GW
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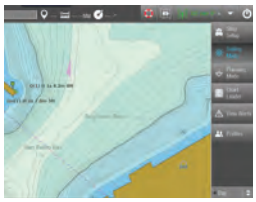
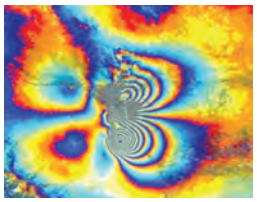
Mapping the Coasts and Oceans



Digital Chart Production

The Advancing Technology of AUVs

Life During and Beyond University



A Ground-breaking Revolution

Interview with FIG President

GW GEOMATICS WORLD

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COVER STORY
The image on the cover shows Jim Powell of the Port of London Hydrographic Service instructing UCL students in the deployment of the side scan sonar set-up aboard one of the PLA survey vessels.

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Next Issue: May/June 2019
Copy Date for Editorial: 08 April
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BY IAN DOWMAN

How Deep, and how Important, are the Oceans?

Oceans cover 71% of the surface of our planet and yet 95% of the ocean floor remains unmapped in detail. This in itself may not seem to be very important but when we realize that 40% of the world's population live within 100km of the coast and that the planet is threatened with sea rise due to climate change which could affect up to 10% of the world's population, and from pollution from man made materials, it becomes very important.

Oceans feature in the Sustainable Development Goals (SDGs) because of this. So, it is appropriate that hydrographic survey is the theme of this issue of GW. We look at two key issues which are topical: unmanned underwater vehicles and charting. The former ties in with our last issue dealing with artificial intelligence and as Gordon Johnston points out in his column, we are seeing things that were unimaginable 30-40 years ago.

Sustainable Development Goal 14 refers directly to oceans and calls for conservation and sustainable use of the oceans, seas and marine resources, but the oceans are important in many other SDGs, for example those relating to health, sustainable cities, energy, climate and hunger.

The oceans are another area where Earth observation has had an immense impact. Many of the global maps with which we are familiar come from satellite observations. NASA lists 15 sets of measurements relating to the oceans including bathymetry, seafloor topography, coastal process, marine geophysics, ocean temperature, waves, wind salinity as well as sea ice and sea surface topography; these would not otherwise have been available, and our knowledge of climate change would have been much poorer.

On the theme of Earth observation, Ren Capes's article on InSAR emphasizes the high precision possible from space and the continuous monitoring that is possible. However, he also points out that clever new techniques are not a universal panacea and that it takes time, money and persistence to integrate new technology into workflows.

On more mundane topics, but no less important to individuals, the article by Tom Allan and Tom Pugh illustrates the importance of interaction between universities/colleges and employers. The University of Newcastle-upon-Tyne's professional awareness fair is an excellent example of how an all-round geomatics education should include experience of what goes on in surveying companies and give students a chance to experience this in order for them to make informed decisions about their careers.

Ian Dowman, editor of Geomatics World

It is with great sadness that we report the death of Walter Smith at the age of 98. Walter has not been active for many years so will not be known to the younger generation, but his influence on the practice of surveying was immense and his professionalism and humanity has touched many in our discipline. His obituary also reminds us of the time that the military had a significant role to play in national mapping, and our report on the DGI conference indicates that this influence is not completely over.

Richard Groom has been technical editor of GW for many years and his entertaining reports on conferences have featured in a good number of issues. It is with regret that he is now leaving the magazine to concentrate more on his day job. Richard has given enormous support and his contributions will be greatly missed. We will be happy to hear from anybody who would like to contribute to GW by reporting on conferences and meetings.

Ian Dowman, Editor

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NASA ICESAT-2 SATELLITE MEASURES ICE SHEETS AND CREATES HEIGHT MAPS

IceSat-2 was launched to measure the shape of the ice sheets to a precision of 2cm. In addition to this, the satellite is now returning a whole raft of other information. It is mapping the height of land, rivers, lakes, forests, and even the depth of the seafloor.

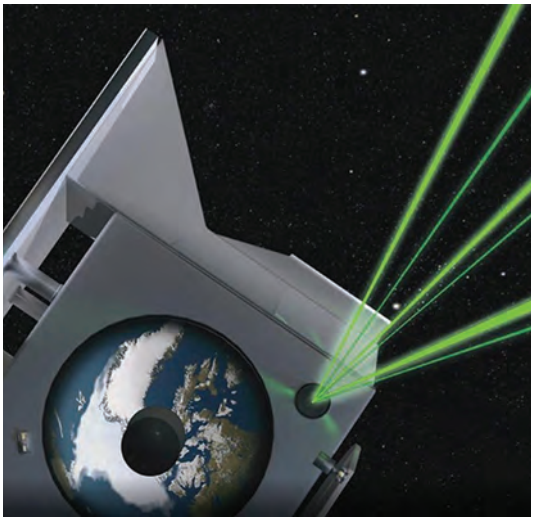
The satellite carries a single instrument - a half-tonne green laser that fires about 10,000 pulses of light every second. Each of those shots goes down to the Earth and bounces back up on a timescale of about 3.3 milliseconds. The exact time equates to the height of the reflecting surface.

Scientists will be using this optical "tape measure" to look for the elevation changes in Antarctica and Greenland that might indicate melting. And the great advantage of the new laser system is that it can detect behaviour in areas that have been beyond the vision of previous satellites.

Heights are calculated from just 150 photons, or particles, of reflected light, but even from just this small number, IceSat-2 can produce an elevation number to an accuracy of a little over 2cm.

Sample data was also presented of forested areas. The laser sees the tree canopy and the ground underneath, which will enable new assessments to be made of the amount of carbon stored in vegetation across the Earth.

On the note of bathymetry, it was suspected that the laser might be able to measure the depth of shallow coastal waters, although not to the same accuracy. A project is already being developed to use IceSat to map the near-shores of about 100 small islands in the Pacific.



IN BRIEF

Shane Jones, owner of **Tahi Engineering**, turned to Topcon Positioning for technology that would be used when setting out points for the complex grand design for building a house in the shape of a Spitfire engine.

A growing number of **police agencies across the USA** are using drones and lasers to transform the way investigators collect data of crash scenes. The addition of a drone to help document crash scenes reduces the risk of secondary crashes by a factor of 24. Lasers are used to measure key ground measurements that can be overlaid with aerial photos and point data to ensure accuracy.

Murphy Surveys becomes the first dedicated survey company in the UK and Ireland to achieve the prestigious BSI Kitemark for BIM Level 2 (Design and Construction). The Kitemark is the highest level achievable for the delivery of infrastructure or building projects that meet the requirements of the UK Government's BIM Level 2 condition of contract. Andy Butterfield, Product Certification Director of Built Environment at BSI, said "BIM is becoming increasingly vital for those working in the construction industry and organizations must be able to demonstrate how BIM-ready they are in order to be considered for projects both now and in the future."

Earth-i announced that it has completed the third annual update of the satellite map of the state of Queensland. The map covers the whole of Queensland's 1.9 million km^2 and was created by Earth-i for the Department of Natural Resources, Mines and Energy (DNRME). The first map was produced in 2016 with Earth-i reappointed for updates in both 2017 and 2018.

MAXAR TECHNOLOGIES REPORTS FAILURE OF WORLDVIEW-4 SATELLITE

Maxar Technologies, a global technology innovator, has reported that its WorldView-4 satellite experienced a failure in its control moment gyros (CMGs), preventing the satellite from collecting imagery due to the loss of an axis of stability.

Efforts are ongoing in conjunction with its suppliers to restore satellite functionality, but thus far these efforts have been unsuccessful. Maxar believes that WorldView-4 will likely not be recoverable and will no longer produce usable imagery. Maxar operations has put the WorldView-4 satellite in a safe configuration and will continue to monitor the satellite's location and health. The satellite was built by Lockheed Martin and the CMGs were provided by Honeywell.

Contingency planning and mitigation efforts are underway to assess the use of the company's other satellites and outside resources to replace imagery collected by WorldView-4 and meet as much of the existing customer commitments and obligations as possible. The company currently believes it will be able to offset US$10-15 million of the annual revenue from WorldView-4 and will work to minimise the potential impact on Maxar's financial results in future years.

FIRST GPS III SATELLITE REACHES ORBIT

After extensive delays, the first next-generation GPS III Space

Vehicle 01 (GPS III SV01) has been successfully launched and reached medium Earth orbit. GPS III SV01 was lofted aboard a SpaceX Falcon 9 in the last days of 2018.

Initially slated for a 2014 launch, GPS III SV01 is the first of ten GPS Block IIIA satellites, the latest generation of the US Air Force's Global Positioning System. The vehicle's completion and launch were successively pushed back by delays related to an untested capacitor used in the spacecraft's construction, and GPS ground system known as the Operational Control Segment.

The new spacecraft will support new civilian L1C and L2C navigation signals, along with a new M-code military signal and the L5 Safety of Life signal. Each of these signals will be classed as fully operational when broadcast by a full complement of 24 satellites, which is projected to be in 2021 for L2C; 2022 for M-code; 2024 for Safety of Life and the late 2020s for L1C.

GEODATA FORUM CO-LOCATES AT GEO BUSINESS 2019

GeoDATA Forum is a new event for data specialists focused on location intelligence and is co-locating with the GEO Business event taking place 21-22 May 2019. This sector has previously been served by a series of showcase events that were organized by Geoaware, part of The GeoInformation Group.

Event Director of GEO Business and now the GeoDATA Forum, Caroline Hobden, commented "It is important to us that we continue to provide a niche forum for the geo data specialists, one that they have grown accustomed to, at the previous showcase events whilst experiencing everything that a larger and broader show like GEO Business has to offer. We believe the synergy between the two will add great value to attendees at both events."

The GeoDATA Forum combines exhibition and seminar sessions for professionals involved with geospatial data software and services. This new event will see a dual track of speakers and keynotes presenting thought provoking talks on a wide range of GIS related issues. Visitors can explore the very latest in location intelligence with sessions featuring case studies on how GIS is used to store, manipulate, analyse, manage and present spatial or geographic data.

Both events are free to attend, and visitors will be able to enjoy the freedom of walking between the two exhibition areas and enjoying all the seminar and workshop content that both shows offer.

BLUESKY AERIAL PHOTOGRAPHS REVEAL HIDDEN IRISH ARCHAEOLOGICAL SITES

The National Monuments Service (NMS) in Ireland is using high-resolution aerial photography from Bluesky to map and investigate a giant 4,500-year-old Henge. The circular structure, located the Brú na Bóinne UNESCO World Heritage Site, is evidence of prehistoric earthworks and was first observed by researchers with drones. Following the discovery, the NMS of the Department of Culture, Heritage and Gaeltacht carried out extensive aerial reconnaissance including commissioning Bluesky Ireland to survey the cropmark enclosure at Newgrange.

Researcher and photographer Anthony Murphy flew his drone over the Boyne Valley and located a large, circular crop mark in open farmland, indicating the presence of buried archaeological features. Following the initial discovery, the NMS used a GIS to organise views of the landscape across maps, photographs and drawings of cropmarks identified to date. The location of the newly identified site was also visited to enable a better understanding of the topographical locations and the physical and visual relationships between sites.

A newly published report – The Archaeology of the Brú na Bóinne World Heritage Site Interim Report – details information on the discoveries. Reinforcing the remarkable level of ceremonial and ritual use of the landscape during the prehistoric period up to 5,000 years ago, immense enclosures of timber uprights and large henges have been identified. These monuments, visible only fleetingly as cropmarks during the dry summer and recorded by Bluesky, clearly form a deliberately structured and ritual landscape of great significance.

GEOSLAM ANNOUNCES UPGRADE TO ANY SLAM DEVICE

With the rapid advancement of SLAM (Simultaneous Location and Mapping) technology recognised particularly across the built environment industry, leading 3D mobile mapping and monitoring specialist GeoSLAM is offering the opportunity to upgrade any SLAM device to an industry leading handheld scanner.

GeoSLAM has launched its upgrade campaign offering £10,000 off the price of its leading ZEB-REVO-RT or the ZEB-HORIZON until 28 February 2019, in exchange for any SLAM device – regardless of its manufacturer.

>

GEXCEL PRESENTS HERON INDOOR MOBILE MAPPING SYSTEMS

The HERON AC-2 and HERON MS-2 (rugged devices for underground mines or difficult indoor environments) have been released and added to Gexcel's portfolio. Both devices are available in the Colour configuration.

With these releases, HERON has become a powerful tool for geospatial data mining to digitally document, collect and geo-reference large datasets and information for indoor environments when integrated with OrbitGT packages.

Benefits to customers include: Great value for facility management, geospatial applications, digital 3D documentation, digital twins for remote planning and project, revamping projects of industrial plants, etc; The GoBlueprint free tool (fast point clouds 2D visualisation), which HERON users can easily share with clients, already in the field and almost in real-time; Point clouds coming from drones and/or static scans, as GNSS known points, can become constraints information inside the workflow of the HERON 3D SLAM data processing.

IN BRIEF

CompassDrone have acquired the **Riegl MiniVux** to provide reliable, consistent data to their customers solutions. They will expand survey capabilities with the addition of the Riegl MiniVUX-1UAV mounted on a DJI M600 Pro Platform.

Leica Geosystems and **SVAB**, a developer of ergonomic and user-friendly control systems for industrial vehicles and equipment, has announced they are releasing a productivity tool for iXE3 and iGW3 machine control solutions based on SVAB's Quantum Tool Recognition system.

Ordnance Survey (OS) releases OS Open Zoomstack, a free, customisable digital mapping toolkit that gives developers the ability to create quick, easy 2D and 3D maps for use in apps and websites and offline pages.

GeoSLAM's ZEB-HORIZON was launched at INTERGEO 2018 and incorporates UAV-ready technology alongside the strongest ever SLAM, capable of collecting 300,000 points per second with a range of up to 100m.

The ZEB-REVO-RT is a lightweight handheld scanner capable of processing data in real-time while the user walks, providing a complete 3D model in minutes.

YUNEEC LAUNCHES RTK VARIANT OF H520 HEXACOPTER

UAV manufacturer Yuneec has released a new version of its commercial hexacopter platform with an integrated RTK unit from Swiss firm Fixposition.

The H520 RTK is capable of 1cm + ppm horizontal / 1.5cm + ppm vertical positioning, making this model suitable for high accuracy, automated inspection tasks, faster 3D mapping, and forensic applications.

The hexacopter has a physical RTK module onboard, and a ground station supporting GPS, GLONASS, Galileo and BeiDou GNSS constellations.

The RTK system is also operable via a national reference station network with a mobile hotspot or other internet connection. All flight data is recorded, supporting PPK applications.

TOPCON INTRODUCES GT-503M MOTORISED TOTAL STATION

Topcon has introduced the GT-503M, an auto-collimating motorised total station for surveying professionals. This total station is both rugged and waterproof (IP65) and has the latest TSshield technology for advanced security and maintenance. The system can also be upgraded to Autotracking when the customer is ready to advance further to robotic applications. The GT-503M can be used for Tunnel Guidance and Periodic Monitoring applications.

The GT-503M can find a prism and lock within the field of view simplifying the steps for the operator to find the prism. No need to focus the GT-503M to find the prism. The direct drive motors of the instrument have an angular speed of up to 85 degrees per second. When connected with an external data collector, the Longlink communication provides license-free communication up to 300m. The advanced encoder technology provides 'Best in class' 3" angle accuracy, and in addition, allows the instrument to calibrate its own angle measurement system automatically.

The red laser pointer is coaxial through the telescope making measurements in dark environments, it can assist the remote rod operator in limited sunlight or over shorter distance shots. Red and Green LED guide lights provide the remote pole man with direction to approximately

find the horizontal line. This feature is extremely helpful during stakeout to quickly find line without communication with the instrument operator, or for trying to find the horizontal angle (line) when cutting brush for a traverse line.

The new dual SIM module allows the customer to insert their own data SIM card in the GT-503M total station to communicate directly to MAGNET Enterprise. The telematics card installed can communicate to the TSshield servers, which can then review it if the total station has any existing error codes, the version of the firmware that is installed, as well as the total station geographical location. From this information, a message can be sent to the total station and advise the operator if further action is available or necessary.

The 800m Non-prism distance measurement uses a phase shift EDM that has a smaller beam width than other non-prism instruments in its class. Distance measurements can be taken as fast as 0.9 seconds in fine mode. Measurement algorithms reduce the noise associated with non-prism measurements providing an accurate result to most surfaces over a longer distance. This is true for darker surfaces and wet surfaces where other non-prisms fail. The smaller beam width also allows the GT-503M to get measurements, for example, to a fence as well as through the fence to any objects behind it.

THE RAINFOREST ALLIANCE LAUNCHES AG-TECH DEVELOPER CHALLENGE

Smallholder farmers produce the vast majority of the world's cocoa, the basic ingredient for chocolate. Cocoa farmers face daunting challenges: declining yields, mounting threats from pests and disease, and persistent poverty. Unfortunately, farmers rarely get the timely training, advice, and financial means they need to change their circumstances.

To help farmers overcome those challenges, the Rainforest Alliance, Grameen Foundation, Touton, Satelligence, University of Ghana, and Waterwatch Projects set up the SAT4Farming program, an initiative to reach thousands of small-scale cocoa producers with information and services to improve their productivity and sustainability. It is designed to use digital technology and satellite imagery to create digital individual Farm Development Plans (FDPs) that guide farmers over a seven-year period with the aim of increasing their productivity up to 1,500kgs per hectare (a 300% increase).

The companies are calling on remote-sensing, high-tech, and

PEOPLE

Professor **Marek K Ziebart** from UCL received the ION Tycho Brahe Award for outstanding innovation and leadership in the area of high precision, physics-based radiation for modelling for spacecraft orbit dynamics. The Tycho Brahe Award is given in recognition of outstanding contributions to the science of space navigation, guidance and control.

The **Open Geospatial Consortium** (OGC) has announced new Consortium leadership, effective 1 March 2019. Dr Nadine Alameh returns to OGC to serve as OGC's Chief Executive Officer (CEO).

EVENTS

Got an event to list? Go to www.geomatics-world.co.uk/events

LiDAR for Drone Conference
20-21 March 2019
Montpellier, France

FARO European BIMovation Roadshow
1 April 2019
Amsterdam, the Netherlands

Geospatial World Forum 2019
2-4 April 2019
Amsterdam, the Netherlands

Future Cities Show 2019
8-10 April 2019
Dubai, UAE

Ocean Business 2019
09-11 April 2019
Southampton, UK

FIG Working Week 2019
22-26 April 2019
Hanoi, Vietnam

SATELLITE 2019
6-9 May 2019
Washington, DC, USA

GEO Business 2019
21-22 May 2019
London, UK

SPAR 3D Expo & Conference 2019
21-25 May 2019
Anaheim, California, USA

ISDE 11
24-27 September 2019
Fiorentino, Italy

TRIMBLE T7 TABLET ELEVATES PRODUCTIVITY

Trimble has introduced the Trimble T7 Tablet, a rugged, lightweight and versatile device for construction surveying applications. Using Trimble Siteworks Software for construction surveying, the Trimble T7 provides real-time data to visualize cut/fill levels, calculate material volumes, check grade and communicate work orders to increase productivity and enable better decision making.

The Trimble T7 Tablet brings powerful processing to the field – a sunlight readable 7-inch touchscreen that supports pinch, tap and slide gestures and a digital keyboard. Users can interact with the T7 intuitively, easily zooming, panning and selecting items on the touchscreen.

The T7 also leverages the power of Windows 10 Professional, driven by an Intel Pentium 64-bit quad-core processor. The processor and operating system make it easy to process data in spreadsheets and run office software programs. Using third-party apps, front- and rear-facing cameras allow contractors to video conference from the field for on-the-job support and capture high-definition videos and images.

The Trimble T7 Tablet is rugged and built to withstand the wear-and-tear of daily construction work in various weather conditions, while remaining lightweight. It meets stringent MIL-STD-810G for drops, vibration, immersion and temperature extremes and with IP65 and IP68 ratings, is sealed against water and dust. The screen uses a Gorilla Glass display that is scratch and impact resistant.

Optional, user-interchangeable Trimble EMPOWER modules make the Trimble T7 Tablet a flexible solution for a variety of applications. The Trimble EMPOWER Platform is a modular expansion system that gives users the power to customize their mobile computing solution to their workflow. Optional modules such as barcode imager, a barcode imager/RFID combo and sub-metre GNSS, give users the confidence of knowing that their investment is scalable for future needs. Contractors can enjoy faster ROI, more flexibility and less downtime by taking advantage of the ability to move radio modules between controllers.

Earth-observation companies to tackle the Ag-Tech Developer Challenge, a competition to build a remote-sensing data product that links to and adds value to the mobile-enabled FDPs. Through this competition, they hope to stimulate participants to create innovative ideas.

DEPARTMENT OF HOMELAND SECURITY RELEASE GPS MEMORANDUM

In April 2018, the CGSIC announced the Department of Homeland Security had released a memorandum titled 'U.S. Owners and Operators Using GPS to Obtain Time' (https://ics-cert.us-cert.gov/sites/default/files/documents/Memorandum_on_GPS_2019.pdf) which is intended to provide an understanding of the possible effects of the 6 April 2019 GPS Week Number Rollover on Coordinated Universal Time derived from GPS devices.

GPS users should review this memorandum and be aware of the potential impacts to their equipment when the GPS Week Number rolls over to 0 on 6-7 April 2019. If you have questions about how your equipment may be impacted by the GPS Week Number rollover, we recommend you contact your equipment manufacturer.

SBG SYSTEMS LAUNCHES HORIZON IMU FOR HIGH PERFORMANCE SURVEYING

SBG Systems has released the FOG-based Horizon inertial measurement unit (IMU), designed for high demanding surveying applications such as high-altitude data collection, or mobile mapping in very dense areas such as urban canyons.

Navsight Land/Air Solution consists in a ready-to-use inertial navigation solution dedicated to surveyors for mobile data collection. It is available at different levels of accuracy to meet the various application requirements and can be connected to various external equipment such as an odometer, Lidar, etc.

Navsight Land/Air Solution already offered two levels of performance with the Ekinox and Apogee IMUs. These MEMS-based IMUs provide most surveying markets with camera or Lidar motion compensation and data geo-referencing. The new Horizon IMU allows customers to bring the technology to the most demanding environments such as high-altitude surveying and highly dense areas, as well as applications where only a single antenna can be used. Horizon IMU is based on closed-loop FOG technology which enables ultra-low bias and noise levels. This technology allows robust and consistent performance even in low dynamics survey.

The Navsight solution is easy to install as the sensor alignment and lever arms are automatically estimated and validated. Once connected to the processing unit, the web interface guides the user to configure the solution. A 3D view of the vehicle shows the entered parameters so that the user can check the installation. By choosing the vehicle, a plane or a car for example, the inner algorithms are automatically adjusted to the application. The Navsight unit also integrates led indicators for satellite availability, RTK corrections, and power.

Completing the Navsight offer, Qinertia, the SBG post-processing software, gives access to offline RTK corrections from more than 7,000 base stations located in 164 countries. The software delivers the highest level of accuracy without having to set up a base station. Trajectory and orientation are then greatly improved by processing inertial data and raw GNSS observables in forward and backward directions.

DIRECT REFERENCING MULTIBEAM DATA

Applanix's POSPac MMS GNSS Inertial software, in particular the Applanix SmartBase (ASB) post-processed virtual reference station technique, has been widely adopted as a robust and reliable method of direct georeferencing multibeam data.

POSPac MMS 8.0 is a PP-RTX GNSS aided-inertial module that provides centimetre-level post-processed positioning accuracies without the use of local reference stations. This method integrates Trimble CenterPoint RTX technology into POSPac MMS. RTX is Trimble's approach to PPP (Precise Point Positioning) with advanced ambiguity resolution, providing its own ephemeris correction service, leading to integer-level ambiguities for accuracy approaching that of RTK.

A global network of approximately 100 stations tracking GPS, GLONASS, BDS, QZSS and Galileo provides the raw data for analysis and processing to produce the PP-RTX corrections, which are then made available via the internet within one hour.

The rapid data turnaround ensures the same for the solution, previously unavailable for post-processed PPP services. In comparison to real-time PPP services, archiving the data on the internet ensures more robust and reliable access to the correction data – improving availability and accuracy.

PERFORMANCE RESULTS

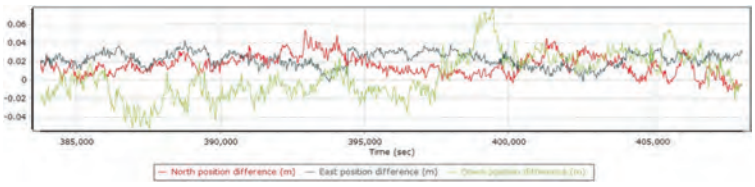
Performance analysis of 14 different datasets from various locations around the world was done by comparing the PP-RTX solution to that from ASB (see table).

PP-RTX - ASB	Mean (m)	std (m)	rms (m)	68% (m)	95% (m)
North	0.000	0.019	0.019	0.012	0.033
East	-0.003	0.021	0.021	0.016	0.035
Down	0.018	0.046	0.049	0.043	0.086

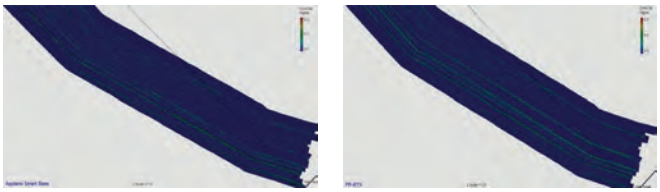
PORT OF LONDON CASE STUDY

A dataset has been collected by the Port of London Hydrographic Service on their vessel Maplin – equipped with a POS MV OceanMaster GNSS-aided INS for georeferencing the R2Sonic 2024 multibeam sonar. Hypack was used for data acquisition, and Fledermaus for the visualization of some results.

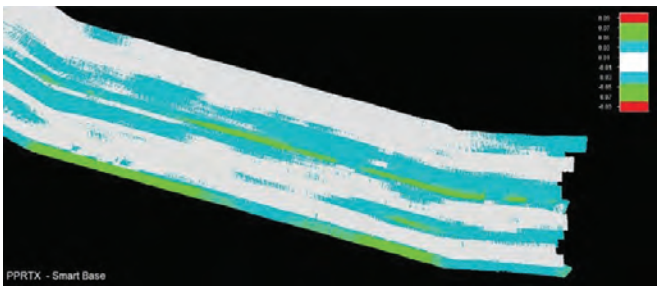
The data was collected in the Thames Estuary, where Ordnance Survey OSNet GNSS reference stations provided the data necessary to compute an ASB post-processed VRS network. The ASB technology allows the computation of a centimetric-accurate position solution, with distances to the nearest reference station on the order of 20-60km. A comparison was then done between the ASB solution and that from PP-RTX (see chart).



The maximum difference is approximately 0.04m in horizontal, and about 0.07m in vertical. Both the ASB and PP-RTX SBET (Smoothed Best Estimate Trajectory) solutions were applied to the bathymetry, and the results were compared by RMS surface derived from each SBET (see images).



Differencing the two surfaces confirms the level of agreement, with no differences greater than 10cm, and the majority less than 5cm.



SUMMARY AND CONCLUSIONS

POSPac MMS using PP-RTX aided-inertial technology has been shown to match the North, East and Down position computed using the ASB network Carrier Phase DGNSS processing for 15 POS MV data sets to an accuracy of 0.019m, 0.021m and 0.049m RMS respectively, which is enough to meet the requirements for most mapping applications. It does not need local reference stations and provides a convergence-free solution by combining the forward and backward solutions. Data is available one hour after collection and allows for the direct georeferencing of a sample MBES data series in agreement with the equivalent ASB solution to better than 0.10m, with the majority agreeing to better than 0.05m. It is available to be used by all models of POS MV.

Applanix would like to thank the Port of London Authority for their generous assistance in collecting the data.

BY JAMES KAVANAGH

New Opportunities for Geospatial

James Kavanagh, Director of the RICS Land Group.

The sun is rising, and spring is very much in the air. The six nations rugby is over (I'll hold back on any commentary) and thoughts are turning towards the summer. Geospatial activity has been constant over the last couple of months with some very big industry issues (such as the scourge of UK instrument theft) being discussed.

RICS has finished the 2018/19 evening lecture series with some very strong lectures on The Red Atlas - the Soviet Union Secretly Mapped the World (www.press.uchicago.edu/ucp/books/book/chicago/R/bo24760505.html), soon to be featured in the RICS Land Journal (www.rics.org/uk/news-insight/publications/land-journal), and a final lecture on marine/offshore survey (in collaboration with our colleagues from the Hydrographic Society).

All eyes now turn to the ever wonderful GeoBusiness 2019 (www.geobusinessshow.com, 21-22 May 2019 in Islington, London). As you are all very aware, this event has become the keystone to everything that we are trying to achieve for our growing geospatial industry and profession and for all collaborating societies, institutions and learned bodies. Geobusiness 2019 (I mentioned the addition of Digital Construction Week www.digitalconstructionweek.com, 16-17 Oct 2019) has also incorporated GeoData (www.geobusinessshow.com/geodata-forum) into this years event. GeoData will maintain its unique personality and focus of geospatial information use by data specialists and locational information experts. Quite a different group and much more aligned to GIS service providers and clients, but you can see the way this is going. GeoBusiness is bringing all the disparate geo-strands together from what has been an unnecessarily fragmented profession. Surveying, mapping, construction, infrastructure, data capture, usage, intelligence, strategy – it's all coming together for UK Geospatial.

Geospatial activity has been constant over the last couple of months with some very big industry issues... being discussed.

GEOSPATIAL COMMISSION

RICS recently hosted the Geospatial Commission, Policy Lab UK and experts from the partner bodies & agencies who spent a full day debating and interrogating the enormous amount of information and commentary submitted during the recent 'call for evidence'. The Geospatial Commission are hoping to formulate their strategy for UK Geospatial during 2019, and RICS, along with our fellow professional bodies, are fully committed to helping the commission realise their objectives. The commission has also recently launched a geodata competition (www.gov.uk/government/news/15-million-geospatial-competition-open-to-improve-public-services) with £1.5 million up for grabs. The Geospatial Commission has partnered with Innovate UK to launch a competition with HM Government, where organizations can apply for a share of £1.5 million to fund projects which use data linked to a location. Between £50,000 to £750,000 could be granted to eligible organizations.

The aim of the competition is to explore the benefits and challenges of crowdsourcing data. It will encourage different organizations to work together to identify innovative new ways for crowdsourced data, to either:

- Improve the delivery of public services.
- Support the third sector.
- Enhance the quality of open public datasets.

Applications have already been made (the closing date was January 2019) but I believe the response was good and indeed we at the RICS have been asked to potentially partner with organizations on some projects. More on this as it develops.

RICS EDUCATION TRUST

Some of you will be aware that the RICS makes quite a substantial sum of funding available for research on a six monthly 'call' basis. The application months are March & October, and for 2019 we are interested in several sectors. The RICS Research Trust is an established grant award entity supporting research in the disciplines of land, real estate and construction across the world.

The Trust, as a charity, has a remit of supporting, delivering and disseminating high quality, independent reliable knowledge and future thinking through research funding right across the world. It's administered by a Board of Trustees, comprising RICS members and independent appointees. The Board meets to consider awards twice a year in May and December.

The RICS Research Trust is encouraging research in specific areas by means of 'defined calls' and is also considering applications outside specific areas as 'open calls'. Research applications under the defined calls and open calls are considered bi-annually.

In the coming year, the trust is focused on subjects that relate to the RICS Governing Council's strategic themes – urbanisation; housing supply and affordability; resource scarcity; climate mitigation and adaptation; and the next generation. As a priority, the trust is encouraging research in the five specific 'defined call' subjects:

- Resilience against natural and man-made disaster in a changing climate.
- Transition to autonomous vehicles.
- Social cohesion in rapidly growing cities.
- The strategic impact on rural land use if growing urban populations are to have access to sufficient nourishment (food safety).
- Big data and the impact of digitization on professional practice.

Proposals should be submitted to researchtrust@rics.org. When making your application please specify whether the application is under one of the defined call subjects or the open call. Further details, the updated guidelines for applicants and the application form can be viewed at www.rics.org/researchtrust.

LEICA ANTI-THEFT CAMPAIGN

Our colleagues in TSA have been pushing forward with an encouraging initiative on helping to combat the scourge of instrument theft (some of it violent) that we have been suffering the UK and Ireland geospatial profession. Some survey firms have even gone to the lengths of having full time security personal on site and/or accompanying surveyors in the field (www.tsa-uk.org.uk/equipment-theft).

Leica have recently launched an inclusive campaign aimed at all security products (such as those highlighted at the SCCS website, www.sccssurvey.co.uk/survey-monitoring/instrument-security-weather-protection.html) and the issue will, again sadly, be a major topic of conversation at GeoBusiness. I know from speaking to surveyors from across the world that this is not a specific UK and Ireland problem but affects all of us on a global scale.

RICS LAND AND RESOURCES VIDEO – 2018 HIGHLIGHTS

RICS Members (and non-members) can get an insight into all of the wonderful 2018 output from the Land & Resources group by viewing the video at https://communities.rics.org/connect.ti/Wikigeo/view?objectId=44498725

Our colleagues in TSA have been pushing forward with an encouraging initiative on helping to combat the scourge of instrument theft...

This video is designed to give delegates at events a quick insight into the multi-faceted world of policy, education, journals (including Geomatics World), standards, best practice, collaboration and events that we work within. Its worth a look, just for that next time someone asks you the 'what do you get for your membership fee?' question.

HAPPY 50TH BIRTHDAY CICES

My congratulations to our colleagues at CICES on their 50th anniversary year (2019). I know that they have a series of events planned (www.cices.org) and RICS is also delighted to see Chris Preston FRICS FCInstCES take the reins as president for this important milestone year.

And finally, the discovery of HMS Endeavour (Cook's famous ship in 2018) could be followed by the discovery of HMS Endurance (Shackleton's equally famous ship) in the usually ice bound Wendell sea off the coast of Antarctica - https://en.wikipedia.org/wiki/Endurance_(1912_ship). Sounds like a topic for an evening lecture.

BY GORDON JOHNSTON

There is No Turning Back the Tide

Gordon Johnston, Chair of the RICS Geomatics Professional Group. Gordon welcomes your comments and thoughts so please email to the following address geochair.rics@gmail.com

This month we are focussed on the water, seas and oceans. Offshore surveying, Hydrography and the various associated survey disciplines in this sector have generally benefitted greatly from technology in recent decades to the point it is almost unrecognizable from even just 30 - 40 years ago.

The analogue single beam echo sounders developed after the wars (especially World War Two), were coupled with sonar systems that would sweep and scan the seabed. Advances in signalling technologies, transducer manufacturing and processing power all enabled the introduction of multibeam sonar systems into commercial and civil survey projects. The improvements continue to this day with even greater signalling and processing power.

At the same time, improvements to the understanding of Geodesy via the use of artificial satellites, gave added opportunity to position almost anywhere on the globe at previously impractical levels of accuracy.

Advances in signalling technologies, transducer manufacturing and processing power all enabled the introduction of multibeam sonar...

Initially, with the TRANSIT system and then of course GPS and the plethora of GNSS options, our adoption of all things satellite has been really staggering.

VISIT OCEAN BUSINESS 2019

These systems and tools are beneficial of course, but as yet, have not replaced the surveyor entirely. However, technology does not stand still and this year at Ocean Business down in Southampton you will have the opportunity to see and network with many companies and groups who are busy developing the next generation of offshore and Hydrographic survey solutions. Robotics, unmanned vessels, multi-sensor integrated solutions, and image and data processing will all be present topics at the event in the hope to bring to life the dark undersea world in virtually real-time.

Back around 1955 several enterprising surveyors got together as realised the potential of seabed development and that it would require positive planning and management for a sustainable future. The objective was to harmonize the coastal and offshore areas with respect to planning and management.

OPERATION CANUTE

Interest in what was termed Operation Canute was briefly re-ignited when RICS Chartered Surveyor Norman Humphris related the story of Operation Canute from its informal mid 50's beginning, through to the 1964 formal start, and on until its main plan was published in the Hydrographic Journal in 1978 when its marine planning elements were expedited by the Amoco-Cadiz incident. Thereafter, the work continued up until the UN Convention on the Law of the Sea conference in 1982 that saw the milestone resolution adopted.

Operation Canute played a role in educating and raising awareness. Various suggestions it made demonstrated the diversity and potential of the offshore sector (the concept of a ship based marine "black Box", a global series of charts, and positioning systems (ENCs)), so attractive for the insurance industry; a rather unusual link from underwater diving experiences to medical benefits with gas and pressure therapies. The seas and oceans are largely still unexplored and still relatively under developed such that new challenges, solutions, technologies and benefits are yet to be discovered.

Ocean Business 2017.

PASSION CAN HELP SOLVE PROBLEMS

The inspiration, devotion and passion to create and deliver new concepts to solve problems and bring solutions to the sector should not be under-estimated. Ocean Business and the associated Ocean Survey conference aim to provide you with some insight and understanding of the current trends and capabilities of our industry and how these might develop. Of course, it is you the reader who will influence and ultimately decide on the success or failure of some of the systems and technologies.

Back in the 1970's, the idea that hydrographic surveyors might spend long periods of time underwater living at their place of work seemed both necessary and fantastic. Happily, technology has come to our aid and enabled us to avoid this scenario. Whether you consider the current trend in robotics, unmanned vehicles and vessels a threat or an opportunity, I recommend you visit and determine for yourself what potential there is for us as surveyors, data managers and custodians of the geospatial datasets of our coasts, seas and oceans.

... passion to create and deliver new concepts to solve problems and bring solutions to the sector should not be under-estimated.

Walter Purvis Smith 1920-2018

Walter Smith CB OBE passed away on 11 December 2018, aged 98. Walter had an impressive career in the industry with Fairey Surveys, as a government officer at Ordnance Survey and internationally with the United Nations.

Walter Smith was born in Houghton-le-Spring, County Durham, and studied at St Edmund Hall, Oxford in 1938. After initial service in the Royal Artillery, he joined the Royal Engineers and was involved in mapping of the northern coast of France in preparation for the Normandy landings and landed at Arromanches-les-Bains and undertook surveys in support of the artillery. He received an MBE at the end of 1944.

Between 1945-1946 he worked with the Control Commission for Germany on the rehabilitation of some German State Survey Offices (HVA). In 1957 he returned to his earlier interest in the Territorial Army where, on promotion to Lieutenant-Colonel, he assumed command of 135 Survey Engineer Regiment TA. He was awarded the OBE in 1960.

After serving in the Directorate of Colonial Surveys (DOS) he returned to the UK to take up an appointment as Chief Surveyor of the Air Survey Company, a subsidiary of The Fairey Aviation Company and known to surveyors as Faireys. He remained in the private sector for the next 24 years and became Joint Managing Director. He was responsible for mapping projects in many parts of the world including the UK, Singapore, East Pakistan, Nepal, East Africa the Caribbean. Employees of Fairey Surveys at the time regarded Walter as an understanding employer who showed respect and consideration to his employees.

Walter's involvement with international boundary determination in Patagonia (Rushworth and Smith, 1968) achieved international recognition as one of the first such projects involving photogrammetry, which was used because of the difficult nature of the terrain and uncertain weather conditions.

He left Fairey Surveys in 1975 to take up the post Advisor, Surveys and Mapping with the United Nations for two years in New York. He travelled extensively, on behalf of the UN, supervising projects of institution-strengthening or mapping in support of various countries' development programmes.

In 1977 he was appointed Director General of the Ordnance Survey (OS), a post he held until he retired in 1985. His term at OS was marked by the departure of all the department's military officers, and work on digitizing all the survey's large-scale plans which involved not only technical skills but also financial and political acumen at a time of financial constraints. At the same time, the work of OS was under review. Walter took the UK into what was then OEEPE, but is now EuroSDR, to strengthen research and collaboration within Europe.

Following his retirement from OS, Smith was deputy chairman of an independent committee appointed to review the handling of geographic information in the UK. He presided over a major international conference on digital cartography in 1985.

Walter was a Fellow of the Royal Institution of Chartered Surveyors and in 1973 he became President of the Photogrammetry Society. Other honours include the appointment as Companion of the Order of the Bath (CB) in 1981, the Patron's Gold Medal of the Royal Geographical Society, and in 1992-1993 he spent a year as the first Director of the Association for Geographic Information (AGI).

Walter Smith died in December 2018 at the age of 98 after a distinguished career which will be remembered by many professionals and individuals.

This obituary is based on information from Wikipedia with some personal additions.

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Rushworth W D and Smith W P, 1968. Mapping and Demarcation of the Argentine-Chile Frontier Case, Photogrammetric Record, 6(22):150-167.

BY FRIEDHELM MOGGERT-KÄGELER

New Challenges for Digital Chart Production - Advanced Technical Solutions Need to be Implemented

Hydrographic Offices (HOs) have realized that bathymetric data is not sufficiently represented in Electronic Navigational Charts (ENCs). A few aspects of this topic have already been touched upon in the presentation 'Innovative approach in automated contour generation' (Moggert-Kägeler, 2017) that was presented at Hydro 2017. This article focuses on the challenges of high-density bathymetry chart production and introduces a new approach to cope with it.

In the past, ECDIS (Electronic Chart Display and Information System) users have repeatedly complained about the lack of bathymetric detail in ENCs. The resolution of depth information is too coarse to adequately display the extent of areas that are safe for navigation. The article 'Bathymetric ENCs in Confined Waters' (Di Lieto et al, 2018), explains this in an excellent manner.

RECENT INITIATIVES

In the last few years, the topic of high-density bathymetry ENC production has been discussed at various IHO meetings. Most HOs supported the initiative, but concerns were expressed including additional manual effort, 5MB file size limit for ENCs, and new ENC layout.

In February 2018, UKHO announced (Admiralty Press Release, 2018) that it had issued a high-density ENC. The ENC covers a small area of the Bristol Channel (2.2 by 1.3km). To confirm accuracy the results were checked manually. In addition, the Australian Hydrographic Office (AHO) in 2018 described their successful experiences with the production of high-density ENCs. The transition from a proof of concept to the implementation of an operational service is the next big challenge.

EXISTING SOLUTIONS

Solutions for the automated production of high-density Bathymetry ENCs have existed for many years. Even though the data is usually technically correct and standard compliant it misses the cartographic 'touch'. All solutions have a focus on automation and efficient processing of large data volumes. Often, the resulting contours are jagged, not generalized to scale and prone to clutter. Some manufacturers use basic methods to update ENC depth information. Hence, the resulting ENC bathymetry is not smoothly integrated and resembles a single bathymetry patch. Other manufactures have come up with solutions where high-density bathymetry is maintained and provided in separate S-57 layers complementing the regular ENCs.

Nevertheless, all these manufacturer-specific solutions have been implemented successfully on a regional basis in close cooperation with local stakeholders and authorities (ports, waterway authorities, pilots). They have not been designed to be used in ECDIS at all. The data is mainly used in portable navigation systems for pilots. However, from an HO perspective it may not fulfil all quality standards.

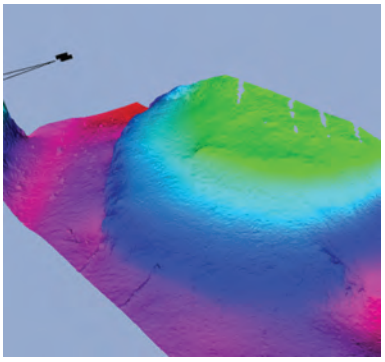

Figure 1a: Raw elevation model.

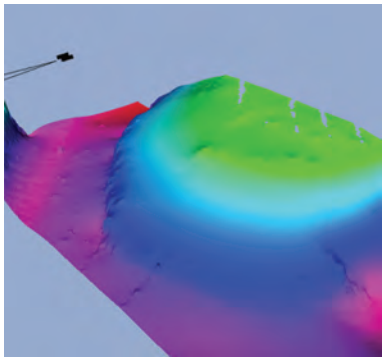

Figure 1b: Generalised elevation model.

A NEW APPROACH

More recently an approach has been introduced that provides an improved solution to produce high-density bathymetry ENCs. It reduces the amount of manual work for the creation of contours and selected soundings, supports automation and honours cartographic principles. Ideally the workflow should start where the underlying source datasets are managed.

The approach derives contour lines from a Nautical Elevation Model (NEM) – a shoal-biased smoothed-out and generalized underwater terrain model. It can be imagined as a draped sheet over rough bottom topography. If a little bit of tension is applied to this sheet it will form a smooth surface. This new surface touches the original model at shallow peaks and bumps and smoothes out noisy terrain and deeper holes as seen in figure 1a and figure 1b.

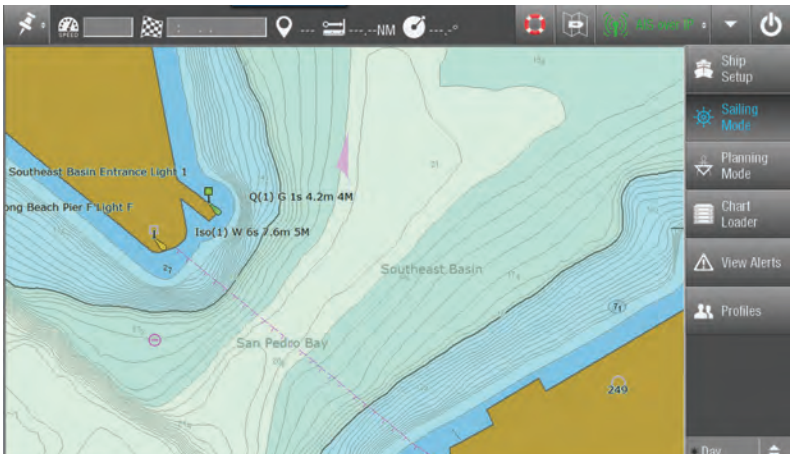

Figure 2: High-density bathymetry ENC in ECDIS.

Creating the contours directly from a rough source terrain model would result in 'noisy' and jagged contour lines. Usually line smoothing algorithms are not shoal-biased – therefore NEM is used instead. If derived from a smooth surface, the resulting contours have a smooth appearance as well. This is not only an aesthetic aspect but contributes to better chart readability and overall acceptance. The shoal-biased character guarantees that the resulting contours correctly represent the minimum depth.

The NEM can be generalized to a distinct product scale. The degree of generalization is controlled by means of a parameter set that is used by the processing algorithms.

Some aspects of the NEM are similar to the cartographic extraction methods of the Navigation Surface approach (Australian Hydrographic Office, 2018). Both use a kind of sheet model for generalization and smoothing of gridded bathymetry. Such sheet models tend to 'over-generalize' steep terrains and features like edges of dredged or natural channels. This is why the NEM integrates methods to dynamically configure the degree of generalization at different vertical levels.

Once the appropriate generalization parameters have been defined and the NEM has been generated, contours can be created. An additional process automatically creates the area-polygons of the depth areas between the contour lines.

The proposed solution can be used to generate contours at much denser intervals than usually found in traditional ENCs. Special effort was made to make sure that the results comply with the strict topology rules for ENCs (IHO S-57, ENC Product Specification, and S-58 Validation Checks).

When contours are created at metre or sub-metre intervals not all contouring algorithms achieve error-free results. This is especially true in terrains where contours are getting pushed very closely to each other.

Once automated production workflows for the generation of high-density bathymetry charts are in place, it is no longer practical to check and validate the results manually – instead automated validation will be used. To confirm the reliability of the contour generation methods, S-58 validation software was improved to be able to handle the large number of lines and areas.

Dozens of high-density S-57 datasets were created and repeatedly tested with the S-58 validation software in order to fine-tune the contour generation process. Finally, a no-error quota of 99% was achieved. This means 1/100 datasets would require manual corrections.

HOW S-100 DEALS WITH HIGH-DENSITY BATHYMETRY

IHO's S-100 is the framework for the definition of multiple future digital products required by the hydrographic and maritime community. Within the S-100 family, S-101 is the new specification for ENCs, and S-102 describes a gridded representation for high-density bathymetry.

S-101 ENCs can include high-density contours in the same way as S-57 ENCs. Both represent depth information by means of soundings, depth contours and depth areas. Hence the production procedures described above are suitable for both S-57 ENCs and S-101 ENCs.

S-102 uses a completely different model for depth information. It's based on a gridded structure and does not use line or area features. In a high-resolution S-102 grid (e.g. 1m x 1m), each grid node represents a single depth value.

S-102 is seen as bathymetric complement to ENCs in ECDIS. >

It has some advantages over the line and area bathymetry of ENCs: it allows for 3D display of depth information, it is suitable for applying advanced water level correction models (e.g. to show real water depths) and it can represent bathymetry close to survey resolution.

However, since S-102 has some disadvantages as well (large file size, too much detail and tendency to cause clutter), high-density gridded bathymetry in S-101 ENCs and S-102 should complement each other.

Up to defined depths, larger scale ENCs could contain high-density bathymetry where they cover channels and fairways. The data should be complemented by S-102 gridded bathymetry in congested or extremely shallow waters and areas where safe navigation is affected by strong variances of water level.

CONCLUSION

Hydrographic Offices will face new challenges if they decide to take the step into regular production of high-density bathymetry ENCs. Advanced technical solutions are available and will have to be implemented to cope with the new challenges. The introduction of S-100 based digital products will provide additional options.

This article is a modified version published in Hydro International July/August 2018.

ABOUT THE AUTHOR

Friedhelm Moggert-Kägeler has an educational background in Geodesy/Hydrography and holds a degree in both fields. He joined SevenCs in 2000 and has worked in various positions ever since. His jobs range from S-57 data production and training, customer support, to research and development. Currently, he is responsible for the overall coordination of the company's product management.

BY IOSEBA TENA

The Advancing Technology of AUVs - A View of the Autonomous Underwater Vehicle Market

Since the last autonomous underwater vehicle (AUV) review in 2016, the market has continued to grow. The biggest market for AUV systems remains the military. The world's most advanced navies own and operate low-logistic AUV systems for mine countermeasures (MCM) in very shallow waters. These systems can operate in confined areas where MCM vessels cannot. The same systems can also be used in search and recovery operations, hydrography and salvage. This market used to be dominated by a handful of AUV providers, however, the number of manufacturers is increasing.

Defence primes are also investing in these technologies through internal development programmes or acquisitions. In the commercial sector, the number of companies offering AUV services has grown too and new concepts of operations have been developed to adapt their use. As an example, Ocean Infinity operates multiple AUV systems from a single vessel, enabling faster data acquisition. The success of this application was demonstrated by the search for and discovery of the ARA San Juan submarine.

TECHNICAL BUILDING BLOCKS

The growth in AUV use is in part driven by continuing improvements in AUV technology and capability. Since 2016, new AUV models have been launched and these can gather more data over longer periods and more accurately. Many of these AUV systems are more compact than their predecessors despite their increased capacity.

Better endurance, improved communications, more accurate navigation, enhanced imaging, artificial intelligence and big data are all contributors. Recent advances in energy density, spearheaded by the mobile phone industry, have helped improve AUV endurance. In parallel, communications, navigation and payload instruments are becoming more effective. The latest advances in signal design are being used to make acoustic communications travel further and carry more data, using less power. Other techniques like free space optical modems are also enabling large amounts of data to be transferred through-water to AUV systems, using the visible light spectrum at distances of up to 150m. More than ten thousand times more data can be transferred this way than is possible with acoustics. In parallel, navigation performance is improving thanks to new inertial navigation systems that can dead-reckon with as much as twice the certainty of what was possible in 2016. This is possible by combining the latest generation gyros and acoustic aiding from Doppler velocity logs as part of a single instrument (https://youtu.be/5pGDMr1tryg).

BETTER UNDERSTANDING OF THE ENVIRONMENT

There are now many more options for AUV payloads. When thinking about a mission, operators can

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Low-logistic AUVs have become the survey tool of choice for expeditionary forces. Pictured is the Bluefin-9 two-man portable AUV from General Dynamics Mission Systems.

C-Worker Unmanned Surface Vehicle and National Oceanography ALR working together in recent trials demonstrating acoustic and optical communications (https://youtu.be/fgv8j9pO4I0).

choose from lasers, sonars and even stereoscopic high-definition video. Electronically scanned sonar systems are now manufactured in all sizes - even as small as a GoPro camera – for every application. Some produce stunning imagery at 5m range using high frequencies. Others, working at lower frequencies, can spot obstacles at ranges of over 1000m. For inspection missions, video and laser are combining to provide stunning pictures of the subsea environment as it has never been seen before; at cm resolution and in full colour. When it comes to survey, operators are not just limited to side-scan sonar imagery and multibeam bathymetry. There is now a new generation of multi aperture sonar systems capable of extending range and producing 3D bathymetry. Synthetic aperture sonar has also proved popular for large AUV systems. This is an industry generating more data than ever before. Fortunately, it is at a time when storage solutions have become more prevalent, and machine learning and big data techniques are becoming wide-spread.

So, how are AUV systems being used? The following section explores some of their current uses.

MILITARY ROADMAPS

Cylinder shaped AUV systems with a diameter of approximately 9-12 inches have become a common sight in MCM. These systems are typically equipped with side-scan sonar systems and high-grade survey systems. They are launched from small vessels or rigid hull inflatable boats and survey rectangular areas of the seabed in search of objects of interest. The data quality and speed of survey make them the ideal tool for this purpose. The number of working systems operated by navies keeps increasing and the number of navies adopting them is also increasing. They are also playing an important role in helping navies understand and learning to use autonomy.

The Belgian and Dutch navies are currently accepting bids for their next generation MCM vessels, which will be equipped with AUV systems and other autonomous assets as standard. This will be a world-first; traditionally, mine hunting vessels are equipped with towed or variable depth sonars. The UK's mine countermeasures and hydrographic capability programme and the US littoral combat ship MCM module follow a similar model. AUV systems may become the de-facto mine hunting tool (https://youtu.be/HrFWepU1iRk).

AUTONOMOUS SUBMARINES

The US Navy announced recently that it had awarded contracts to Boeing and Lockheed Martin to develop extra-large diameter AUV systems. These systems will replace submarines in many of their missions, deploying from shore and travelling thousands of nautical miles to conduct intelligence gathering, surveys or inspections. It is not just the military that is contemplating long-endurance AUV systems. The National Oceanography Centre (NOC) in Southampton, UK, has developed a range of systems named Autosub long range (ALR) which can travel for months and conduct scientific missions across large distances. The most famous ALR, nick-named Boaty McBoatface, will be operated from the UK's flagship oceanographic vessel the RSS Sir David Attenborough when it launches. The ALR has already demonstrated the ability to operate 'over-the-horizon' by linking to an unmanned surface vessel and using it to establish a link to shore. It has also demonstrated the ability to detect leaks and seeps and its use for carbon capture inspections.

Extra-large diameter AUV systems can be deployed and recovered from shore, so launch and recovery is simpler and they can operate in a much wider set of sea states. They do, however, need a large battery pack and very accurate navigation. The promise of this technology is that it can deliver science at a fraction of the cost of a vessel and crew. Others may well follow NOC's designs.

OIL AND GAS

This sector has been using AUV systems commercially for many years for deep water surveys. The year 2016 saw some new players enter the market and a renewed interest in autonomy from operators in autonomy. The downturn in the oil price meant that operators had to seek more efficient ways to operate, and AUV systems were and remain part of the solution. The commercial use of AUV technology is still dominated by the deep water survey market. There are also some systems available for surveys in shallower waters and a lot of work has been done with these in West Africa. Companies like Ocean Infinity are questioning the status quo and it will be interesting to see what happens. Other companies, like MMT, have banked on remotely operated vehicles (ROVs) capable of fast survey speeds. Interestingly, these fast ROVs look remarkably like an AUV but remain tethered to a surface vessel.

Will there be a time when the tether is severed? Perhaps not for survey tasks. However, as far as subsea

inspections are concerned people are asking when, not if, the tether will be severed. In this area, there is a race for dominance. Saab Seaeye introduced the Sabretooth product, a hybrid ROV/AUV for prolonged duration inspection missions many years ago. Since 2011, i-Tech Services has been working on its autonomous inspection vehicle (AIV) offering for oil and gas inspections. These companies are being joined by Oceaneering, with its Freedom concept, Saipem, with Hydrone and its FlatFish license, the Eelume snake-like AUV, and Houston Mechatronics' Aquanaut. IKM also offers a resident electronic ROV concept. While each system has its differences, they all mix remote operation with autonomous decision-making. Furthermore, they are all being built in response to operator demand. Companies like Equinor have made no secret of their vision for underwater intervention drones, a term they have trademarked. Recently, other companies including Aker BP have included AUV operations in their vision statements. This promises to be an exciting space to watch.

AUV SWARMS

Another development is the proliferation of low cost, small AUV units, which collaborate and work together for one common goal. This is typically referred to as a swarm of AUV systems. There have been some well publicised trials by several companies, and other work has been published but not discussed in the open media. More work is being conducted by companies which prefer to remain outside of the public domain while their technology is being developed, deployed and manufactured. The biggest commercial driver for this technology is thought to be for marine seismic applications. However, the military and oceanographic bodies are also keen to develop tools that enable them to cover larger swaths of the oceans. This is very much a work in progress and it is hard to predict when the technology will become commercial. Crucial technical hurdles still need to be met: How does the swarm communicate? What payload sensors can it carry and afford while remaining commercially viable? How do we launch, operate and recover every AUV?

THE SHELL OCEAN DISCOVERY XPRIZE

While this article was being written, the final of the Shell Ocean Discovery XPRIZE was taking place in Greece. Many teams entered the competition with the ambition of being the first to provide a solution capable of launching from shore or air in order to explore the competition area, to survey it and to photograph a specific object. The competition area is up to 4,000m deep. There is US$7 million in prize money to be won. Eight teams made it to the final, each with their own unique concept, from AUV systems supported by USVs for launch and recovery, to air-deployed ones.

The aim of this competition is to help increase our knowledge of the oceans. Only 5% of the ocean floor has been explored, yet the oceans provide 50% of our oxygen. In fact, we know more about the surface of Mars than we know about our own seabed.

ACADEMIA AND NATIVE AUV SYSTEMS

Academia continues to use and develop AUV systems. Institutions such as the NOC, Woods Hole Oceanographic Institution, Scripps Institution of Oceanography and Monterey Bay Aquarium Research Institute have led these efforts. Now, many other programmes are being developed across the world. From South America to South East Asia, researchers are developing home-grown AUV systems to help advance their own understanding of the technology and to help adapt it to their own needs. This is evidenced by the diversity of teams that took part in this year's AUVSI Robosub, a high school and undergraduate AUV design competition. The top three teams were from China, Singapore and Canada, respectively - in a competition that took place in the USA.

WHAT SHOULD WE EXPECT TO HAPPEN NEXT?

Operating autonomously subsea is challenging: lack of communications, intense physical pressure, no ambient light and unchartered waters add up to make it one of the most difficult technical challenges for humanity to solve. Solutions have been found and over the last two decades the market has grown in ways which we never anticipated at the start of this journey. As new blue technology industries such as aquaculture, mining and renewables evolve, I expect AUV systems to play a part in their evolution. The successes since 2016 should help with the continued expansion of the AUV market. New successes to come will in turn fuel future market growth. Will the market be dominated by extra-large AUV systems, AUV swarms or extra-large AUV swarms? Most likely a combination of them all.

This article is a modified version published in Hydro International November/December 2018.

ABOUT THE AUTHOR

Ioseba (Joe) Tena is tasked with shaping and growing Sonardyne's instrument business for marine robotic systems across all application domains including offshore energy, defence and ocean science. He works alongside his colleagues to ensure that clients' operational requirements are completely satisfied through the delivery of low-risk subsea technologies, products and services. He has been involved in developing smart solutions for the underwater vehicle industry for more than two decades and continues to lend his expertise to the engineering team.

BY TOM ALLAN AND TOM PUGH

Life During and Beyond University - How to Get the Best out of it

What do you call a group of surveyors? A herd? A gaggle? Or perhaps, a congress? Seldom do you find such a large group of geospatial professionals gathered than at Newcastle University's professional awareness fair 'Life During and Beyond Geomatics' which takes place every October for students enrolled on the geomatics degree courses.

Now in its thirteenth year, the event has grown from just a handful of exhibitors, to an extensive array of 23 companies, ranging from traditional land surveyors to large construction firms, building consultancies, instrument manufacturers and data providers.

The event is designed to give undergraduates the opportunity to see first-hand, some of the roles that they may find themselves in during their time on the course, as well as post graduation. It is both a testament to the course, and the event, that such a large number of the exhibitors, representing industry leading firms, are alumni from the university.

A STUDENT'S VIEW

Tom Allan is a third-year student studying Surveying and Mapping Sciences at Newcastle University. Below, he describes his experiences with the Life During and Beyond Geomatics career fair and the valuable placement he gained at Malcolm Hollis, as a result.

The event is a cornerstone of the geomatics studies at Newcastle University. Each year, alongside regular exhibitors, students connect with industry players, all of which are keen to share the opportunities they have for budding students.

This provides students with a varied and comprehensive understanding of the types of firms operating within the geospatial industry and the roles available. During my time at Newcastle University, I have seen the event grow in size and popularity – showing the appetite for strengthening the link between academia and industry. Interestingly, the fair is also supported by an increasing number of Newcastle alumni, now working in many of the exhibiting firms.

On the day, students can ask potential employers about job roles, graduate schemes and placement opportunities. The outcome of which, is an improved understanding of the variety of jobs relevant to geomatics degree courses. This is vital for students unfamiliar with the diversity of opportunities available in the geospatial industry.

Students also see first-hand, the evolution of equipment and software from suppliers. Observing the development of new laser scanners, such as the Leica Pegasus Back Pack and Leica RTC 360 scanner. Companies such as Quest UAV and Plowman Craven are pioneers in technological assessment tools and present cutting-edge equipment; these tools benefit the industry directly by increasing the efficiency of data acquisition, and therefore project completion times. Not only are they an exciting change and development to current devices, but they also illustrate how new products are shaping the future of the geospatial industry.

Having developed an introductory understanding of the industry, students are left well placed to begin enquiring with exhibitors about real placement opportunities, laying the building blocks for a successful career in geomatics. Exhibitors offer a wide variety of placement opportunities, encouraging students to apply on the day or via formal correspondence later.

... what is it really like in the real world?

At the last event, I intended to scout the job opportunities and graduate schemes offered by exhibiters in relation to work sectors that I enjoyed. I particularly relished speaking with surveying consultancies and oil companies about the roles of geomatics in their industry.

After the event, I applied to a range of companies, including Malcolm Hughes and Malcolm Hollis, who are both highly respected in the industry. I was lucky enough to gain a three-month internship with Malcolm Hollis under the wing of Tom Pugh, a partner and head of their measured surveys service.

The experience I gained during my summer placement enhanced my knowledge of software programmes from AutoCAD to Cyclone. I also worked with multiple surveying tools, such as laser scanners, providing me with a better understanding of the geospatial industry, it's diversity of jobs, and the application of my degree in the real world.

I have taken my learning back to my academic study where it is supporting my current research project which focuses on the improved measurement efficiency resulting from modern measurement tools. Knowledge, I feel, would have been hard to obtain without real-world experience.

I see this event as one of the most important and valuable aspects of my course. The ability to connect directly with the industry, learn about the opportunities out there and obtain relevant experience is brilliant and something that should be strived for by any course provider.

As the career fair grows in notoriety, so does its value to students. It perfectly illustrates the collective efforts of the industry and academia to provide positive career guidance for the next generation of geospatial professionals, supporting future job security and diversity in the industry.

THE EMPLOYERS PERSPECTIVE

Tom Pugh, MRICS, is both an Alumni and Exhibitor and has experienced the evolution of the event over its lifetime, being one of the exhibitors of the first fair with Plowman Craven, to now exhibiting with Malcolm Hollis LLLP.

As an alumni from the course, I recognize the importance of passing on my experiences to the next generation of students. Regrettably, Newcastle University did not create this event until after I left. I therefore knew first-hand how difficult it can be to make connections within the industry without this type of resource. The real value to the students is that they can listen to like-minded individuals to get answers to burning questions like 'what is it really like in the real world?' and 'what careers can I use my degree with?'

The key piece of advice I give to students is to speak to as many exhibitors as possible, gather a broad range of views, see who has summer placements available, and who has graduate opportunities at their firms. As someone who undertook a summer placement during my studies, I can vouch for the benefits of working for an extended period. Thus, putting into practice what I had learnt in lectures and practical sessions.

Students who are more interested in GIS can speak to the companies which specialise in this area. Similarly, if they have an interest in heading offshore, then the exhibitors can tell them what it is really like being confined to a boat for weeks on end and what kind of activity they will conduct whilst working there.

Obviously, from an employer's point of view, we are looking to attract budding surveyors to apply and come to work at Malcolm Hollis. Over the four years that Malcolm Hollis has attended the event, we have had four summer placement students, with one converting into a full-time graduate employee. Toni Goldsmith joined the firm this year, having spent last summer on placement with us. Newcastle is one of the few places in the UK which offers an undergraduate degree programme for geomatics, and the calibre of students is always high.

Newcastle University's work to create this professional awareness fair is of great benefit to the students undertaking geospatial degrees. It helps them familiarize themselves with key industry players, and vice versa. For Malcolm Hollis, we see it as a great opportunity to present our social values, wellbeing initiatives and the rewarding work that our employees are involved with. This is an event that we as a business will continue to support, with the aim of helping to inform the coming generations of geospatial professionals and provide them with valuable opportunities to begin careers in the commercial property industry.

Tom Allan and Tom Pugh at the Newcastle Careers Fair.

BY RENALT CAPES

A Ground-breaking Revolution - InSAR used to Create Ground Stability Maps

Satellite radar interferometry (InSAR) is a technique that can measure millimetre-scale movement of the ground from space. It does this by comparing the return echoes, and thus the signal-path length, from two or more radar images taken over the same place, over time. Although ground movement using satellite radar was first demonstrated as long ago as 1989 (Gabriel, Goldstein, & Zebker, 1989), it was not until the launch of the European Space Agency's Earth Resources Satellite-1 in 1991 that a consistent archive of radar images begun to be assembled that allowed further development of the technology for terrestrial applications.

Modern InSAR is now used by a range of industries concerned with ground or structural stability, from building development and control, to oil and gas production, to mining, to road and rail management. This article explains some key aspects of InSAR technology and its operational development, from simpler two-scene processing for mapping earthquakes, to the multi-thousand image processing now undertaken to produce national (or a very wide area) coverage ground stability maps.

PHASE SHIFTERS

InSAR is based upon 'repeat-pass' (multi-temporal) data collected by radar satellites orbiting the Earth at several hundreds of kilometres altitude. These satellites actively emit microwave radiation and record the echo on a pixel-by-pixel basis. The echo comprises a sine wave caught by the receiving antenna at a specific point in its 360^0 phase cycle. All things being equal, the echo response in any subsequent image for this pixel will be caught at the same point. However, in real life, all things are not equal, and an amount of phase shifting between images can occur for various reasons, including; system noise, instrument vs target geometry, influence of topography, decorrelation due to ground-cell disturbance (e.g. vegetation movement), atmospheric refraction, and then the signal in which we are most interested; any difference in the signal path length due to movement of the ground away from or towards the satellite. See Figure 1.

The first three of these phase-shifters can be corrected. The effects of most vegetation, or other ground-cell decorrelation, cannot be overcome, but can be helpfully indexed as a quality

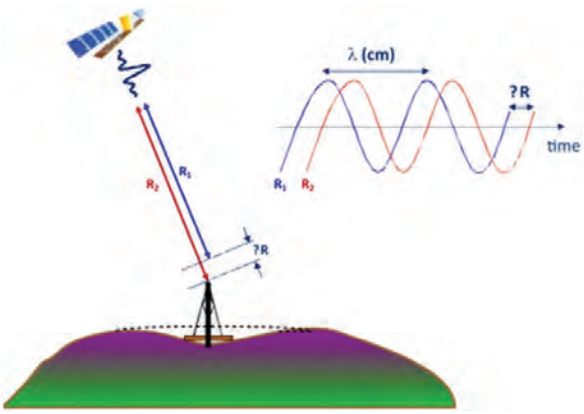

Figure 1: The principle of InSAR for measuring ground movement. Copyright: TRE ALTAMIRA 2018.

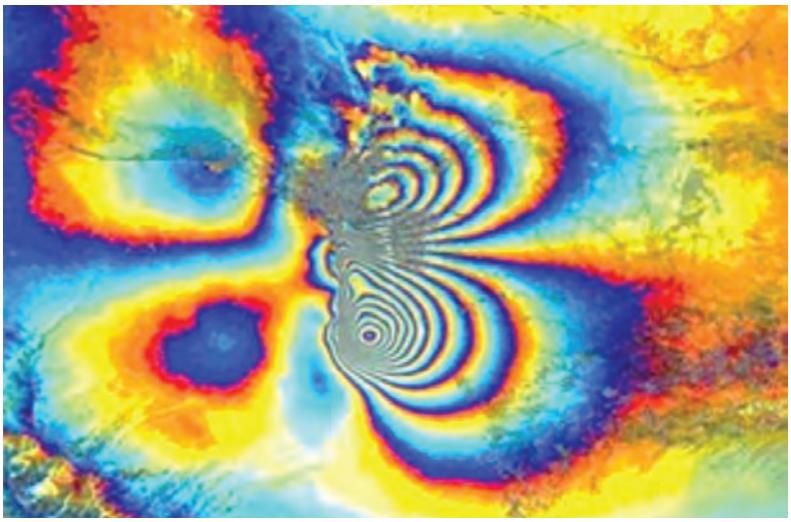

Figure 2: Example interferogram (Bam earthquake, Iran, 2003). Each 'fringe' represents half the wavelength (~28mm) displacement in the satellite line of sight. Copyright: TRE ALTAMIRA 2018.

measure of coherence. Signal refraction, however, cannot usually be corrected, and becomes a main limiting factor in the 'displacement resolution' of the InSAR process applied.

InSAR processing in its simplest form for movement detection uses two radar images of near identical specification, bracketing in time the event of interest, say, an earthquake. The phase data of the first radar scene is compared with that of the second one to produce an interferogram (figure 2) that shows the different range values between the two image dates - the displacement resolution of such a product is typically one or two centimetres at best and is limited mainly by the round trip of each radar signal through the atmosphere. Indeed, rain-clouds and other atmospheric phenomena can severely refract signals and completely disrupt useful measurement.

Although conventional interferometry has its limitations, in some commercial scenarios such as open-cast mining where potential movements can be relatively large and rapid, these products can have real value in augmenting ground-based instruments to provide regular and fast safety assessments. However, for smaller, more subtle movements, the vagaries of our atmosphere were always going to prevent 2-scene differential interferometry from developing into a tool of more clinical precision.

PERSISTENCE PAYS

Around the turn of the millennium, a team led By Professor Fabio Rocca at Milan Polytechnic came up with an elegant solution to the effects of the atmosphere that exploited the large archives of satellite radar data that were being systematically collected by ESA's ERS missions (Ferretti, Prati, & Rocca, 2001). The technique they invented looks at all the images archived over a certain location to identify arrays of ground features that naturally and persistently reflect back to the satellite in every image - 'persistent scatterers' (PS – sometimes referred to as 'permanent scatterers'). The phase for each scatterer is cross-compared across all the scenes of the archive to calculate any movement. By analysing a minimum number (a few tens) of images, the major effects of the atmosphere can be modelled out, and displacement resolution improved by an order of magnitude over conventional InSAR. Quite remarkably, using this technique, movements of the ground as small as a millimetre per year can be measured from 700km away in space. Persistent scatters are typically buildings, infrastructure, or even bare rocks, and in urban environments can number from a few hundred, to many thousands of points per square kilometre, depending on satellite resolution. In Figure 3 we can see an array of InSAR measurement points (permanent scatterers) related to a small town within an agricultural context. The points are colour-coded by average velocity; green points are stable, yellow-red points are moving away from the satellite, in this case, subsiding. Each point holds a time-series that can reveal trends in deformation.

Since 2010, further refinements to the 'PS'-InSAR process have ensued to squeeze as much out of the data as possible. Persistent scatterers are related to the radar impulse responses of individual ground-cells, and their point spread functions result in single points (even though the satellite spatial resolution might be, say, 20m x 5m (Sentinel-1), a correctly-oriented, 1m trihedral corner reflector in an uncluttered field would still be clearly discernible). Through further advanced research, the arrays of PS measurement points have now

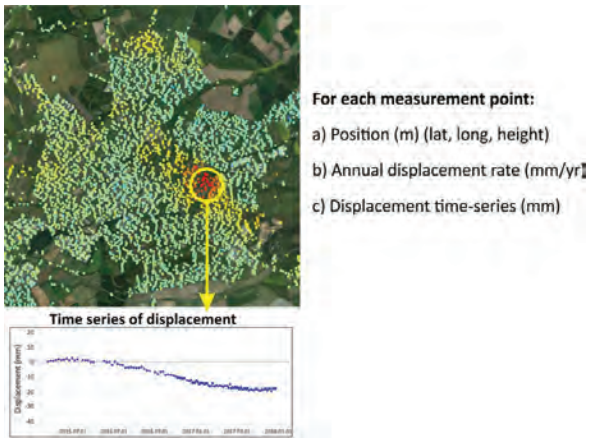

Figure 3: Example persistent scatterer products. Copyright: TRE ALTAMIRA 2018.

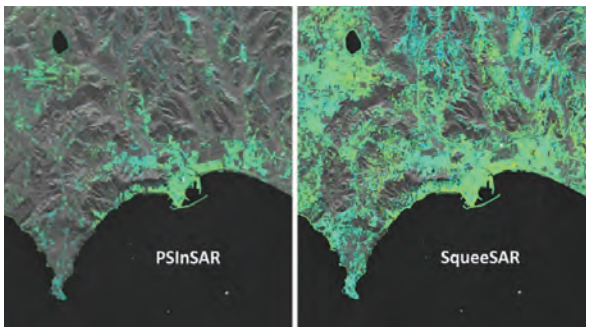

Figure 4: Example PS vs SqueeSAR. Copyright: TRE ALTAMIRA 2018.

been joined by arrays of 'Distributed Scatters' (DS), where clusters of ground cells with adequate coherence but low amplitude are aggregated to create a secondary form of measurement point, thus significantly increasing overall coverage (Ferretti, Novali, Rocca, & Rucci, 2011). See Figure 4.

PRODUCTS

So, what are the actual products from the PS+DS InSAR process? The main output is the array of measurement points as a spreadsheet. For each point, its location, elevation, average velocity, time-series, and quality parameters are given. This data enabled a 2D vector plot to be visualised in a GIS where each point is colour-coded depending on velocity in the line-of-sight of the satellite. Depending on software, clicking on a point will reveal its time-series

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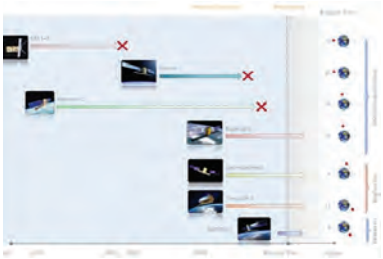

Figure 5: InSAR-compliant radar satellites, past and present. Copyright: TRE ALTAMIRA 2018.

Figure 6: UK InSAR map of ground stability. Colours indicate average ground velocity in mm per year. Greens are stable, yellow-red points are moving away from the satellite with blue points moving towards the satellite. Copyright: TRE ALTAMIRA 2018.

where the evolution of its motion can be examined. The overall period measured is user-specified and archive-dependent, but data for some applications go back to 1992, so ground motion trends over the last 26 years can be assessed. This data can be superimposed by other geospatial layers to determine any coincidence of ground motion to help assess risk.

It is not suggested at all that InSAR is a panacea for monitoring ground motion, nor does it replace conventional survey techniques. It does, however, have its unique perspective and 'non-invasive' attributes, and can help prioritize ground surveys, or reduce their required frequency and density; moreover, it can provide displacement data over very wide areas (thousands of square km), where the cost of a conventional survey would be prohibitive and not always possible.

LIMITATIONS

Although a remarkable technology, InSAR has limitations;

- Radar data availability: Data acquisition by the various InSAR-compliant satellites has not always been of consistent quality or adequate coverage, or of high enough frequency. Before any job, the archives have to be checked for suitable time sequences and for quality.
- Rural coverage: Ground-cell similarity between images decorrelates with time, and so the interval between data acquisition is critical to getting good measurements. Currently, and especially at temperate latitudes, InSAR is unreliable over most types of vegetated landcover, limiting its application to the built (or rocky) environment. Soil moisture also directly effects penetration of the radar signal, and so variation in the former may result in phase changes mistaken for displacement. However, rural areas often contain linear or sporadic infrastructure from which good measurements can be taken, and movement of these can be indicative of a bigger picture.
- Where's the PS? The precise location of Persistent Scatterers cannot be predicted before processing (unless radar corner reflectors are specifically sited). What constitutes a PS depends on many factors such as materials, geometric shape, orientation, and aridity. Plus, some echoes may in fact be the result of bounces between multiple ground-based objects before the signal is returned to the satellite. This presents a marketing dilemma, particularly for more medium resolution products where the density of scatterers, even in towns, can be insufficient: the client wants to know if a certain area or feature is moving, but we don't know if there will be any measurement points in the right places until after we've invested in processing. Pre-processing and experience help overcome this problem.
- Costs: InSAR processing is complex, from accessing the right radar data to understanding what the outputs mean. InSAR service provision means advanced and complex software, high-performance computing power, and highly-qualified and expert staff. For higher resolution InSAR, there is also the high cost of the raw radar data needed. InSAR can be expensive and is not cost-effective in some scenarios.
- Market inertia: There can be resistance to disruptive technology, especially if significant investment has already been made in alternative survey technology. It's also not always clear to see exactly how InSAR might fit into an organization's existing workflow. The only answer here is education, in both directions. The pros and cons of using InSAR need to be balanced against using current methods. InSAR is now gaining traction and becoming accepted by a growing number of sectors.

THE ERA OF COPERNICUS

Copernicus is the world's largest single Earth observation programme, directed by the European Commission in partnership with ESA (www.copernicus.eu). The programme went live in 2014 with the launch of the first of the Copernicus Sentinel satellites, Sentinel-1a, a high-quality radar specifically configured for operational InSAR service provision. This was joined a year later by Sentinel-1b, an identical sister satellite placed in orbit 180^0 apart, to double temporal resolution of the overall mission to an InSAR-compliant repeat every six days. Sentinel-1 has since been joined in orbit by the (non-InSAR) Sentinel-2, 3 and 5 missions that are focusing

on other issues such as agriculture, pollution and climate change. The data from all Sentinel missions are free and openly available via the Copernicus Open Access Hub (https://scihub.copernicus.eu), although of course they need processing. For more information on the Sentinel missions, see https://sentinel.esa.int/web/sentinel/missions.

SENTINEL-1

Sentinel-1 has disrupted the InSAR market - in a good way. Finally (at this 'medium' resolution), after 20 years of scrabbling around trying to develop commercial markets with unreliable or non-existent radar data, we now have reliable global coverage that repeats every six days from two different look-angles. That equates to 120 regular acquisitions a year over all areas. As less change is occurring in between image acquisitions, overall coherence is higher (although vegetated landcover still remains problematic). Given the right processing in the right circumstances, Sentinel-1 data provides clean, precise InSAR measurements. Furthermore, robustness and continuity are assured, with follow-on satellites already in the pipeline. This fosters confidence and enables the public and private sectors to build satellite services into their workflows and benefit from the many advantages of operational satellite remote sensing.

It must be emphasised that Sentinel-1 provides what we term 'medium-resolution' data, meaning that derived InSAR products are mostly suitable for wider-area, synoptic analysis of ground and structural motions, equivalent to around 1:50,000 scale mapping. Other higher resolution satellites are available for more detailed inspection of individual buildings or infrastructure. Sentinel-1 data can be considered useful for identifying ground motion hotspots over a wider area that might then demand a closer analysis with a higher resolution radar mission, such as AIRBUS's TerraSAR-X that will give results in urban scenarios to around 1:10,000 scale. Figure 5 shows the main InSAR-compliant missions, past and present.

BRAVE NEW WORLD

Extraordinary volumes of data are downloaded from Sentinel-1, currently around 3.5TB per day (>1 PB per year). As of February 2019, 3.5 million Sentinel-1 products were available for download, their raw versions representing ~7PB total. Each raw radar image is around 8GB. The sheer amounts of data now available challenge computing power and traditional methods of image processing. Fortunately, through Moore's Law, computing power has kept up, and rather than analysing individual images, big-data principles mean that complete multi-temporal archives are being intelligently mined to extract new types of change-data. PS-InSAR was perhaps the 'remote sensing pioneer' in big data processing, pushing technological boundaries by processing complete archives, albeit over relatively small areas. Now, with advanced InSAR algorithms that exploit multi-node cloud computing, combined with the systematic radar data generation and supply that Senintel-1 affords, large-scale processing, and significantly pre-processing of very wide areas is not only practically possible, but already a commercial reality.

UK MAP OF GROUND STABILITY

Based on the processing of 7,500 Sentinel-1 radar scenes covering 2016 and 2017, TRE ALTAMIRA have produced the first ever double geometry PS-InSAR map of the UK, mapping the nation's ground stability to a unprecedented accuracy (see figure 6). By integrating different satellite acquisition modes, motion vectors have been deconvolved to produce two geospatial layers; one of purely vertical motion, the other of just east-west (the satellite is not sensitive to ground motion parallel to its orbital path, which is nearly north-south around the Earth). Measurement points are provided on a regular grid to ease integration with other data.

The map was updated mid-2018 with some improvements, with 2019 being updated quarterly. This is in fact the sixth very wide area product processed by TRE ALTAMIRA and made possible by Sentinel-1, the others being all of France, Denmark, Japan and Italy, plus a large part of California, USA. As mentioned, this data is not suitable for the monitoring of individual structures, but appropriate for wider-area identification of hotspots that might then require closer inspection (see Figures 7 and 8).

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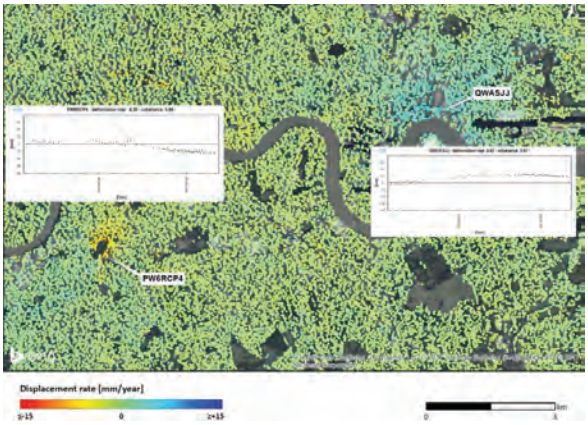

Figure 7: Ground motion in London. Copyright: TRE ALTAMIRA 2018.

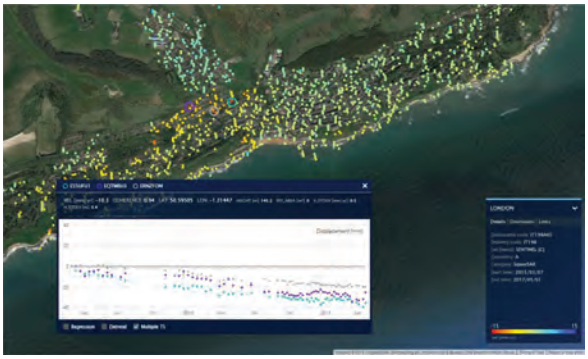

Figure 8: Slope instability at Ventnor, IoW. Copyright: TRE ALTAMIRA 2018.

CONCLUSION

This article has given a brief overview of the development of terrestrial InSAR since its pioneering beginnings in the mid 90s to the automatically computed national products that are based on data from truly operational and service-driven satellites. InSAR is not yet a commodity, and potential users still need to be careful who they choose to do their processing, and of course there will always be the demand for more customised InSAR processing, and with higher resolution satellites. Nonetheless, the Copernicus programme has broken new ground by providing some fantastic satellites by which it can be measured.

ABOUT THE AUTHOR

Dr Renalt Capes has 26 years experience in satellite remote sensing of which 24 have been devoted to the development of InSAR. He currently contracts to TRE ALTAMIRA in support of the development of the UK market. He can be contacted at ren.capes@tre-altamira.com

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Short Course on Small Unmanned Aircraft Photogrammetry Lifts Off at the Survey School

A two-day course, dedicated to maximising the impact of data collected using a Small Unmanned Aircraft (SUA), launches at the Survey School, Worcester on 9 April 2019.

Over two days, a maximum of 12 students, guided by an expert tutor, will learn how to plan and process SUA imagery to achieve professional survey output. The course content is delivered in four sessions, each lasting 2.5 hours. Through a mixture of lecture room presentations and software demonstrations, delegates will learn to plan flights for optimum coverage and be taken through workflows to ensure accurate data delivery. Advice given on how to produce the highest quality imagery will cover camera settings, lenses, field of view, resolution, distortion, ground sampling distance (GSD), coverage/overlap and photo-control.

Delegates will be given a brief background in photogrammetry theory to place technology advances in context and an explanation of how 3D data is produced from an orientated and overlapping series of 2D images, both for stereo mapping and the modern multi-image software products.

With the emphasis on flight planning, field checking and quality control, the survey outputs available to the SUA user will be explained at each stage of the process. These include photogrammetric point clouds, triangular surface meshes, textured 3D models, raster digital elevation models for GIS, and orthophotography and 3D vector data collection. Software demonstrations and case studies will help to crystallise the information learnt from the previous sessions. For more information, visit https://bit.ly/2Tg6iz4.

A three-day course covering theoretical and practical photogrammetric techniques is on offer from 12 March at the Survey School. Six delegates led by a highly experienced tutor will be shown how to plan, take and process high quality images to create accurate and detailed 3D site, building and topographical models from both terrestrial and aerial photography.

Due to rising demand and the small teaching group approach, the use of cameras, combined with a hands-on processing experience will be a regular feature of the course at the Survey School.

Tutor, Clive Boardman, said "Demand for the course has arisen because of the recent introduction of more user friendly and semi-automated methods, developed via a combination of computer vision algorithms and conventional photogrammetry."

Delegates can expect the course content to include plane and orthorectification of imagery, the application of user-orientated techniques using lower cost software, how to specify and commission projects and useful case study illustrations.
For more information, visit https://bit.ly/2E271KS.

GOLD CARD APPROVAL FROM CSCS

Past graduates of The Survey Association's (TSA) surveying course can now obtain a Gold Card from The Construction Skills Certification Scheme (CSCS).

Following an application by TSA, CSCS, the UK's leading skills certification scheme within the construction industry, has agreed the waiver for the 381 Survey School graduates who started the course before April 2018.

Director of Operations at CSCS, Gordon Jenkins, said "CSCS is pleased to work alongside TSA to reach an agreement that benefits the construction industry and aligns with the objectives of the Construction Leadership Council. Working with the standard setting body, we have concluded that the TSA surveying courses, which started before the Level 3 Diploma, meet the required standards for this occupation."

Students who started the TSA Surveying Course after April 2018 will not be able to use it to get a CSCS card. They must instead complete the Level 3 Diploma in Engineering Surveying.

TSA Council Member and Survey School Governor, Nathan Spencer, said "The course has been the foundation for the Level 3 Diploma and Level 3 Apprenticeship, ensuring the next generation have the skills required to support the construction industry. It is very positive news for the surveying industry that CSCS recognises TSA's contribution."

To apply for the Gold Card, with endorsement as Engineering Surveyor, candidates will need to present their graduation certificate and a letter of authentication to CSCS. To obtain these documents, email the Survey School at office@surveyschool.org.uk. The cost for this is £80 + VAT. The Survey School can provide a duplicate certificate if needed.

BY DURK HAARSMA

Interview with FIG President Rudolf Staiger - Supporting the Profession with Expertise, Proposals, Solutions and Platforms

Durk Haarsma, publisher of GIM International, sat down with Rudolf Staiger, FIG President, to discuss the surveying profession as it is now and how it will look in the future.

GIM INTERNATIONAL: CONGRATULATIONS ON BECOMING THE NEW PRESIDENT OF FIG! CAN YOU TELL US A BIT MORE ABOUT YOURSELF?

Rudolf Staiger: Having grown up in the Black Forest in south Germany, I studied geodesy at the University of Karlsruhe, after which I spent a year in Paris, France, also studying geodesy, at the National Geographical Institute (IGN). After that I worked for a few years in the private sector, including at Wild, which was later taken over by Leica Geosystems. I then returned to the academic world working as a researcher at the University of Essen and later Bochum. In Bochum, I became vice-president of the university, responsible for research & transfer. I've always enjoyed sports; I used to swim, play volleyball and cycle, and nowadays I love going hiking and skiing – but unfortunately not as often as I would like.

Rudolf Staiger.

GIM: THE PROFESSION IS IN TRANSITION. WHICH NEW CHALLENGES AND OPPORTUNITIES IS THE DIGITAL TRANSFORMATION CREATING FOR SURVEYORS?

RS: We are currently facing a general and global transition. I see various challenges, such as the rapid pace of technological change and the transformation of our markets and products into becoming more open and less restricted. [This] presents an opportunity, because geospatial products are used by everybody – think of Google Maps or navigation for self-driving cars. Geospatial products are seen as part of a beneficial and necessary infrastructure for the development and well-being of our society, so our products have shifted from being 'invisible' or 'classified' to being an essential and important element of our future digital society. One of the major challenges for surveyors is to show clearly why their professional knowledge is needed to secure and interpret data and optimize the use of the available technologies.

GIM: ANOTHER KEY CHALLENGE FOR THE SURVEYING PROFESSION IS TO ATTRACT NEW STUDENTS TO GEOMATICS. WHAT IS THE RIGHT STRATEGY, IN YOUR OPINION?

RS: The answer to a young person's question 'What am I going to study?' is obviously heavily influenced by the image that they have of the various professions. But how and where is this image created? It is strongly influenced by TV, social media and – most importantly – in school. We should therefore go into schools and present the surveying and geospatial profession, because a lot of school pupils have no idea about our tasks, tools and the way we work. We need to show them current opportunities in our profession and at the same time highlight how interesting and beneficial it can be – also for society as a whole – to work in this industry.

GIM: THE ACCELERATION OF URBANIZATION WORLDWIDE IS PLACING HIGH DEMANDS ON SPATIAL PLANNING. WHAT IS THE SURVEYING COMMUNITY'S ROLE?

RS: First, we have to deliver all the geographic material and data in maps, 3D models and so on which are necessary for the planning,

construction and maintenance of our urbanized world. Spatial planning based on those products is also an important part of our profession. In this respect, our planning specialists should bring in their expertise and ideas, because the catalogue of demands is quite complex: we want to create a future society with improved living conditions, also taking account of aspects like climate change, sea-level rise, limited energy resources and affordable housing.

GIM: IN 2015, THE 17 SUSTAINABLE DEVELOPMENT GOALS (SDGS) WERE SET BY THE UNITED NATIONS GENERAL ASSEMBLY. HOW WOULD YOU DEFINE THE ROLE OF GEOSPATIAL INFORMATION IN ACCOMPLISHING THESE GOALS?

RS: If you want to 'measure' the 17 SDGs and their degree of fulfilment, it is obvious that more than 70% of the goals are directly related to geospatial data. So, the first priority for our profession is to deliver precise and up-to-date data enabling SDG-related performance to be measured. There is no doubt that the 17 SDGs are important milestones on the way to a better world in order to improve the living conditions for everybody. FIG will support the accomplishment of these goals without restrictions. The role of a professional organization like FIG is to offer expertise in the form of proposals, approaches or even solutions. In addition to this, with events like our Working Weeks and our Congress, FIG provides platforms where experts from all over the world – coming from academia national mapping agencies, cadastre agencies, private-sector companies and international bodies – can gather and meet.

GIM: NATIONAL MAPPING AGENCIES TAKE CARE OF THE NATIONAL GEOSPATIAL DATA ENTERPRISE, WHICH IS A HUGE TASK. WHAT IS THEIR ROLE IN THIS AGE OF DIGITAL TRANSFORMATION?

RS: Up until 1990 the national mapping agencies, along with the national military institutions, had the exclusive access to geospatial data. Nowadays this is totally different: geospatial information has become a public good and is available in high quality, often free of charge. In addition to this significant change, we are facing another challenge in the form of big data. Due to the enormous progress in data acquisition, especially regarding the degree of automation and the speed, it will be essential to develop strategies and software solutions for the handling and treatment of the huge datasets which are collected every day.

GIM: IT HAS BEEN SAID THAT UAVS ARE DEMOCRATIZING GEOINFORMATION AND TURNING CITIZENS INTO SURVEYORS. IS THIS A HYPE, OR THE NEW REALITY OF A CHANGING GEOSPATIAL LANDSCAPE?

RS: It is also said that 'the difference between men and boys is the value of their toys!' This is one possible perspective if we talk about UAVs, but it's definitely too shortsighted because UAVs are offering fantastic opportunities. Let's start with the technical part: at first glance, a UAV is nothing more then a 'flying tripod'. But combining this with new digital cameras and treating the acquired data with SLAM software packages, such as AGISOFT, gives us totally new and exciting products and tools which can be used in a variety of applications. In this respect, UAVs can become a basic toolset for our entire profession.

GIM: IN GENERAL, HOW DO YOU SEE THE FUTURE OF THE GEOSPATIAL SOCIETIES?

Rudolf Staiger being presented with the FIG chain of office.

RS: As geospatial societies, we play a very important role: we offer a global platform of exchange for our stakeholders – authorities (national and international), administration, private companies, education and manufacturers. The geospatial societies are supporting and promoting our profession as an entity and our approach is non-commercial and for the sake of the whole profession and our society.

GIM: WHICH MAIN GOALS DO YOU HOPE WILL BE ACHIEVED DURING YOUR PRESIDENCY?

RS: The FIG 'brand' is very well known and we are the biggest international society representing the geospatial and surveying profession on a very broad base. Nevertheless, except for our FIG office in Copenhagen, we are all volunteers. We have to strengthen our organization and prepare it for the near future. One of the major tasks will be to activate people who are willing to contribute to all FIG's commissions, networks and taskforces in the future. Also, we have to prepare our members for rapid and fast technological change, including the digital transformation and the resulting opportunities. And, last but not least, we want to continue playing an active and well-respected role within the UN system, together with the World Bank and other organizations.

This is a modified version of an article from GIM International January/February 2019.

BY IAN DOWMAN

DGI 2019 - Geospatial Intelligence for National Security

DGI 2019 followed the pattern of previous years with a subtitle of Geospatial Intelligence for National Security and with similar themes, the main ones being collaboration, integration and partnerships. There was an emphasis on the role of geospatial analysts, with sessions on what makes a good analyst, training analysts and how to get analysis to decision makers in command centres and the field. Although the conference is focused on geospatial intelligence for defence (GEOINT) there is much for civilians to take from the conference.

A Planet Dove.

Collaboration, integration and partnerships are clearly related and many speakers emphasized the need for trust between collaborators and added that trust does exist between military mapping organizations within their own groups. One speaker noted how trust has eroded by comparing the reaction of the Soviet Union to the evidence derived from satellite imagery during the Cuban missile crisis, to the reaction from Russia to similar evidence during the incursion into Ukraine. "Geo is true" is no longer accepted fact.

There were several sessions on training and recruitment. It is considered essential that analysts come from a wide spectrum of backgrounds and that knowledge of geospatial can be added to their primary subject – the Australian Geospatial Intelligence Organization recruits at 'tech' conferences such as Comic Con.

The commercial involvement in DGI comprised an exhibition and presentations. Major defence companies such as Airbus, BAE, Raytheon, and Digital Globe attended, along with a number of smaller data acquisition companies and a number of data analysis organizations. One newcomer is Capella, who use SAR to give persistent surveillance from space using 36 orbit planes with 1-hour revisits when fully configured. Orbits are non-sun synchronous with a 90-degree inclination. Other companies underlining the increasing importance of SAR are NovaSAR and ICEYE. The latter is a Finnish company supported by Seraphim Capital, a UK investment company specializing in startup companies with and interest in space. Revisit capability is also increasing for optical sensors. Planet now collects 1.5 million images a day and has an average of 800 images for every location on Earth.

Vanessa Lawrence in her presentation on the Space Application Catapult highlighted the success of UK start up companies such as Birdi and noted that they are involved with image analytics and encourage collaboration between military and commercial.

There are other opportunities for commercial companies and agencies responding to disasters to collaborate with defence organizations. It was noted that although the military has much to offer, for example in data assurance and data fusion, they also have much to learn about response to disasters and working with a professional NGO service. There is a need to be prepared for collaboration, it is too late when a disaster occurs. A speaker from UNOSAT, one of the United Nation's agencies dealing with satellite imagery referred to a paper by Quin et al (2018) which showed how AI has been used to study refugee settlement mapping.

One question which arose from the conference was 'what is the relevance of DGI to UK commercial activity?' First it can be seen that the papers are not only about GEOINT, many presentations covered technology and applications of interest to commercial companies. There is also a strong emphasis on the need for collaboration and standards, and the commercial sector can learn from the way that this is done, for example in military education (educating technical and leadership students together to learn from each other).

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