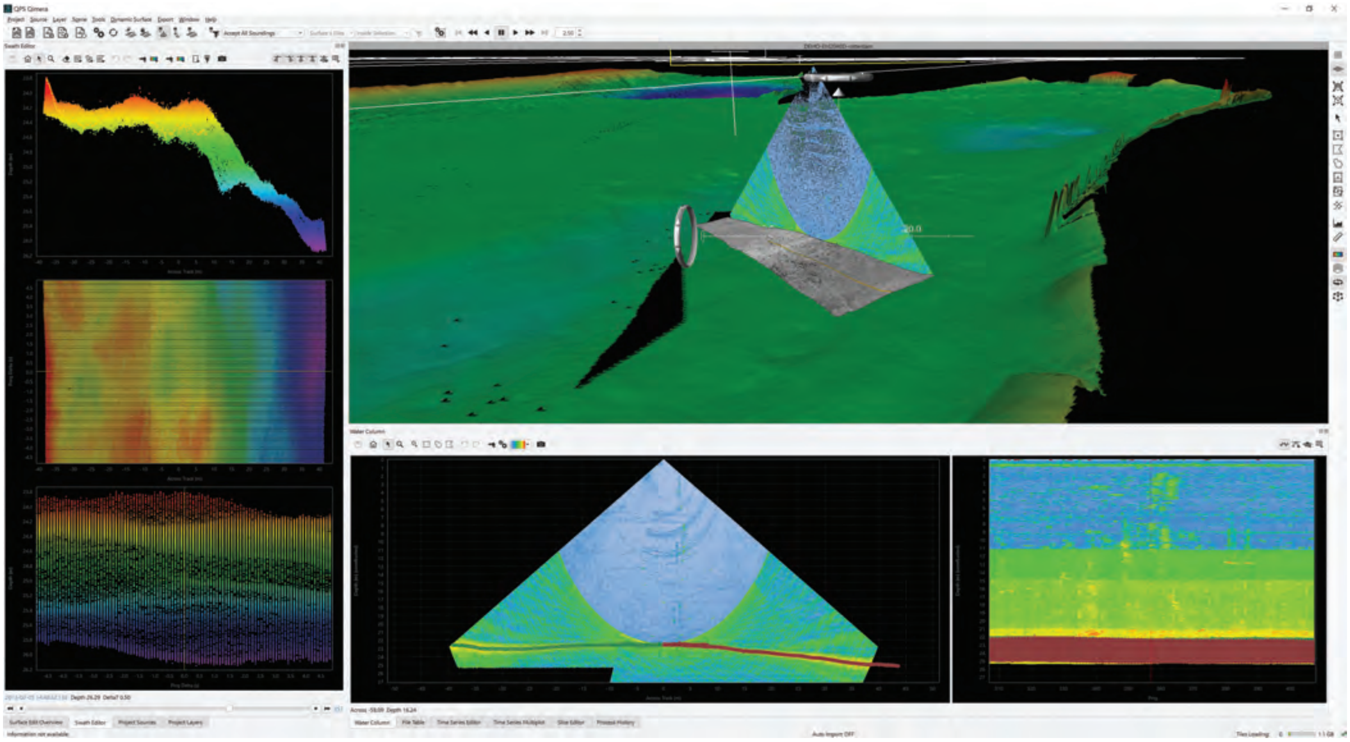
A key objective for QINSy is to save time in post processing and the possible need for re-survey. By providing tools for real-time QA/ QC and on-the-fly correction for sensor offsets, attitude, sound velocity refraction, data flagging and tide/height, DTM points are derived as the survey proceeds. The multi-layered sounding grid data shown in the QINSy displays is populated with corrected DTM points on-the-fly, giving the operator a complete view of what has been surveyed. Advanced surface shading and DTM cell attributes like the "95% confidence level" and "hit count" are some of the tools that promote real-time QA/QC of collected data. A design DTM and/or previous survey allows real-time monitoring of DTM differences.

Paradigm Shift

Despite the collection of high quality data, producing a high-quality product is still hard. Mistakes still happen despite safeguards being put in place to minimize or eliminate and sometimes at great cost. Despite field procedure improvements, the hydrographic workflow is complex since it requires a human to connect all the pieces to produce a final product. Following in suite with the QINSy model, QPS has evolved the Guided Workflow into the Processing portion of the Workflow. The solution is known as Qimera and represents a paradigm shift in Hydrographic Processing. Qimera incorporates the QINSy Hydrographic algorithms with the Fledermaus 4D visualization capability and its optimised file/data handling methods provide users with a seamless, dynamic and pleasant work environment. It performs complete hydrographic processing for most modern sonar formats (.db, .all, .s7k, .hsx, .jsf, .gsf, etc), it supports many ancillary formats (SBET, PosPac, most tides and SVP) and it can export to a variety of industry standard exchange formats (GSF, FAU, BAG, Arc and other image formats).

The Qimera paradigm shift is the reduction of human induced TPU. This is accomplished through automation of mundane and error prone tasks (transcription automation and processing state management) to isolate the stages for which the hydrographer is best suited. Examples of such best suited stages include: data validation, processing configuration management and trouble-shooting. To accomplish this, two types of workflows are incorporated: Guided and Dynamic. The Guided workflow allows for non-expert users to arrive at typical bathymetric deliverables with little training or expert knowledge. The Dynamic workflow is processing state management which codifies and manages the relationships between the observations and the results. You don't need to

Figure 3: Typical Qimera Data Processing Environment showing support for processing all modalities of MBES data.



remember what processing need to be done but rather that “some” processing must be done. Everybody, regardless or knowledge or experience should be able to reach the end of a post processing session with a data deliverable.

Using what’s already there

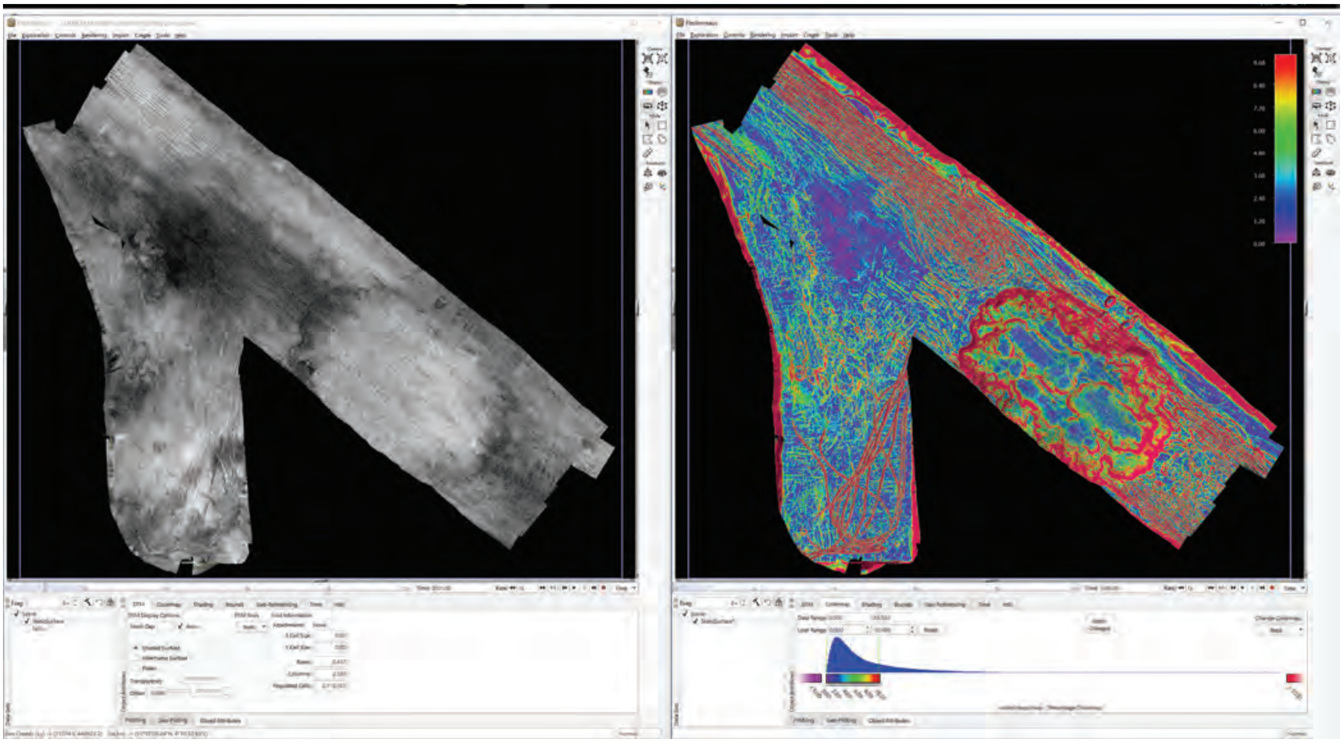
The Guided workflow within Qimera is a series of prompts that step the user from one stage to the next. However, the innovation lies in the background. Upon opening Qimera, a minimum of seven (7) functions are automated. For example, creating a project establishes the file structure, organizes by file type (processed, grid, image, SVP, tide, SBET) and structures where all raw and soon-to-be processed data will be stored. Most modern file formats (.dB, .all, .s7k, .gsf) contain most if not all the necessary information required for processing as setup prior and during acquisition. Qimera utilizes the available information to guide the user thus eliminating the necessity of manual check lists. File import searches each format for what information exists (range, angle, motion, dynamic heave, SV, SVP, etc), catalogues data availability, transcribes all vessel configuration information, processing configuration and then performs the initial processing such as ray tracing based on the raw sonar data (bathy & ancillary), etc. Following the initial automated processing, Qimera prompts you as to how you wish to create your surface. Resolution, CUBE settings and colour map are presented in a simplified interface. Within a minimum number of mouse clicks and in the shortest time possible, you the user has a map view of your data and are now ready to utilize one or many of Qimera’s data editing tools to clean and validate your data, apply SBET’s or edit & validate both the assembled bathymetric data and the ancillary data used to calculate them.

Data validation consists of creating a loop between the DTM surface and calculated point cloud results to expose errors immediately. This is referred to as “Live” processing state management. In Qimera it is very easy to make processing configuration adjustments or to perform data validation and to immediately asses the impacts of any changes. Near immediate feedback shortens the time between cause and effect while promoting causal reasoning which is a key ingredient for natural cognitive evolution. In short, it allows users to train themselves through something as simple as immediately recalculating the dynamic surface and showing the user they have accidentally deleted good data or applied the wrong SVP, etc (Figure 3).

Scalability: Collaboration and Production Line Processing

QPS provides workflows within Qimera that scale to multiple users (a team of data processors) contributing to an overall processing effort through Cooperative Cleaning and Production Line Processing. Cooperative cleaning allows multiple users to clean a large project by dividing it into smaller, more manageable projects, while also maintaining complete data

Figure 4: Typical Fledermaus Geocoder Toolbox results showing the backscatter mosaic and derived seabed slope. Seabed roughness, average grain size and an estimation of the seabed material are also possible.



integrity. Data processors work within their sub-projects and, once complete, merge 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 sub-projects are incorporated back into the main project without impacting the overall progress of the entire project but enormously increasing efficiency.

Production Line Processing on the other hand allows for projects to be broken down into stages. These stages can be done based on survey days, survey segments, survey vessels, etc. The processing for a stage (e.g. a day, vessel, segment) of data in handled in its own isolated processing project. The processed outputs from this effort are then aggregated into a master project where it is evaluated by the senior Hydrographer and compared to other stages for either approval or for further cleaning either separately or within the master project. This is done repeatedly and combined with other stages within the master project. If problems are identified, the stage project can be re-opened, corrections applied and then re-introduced into the main project. The net result is the integration of multiple smaller projects processed in the exact same manner into a final deliverable.

Backscatter and Water Column Data Modalities

Seafloor mapping is all about creating a complete picture of the seabed – the morphology, sedimentology, and biology – and interpreting the results to create thematic maps of distinct habitats that can guide marine policy, management, and resource utilization. Fledermaus Geocoder Toolbox (FMGT) is designed to visualize and analyze backscatter data from MBES and to a lesser degree SSS sensors. In processing the source files into mosaics, it is designed to perform as many sonar data corrections as possible to maximize the information content within the backscatter signal. The software can read multiple files of backscatter data, apply corrections, and then create a 2D representation of the ocean floor called a backscatter mosaic. Once the mosaic has been generated, various statistics can be calculated and exported in a number of formats, along with the mosaic backscatter value. Angle Range Analysis (ARA) can also be performed to attempt to classify the seabed types. All of the processing stages of FMGT are multi-core aware to maximize throughput of data and minimize any required reprocessing due to changes in desired output mosaic resolution or alteration in the number of data files.

FMMidwater can rapidly extract relevant water column features from a range of sonar file formats. Typically raw sonar files are first converted to a Generic Water Column format (GWC) for use in further processing and visualization. A simple graphical user interface is used to perform threshold filtering on a number of key parameters to help with feature extraction. FMMidwater also provides multiple views of the water column features and finally allows for easy export to a variety of Fledermaus visualization objects and exchange files. Being able to show echosounder bathymetry and water column data, interactively in the same Fledermaus 4D scene, significantly aids the subsequent interpretation of seabed survey results during hydrographic surveys for charting purposes Identifying the shoalest depth has often proved tricky to achieve, with a Bar Sweep typically being the preferred methodology. In recent years, results derived from water column data has been accepted as an alternative, and far more cost efficient and safe, way of determining the shoalest depth. The most recent developments for the Midwater utility have been in the field of semi-automated Seep detection (Dr. Tom Weber CCOM UNH), for Oil and Gas projects and this research has not gone unnoticed by the dredging community who are increasingly interested in making full use of the data modalities available from today's echo sounders, in order to identify different seabed types and to research the visualization of dredge plumes.

Very Rapid Electronic Chart Production

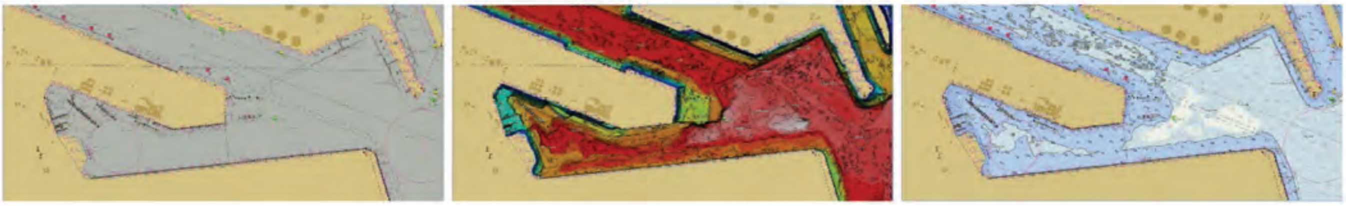
"The Port of Rotterdam ENC and IENC production is coming close to perfection thanks to the use of the latest versions of ArcGIS, QPS QINSy Processing and QPS Qarto."

Thanks to a cooperation between Esri, QPS and the Port of Rotterdam, the port's ENC production process has been improved by the following steps:

- ENC and IENC production from the ArcGIS product library
- The ArcGIS S-57 validation utility
- The QINSy Processing generalize DTM utility
- Qarto depth contours and depth areas have quality and performance improvements
- Qarto date-of-survey areas (M_SREL) auto populated from DTM metadata
- The Qarto S-58 validation utility

Starting from an up-to-date GIS database, a must for a world class port, the Maritime and Inland ENC's are produced within minutes for each ENC cell. The Qarto workflow is completed within just a few mouse clicks and takes the GIS exported ENC (base cell) and integrates this with the depth model from

Figure 5: QPS Qarto, makes possible rapid ENC production in just a few (supervised) steps



QINSy Processing to make available user defined depth contours, depth areas and spot soundings.

Maximise port availability and goods throughput

All ports aim to maximize the availability for vessels under all circumstances and to increase the throughput of goods by maximizing the vessels draft as much as possible. The two principal ENC consumers at the Port of Rotterdam are the Port Authority and the Marine Pilots group. Both of these groups use the information in different formats to assist in the safe navigation of ships with marginal UKC. The use of High Density ENC's or BENC's by marine pilots is a critical factor in this part of the operation, as this shows exactly where and where not it is safe to navigate a ship, taking the vessel draft and the real-time water level into account. Any ship that is limited to the fairway by draft has to call in to the Port Authority at least 48 hours ahead. When the ship calls in, the Harbour Masters' Harbour Coordination Center office (HCC) checks the fairway and berth depths using ArcGIS Maritime Chart Server (MCS). In the MCS user interface, the HCC officer can enter the ship's draft, UKC and the tide level. The safety contour will be derived and shown automatically in MCS. During this time, the pilot will update his Portable Pilot Unit (PPU) with the same ENCs as MCS to prepare the ship's transit to the berthing location.

The Port of Rotterdam produce in total some 300 usage 5 and usage 6 ENC's. The usage 6 charts all have 10cm interval depth contours, giving it a BENC or High Density ENC. Based on the hydrographic surveys done in the port the new editions for the charts are selected and produced over night. In other words, what has been surveyed yesterday is available as a BENC today and in use by the pilots and the harbour masters, and potentially even likes of the captains (with dispensation) of the ferry services that have daily schedules to and from the port.

Summary

This article demonstrates how today's shallow water multibeam echosounder are capable of efficiently delivering bathymetry, backscatter and water column data types. Accordingly, to benefit from this technology, Hydrographers are having to adjust their data collection and data processing workflows to deliver detailed and accurate information in an effective manner to a wider variety of End Users.

The hydrographic workflow offered by QPS has evolved to provide a dynamic multidimensional user interface that allows those even with a low knowledge threshold to make good decisions that lead to high-end final products. The critical component is the isolation of tasks within the workflow to capitalize on the technological advances in computing technology to automate the mundane error prone tasks to bring more value to the stages in which the human brain brings value. QPS through its products QINSy, Qimera, Fledermaus and Qarto innovate the user experience through several key design features including: Guided workflow, Transcription automation,

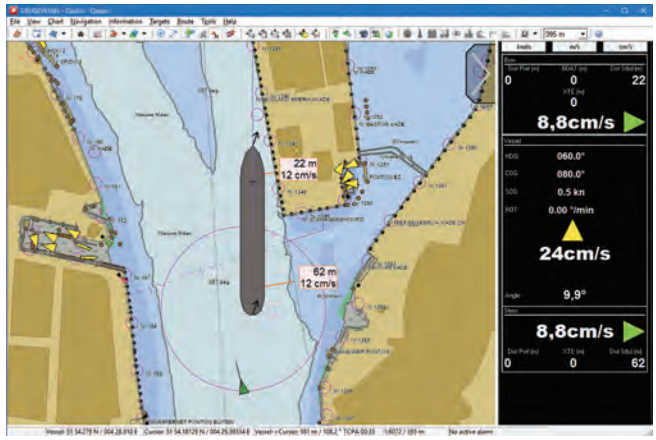


Figure 6: The cruise ship Ovation of the Seas arriving in Rotterdam, and as seen in QPS Qastor

processing state management, real-time QA, the dynamic workflow for validation, collaborative cleaning and production line processing are all processes to reduce human error, the QA burden in general and lowers the entry knowledge barrier. For the hydrographic manager, the return on investment is found in; a demonstrate ability to collect once and use many times, in lower trainings costs due to the guided workflow (easier to learn and retain knowledge), in improved processing outcomes, through easy scalability, in reduced post-processing times and finally in better results.

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QINSy

QPS QINSy is navigation / positioning and reporting software used on board offshore construction vessels, pipe-lay barges, drilling rigs, seismic research vessels and all manner of hydrographic survey vessels (Surface and sub-surface). QPS is a market leader in the offshore renewable energy industry, the dredging industry and port communities.

Qastor/ Connect Server

Precise navigation - Using wired or wireless methods, QPS Qastor interfaces to most devices outputting NMEA data strings to AIS transponders/receivers and to the QPS Connect Server. Connect typically supplies ENC updates and meteorological data feeds to Qastor users, but is also capable of distributing other types of information (like VTS feeds or Qastor common files).

Qarto

The strength of Qarto is the very fast and automated ENC production. Qarto makes possible the short turn-around times from survey to chart that are necessary for the safe operation of the busy waterways. Qarto vn3 distinguishes itself by its efficient way of data storage and by its principle based on semi-static base cells that are updated with highly dynamic hydrographic data. Completely updated ENC base cells are ready for distribution avery shortly after the survey being completed.

QPS

a SAAB group company

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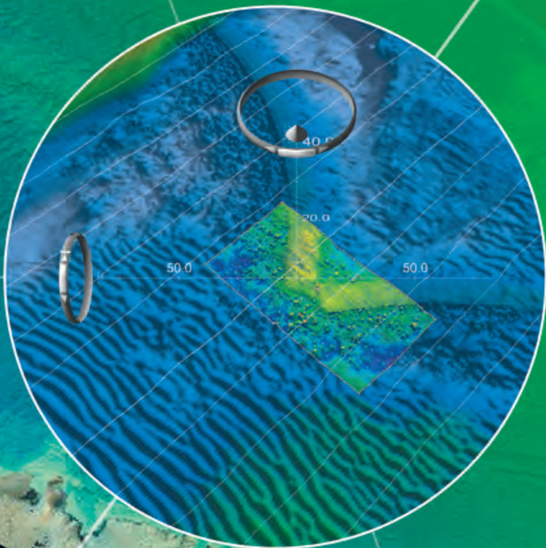
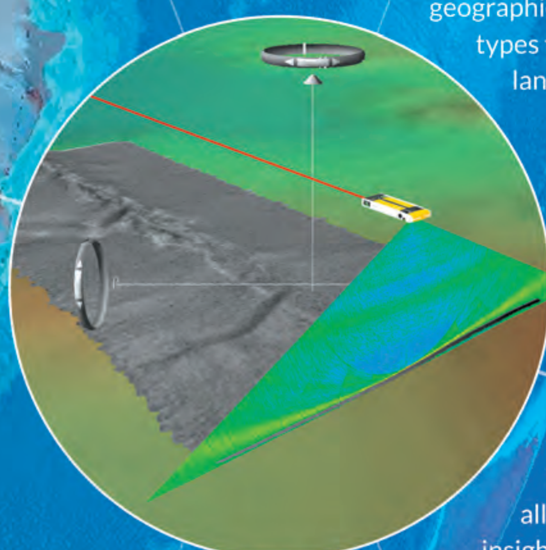
Qimera



QPS Qimera is probably the simplest yet most powerful post processing application available. Built on the strengths of QINSy and Fledermaus and optimized for the latest computing technology, Qimera is feature rich and extremely easy to use. Able to work with QINSy data files, plus many other raw sonar file formats, the Qimera Dynamic Workflow revolutionizes the efficiency with which post processing can be completed.

Fledermaus

QPS Fledermaus is an industry leading interactive 4D geospatial visualization and analysis tool. Commercial, academic and government clients use Fledermaus to interact with massive geographical datasets of numerous data types for ocean mapping and land-based projects.



The intuitive 4D display allows clients to rapidly gain insight and extract more information from their underlying data. This provides our clients with added value in data interpretation efficiency, quality control accuracy, data analysis completeness and project integration. All of which promotes clear communication.

QPS makes industry leading software (QINSy, Qimera, Fledermaus, Qarto and Qastor/Connect) for all aspects in regards the management of maritime geospatial data. Our offices are in the Netherlands, USA, Canada and UK and globally we have a business partner network. Since 2012, QPS is a member of the Saab Maritime Traffic Management (Sweden) group of companies.

Improved Operational Decision-Making for USV Fleet Surveys

Authors: Travis Hamilton and Michael Redmayne – Teledyne CARIS

Introduction

Significant interest in autonomous and unmanned vehicles has developed within the survey community during the last few years. Unmanned Surface Vehicles (USV's) are being considered for tasks such as data gathering in waters considered too shallow for manned vehicles and in areas presenting hazardous operating conditions. Looking forward, the concept of operating a fleet of autonomous and unmanned surface vehicles, with or without manned vessels as part of the fleet, holds great promise to improve survey efficiency.

When operating a fleet of several vessels which include USVs for hydrographic surveying, the Hydrographer In Charge (HIC) must be able to ensure that each platform is collecting quality data, while also keeping each platform tasked to the optimal area to meet the operations goals in the most efficient way possible. The most critical piece of information to support the HIC's operational decision making is the survey data itself, this may be in the form of depth information, data quality or in the case of search and recovery surveys, the identification of an area of interest. Having all sensors integrated into a processed product allows the HIC to monitor that the survey requirements are being met, and the overall coverage is in line with the operational plan. There are several approaches to accessing and processing the survey data with varying degrees of benefit to the HIC.

The first approach is to wait until the survey platform has been recovered to the support vessel, at which point the data may be downloaded from the platform, and processed into an overall project. This approach has the benefit of presenting the data from all platforms in the fleet in a single portal, however there is significant delay between when the data is being acquired, and when the HIC first has access to it. The delay could result in prolonged collection of poor quality data, or areas in need of further investigation or re-survey may require

ASV C-Worker 5 operating autonomously

significant transit time to be spent returning to a survey site.

The second approach is to install a desktop processing application on each platform. The application can be accessed through a remote desktop link (ex. VNC) to process the data manually, or via automated batch scripts. Although this approach processes the data while the platform is still on site, the data from each platform is handled independently. Without the ability to access the processed data from all platforms in a single portal, the HIC has no ability to check agreement between platforms in overlapping areas, nor do they have an overall view of the entire fleet. This method also assumes that there is sufficient bandwidth to access each survey platform in real time through a remote desktop link.

The third approach, which is the focus of this paper, involves having the data automatically processed on the platform using a web application based processing service. This approach combines the benefits of the previous two methods. It processes the data automatically on the platform in near real-time, so there is no delay to access the information. The HIC is also able to access the processed products from all platforms through a single portal, allowing the coverage and quality of the entire fleet to be assessed as a singular unit.

Proof of Concept

To test this concept, Teledyne, ASV Global and Kongsberg ran a successful trial at the recent Ocean Business 2017 conference in Southampton, UK using a variety of commercially available products. Two vessels fitted with multibeam systems were used, including an ASV C-Worker 5 autonomous surface vessel. Collected data was processed on each vessel using Teledyne CARIS's near real-time data processing software, CARIS Onboard, and communication took place via the Kongsberg Maritime Broadband Radio (MBR).

ASV

To survey the Empress Dock area, just outside of the conference hall, the ASV C-Worker 5 was equipped with a Kongsberg EM2040P multibeam. The vessel was programmed to

Setup in the conference hall. Upper left ASV control software. Upper right connection to CARIS Onboard, combined surface from ASV C-Worker 5 and Falcon Spirit, Lower Right, VNC connection controlling SIS

autonomously run preplanned survey lines.

Communication between the conference hall to the ASV was provided through the Kongsberg MBR. Using a VNC connection through the MBR, SIS was used to operate the EM2040P, and data from SIS was automatically processed using CARIS Onboard.

Falcon Spirit

To survey from the Empress Dock and through the main channel, the Falcon Spirit was equipped with a Teledyne Reson T20 Integrated Dual Head multibeam. This was a manned vessel, operated by a hydrographer, and data was acquired through Teledyne PDS then passed to CARIS Onboard for automatic processing. Communication between the conference hall to the Falcon Spirit was provided through standard commercially available 3G mobile broadband. It should be noted that this represented a more limited bandwidth than the MBR used on the ASV.

Data Processing

On both vessels CARIS Onboard was installed on the acquisition PC. Once set to run (either by the hydrographer on board or remotely), the software then processed the raw sonar data in near real-time according to a pre-defined workflow designed by the hydrographer beforehand. In this case the data was imported to a HIPS project, Total Propagated Uncertainty (TPU) calculated, data filters applied (both basic and CUBE algorithm filtering), tidal corrections applied, and finally a processed bathymetric surface was calculated from the data. Each of the surfaces were then registered to the CARIS data service running on each platform which is part of Onboard, making them available for remote viewing through a standard Teledyne CARIS desktop application.

As CARIS Onboard is web enabled, it can be accessed and controlled from any PC which is networked to the vessel. For the demo, a single laptop was setup in the conference hall and connected to both vessels simultaneously. For the ASV C-Worker, the communications was carried through the MBR,

Hydrographers in the Netherlands viewing live feed from demo in the United Kingdom

while communication to the Falcon Spirit was through the cellular data network via a 3G hotspot. Within the desktop application the HIC could view one or many surfaces, showing various attribute layers such as depth, quality (for example, depth standard deviation per cell or number of CUBE hypotheses per cell) or data density. In this case the data was on an open network, which enabled anyone with the correct network address to access the surfaces. During this demo there were hydrographers in the Netherlands viewing the surfaces in real time, showing that the physical distance from the platform is not a concern to where it is monitored.

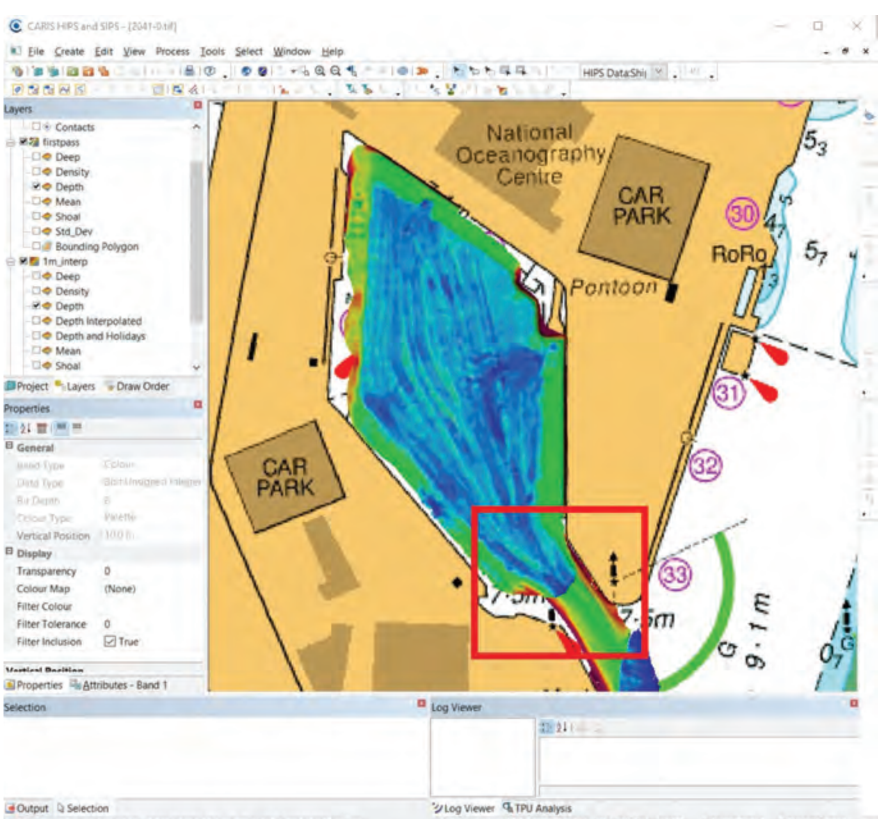
As an illustration of one of the benefits of this approach is it was noticed during the trial that there was a difference in the overlap between the two vessels, which was caused by an incorrect waterline Z offset. This was then corrected in between runs in order to ensure consistency in the overlapping data. If the HIC was forced to view the products from each platform through independent remote desktop connections the offset would not have been noticed until the end of the day when the data from each platform was recovered and reconciled in the post processing environment. However by using CARIS Onboard the surfaces were viewed together in a single map view, allowing the discrepancies to be detected while both vessels were still deployed.

Finally, the other major benefit of using CARIS Onboard was the ability of the HIC to download an almost completely processed dataset from each platform at the end of the demo. This could be very quickly opened in a desktop processing application such as CARIS HIPS & SIPS and the final processing steps which require human intervention could be applied, such as manual data editing and cross line comparisons. This addresses the fact that although using multiple vessels to survey an area reduces the overall survey time, the data rate is correspondingly increased as there are more sensors in the water at any given time - using CARIS Onboard mitigates this data bottleneck.

Conclusion

The demonstration at Ocean Business successfully showed that it is possible to effectively manage a fleet of hydrographic survey platforms with CARIS Onboard, despite using multiple methods of communication to each vessel. By running CARIS Onboard to process the data, and accessing the products through the MBR, an HIC is able to keep track of the production from all assets by accessing information on conformance between platforms, and the overall coverage and quality. This information can be used to ensure each platform is properly tasked to run a complex survey at maximum efficiency, and also significantly assists in the subsequent processing of the data once the platforms are recovered.

Viewing the demonstration as a proof of concept, it is easy to extrapolate to a scenario where multiple autonomous surface vessels are working alongside a mothership as force multipliers. With an MBR network established between all vessels, the HIC on the mothership will be able to access the data processed on the vessels by CARIS Onboard. This real-time and complete overview of the entire fleets progress will provide the HIC with the information required to make effective operational decisions. Additionally having each vessel return from its deployment with nearly complete processed datasets addresses the data bottleneck created by having an increased number of sensors deployed, and reduces the overall time from ping-to-chart.



Live connection to surfaces from the ASV C-Worker 5 and the Falcon Spirit. Offset identified in overlap area inside the red box

Acknowledgements

Teledyne CARIS would like to thank ASV Global, Kongsberg and Teledyne Reson for their assistance in making this trial possible.

Listening to your customer is key when designing a new product

By Valeport sales and marketing manager, Kevin Edwards

As a manufacturer, we are always striving to create products that we believe to be what the end users desire. The technology around which our lives revolve these days has had a strong influence over what we expect from products in every area of life. For instance, I have my smartphone, tablet and laptop; I have high speed access to information and data via the internet. Hardware is easily charged, memory is plentiful and expandable, quality is good and costs are reasonable. So, these are the standards I expect from the equipment I am about to use when hydrographic surveying. Valeport has led the way in sound velocity technology for more than a decade and our latest addition to the portfolio, the SWiFT SVP, was designed from the outset with customer feedback front of mind and a practical understanding of what customers actually want from an instrument.

One of the overriding design principles with the SWiFT was ease of use. Feedback from customers told us that, while they had confidence in the measurement technology itself, there was room to improve the experience of using our profilers in practice. An anecdote from a hydrographic surveyor conveyed that - on average - an SVP would take 5-10 minutes to deploy, connect the data cable in, load up the software, download the profile, reformat the data and import it into the survey software. It might not sound like much in isolation, but if you have to do that once an hour, the time starts to add up. We recognised that with the creation of the SWiFT we could address and improve this experience for the user.

I don’t want to use cables if possible for data set up and data extraction

Traditionally, SVPs have required cable connection for data transer, but this has its drawbacks. Most particularly, connectors are a weak point. Repeated mating and unmating of connectors stresses them and eventually causes them to fail, so it’s hardly surprising that customers want to dispense with cables where possible. WiFi offers a popular alternative but, as many smartphone owners will know, can be power hungry and diminish battery life. Our solution is the use of Bluetooth

The SWiFT SVP is Valeport’s latest addition to its portfolio of sound velocity sensors and profilers

Low Energy (BLE) technology that allows short range communication up to around 10 metres: plenty for fast data transfer to a smartphone or PC. Where multiple Bluetooth devices are present, pairing mismatches can occur. To anticipate this issue, we provide a custom USB Bluetooth dongle with the SWiFT which is bound to the profiler that it is supplied with and automatically connects whenever the SWiFT is in range.

No more wasting batteries!

Batteries continue to present a disposal and recycling challenge due to their toxic nature, so are often an unfortunate waste. Achieving a balance between creating ease of purchase for the customer by supplying standard internationally accepted alkaline battery types, against a bespoke packaged type which better suits the power demands of an instrument, is not always easy. These days, we expect to simply re-charge a device and, for manufacturers, this should be our aim for our instruments. We upgraded the SWiFT to a rechargeable battery for both environmental and practical reasons but, in doing so, presented ourselves with a further challenge; the possibility of gassing in a sealed housing under charge. A simple vent would resolve this issue, but it is then reliant on the user who must remember to re-fit the vent when deploying the instrument again. The SWiFT SVP employs an innovative approach by incorporating the vent within the suspension point used for deployment, which means it will not deploy if it is not fitted. Ultimately, we have delivered the SWiFT SVP with the high energy density of a rechargable li-po battery pack which, fully charged, will operate for over 100 hours. The SWiFT is easily charged via USB or bespoke AC adaptor, offers a five year battery life span and fully complies with IATA regulations.

Visual aids help – Green is Good.

Have I switched it on? Do I have a GPS signal? What is the battery status? It is always of concern when you are about to deploy an instrument and we understand that surveyors would like that peace of mind, knowing all is OK before taking measurements. Which is why our SWiFT SVP employs a simple

SWiFT in action on a Swath Services Training Course

With a simple twist action for on/off and LED status indications for GPS, battery and communications SWiFT offers surveyors peace of mind all is OK before taking measurements

twist action for on/off and four LED icons to indicate Operational, Battery, GPS and Bluetooth status.

Where did I deploy that probe again?

In large data sets, precise geo-referencing is critical to delivering a satisfactory user experience to ensure surveyors are never left wondering where a profile was taken. For this reason, every single SWiFT SVP profile is geo-referenced by the integral GPS chip so there is no longer a need to refer to soggy notebooks. In the header of every single file is a latitude, longitude and UTC timestamp to precisely place the profile.

I want less steps in getting my data

The nervous post recovery process is followed religiously by surveyors worldwide: connecting to the instrument, uploading data, and checking it is OK. But why shouldn't it be automated?

Valeport Connect is our new cross platform application to extract, visualise, translate and share data from the SWiFT SVP straight to the PC application or IOS and Android mobile apps.

Automated connection, extraction and translation of files means no more repetitive clicking and, by the time you get back to your workstation with the SWiFT, the processing SVP should be waiting for you.

Will data be in the format I want to match my survey software?

Recognising that one size doesn't fit all, we have ensured that all the major exchange formats for sound speed profiles can be exported from Valeport Connect; and we are continuously adding new formats.

Beyond Valeport Connect, there is a growing movement from key survey software providers to integrate the SWiFT directly into their own software. QPS and Foreshore are two of the first to do so, with others developing this functionality.

Valeport actively engages with survey software providers to use our instrument micro processor commands to recover data directly without conversion to the accepted formats they work with, which speeds up processing of multi-beam data.

Any other data available?

Computed data from parameters measured is perfectly accepted and sometimes the only way of getting measured data. In addition to the directly measured sound speed, temperature and pressure observations, conductivity, salinity and density

Valeport's SWiFT SVP, their best, professional and affordable SVP to date

Weighing in at just 2kg Valeport's SWiFT is positioned as the ultimate handheld profiler

are calculated using Valeport's proprietary DASH algorithm developed from extensive laboratory and field work.

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

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

Valeport has supplied to the subsea sector since it was established in 1969. Now an independent, family owned business, Valeport employs more than 80 people 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.

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www.valeport.co.uk

Aimed at the shallow water market, Valeport's SWiFT is light-weight and easily deployed

SUB-BOTTOM PROFILING ACQUISITION & PROCESSING IN HYPACK®

Dr Peter Ramsay (Business Development Leader, HYPACK)

INTRODUCTION

The newly launched HYPACK® SUB-BOTTOM is a sub-bottom profiling acquisition and processing software package designed for marine geophysical, engineering & geotechnical site surveys, dredging, mining applications. It's a simple and easy-to-use solution for most sub-bottom profiling survey requirements. Basic sub-bottom profiling acquisition & processing has been available in HYPACK for the past few years, but during the first quarter of 2017 a considerable amount of effort has been put into improving the stability, memory allocation and features of the program. This article is highlights some of new features and functionality of HYPACK® SUB-BOTTOM.

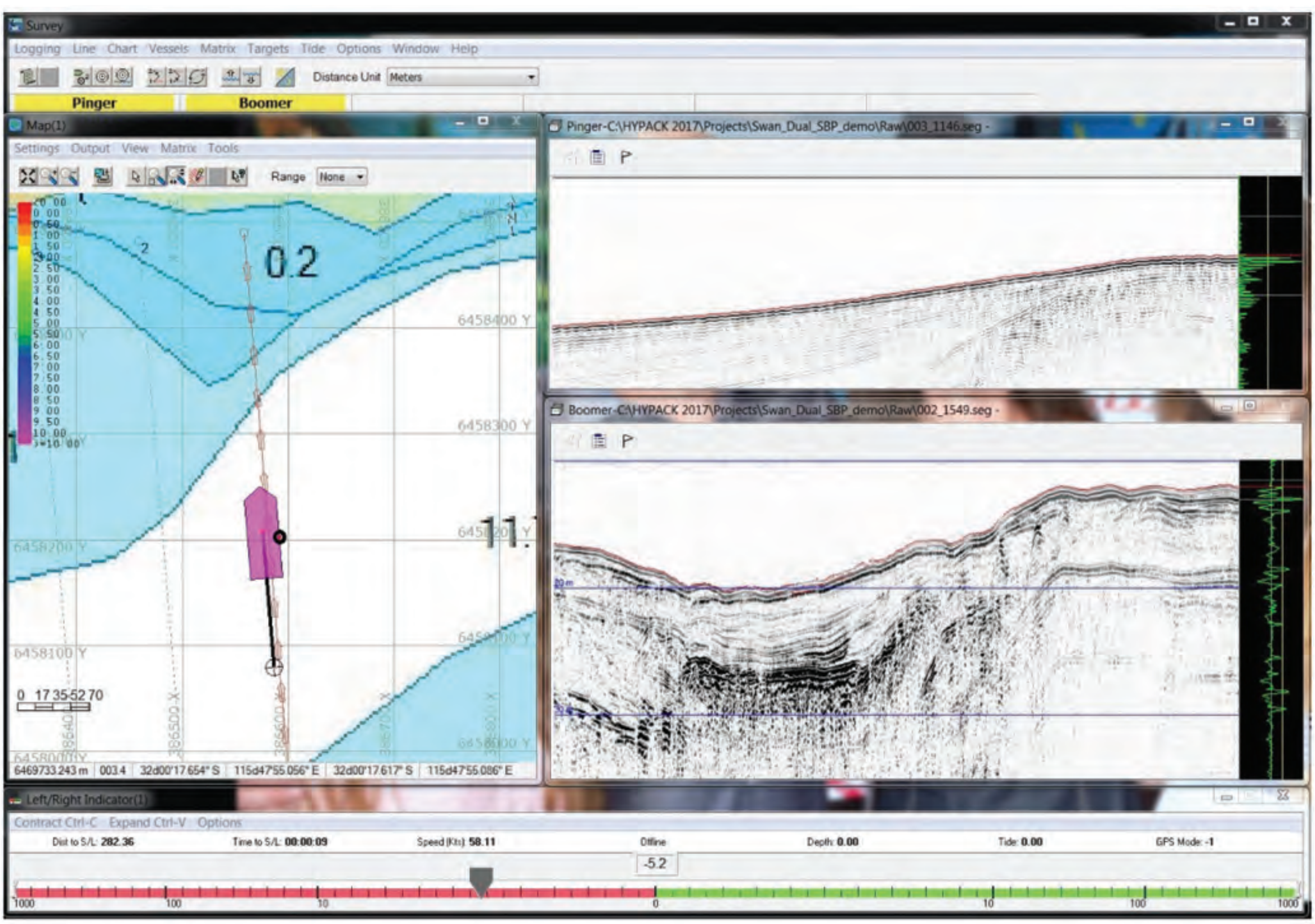
DATA ACQUSITION

HYPACK® SUB-BOTTOM supports data acquisition in most coordinate systems using HYPACK's comprehensive Geodesy library. The program has drivers to acquire data from any analog sub-bottom profiler (using a National Instruments digital acquisition card) or digital sub-bottom profiling data from the industry's leading manufacturers. In addition to this, a sophisticated triggering system enables simultaneous acquisition of two different SBP systems with no acoustic interference between the systems (Figure 1).

SUB-BOTTOM DATA PROCESSING

HYPACK® SUB-BOTTOM has the ability to load large sub-

Figure 1. Dual SBP acquisition in HYPACK® SURVEY with no acoustic interference between the SBP systems. Note the positions of the sensors in relation to the vessel.



bottom profiling datasets in SEG-Y or JSF formats. The program stores the project data file lists and user defined processing parameters in XML and Configuration files which makes it easier when re-opening the project again. HYPACK® SUB-BOTTOM can read navigation from the SEG-Y (or JSF) file, RAW file or EDT file (Figure 2). In HYPACK® MAX (SB-MAX) one can edit the navigation in a RAW file for "spikes" and apply the corrected EDT navigation to the sub-bottom profiling data.

Once the data files have been loaded, the sub-bottom profiling data is displayed in the Sub-Bottom Processing window and the navigation data in the View Tracks window; the Settings window is used for the application of data processing parameters (Figure 3). The sub-bottom profiling data can be trimmed to a border file which is very useful if one is only interested in viewing and interpreting a section of the dataset.

The Settings window is used to correct the dynamic range of the data, apply band pass frequency filtering, time varied gain (TVG), bottom tracking, water column blanking (removing water column noise) and swell filtering to the data (Figures 4 & 5). The Dynamic Range tab controls have options to view the data in Bipolar, Rectified or Unipolar modes and apply different color palettes. These controls allow the user to visually enhance various geological surfaces (or strata) without altering the original raw SEG-Y or JSF data. Various exponential TVG curves can be applied to the data as well as user defined TVG curves. These curves can be saved for each line or project and re-imported/applied at any later stage. There

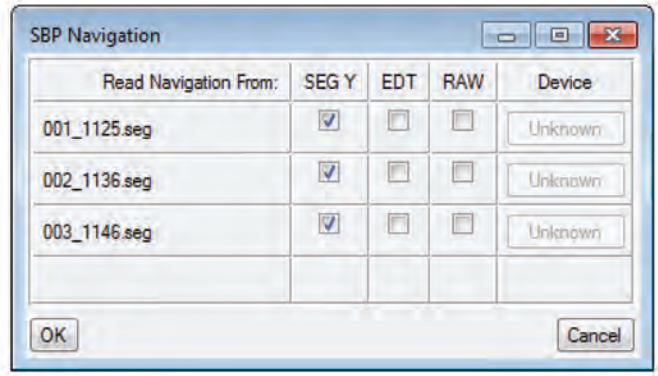


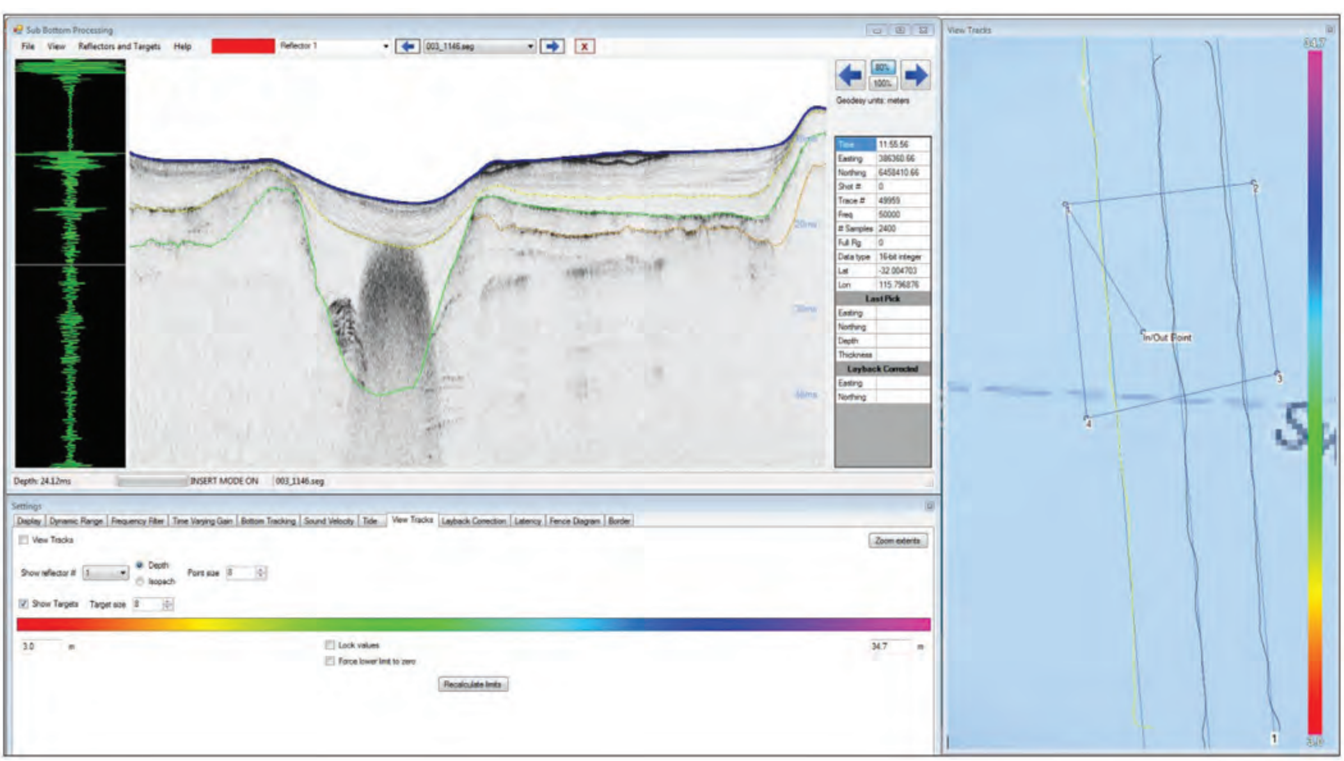
Figure 2. Navigation options in HYPACK SUB-BOTTOM.

is an Auto Range, TVG & Bottom Tracking button under the Display Tab in the Settings menu which can provide initial settings for users not familiar with processing sub-bottom profiling data.

GEOLOGICAL INTERPRETATION

Geological interpretation of sub-bottom profiling data involves reviewing the different reflectors which are evident below the seabed. Individual reflectors represent changes in the reflection amplitude which are generally related to the density of the sub-surface sediments. By digitizing these reflective amplitude anomalies the user can separate the sub-surface geology into units with different sediment/rock characteristics. This thickness of a discrete geological unit, such as an

Figure 3. Window layout of HYPACK SUB-BOTTOM.



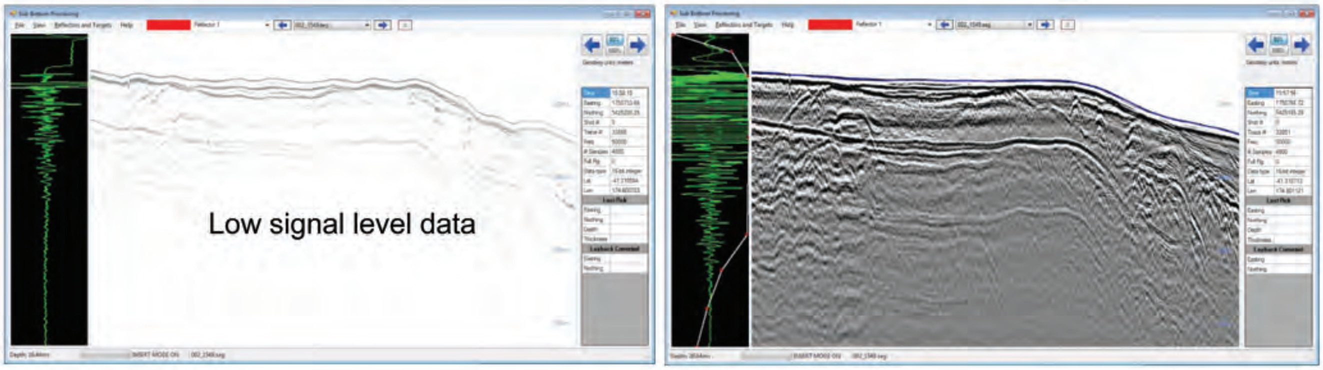
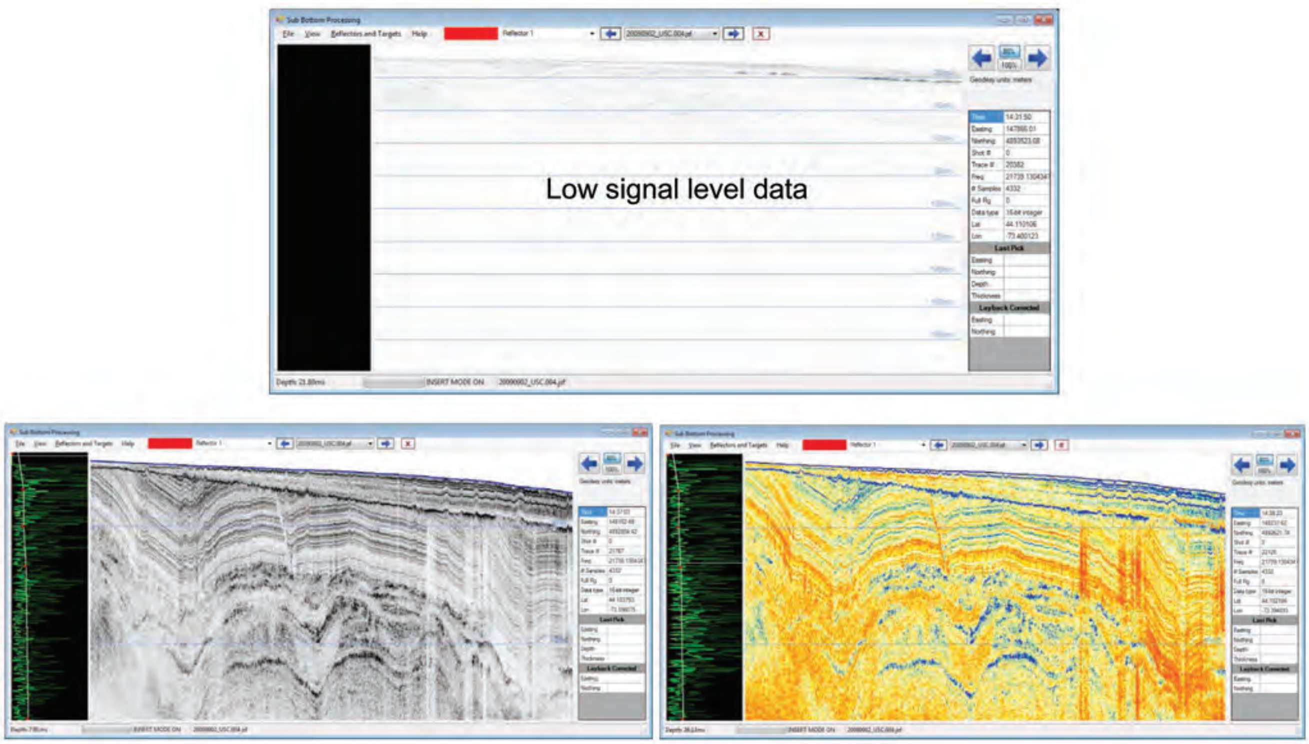


Figure 4. Raw boomer data (left image) and processed boomer data (right image). The processing involved changes to the image dynamic range, band pass frequency filtering, TVG, bottom tracking, swell correction and water column blanking.



Data courtesy of EdgeTech

Figure 5. Raw (top image) and processed Chirp data (bottom right & left images). The processing involved changes to the image dynamic range, TVG, bottom tracking, water column blanking and the application of a color palette (bottom right image).

unconsolidated sandy unit, is termed an isopach. HYPACK® SUB-BOTTOM supports the digitizing of 20 unique reflectors which can be assigned custom names and colors (Figure 6). Reflector digitizing points (“picks”) can be edited or deleted at any time to modify the interpretation. A handy annotation is also provided which gives the depth and sediment thickness values, at the cursor location point, of each discrete geological unit.

Another useful feature is the ability to be able to color each geological unit as an isopach polygon using a custom color palette and transparency (Figure 7).

The reflector digitizing depths or isopachs (sediment thickness) can be seen plotted on the View Tracks window as digitizing interpretation is progressing (Figure 8). This is a useful quality control tool as the consistency of the interpretation can be gauged by reviewing the interpretation on adjacent or cross-lines.

DATA OUTPUTS & CORRECTIONS

The data interpretations generated from digitizing the various reflective sub-surfaces can be output as ASCII XYZ or HYPACK EDT files. Various corrections can be applied to the data outputs such as:

- Sound velocity correction in the water column (average value or apply a sound velocity profile) and separate velocity corrections for saturated sediment or rock.

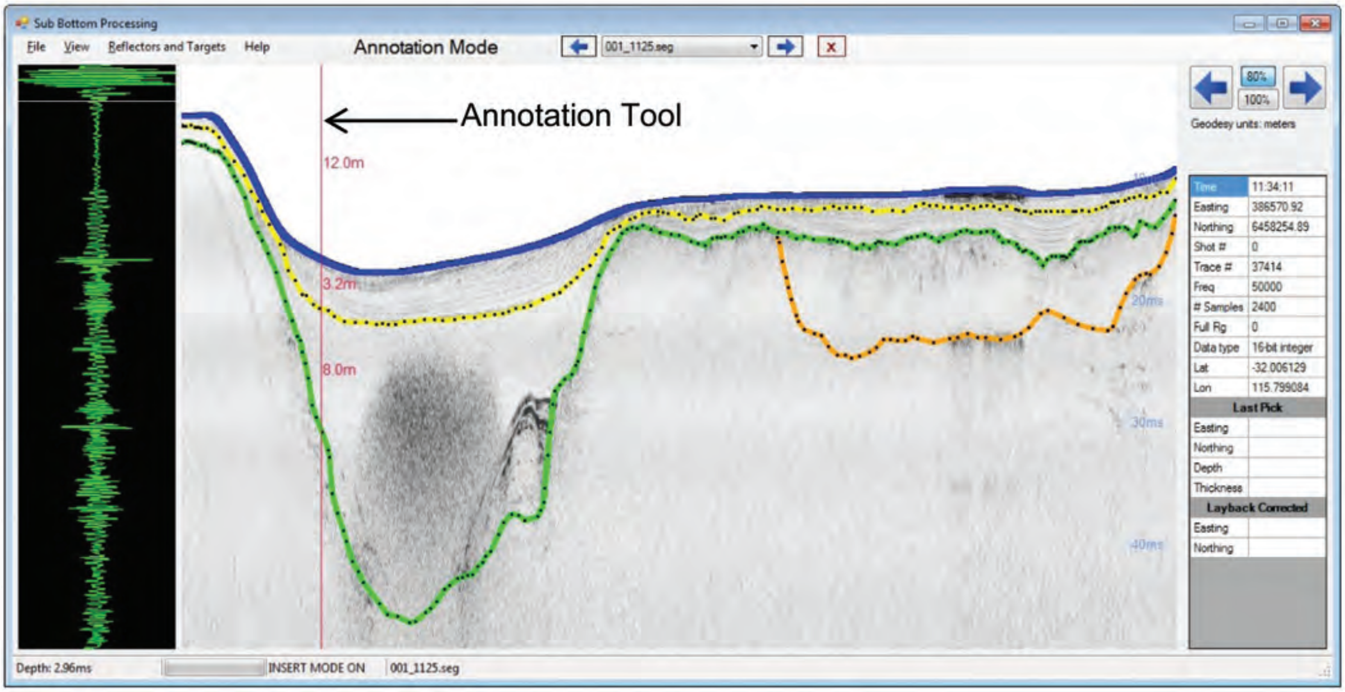


Figure 6. Sub-bottom profile showing the interpretation of three distinct geological units. Note the annotation tool which shows the depth to the seabed and the thickness (isopach) of each geological unit.

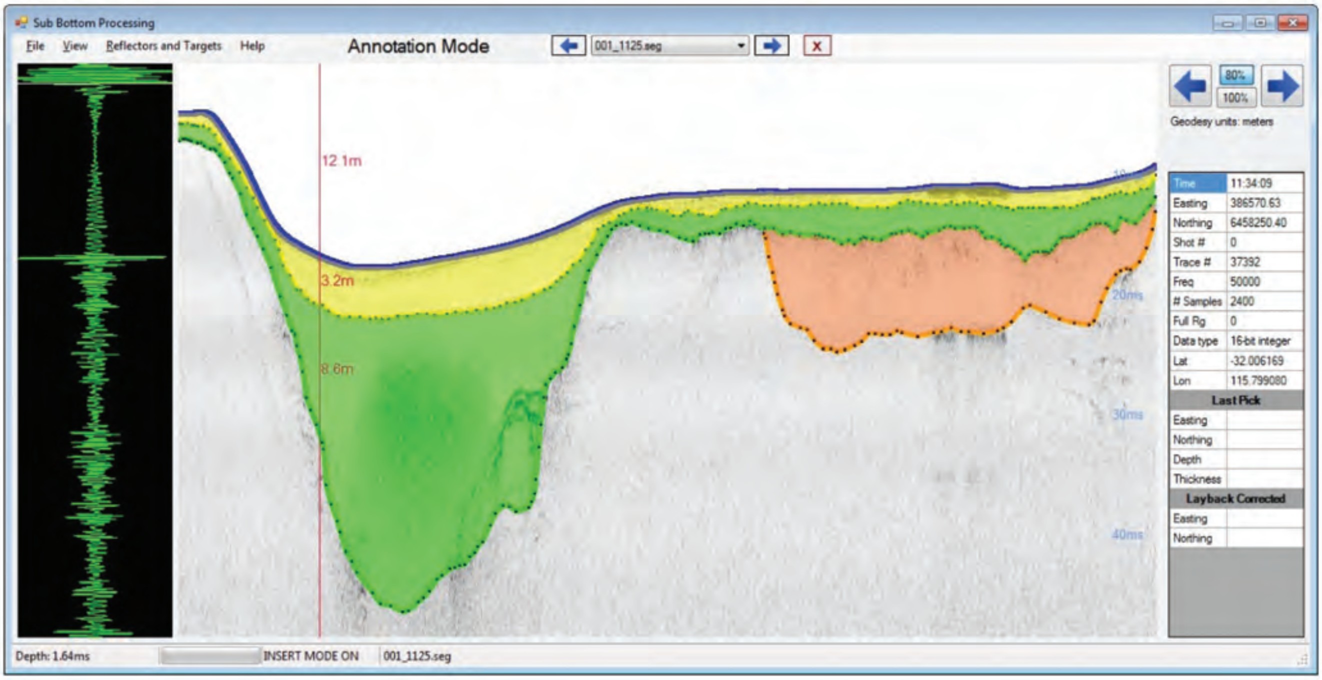


Figure 7. Colored isopach polygons being applied between various digitized reflectors representing different geological units.

• Tide corrections using a HYPACK tide file.

• Layback corrections to the data outputs if these were not specified in HYPACK hardware. If the data were acquired in HYPACK and HARDWARE was correctly figured then the coordinates in the SEG-Y file will be corrected for the sub-bottom profiling sensor position.

• Latency corrections between measurement and transmission to the data acquisition computer.

• Interpretation outputs can be trimmed to a border file.

A separate reference file is generated with each ASCII XYZ

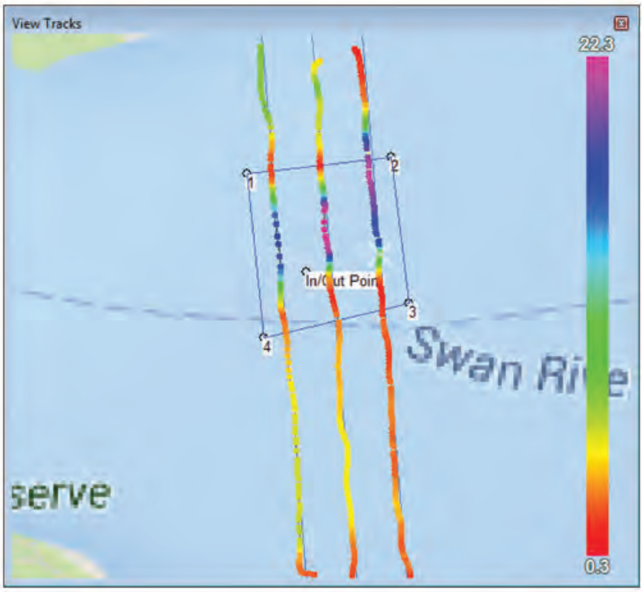


Figure 8. View Tracks window showing the digitized reflector isopach interpretation values represented as colored isopach (thickness) points for three survey lines. A color scale bar is provided too.

file high-lighting the corrections applied to the data.

Screen shots can be captured in various image formats (PNG, JPG or BMP), with or without the superimposed reflector interpretation. A coordinate reference file is produced with each image which allows the image to be used as a vertical seismic curtain in third party software packages.

ADVANCED VISUALIZATION FEATURES

HYPACK® SUB-BOTTOM has the ability to produce 3D fence diagrams of the sub-bottom profiling lines with superimposed reflector interpretation and colored isopach polygons (Figures 9 & 10). The fence diagram can be rotated in any direction and the transparency of the data controlled. The fence data can also be trimmed to a border file to highlight a particular area of interest. This is a useful tool for visualizing the data in three dimensions to provide a better understanding of the sub-surface geology.

CONCLUSION

HYPACK® SUB-BOTTOM is powerful, simple to use and feature-rich software package designed to meet most sun-bottom profiling requirements. This software is available with the 2017 a release of HYPACK or as a stand-alone package for those uses who only undertake sub-bottom profiling surveys.

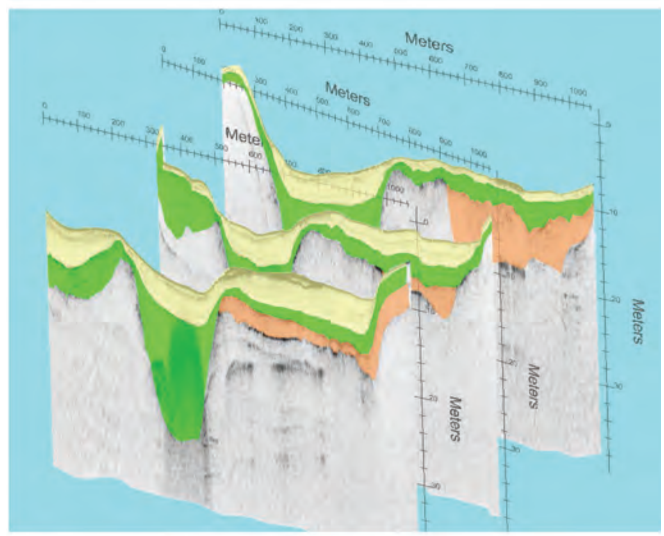
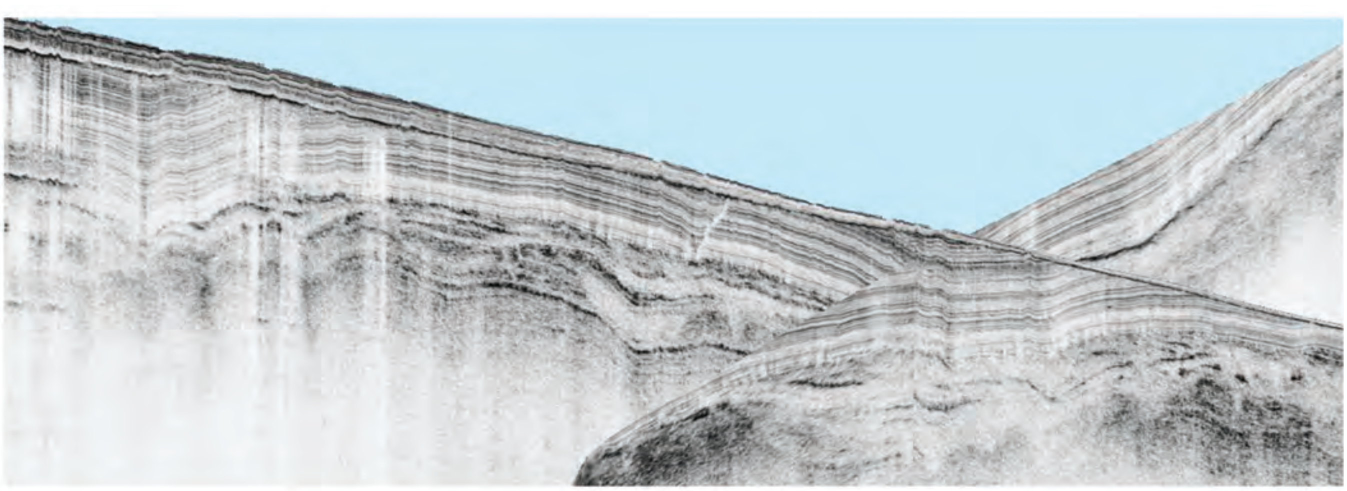


Figure 10. 3D fence diagram of three parallel sub-bottom profiling lines showing superimposed interpretation and scale bars.

Figure 9. 3D fence diagram of two intersecting sub-bottom profiling lines.



Data courtesy of EdgeTech