

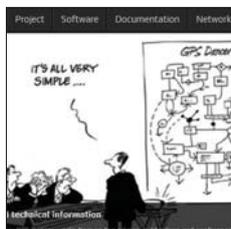
Geospatial technologies at 'Prosumer' show



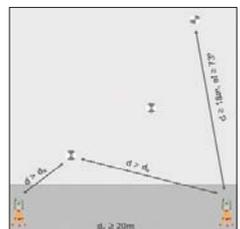
Mapping Ireland's marine resources for sustainability



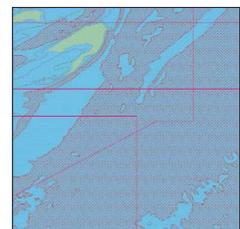
GNSS and antennas: thinking outside the box



Calibrating HDS scanners and user checks



From nautical charts to digital marine mapping





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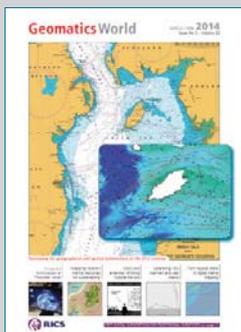
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COVER STORY

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>> GW's DIGITAL EXTRAS You can read more of this issue online including:

MapAction deploys to The Philippines — the vital role played by mapping in disaster emergency response, is explained by Nigel Woof, OBE. Go to:

<http://www.pvpubs.com/archives.php?titleid=1&issueid=222>

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Note: the electronic version can now be downloaded as a PDF.

NEXT ISSUE The next issue of **GW** will be May / June 2014.

Copy dates are: Editorial: **07 April** Advertising: **17 April**

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With a focus on hydrographic topics and the at times apocalyptic wetter side of life, there is still space for tunnelling, calibrating laser scanners, cheaper GNSS solutions and BIM.

Fluvial times highlight what geomatics can offer

We don't often cover consumer events but **Adam Spring's** report in this issue (page 12) from the Las Vegas International Consumer Electronics show reveals what we've been missing. UAVs, digital imagery, location technology, robotics, 3D printing are all technologies with relevance to our industry. In their beginning these technologies were the province of the military, then business and finally the consumer. But the innovation drive may have shifted to the consumer sector, which of course is where the big bucks are. Just take a look at the Panono for a fun product that could have serious geomatics applications, especially with GNSS aboard.

Readers working in construction will not be surprised at the tale of woe recounted on page 06 of the News regarding the penetration of a rail tunnel by a piling auger. **Richard Groom** has carefully read the Rail Accident Investigation Branch's report and precised it for us. **Malcolm Draper** in Undercurrents recounts an older but similar incident, while **Carl Calvert** examines the legal implications. When will those designing and engineering schemes learn the value of a site surveyor?

As we go to press Britain is facing the worst flooding in most people's lifetime. While the Severn estuary has long been a manageable threat we thought we'd tamed the country's mightiest river. Not so, as Old Father Thames rolls not just on but to right and left as well. It is not for those in geomatics to play the blame game, although the fault lines seem increasingly to be between those who rely on evidence based on scientific enquiry and statistical records and those who put their trust in the press and a gut feeling that flooding just happens sometimes. For us there should be opportunities ahead as ever more accurate flood maps and terrain models are called for, not least by insurance companies and the Environment Agency.

So to mark these fluvial times this issue has a distinctive "wet" look (and that doesn't include Splashmaps, see page 32). **Richard Groom** has undertaken a detailed analysis of the papers presented at the recent Digital Hydrography on the Maritime Web event, while **Fergal McGrath** introduces INFOMAR, Ireland's detailed survey of its commercially valuable waters including some stunning mapping, which I hope we've done justice to. Meanwhile Dr **Mike Osborne** and **John Pepper** of Oceanwise explain how they pioneered the re-engineering of the Admiralty Chart into digital data fit for GIS and Electronic Chart Display Systems. However, they question whether fundamental issues remain.

The sea played a more sinister role in what happened in The Philippines last November. While the typhoon claimed many lives, the aftermath has seen one of the best coordinated rescue efforts with MapAction playing an essential role in providing the information teams need before venturing too far on the ground. **Nigel Woof**, who was awarded an OBE this year for his past efforts for the charity, provides a vivid account of MapAction's role. To read Nigel's tale you'll need to go to *GW's* extra pages; online at <http://www.pvpubs.com/archives.php?titleid=1&isueid=222>

For the technically inclined articles on two of geomatics' key technologies provide interesting reading. **Joel Van Cranenbroeck** was formerly with Leica and really knows his stuff when it comes to monitoring and using GNSS. He suggests a rather cheaper way of keeping track of several locations than installing a receiver at each one. Meanwhile, Leica's Hans-Herbert Tuexsen describes the painstaking procedures necessary to calibrate an HDS scanner.

Finally, Professor **Ian Dowman** reports from this year's RICS BIM conference with question marks hanging over whether the industry is ready – especially the Qs and FM managers – for BIM level 3.

Stephen Booth, Editor

TEN YEARS AGO

GW MARCH/APRIL 2004

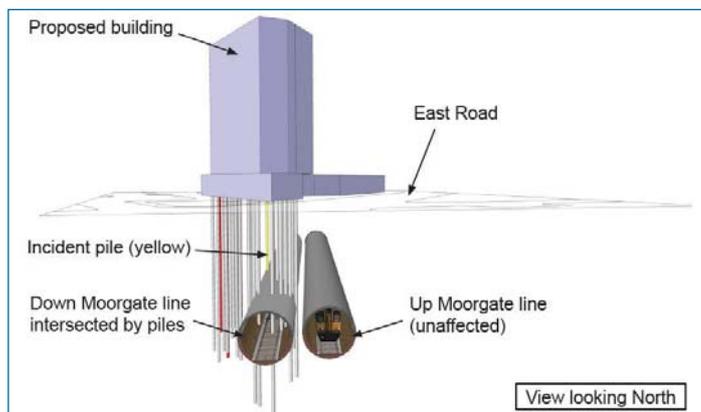
In some respects 2004 doesn't look particularly different from 2014. Much of the technology we enjoy today was well established. Leica had just announced the System 1200 total station with a GPS option, while top-end instruments like Topcon's newly launched GTS-720 featured Blue Tooth and WinCE. To see a more startling difference one has to go back 20 years to our predecessor journal, *Surveying World*. The March 1994 issue majored on satellite imagery, – back then an undeveloped market but with huge potential.

One thing that has changed is the rarity of book reviews today. Almost every issue of *GW* back then had one or two. March/April 2004's had one I still recommend as a sound introduction to project management. The Sydney Opera House, fine iconic building that it is, was a tale of woe from the moment an unknown Danish architect sketched a few flamboyant sails on the back of an envelope more than half a century ago. *The Saga of Sydney Opera House* by **Peter Murray** is full of insight and an easy read (156pp).

The editor welcomes your comments and editorial contributions by e-mail: editor@pvpubs.demon.co.uk or by post:

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RAIB reports on punctured rail tunnel



It was only train driver vigilance and a measure of good luck that prevented a serious rail accident on Network Rail's Northern City Line tunnel between Old Street and Essex Road stations in London on March 8th 2013. A driver reported seeing water pouring through the roof of the tunnel as he passed through. Then a second driver, who was sent with an out-of-service train to investigate, found a pile boring bit and debris on the tracks. The incident was caused by piling from a building site 13m above the tunnel puncturing the tunnel lining.

The Rail Accident Investigation Branch (RAIB) published its report on 14th February 2014 – eleven months after the incident. The investigation found that no-one knew about the tunnel beneath the site. The tunnel route is not shown on OS MasterMap or historical OS mapping. The presence of a tunnel is hinted-at, somewhat cryptically in the registered title for the site, which states: "So much of the sub-soil as was vested in the Great Northern and City Railway is excluded from the registration". Unfortunately, the solicitor handling the latest change of ownership of the site saw no need to search further and the information was not passed on to the architect or design engineer. The tunnel is owned by Network Rail, but because the developer was not aware of its presence, a search had not been requested. The local authority also failed to pick up the presence of the

underground railway during the planning application process for the same reasons.

Concerning mapping, some, but not all railway tunnels are shown on OS mapping. The report does not make a recommendation concerning this apparent inconsistency but instead recommends that railway infrastructure owners should publish information concerning railways that are not shown on OS maps. The investigation also looked at Google maps. We should perhaps ask why it considered Google maps, because they cannot be considered authoritative, but setting aside that point, the RAIB investigation found that some tunnels are shown but in a schematic way, so that the actual alignment of the tunnel may differ significantly from the actual alignment.

The client undertook utility searches by approaching each company separately but did not consider the possibility that railway tunnels might be present. The report does not examine this, but following the privatisation of most utilities, it is common practice to use utility search companies to contact the numerous underground utility owners. Some search companies offer a 'gold, silver or bronze' service, where only the gold service covers all utilities. The concept of gold silver and bronze searches is worrying enough, but does their definition of utility include railway tunnels? Worth a check, perhaps.

Finally, the investigation report mentions two previous incidents of a 'similar character'. However, the crucial difference

between the Old Street incident and these previous incidents, and the factor of importance to the geomatics profession is that both were caused by "an error in the positioning investigation equipment at ground level". The first resulted in puncturing of the Central Line at Wanstead during construction of the M11 link road in 1986. It pre-dates the RAIB and there is no report online. The second incident, at Kennington on 20th November 2007, did not result in puncturing of the tunnel, was not investigated by the RAIB and was not publicised within the surveying industry. If anyone wishes to send GW the report, we will extract any learning points for the benefit of all.

This report summarises aspects of the investigation that are most relevant to geomatics. You can read more at http://www.raib.gov.uk/publications/investigation_reports/reports_2014/report032014.cfm

Ground-based sense and avoid

Following a successful demonstration of the system, the US Army plans to install a new ground-based sense and avoid (GBSAA) network at five installations by 2016 to ensure its UAVs can operate safely with other aircraft in domestic airspace. The army's largest UA, the MQ-1C Gray Eagle is flown at the five sites. It decided to develop GBSAA as an efficient means of complying with Federal Aviation Administration (FAA) regulations for flying in domestic airspace. Visit:

<http://www.army-technology.com/news/newsus-army-demonstrates-gbsaa-radar-capabilities>

Huge support for GEO Business

GEO Business – the highly-anticipated new geospatial event to be held in London from 28th – 29th May 2014 has kicked off its visitor marketing campaign with a bang. To date, seventy-six live workshop sessions have been arranged, the exhibition will have over eighty international companies and the Gala Dinner is already nearly sold out. The call

for conference papers resulted in submission of over 110 abstracts. The full programme will be in place by 1st March 2014. Visit www.GeoBusinessShow.com

OS wants graduates

Ordnance Survey is offering seven graduates the opportunity to lead the way in developing innovative and inspirational solutions for digital data via the national mapping agency's graduate recruitment scheme.

OS Head of Human Resources, Nadine Prior, explains: "This year we've expanded our graduate scheme and we are looking for seven exceptional, results-driven graduates to push the boundaries of what we do, challenge our thinking, develop our people and help us create the products and services of tomorrow. Visit: www.ordnancesurvey.co.uk/graduates

BIS consults on LR future

A consultation on proposals to create a new company responsible for the 'service delivery functions' of Land Registry in England and Wales closes on 20th March. The Department for Business, Innovation and Skills (BIS) wants 'the business of land registration to be more delivery focused and for Land Registry to have greater flexibility to operate'. BIS claims to have carefully considered the views of customers and stakeholders and has sought to mitigate any concerns – in particular through retention of the 'Office of the Chief Land Registrar' (OCLR). The latter would be retained in government to 'perform regulatory and fee-setting functions to ensure that customers' interests continue to be protected'.

Ownership of the service delivery company (not yet branded) has not been decided but could be 100% government owned; joint government/private sector; or 100% government owned with day-to-day operations contracted out to the private sector. Visit <https://www.gov.uk/government/consultations/land-registry-new-service-delivery-company>

Atkins and Yotta win HA contract

The Highways Agency has awarded a £600,000 contract to Atkins and Yotta for the supply of Yotta's Horizons visualised asset management software and associated implementation services. The contract will deliver and enable the use of software to inform and improve the development of the Agency's road renewals programme. This tool will enable modelling to understand the current and future condition of the network based on its national pavement condition survey. The model will then be used to predict where and when maintenance is likely to be needed.

Help for Wash ports

OceanWise, in collaboration with Valeport, has been awarded a contract to deliver a Tidal and Meteorological Monitoring, Telemetry and Display System (TMMTDS) to the ports of Boston, King's Lynn Conservancy Board and Nene Ports. The TMMTDS includes three water level and weather monitoring stations in the estuary, plus a data feed from a monitoring station operated by the Environment Agency. Water level monitoring equipment for the project is being supplied by Valeport using the VRS20 radar sensor, and Gill Instruments weather sensors. GSM telemetry equipment provides bi-directional control of the outstations. System design, integration and all control, database and publishing hardware and software is being provided by OceanWise.

Cyark first 200

Following the October launch of the CyArk 500, the first round of site nominations will be passed to the 500 Advisory Council for their review. CyArk received nominations encompassing nearly 200 sites in 28 countries. Sites include a monastery complex carved out of caves in Georgia, the modernist Oscar Niemeyer house in Brazil, ancient Buddhist site Borobudur in Indonesia, rock carvings in Iran, the Medieval Palace at Visegrád in Hungary and

Kasbah "Taourirt" in Ouarzazate Morocco – to name just a few!

Once the Advisory Council reviews the applications, selected projects will continue onto the next round and will be asked to complete a full-fledged application, which includes detailed information on the significance of the site and scope of digital documentation necessary. Nominations will be considered on a three monthly basis. Visit www.cyark.org

Support for Student Organisations

The Trustees of the Aubrey Barker Fund have announced that the fund will consider applications from student organisations within the field of land surveying, quantity surveying and land economy to support student meetings. Funds to support student meetings can be used as travel bursaries to attend the meeting, to support tutors on training courses, or for specific costs in setting up a conference or training course. Visit www.abfund.net.

OS Developer Challenge

The Ordnance Survey has issued its latest challenge to application developers. Do you have a great idea for a geo-app or a business idea involving geo-location? If you know of a current business to business (B2B) problem or opportunity that could be solved, at least in part, by using OS data, the OS Developer Challenge could help to launch your business, without incurring many of the associated overheads. Free flexible working space and a mentor programme is on offer from TechHub as well as free access to OS datasets.

Visit: <http://www.ordnancesurvey.co.uk/innovate/developers/developer-challenge.html>

Support for Saudi Arabia

Marine data management specialist OceanWise, has combined with hydrographic software provider Caris BV to support the General Commission for Survey (GCS), Kingdom of Saudi Arabia (KSA). The support is helping KSA to further develop its capability and capacity as it

Mapping pollution



Bluesky is to conduct trials of the world's first integrated night mapping system. Combining a specially adapted camera with Bluesky's LiDAR and thermal imaging sensors it is hoped the trials will produce data to help combat light pollution, energy wastage and help manage urban habitats. The resulting map-accurate images will be a useful tool for managing street lighting operations and maintenance and as a resource to tackle energy inefficiency. The system has been developed in partnership with the University of Leicester following a research project funded by Bluesky.

Also in partnership with the University of Leicester, Bluesky is developing a system to map air pollution using a spectrometer to detect nitrogen dioxide. The system has been trialled successfully in Leicester and the researchers are now looking to conduct trials further afield.

embarks on an ambitious programme to produce Electronic Navigation Charts (ENCs) of its national waters, as well as supporting wider uses of hydrographic data, as part of the Kingdom's National Spatial Data Infrastructure (NSDI).

OGC adopts GeoPackage

The Open Geospatial Consortium (OGC) has adopted the OGC GeoPackage 1.0 (GPKG) Encoding Standard. The GeoPackage standard will make it much easier to exchange and share geospatial (or location) information across different devices, applications and web services throughout the mobile world.

The GeoPackage standard defines an open, non-proprietary, platform-independent SQLite container for distribution and direct use of geospatial data, including vector features and tile matrix sets. This approach simplifies development and gives applications access to a very wide variety of Web-based geoprocessing services.

BRIEFS

■ **The KOREC Group** has announced a new division dedicated to software development. The in-house capability will enable KOREC to customise Trimble solutions to meet customer requirements and applications. The new division will assist with a wide range of requests under the geospatial banner from GIS workflows and integrations, to Trimble Access modifications, to processing scan data from Trimble's mobile geospatial system, the MX8.

■ **Severe solar flares, space storms** and solar wind can disrupt satellites, GNSS, power grids and radio communications. The UK Met Office will be providing space weather forecasts from spring 2014 following an investment of £4.6 million by the Department of Business, Innovation and Skills. The forecasts will run all day, every day to provide a warning service to help protect this infrastructure.

A Home for Old Equipment

How many of you have older survey equipment sitting in the cupboard or storeroom, collecting dust but kept just in case it will be needed sometime?

Well it is needed now!

We at the Aubrey Barker Fund (Charity Commission No. 263855) support education, training, research and projects related to the disciplines of Land Surveying, Quantity Surveying and Land Economy in the developing world. The aim is to encourage students in these disciplines develop their knowledge and skills to help their countries in the future.

The fund was set up in March 1972 in memory of **Aubrey Barker**, a distinguished surveyor from Guyana, who was president-designate of The Commonwealth Association of Surveying and Land Economy (CASLE), but died before taking office. He had done so much to promote CASLE that colleagues throughout the Commonwealth contributed to the fund.

The trustees regularly support students to attend conferences, provide journal subscriptions to a number of universities in Africa, and have supplied relevant books (older editions) and surplus survey equipment to help with teaching and training.

This is where you come in. We have had a number of requests from universities in Africa for help with equipment and training. These departments have very little survey equipment, certainly nothing new, but for education purposes they do not need the latest equipment. Older equipment is perfect to teach the basics of surveying, similarly textbooks do not have to be the latest edition to be useful. Anything is better than nothing!

The Aubrey Barker Fund will arrange collection of equipment/book donations, get the equipment checked and then ship it overseas to where it will make a very big difference to the learning experience of students and their future.

• For further information or to arrange donations please contact:
Chris Little – clsurveytraining@gmail.com Tel: 01582 794262

■ **StreetMapper is being** deployed to laser map city centres and transportation networks across India. The system has been purchased by Geokno, a technology company specialising in GIS following the recent announcement of another \$400m of funding to boost investment in the sub-continent's infrastructure.

■ Technics Group has won the Surrey Property Awards for the second year running in the Surveying and Professional Services category.

■ **The BBC website reports** that the RAF were called in to fly SAR imagery over the recently flooded areas of southern England. During a five-hour flight they mapped the Thames Valley, the Somerset Levels and then the River Severn. Visit: <http://www.bbc.co.uk/news/uk-26187301>

■ **The next RSPSoc annual** conference will be held in Aberystwyth, Wales between 2nd

and 5th of September 2014. The event will be hosted jointly by Environment Systems Ltd and Aberystwyth University. It will bring together a progressive and diverse community that showcases the work being undertaken in both the academic and commercial sectors.

■ **The new RICS Research Trust** was launched at an event in December last year that brought together over 80 leading academics, research practitioners and think tanks in the field of property, land and construction. The Trust aims to support, deliver and disseminate high quality research, independent reliable knowledge and future thinking in the sector.

■ **Following our report in the** Sept/Oct issue of *GW* of a distribution agreement, Leica Geosystems parent, Swedish Hexagon Group, has acquired Aibotix, the German manufacturer of UASs. The move gives Aibotix access an international sales structure and the opportunity to integrate a wide range of sensors and software.

Nigel Woof awarded OBE

Former CEO of MapAction Nigel Woof has received an OBE in the New Years Honours List for Humanitarian Services. Nigel joined MapAction, the Buckinghamshire based charity, as a volunteer in April 2003 and quickly showed special talents during early deployments to Sri Lanka for the Indian Ocean tsunami in 2004 and the Pakistan earthquake in 2005. He became Operations Director in 2007 and then CEO in 2009.

Although he handed over his role as CEO in January 2013 he remains a very active MapAction volunteer and has just returned from the Philippines where he, along with other volunteers, prepared information maps to assist the UN Disaster Assessment and Coordination Team in the aftermath of one of the worst hurricanes ever to hit the Philippines.



Major John Eady (Retd)

The Defence Surveyors Association has advised of the sudden death of Major John Eady on 28th January 2014, aged 78 years. He retired from the army in 1981 and became a mathematics teacher at Queen Mary's Sixth Form College in Basingstoke. After retirement from teaching he became Secretary to the College Board of Governors and finally retired late last year. He lived in Winchester for at least the past 25 years and is survived by his sons Richard, Clive and Carl and his daughter Jane.

Events Calendar 2014

• SEMINARS • CONFERENCES • EXHIBITIONS • COURSES

We welcome advance details of events likely to be of interest to the Geomatics community. Please send details to:
editor@pvpubs.demon.co.uk

Esri International Developer Summit
10-13 March 2014, Palm Springs Convention Centre, California USA.
Contact:
www.esri.com/events/devsummit

AGI – Geo: The Big 5: 1: Future Cities
18 March 2014, Glasgow City Chambers, Glasgow, UK.
Contact:
www.agi.org.uk/the-big-5/

Oceanology International 2014
11-13 March 2014, London, UK.
Contact:
www.oceanologyinternational.com

RICS Geomatics Evening Lecture: SnakeGrid and Network Rail
27 March 2014, RICS Lecture Hall, London, UK.
Contact: Email pgsupport@rics.org

GEO Maritime
8-9 April 2014, Radisson Blu Hotel, London, UK.
Contact:
www.geospatialmaritime.com

SPAR International 2014
14-17 April 2014, The Broadmoor, Colorado, USA.
Contact:
www.sparpointgroup.com/International

Improving growth for SMEs in a GeoSpatial market
23 April 2014, The Royal Scots Club, Edinburgh, Scotland. Contact:
www.smeSpire.eu or email anne@gistandards.eu

INTERGEO Eurasia
28-29 April 2014, Istanbul, Turkey.
Contact: www.intergeo-eurasia.com

Everything Happens Somewhere Conference and Exhibition 2014
29 April 2014, Emirates Old Trafford, Manchester, UK. Contact:
www.geoplance.co.uk

GEO Business 2014
28-29 May 2014, Business Design Centre, London, UK.
Contact:
<http://geobusinessshow.com>



The recent Geo Forum lecture shone the spotlight on open source software and data. Is there an opportunity here for Geomatics, wonders **Chris Preston**, chair of the Geomatics Professional Group Board.

Chris Preston welcomes your comments and thoughts so please email on the following address geochair.rics@gmail.com

Drawing the right conclusions from open source and open data

– plus scan to begin and time to peer into the future

As Spring beckons in the UK, I hope that your businesses and homes have not been affected by the almost biblical flooding proportions here in the UK.

A recent Geo Forum Evening lecture at RICS GGS looked at Open Source innovation. It raises many questions about the software and data that we use. How many of us use open source software for business purposes? The mere fact it is open source, enables us to modify it for our own needs, a blessing or a curse?

The internet has enabled so much more open source data to be found too – and when combined with open source software provides enormous potential to understand our world. It was interesting to see **Stephen Booth's** and **Richard Groom's** article in the last *GW* that boldly stated the words of the ESRI founder, "WebGIS to transform cartography." WebGIS is available now and "will bring 3D and real time mapping to our desktops." However, what will that mean for geomatic surveyors? We understand about data and what it is suitable for in terms of use. We are able to assess from what we see and the metadata, the quality of the dataset. By relating it to other quality assured data, a view on its usefulness may be obtained. However, open source suggests others less skilled will be using that software and data too but will they be drawing the wrong conclusions? An opportunity for us perhaps.

Scan first message hits the spot

Good to see in *Modus* 02/14 a short column called "One thing I know," **Allan Hunt** (BIM Lead Director, Aedas Building consultancy) comments "Do not forget how important

laser scanning can be to a project. It's an accurate snapshot in time providing a dependable base on which all aspects of the project will rest. So the message is beginning to get through just how important a survey is at the outset of a project. It is hoped that more of our clients will understand the value we provide at a modest cost.

Crystal Ball time

How much time does your company devote to remaining relevant and planning for the world of tomorrow? What sort of future jobs will there be? What skills will be needed? What additional skills can you bring to a multidisciplinary project? Networked teams are likely to need foreign language ability. Does that concern you? The person asking these questions is none other than **Michael Newey**, the RICS President. The universities want to be able to provide suitably skilled graduates and provide courses the industry wants. Some universities have enabled links between, students, companies and alumni. The best companies offer trainees guidance and mentors within their own company. Universities are increasingly offering whole courses online. Has community crowd sourcing got a part to play to share what is known? Is this the way forward for Geomatics? It would be great if you could all look into your crystal balls and let me know what you think because this can help shape the way forward for our profession.

To update you on the GeoBusiness conference: we have had 111 paper abstracts to filter down to a manageable number for the high quality conference, so have you registered yet? <http://geobusinessshow.com/>.

CHANGING ADDRESS OR MOVING ON?

If you receive *GW* as part of your RICS membership, you must inform the Institution of a change of address – the publishers of *Geomatics World* cannot change the RICS membership database for you. Call +44 (0)870 333 1600 or login to the RICS website or write to: RICS Contact Centre, Surveyor Court, Westwood Way, Coventry, CV4 8JE, UK or email contactrics@rics.org

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Piling on the agony brings woe for tunnellers

Tales of woe for those driving piles above tunnels and some really great pics this time. If you've worked in Legoland you must have met our friendly surveyor, but surely he should have had a mate for the staff?

I do hope none of our readers have been affected by the flooding. Friends and readers overseas tend to regard Britain as a rather small country and therefore major flooding along the Thames and western counties means they assume we're all wallowing along in waders and wellies and the furniture has floated away. I live right beside Old Father Thames but we're still above high water mark. . . so far. But I am wondering whether the much maligned Environment Agency records these points.

Undercurrents' flood expert advises that high water marks are recorded by a variety of means: river flow gauging stations, surveying using aerial photography (and hopefully SAR), by recording the location and level of trash and other marks left behind by the flood and - ultra scientifically - where members of the public say the water reached. I like the last one. I heard one lady on the tele confidently say in one breath that the water was half a metre up the side of her car and two inches below her front door. Don't get me started on measurement systems.

You'll read in this issue (News, page 06 and Carl Calvert's column page 33) about an

accident that occurred last year when a piling rig punctured a railway tunnel in the City of London. The tunnel was not shown on OS MasterMap (not all are and in any case MasterMap shows "topography" not subterranean features). No investigation of the tunnel was called for by either the architect or engineer, indeed they were blissfully unaware of its existence. So who would have thought there might just be a railway tunnel passing through the capital city? An underground services surveyor perhaps?

This has all happened before. In the late 1980s a similar incident took place although on that occasion the engineers (who shall be nameless) not only knew of the tunnel's existence, they'd even surveyed it but

didn't think it worthwhile staking out the line on the surface. Instead, they trusted the coordinates given by the designer for the pile positions, which had been scaled off a 1:2500 OS sheet. Alas their coordinates relied on a site grid and were out by a few metres from OS National Grid, with the result that a London Underground train hit the piling auger when it pierced the tunnel lining. Fortunately no one was seriously injured.

Clients too often skimp on having proper surveys done. On that job they wouldn't pay for a surveyor to be on site permanently and instead called one in from time to time. This may seem like the right economic approach but they forget that the same surveyor may not be available, so a new one, unfamiliar with the site and the history, has to take up the job. All too easy to make a mistake. There was no continuity of site knowledge. It was a mistake waiting to happen!

Shady shaddock

I was lucky enough to go to Barbados again last month and coincidentally met up with **David Powell**, the renowned RICS boundary specialist and former chair of Geomatics. We went to see **Brian Hart**, a friend and local surveyor with his own business and a lovely house. Brian and his wife **Janice** treated us to a delicious afternoon tea of mauby syrup (a West Indian speciality), rum punch, coconut cake and banana cake. Our pic shows the three of us in Brian's garden in front of his amazing shaddock tree. The fruit is also known as the pomelo (*citrus maxima* for those proud of their Latin). The fruit arrived in the West Indies and was named after a captain who introduced it from the East Indies.

Miscellany

When I was young (several years ago) and my intent was to go to medical school. The entrance examination included several questions that would determine eligibility, one of which was "Rearrange the letters P N E S I to spell out an important part of the human body that is more useful when erect." Those who wrote "spine" became doctors. The rest ended up in parliament.

I asked someone recently if he played golf. 'No' was the firm reply, 'I'm still sexually active!'

A group of pensioners was sitting around



Under the shade of the shaddock. Three surveyors gather in Barbados. Brian Hart (left), David Powell and yours truly.

talking about their ailments at the local coffee shop. "My arms have got so weak I can hardly lift this cup of coffee," said one.

"Yes, I know," said another. "My cataracts are so bad; I can't even see my coffee" commented another. "I couldn't even mark an X at election time because my hands are so crippled," volunteered a third. "What? Speak up! What? I can't hear you, said one elderly lady!" "I can't turn my head because of the arthritis in my neck," said one, to which several nodded weakly in agreement. "My blood pressure pills make me so dizzy!" exclaimed another.

"I guess that's the price we pay for getting old," winced an old man as he slowly shook his head. The others nodded in agreement. "Well, count your Blessings," said a woman cheerfully. . . "Thank God we can all still drive."

It was hard getting over my addiction to the Hokey Cokey. But I've turned myself around and that's what it's all about.

Police have just released details of a new drug craze that is being carried out in Yorkshire nightclubs. Apparently, Yorkshire club goers have started injecting Ecstasy just above their front teeth. Police say the dangerous practice is called "e by gum"

A Yorkshire man takes his cat to the vet.
Yorkshireman: "Ayup, lad, I need to talk to thee about me cat."
Vet: "Is it a tom?"
Yorkshireman: "Nay, I've browt it with us."

A Yorkshireman's dog dies and as it was a favourite pet he decides to have a gold statue made by a jeweller to remember the dog by.
 "Can tha mek us a gold statue of yon dog?" he enquires.
 "Do you want it 18 carat?" asks the jeweller.
 "No I want it chewin' a bone yer daft bugger!"

Now for some more of those sayings from Confucius, which he may or not have said but might have, if he'd thought of the point!

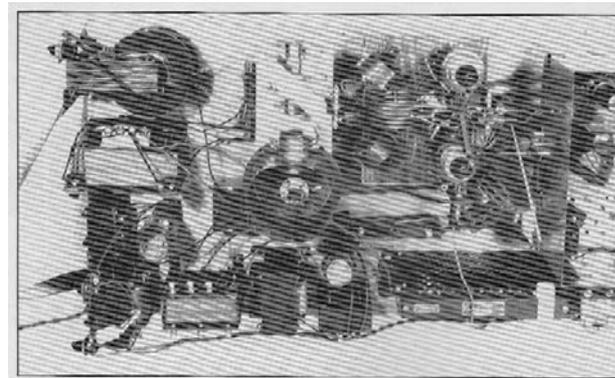
Is this what happens to surveyors who go working in Legoland? Professor Jon Mills at Newcastle upon Tyne sent us this. He says, "Not too sure about levelling with a total station, but no problem, my son thinks it's a laser scanner anyway!" For those keen to get Smiley the Surveyor go to: Amazon and look for the Playmobil 5473 Surveyor with equipment



John Tomlinson spotted this sign in Mt Manganui, north island New Zealand. He thought he might pinch the slogan, but leave out the "so much more than".



Now for one of our occasional competitions. What is it? No it's not an early digital drum kit. Answers please by 14 April latest. A small prize for the correct one. In the event of a tie, we'll draw for an Undercurrents special prize.



Man who wants pretty nurse, must be patient.
 Lady who goes camping must beware of evil intent.

Man who leaps off cliff jumps to conclusion.

Man who runs in front of car gets tired. Man who runs behind car gets exhausted.

War does not determine who is right, it determines who is left.

Man who drives like hell is bound to get there.

And finally Confucius did say. . .
 "A lion will not cheat on his wife, but a Tiger Wood!"

Got a tale to tell?

Please send letters for publication by e-mail to the Editor: editor@pvpubs.demon.co.uk or contact Undercurrents, in strictest confidence if you wish (we promise to change names, places, etc to protect the guilty!), via e-mail: rentamal@aol.com



27 Zones for the "prosumer" at International CES 2014

Above: The xxArray camera rig used PhotoScan to document visitors in all dimensions.

Robotics, UAVs, VR, 3D printing, location aware devices can all set consumers twitching. But these technologies have plenty of crossover apps for business too. From Fleetwood Mac to Will.i.am, **Adam P. Spring** reports from Las Vegas's star-studded mega International Consumer Electronics Show (CES).

The International Consumer Electronics Show "CES" was first held in New York in 1967. It now attracts 150,000 + visitors each January, and has been held in Las Vegas since it changed from bi-annual to yearly format in 1998. One of the largest trade shows to run on an annual basis, it is the event to attend for an holistic view of the consumer technology scene. Unmanned aerial vehicles "UAVs", laser scanning and 3D printing featured across all four days of the show.

Spatial technologies were packaged in multiple ways at CES 2014. Location aware devices, UAVs, 3D printing and robotic systems all held a prominent place in both the conference and exhibition areas. Augmented reality and connected devices were also en vogue. For example, Google Glass and crowd-funded projects like Oculus have paved the way for affordable virtual reality headsets. Even Sony demonstrated a commitment to VR wear through its HMZ-T3Q headset – a wearable 750 inch HDTV with a 45 degree field of view.

The Zones

Academia Tech, 3D Printing, Cisco's Internet of Everything, Eureka Park, Gaming Showcase, Robotics and Motion Tech were the standout exhibition areas. Thought provoking products included wearable sensors. For example, the human body is rapidly becoming part of the documentation process through glasses like Move Eye. Minnesota based Tarsier are using web cameras to record depth of field in the same way that the human eye does, albeit digitally.

There was clear synergy between consumer markets and otherwise specialist solutions looking to go mainstream. For example, xxArray uses structure from motion - "SfM" - via PhotoScan at the Nikon stand. A booth of 68 cameras was used to generate solid surface meshes of willing volunteers, then turned into 3D printouts and physically sent to each

PhotoScanned person through the mail. Parrot and Velodyne – companies that operate in both consumer and specialist markets – also had a sizeable presence. In addition to a netted area full of dancing UAVs, Parrot showcased their professional senseFly UAV system and the Pix4D mapping solution. Pix4Dmapper is another SfM based software and now part owned by Parrot.

Internet of Things repackaged

On the back of their involvement with the Internet of Things (IoT) Europe, Cisco Systems added "Every" for the US market. The Internet of Everything (IoE) was used to explain increased connectivity between devices, affordable sensors and sensing (see *GeoInformatics* 15 (7): 32-34). Companies like Nvidia demonstrated their commitment to IoE through the Tegra K1 super chip inside an Audi car equipped with a laser scanner, which is used to navigate it. Manufacturers like Chevrolet showcased a self-monitoring car with built-in windscreen camera, as well as an app store to support developments. IoT as IoE could be seen in most products at CES 2014.

Design and manufacture

The 3D Printing Technology Zone was sponsored by 3D Systems. The South Carolina based company showcased their Cube 3D printer, a collaboration with Intel that is looking to grow 3D scanning and 3D printing user communities, as well as the announcement that Black Eyed Pea **Will.i.am** was their new chief creative officer. At this time, the scanner component of the 3D Systems Sense workflow was a repackaged Prime Sense sensor.

In addition to announcing new 3D printers, Makerbot also unveiled a strategic partnership with SoftKinetic for their next scanner. **Bre Pettis**, MakerBot CEO, used a camera analogy when he introduced a new range of 3D printers – the Replicator Mini (point and shoot), standard Replicator update (SLR) and Replicator Z18 (Hasselblad). At USD \$6500 for an industrial printer, the Replicator Z18 was the most interesting development of the three.

Intel and Autodesk

Intel continue their commitment to developing a prosumer market – the space where consumer and professional meet - geared toward 3D design. For example, the RealSense 3D camera was announced in the Intel Corporation keynote presentation. Vice president of consumer products at Autodesk, **Samir Hanna**, took to the stage to talk about the continued development of a strategic partnership. Hanna discussed the SD card sized Edison computer as an added feature

Below: Parrot showed off senseFly and Pix4D.



Fleetwood Mac was the show's hot ticket.



in 123D Circuits – a design solution obtained by Autodesk through the acquisition of circuits.io. Through open sourced solutions like Arduino, the value of affordable and programmable micro-processors has begun to be realised by large corporations.

Emerging technologies

Emerging technologies were heavily featured at the Venetian Hotel exhibit areas. For instance, the “Indiegogo” area was for crowd-funded projects that had been supported by customers before they were built. Priced at around USD \$600, the Panono 360° panoramic camera ball was one of several documentation tools that stood out from the funded crowd. Panono demonstrated its potential to be a low-cost alternative to solutions like NCTech’s iStar camera.

The Panono was built by **Jonas Pfeil** to contain 36 cameras, and was the result of his master’s thesis at the Technical University of Berlin. Future iterations will include GNSS so that a location can be recorded at the same time as a panoramic photograph. The “panospective” ball generates a 108 Mpx image when thrown into the air or triggered automatically. Examples can be seen at (<http://www.panono.com/v/326/>) or through Apple App Store’s free Panono app or Android Play Store. Surveillance has proven to be an unexpected application for Panono’s creators.

Remote reality and motion capture

Remote Reality was another company that reconsidered 360 panoramic imaging. The Connecticut based outfit used a “donut approach” for their 360° vistas – all-in-one solutions that are already popular in military applications. For CES 2014, Remote Reality was looking to crossover into the consumer space and had developed a lens for GoPro cameras. Its launch was planned for late 2014 to early 2015 with an accompanying price tag based on the cost of a fisheye lens.

Motion capture for virtual environment had an active presence at the show through Xsens MVN. In addition to plug-ins for Autodesk MotionBuilder and Maya, this inertial sensor body suit solution had ready-made pipelines for 3D Studio Max, Softimage and LightWave. The wearer also has a complete six degrees of freedom; with basic calibration taking ten seconds and advanced calibration accommodating people with a limited range of movement.

Below: The Oculus headset demonstrated it was viable to bring a VR headset to market.



Right: Xsens body suit can generate a complete augmented reality experience. Below: Remote Reality captures a 360 degree panorama by turning the field of view into a donut shape.



The awards

The event was host to numerous award ceremonies over the course of the four days, including the Photo Imaging Manufacturers & Distributions Associations (PDMA) awards, Engadget 2014 Best of CES Awards, CEA MoDev Hackathon, *Variety Magazine’s* Breakthrough of the Year Awards and the Technology and Engineering Emmy Awards. Despite being A list celebrity events, this aspect of the conference still singled out the recognition of technological achievements that had been made its top priority. For example, it was the new ground covered by Monster through their sound equipment that stole the show at the 2014 Retailer Awards – not their house band *Fleetwood Mac*.

Fleetwood Mac

Fleetwood Mac played in the Paris Hotel Ballroom to a maximum capacity audience of 8,500 people. It was an experience few fans had had since *Rumours* was released in 1977 – an album that has sold 45 million plus copies to date. The band played 12 songs to an audience that included guests like **Mary J. Blige**.

Summary

The International CES show operates on an unparalleled scale. Twenty seven technology zones were housed across the Las Vegas Convention Centre and those legendary Las Vegas hotels: Venetian, Wynn, Cosmopolitan, Bellagio and Mandalay Bay. In addition, there were also events hosted at other venues like the MGM Grand.

3D imaging, 3D printing and UAVs were highly visible products. The shrinking divide between consumer and special markets could be seen through PhotoScan, Sensefly and Pix4Dmapper – solutions usually associated with otherwise specialist applications. Smartphone and tablet manufacturers continued to experiment with augmented reality, while bodysuits like Xsens made it a reality.

“The “panospective” ball generates a 108 megapixel image when thrown into the air...”

About the author



Adam P. Spring is a consultant and visiting lecturer in Applied Technologies and Reality Capture in the Department of Archaeology, University of Plymouth. He has featured in numerous academic and research publications. In addition to reselling 3DM Analyst, he has been a consultant for Autodesk and Leica Geosystems. For more information, visit <http://remotely-interested.com/>

Mapping Ireland's Marine Resources

Writing on behalf of Ireland's INFORMAR team, **Fergal McGrath** describes the team's data collection programme and drive to deliver value added products for all applications.

The INtegrated Mapping FOre the Sustainable Development of Ireland's Marine Resource (INFOMAR) programme is a joint venture between the Geological Survey of Ireland (GSI) and the Marine Institute (MI). The programme is a successor to the Irish National Seabed Survey (INSS). Covering some 125,000 square kilometres of Ireland's most productive and commercially valuable inshore waters, INFOMAR will produce integrated mapping products covering the physical, chemical and biological features of the seabed. The programme is funded by the Irish Government through the Department of Communications, Energy & Natural Resources.

For the past 14 years Ireland's offshore waters and coastal seas have been subject to one of the largest seabed surveys in the world. The INSS 1999 - 2005 was responsible for mapping about 81% of Ireland's seabed territory from the exclusive economic zone delineation to the 200 m contour, using primarily multibeam echosounder.

The INSS delivered a baseline dataset which has facilitated and underpinned a wide range of decisions taken at a national level. It also resulted in development of the knowledge and skills required to carry out surveys of this type, and at this scale. The importance of the dataset as a national resource is illustrated by the Real Map of Ireland which is now part of the national education curriculum. Its value

lies in the fact that it presents Ireland as a territory, both above and below sea level. This is a departure for those of us that grew up thinking that Ireland stopped at the beach and it will facilitate a mindset in future generations that can only be beneficial in the long term.

The INSS was succeeded by the INFOMAR programme, tasked with mapping the remaining coastal waters. This is being undertaken in two phases; Phase one (2006 -2016) focusing on 26 inshore priority bays and 3 priority coastal areas, and Phase two (2016 - 2026) mapping the remaining unsurveyed Irish territory.

It has a focus that is expanded to include three programme areas, namely:

1. **Data Acquisition, Data Management and Interpretation**
2. **Data Exchange and Integration**
3. **Value Added Exploitation**

Data Acquisition

The programme team utilises a range of vessels to undertake hydrographic and geophysical surveys. The Marine Institute's RV Celtic Voyager and Geological Survey of Ireland's RV Keary and RV Cosantóir Bradán facilitate multibeam and shallow seismic surveys as well as ground truthing, side-scan sonar and ROV operations. They are supported by the RV Geo which is suited to very shallow water operations, and other third-party vessels as required.

In areas shallower than approximately 10m

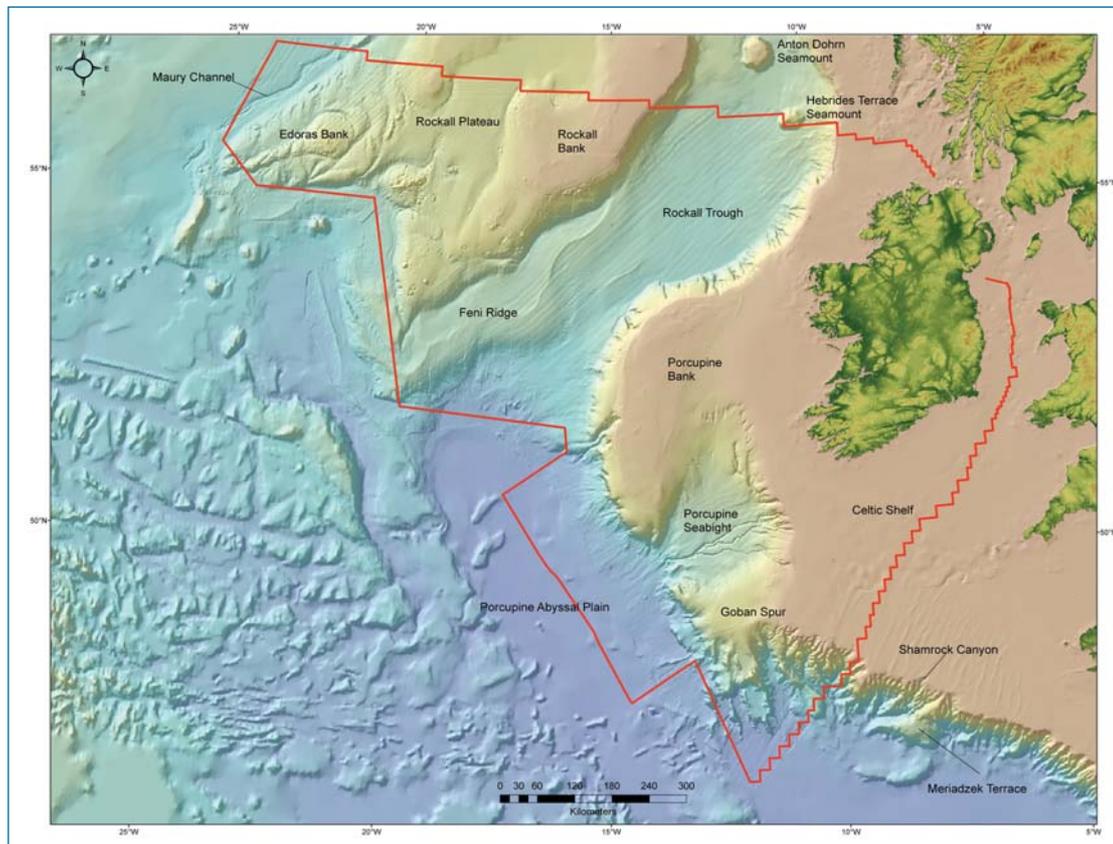


Fig. 1 The Real Map of Ireland shows the delineation of the Irish Continental Shelf

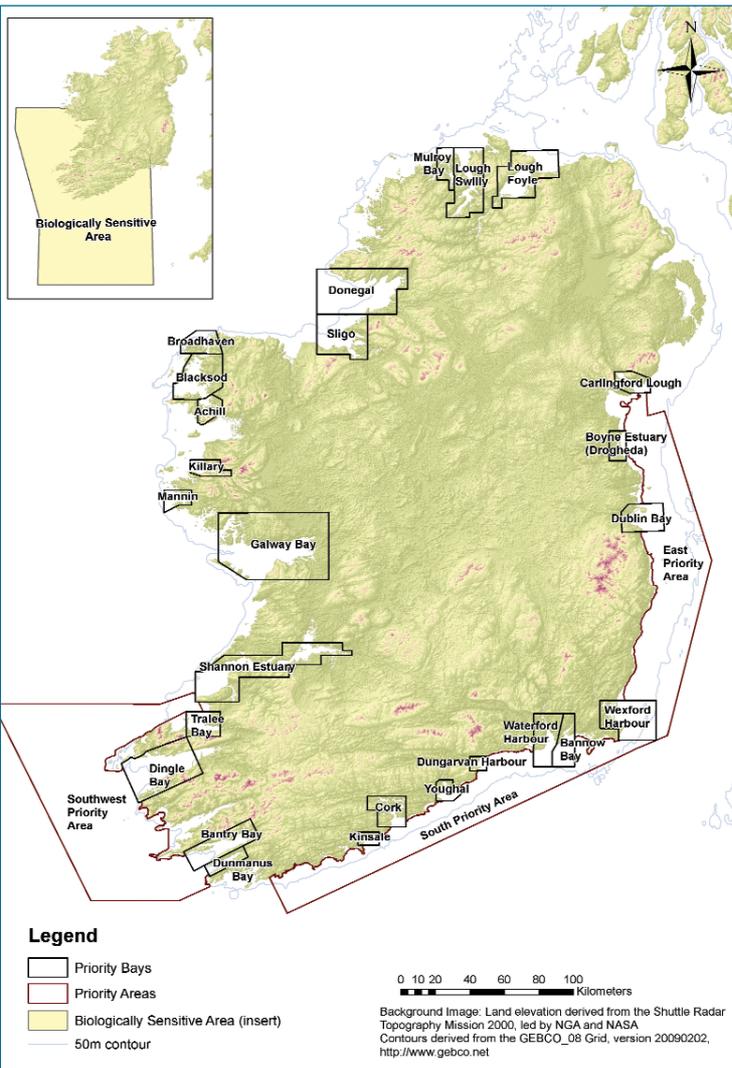


Fig. 2 INFOMAR Phase one (2006 -2016) focusing on 26 inshore priority bays and 3 priority coastal areas.

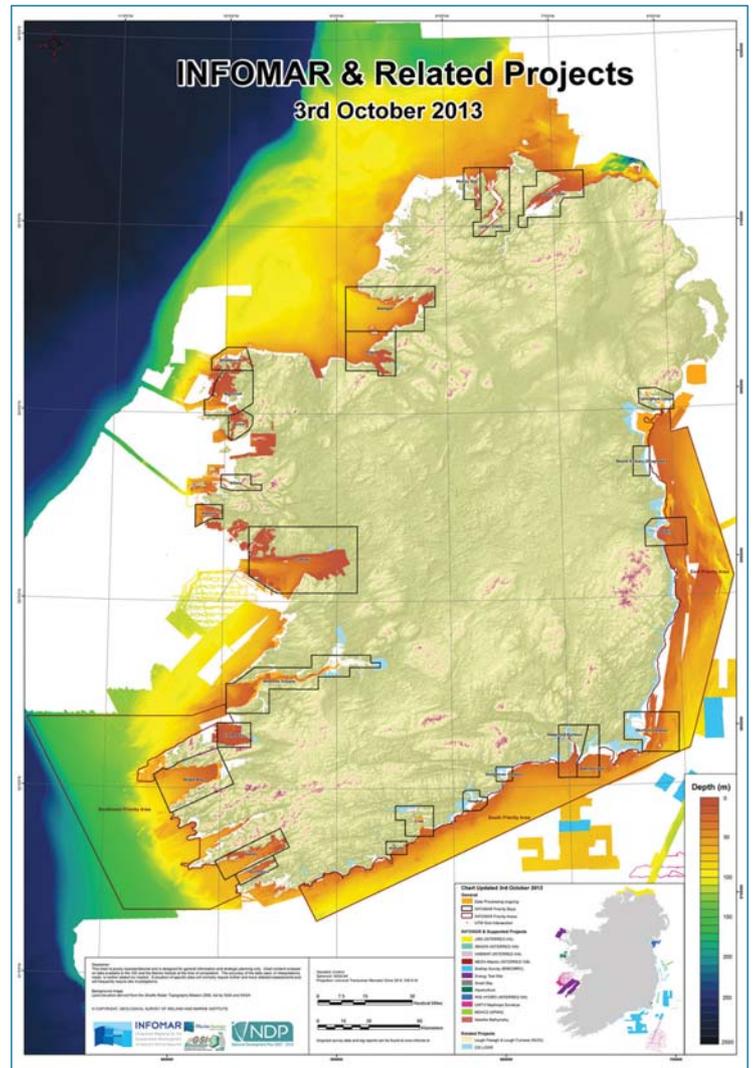


Fig. 3 Bathymetric coverage map as of end of 2013.

water depth, airborne LiDAR and satellite remote-sensing surveys are outsourced where feasible and economically viable for the near-shore waters, particularly in areas where vessel activities are either hazardous or impractical (e.g. extensive shallow mudflats).

Data exchange and information

INFOMAR delivers an enhanced data management and delivery service for data gathered under both the INSS and INFOMAR. This data delivery strategy is intended to promote the creation of value-added products through improved dissemination of information to researchers, policy makers, private sector and the public.

INFOMAR provides key baseline data to support coastal and inshore infrastructural and economic development across a broad array of sectors, including shipping and transport, marine tourism and leisure, marine renewable energy, and fisheries and aquaculture. Data collected are critical to underpin current, wave, pollution and carrying capacity modelling, in support of existing and evolving marine activities. Additionally, the data are of value for applications including marine spatial planning, coastal zone

management and licensing decision support, as well as coastal and offshore engineering, cable routing, fisheries management and environmental impact investigations.

The programme strives to maintain a strong working relationship with all marine stakeholders. This is a two way process and visibility is key to it. The programme's sustainable marine resource development remit helps to ensure that the data are used constructively, in areas that contribute to the reduction of risk at sea, and promotion of jobs and growth, while observing the requirements to maintain the sensitive marine environment.

One of the main challenges for a programme of this scale is to facilitate as many stakeholders as possible in order to demonstrate value. This is done initially through the provision of the data for free as well as through the development of a product suite. It is important that as the technology to acquire, create, and deliver evolves that products can evolve.

Chart products

Currently, INFOMAR produces a range of products including a series of charts (Shaded

“Its value lies in the fact that it presents Ireland as a territory, both above and below sea level.”

Relief, Backscatter, Bathymetry and Seabed Classification), sub-seafloor shallow seismic data and seabed sampling results. All of these datasets can be freely accessed via the INFOMAR website data and products page.

[HTTP://www.infomar.ie/data](http://www.infomar.ie/data)

Standard data products Include:

- MBES bathymetry, shaded relief and backscatter charts, grids and ascii files.
- Acoustic seabed classification maps.
- Sub Bottom Profiles raw data and tiff images.
- SBES raw and XYZ data.
- Magnetometer raw data.
- Survey tracks, seabed sample stations and sound velocity profile stations.
- Survey log, shoal and wreck reports.

Adding Value

A specific objective of INFOMAR is the delivery of national and international value added research to leverage the skills, expertise and data from the INSS and INFOMAR. Through this programme area, INFOMAR has infrastructural capacity to support active participation in a variety of relevant European mapping and marine data management research projects and initiatives, funded externally to INFOMAR, including EMODNET (DG Mare EC Contract), GeoSeas (FP7 Infrastructure), MESH Atlantic (INTERREG IVB), INIS Hydro (INTERREG IVA), ATLANTERRA (INTERREG IVB).

Involvement in partnership networks facilitated by these projects has allowed INFOMAR to develop product areas. More importantly, it has facilitated engagement with agencies from other jurisdictions, which has enabled continued and focused refinement of deliverables. The most tangible benefits to INFOMAR from involvement in these projects is, arguably, the network of engagement with other agencies.

In addition to support of this international project stream, the programme office coordinates research calls and associated grant aid award schemes, and encourages industry and research partnerships and collaborative applications, particularly in areas related to INFOMAR activities where there is future scope for commercial opportunities, growth and/or jobs.

23 research projects were funded in 2012 across a broad array of disciplines and areas including;

- Data management, visualisation, analysis, and integration
- Geoscience, Oceanography, Acoustics
- Ocean Energy
- Technology Development
- Education and Outreach

At a national level, marine survey data acquisition and analysis expertise is provided in support of 3rd level research programmes through formal partnership on research grant aid applications, as well as through assistance, advice and equipment loans. INFOMAR frequently supports 3rd party (private and government) research and mapping requirements as strategic and/or EU Directive commitments dictate.

Cost-benefit demonstrates value

An independent cost benefit analysis of the INFOMAR programme was commissioned, and carried out in 2008 by PricewaterhouseCoopers LLP (PwC). This cost benefit analysis estimated a return to the Irish state of between four to six times the cost of the programme over its life span (PwC report, 2008,

<http://www.infomar.ie/publications>). This was followed by an independent programme review undertaken mid-2013, again carried out by PwC.

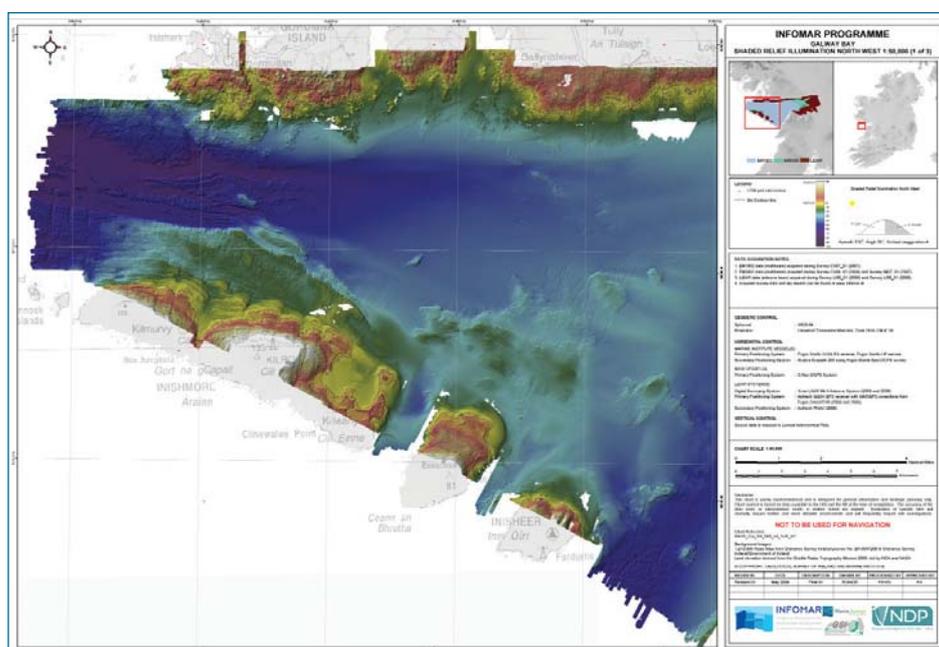
The results of this review were generally positive and captured the extensive breadth and impact of INFOMAR activities. In response to the recommendations contained within this report, INFOMAR is now working with MindSeed and the Dublin Business Innovation Centre in order to realize the full potential of the Irish seabed mapping endeavour. The team is working on development of a structured training programme, mobile application technologies, and marine science outreach programmes.

INFOMAR is committed to making the vast data resource widely and openly available on an ongoing basis to stimulate research and sustainable development of Ireland's marine resources, and to realise the benefits achievable through the programme investment.

Vast quantities of data have been acquired during the ongoing Irish seabed mapping programme, through utilisation of the most advanced survey technologies and techniques. The Value Added Exploitation Programme aims to develop a

“... a return to the Irish state of between 4-6 times the cost of the programme over its life span.”

Fig. 4 Current Products - Galway Bay Shaded Relief Chart.



range of value added opportunities through leveraging and outputting these data and the associated knowledge to meet user requirements and in particular to support sustainable development and job creation.

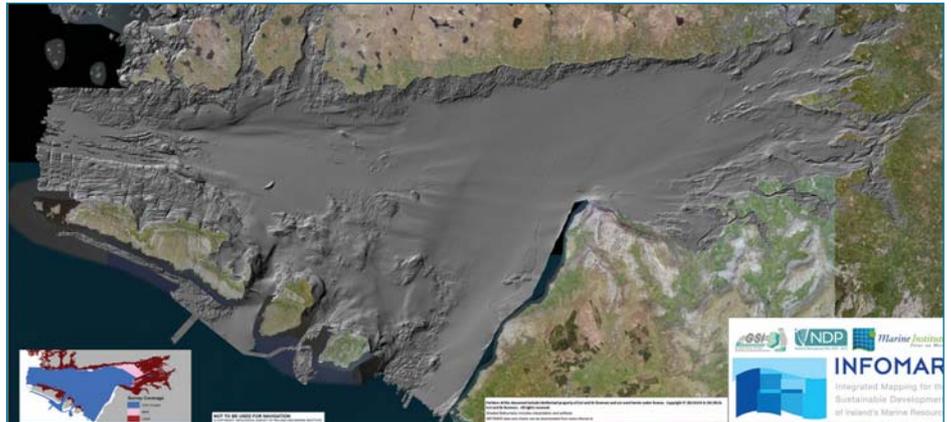
Data Access

All INFOMAR data are made freely available to the public. Access to data is online via the following links, or alternatively, data requests can be made by emailing DataRequests@marine.ie;

Image Viewer: The Image Webmapping Viewer allows the user to view high resolution imagery: bathymetry, backscatter and shaded relief images, or vector data: tracklines, tide gauges, grab samples and particle size analysis of samples, charts and survey areas. The user can query bathymetry and grab sample data; download charts and shipwreck reports and link to the IWDDS download site.

[HTTP://geos2.marine.ie/infomar/](http://geos2.marine.ie/infomar/)

Public Viewer: The Public Webmapping Viewer allows the user to view INFOMAR & INSS data (bathymetry, tide, backscatter, tracklines, sound velocity profiles, grab sample). Data can be queried and downloaded (.xls, .kml & .shp) via the IWDDS and a Web Mapping Service.



Above: Fig. 5 Galway Bay – A Different View

[HTTP://spatial.dcenr.gov.ie/imf/imf.jsp?site=INFOMAR](http://spatial.dcenr.gov.ie/imf/imf.jsp?site=INFOMAR)

Download: Via the Interactive Web Data Delivery System (IWDDS). Data such as bathymetry & backscatter grids, ASCII files, Fledermaus scenes, Google .kmzs and leg reports for all INSS & INFOMAR surveys can be downloaded.

[HTTP://jetstream.gsi.ie/iwdds/index.html](http://jetstream.gsi.ie/iwdds/index.html)

Metadata: INSPIRE compliant Metadata for the various data collected by INFOMAR can be searched via an online catalogue of data holdings. The catalogue also lists metadata on all other datasets held by the MI and GSI.

[HTTP://isdesearch.marine.ie/isdeportal/](http://isdesearch.marine.ie/isdeportal/)

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Thinking outside the GNSS receiver box and antenna

By Joël van Cranenbroeck

With so many off-the-shelf GNSS solutions is there still room for innovation? **Joël van Cranenbroeck** thinks so. One such solution could be based on multiple antennas. But remember, the antenna is still the analogue part that drives the final quality.

Hydro power station monitoring. Six antennas connected by multi-switching to one receiver.



After decades of research and improvement of GNSS receiver and antenna technology, we have to admit that today solutions are mostly available off the shelf and so you would not expect there to be much room left for innovation. Yet, surprisingly, there are still GNSS applications where there is scope for development.

Reliability for monitoring

In geodetic deformation monitoring, for instance, there has been a long struggle to request from the industry more affordable solutions, but at the highest performance in terms of accuracy and reliability. The old fashioned single frequency L1 GPS receiver is still a topic of research blended with wireless communication and low power consumption. And although it may seem that OEM boards and chipsets meet today's expectations, we would prefer double measuring boards to increase their reliability. There should also be some integrity checks (zero baseline test) especially when the receiver is deployed for mission-critical measurements or located in remote places where the costs associated with travelling to the site to exchange failed equipment are prohibitive. Despite the low cost of GPS L1 OEM boards we should not forget that to achieve high accuracy the antenna is still the analogue part that drives the final quality. Low cost microstrip antennas

must be calibrated if we want to keep the solution effectively affordable. Connecting a low cost GPS L1 receiver to a geodetic grade antenna makes no sense.

For GPS deformation monitoring-based applications, the receiver and the antenna comprise a very sensitive part, but the whole system, including communications, power supply, cabinet and pillar, must also be reviewed. Security of the equipment is also a sensitive matter and there will be resistance from the project's owner if vandalism can impact installations that are deployed on public areas.

One receiver, several antennas

The multi-switch antenna concept has been an attempt to decrease the cost of GPS technology used for deformation monitoring. The principle is to share multiple antennae with only one GPS receiver. The receiver connects sequentially with each connected antenna. The Chinese hydro power industry now considers this approach to be a de-facto standard, but in western countries, until recently we have simply ignored the idea, even though it could certainly fit with civilian client expectations regarding budget, without any concession regarding the performance needed by the equipment to provide effective results from unstable areas such as landslides, large subsidence areas and so on.

The concept of connecting multiple antennae to a single GPS or GNSS receiver can also bring an interesting possibility for handling the situation where it is impossible for physical reasons, or forbidden for security reasons, to set up an antenna. The case of high rise buildings and towers has raised interest for such a solution. Instead of trying to place an antenna right on the top of the structure, why not surround the structure with three or four antennae, all connected to a common GPS or GNSS receiver? Each antenna will track only the part of the satellite constellation that is visible at each location, but signals not observed at one antenna will be observed at one or more of the others to make a complete sky view. Combined into one GPS or GNSS receiver, the signals will be received through separate channels and, in case of multiple signals coming from one given satellite, the multipath rejection algorithm will identify the strongest signal. We may argue that the point solution will no longer be for a physical point, but a virtual station, however such solutions have been introduced for GNSS Network RTK technology without many concerns.

Software receivers

Software GNSS receivers have popped up, mainly from academics who wanted to get a better insight into the whole digital signal processing chain. Considered as a curiosity by the industry, the simple idea of placing the analogue to digital part of the processing chain on to the antenna, means that signals can be transmitted to the cloud and processed using GNSS software receivers in the cloud. We can imagine various adaptive processing strategies for this concept and certainly a breakthrough for GNSS network positioning infrastructure, especially when it is important

to tune the electronics to cope with adverse environments to get the best of the signal quality. In that case there will not be any box to think outside of!

Diverse applications, same technology

Another paradox from the manufacturing industry is a great keenness to diversify the applications for its range of products into various types of receivers all using the same hardware, which are all tuned for high dynamic tracking situations. This is certainly an advantage for surveyors, who need to track all satellites in view when they are working dynamically in an over-masked environment such as forests or urban conditions where satellites frequently come in and go out of view. However, for permanent installations the situation is different. GNSS antennae used for Network RTK infrastructure or deformation monitoring are static and operate in open field conditions. So, why not make use of these characteristics to tune the code and phase lock loops differently? Receivers tuned in such a way will not track suddenly any new satellite signal in view, or nearly in view, above a given cut-off angle and it will take a little more time to track satellite signals, but we can expect at least to improve observational accuracy, which is certainly what people involved in infrastructure and monitoring applications are searching for.

There is currently an emphasis on providing more channels onboard to track not only GPS and GLONASS constellations signals but also future signals coming from new constellations (Galileo and Compass / Beidou). It would also be interesting to consider tracking ground positioning system signals as well, such as Locata and eLoran (enhanced Loran). In this connection, there are voices expressing the need to back up vulnerable GNSS signals that may be jammed, interfered with or even made unavailable due to GNSS signals overlapping with wireless telecommunication, such as nearly happened with the LightSquared issue in the USA. Vulnerability is becoming a serious concern.

Positioning in canyons

Meanwhile, Europe is still convinced that the Galileo constellation is a must-have, but being largely urbanised and having a new "made in Europe" constellation will not help fix the surveyor's position in the middle of Paris or Milan. Having more satellites in the same "corridor" (urban canyon) will not contribute to improving the GDOP (Geometric Dilution of Precision), but research into developing signals transmitted from the ground would definitively place Europe in a leading position. Thinking outside the GPS (GNSS) box can lead the industry to extend its design by welcoming other signals or even to transmitting or replicating some of them.

The GPS Dancer, a peer-to-peer process on the internet for precise geodetic analysis of GPS data.



Last but not least, the look and feel of most of the GPS receivers available in the market place is not really appealing. From all on the pole, then with backpack and again on the pole, a visit to a large exhibition like Intergeo will reveal that there is not so much difference between the receivers' performance beyond their colours. Creativity seems to have disappeared when it comes to design of housings and shapes of GPS and GNSS receivers and antenna.

GPS Dancing

To conclude, let's hope that challenging the actors in the GPS/GNSS industry to think outside the (GPS) box will bring us back the original excitement we had when the first GPS satellites rose over the horizon of geodesy. For sure the world is not yet flat enough and the next revolution will surely come from the Internet of Things (IoT) where the boxes will start to socialise with each other and share some features and capacity.

A good example of things to come is the GPS Dancer, a peer-to-peer process on the internet for precise geodetic analysis of GPS data. It is being developed as a voluntary project under the auspices of the International Association of Geodesy. A single Dancer peer is a computer program for analysing observation data from a geodetic GPS receiver. All by itself, the Dancer peer would never be able to compute global products such as satellite orbits, satellite clocks or Earth rotation parameters. However, if the Dancer peer connects to a couple of other peers on the internet, it is no longer alone. A global network of GPS Dancer peers forms a worldwide grid computer with all the functionalities of a global analysis centre, but with a much larger processing capacity. With Digital GNSS Antennas and software receivers, we can dream about a truly exciting future for geodesy. Imagine, for example, forecasting crustal deformation in the future just as the weather is forecast today.

- *This paper is based upon a presentation given at the 2nd Joint International Symposium on Deformation Monitoring (JISDM), 9-11 September, 2013, Nottingham.*

“... the boxes will start to socialise with each other and share some features and capacity.”

About the author



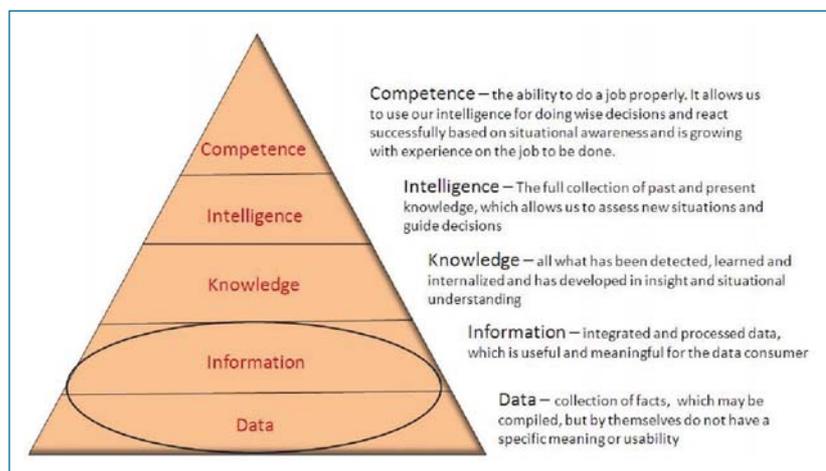
Joël van Cranenbroeck is the founder and managing director of Creative Geosensing, a new Belgian limited company acting in consultancy, projects and technology. His previous position was with Leica Geosystems, where he led the development of hardware and software solutions for GNSS Network-RTK and made significant contributions in geodetic monitoring development and applications such as the method for aligning high rise structures including the Burj Khalifa in Dubai. Joël is chair of Working Group 6.2 of FIG Commission 6. Email: joel@creative-geosensing.com

Digital Hydrography on the Maritime Web

Digital charting is throwing up some interesting challenges as well as pitfalls for unwary hydrographers and navigators. **Richard Groom** reviews the published papers from a recent conference.

“...rather than provide the greater situation awareness that might be expected, it actually has the opposite effect.”

The pyramid of competency (Bergmann, M (2012) e-Maritime Annual conference, 22-23 November, Brussels



The Hydrographic Society UK in association with the International Federation of Hydrographic Societies and the International Hydrographic Organisation, held this two-day conference on digital hydrography in October 2013 at Southampton Solent University Conference Centre.

The navigator's view

The conference commenced with contributions from the users of hydrographic products, but it was interesting that this section included presentations only from those using hydrographic data for navigation.

Nonetheless, the views of the navigators make interesting reading and they are, after all, the main customer for hydrographic charts. **Ole Berg, Aron Sorensen and Maarten Glamso** spoke on e-Navigation: A user's perspective. For them, e-navigation is more than just the chart, it is the exchange of information between a ship and others. Information overload is their main concern and particularly repeated communication of the same information to various authorities and (they suspect) provision of data because it is available, rather than because it is needed. They state "the ship is manned by experienced mariners". Yes, well yours might be, but in the presentation following, examples were given where this was not the case.

The problem seems to be the authorities trying to make modern methods fit tradition. In Europe the problem has been solved by the implementation of a system called SafeSeaNet a database management system for Europe plus Norway and Iceland that makes the information required accessible. The hope is that this can be extended worldwide.

The main criticism of the current system is that it is driven by authorities on shore. The

authors draw the distinction between a navigating navigator and a monitoring navigator. The former continuously monitors the ship's progress and takes corrective action, if necessary. He also monitors the condition of the cargo, the traffic around the ship and floating objects in the water.

The monitoring navigator is going to rely more heavily on automated processes, standardised procedures and equipment. This, the authors argue, is similar to the role of the pilot on an aircraft. The theory is that shore-based staff will be able to navigate better than navigators on the ship. The two main dangers with this concern monitoring conditions by eye – both sea conditions and obstacles, such as icebergs. There are parallels here with the current debate on the regulation of UAVs.

Situational awareness is the goal

David Wheal is principal inspector of Marine Accidents at the Marine Accident investigation Branch. He commenced with a quotation from a MAIB report on an collision between two vessels in which the board found that "the investigation quickly identified that the watchkeepers on the two vessels, both of whom were senior offices, did not maintain even the most rudimentary level of watchkeeping." Perhaps competence cannot be treated as given after all.

Wheal focused on Situation awareness. This is a common term from the world of emergency planning and the military. He quoted a useful definition: "... the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future." (Endsley, MR, 1988). Situation awareness is enhanced by radar. By continuously 'plotting' the position of obstacles it becomes possible to use the information to avoid collisions.

An Electronic Chart Display and Information System (ECDIS) enables the officer on watch to see the current and previous positions of the vessel. The system also incorporates a function to predict potential grounding. However, there is a downside to greater technology. Over reliance on the technology can cause fatigue because the officer on watch does not have enough to keep his attention and that, rather than providing the greater situation awareness that might be expected, it actually has the opposite effect.

Common Maritime Data Structure

The second session covered Products – Quality

and Presentation. **Michael Bergmann**, Director Maritime Industry, Jeppesen and President CiRM (Germany) said that hydrographic data is now being used for many purposes beyond its core role for navigation.

The International Hydrographic Organisation has approved the Universal Hydrographic Data Model (S-100) as its data standard and now, in conjunction with other maritime organisations, it has been adopted as the basis for the "Common Maritime Data Structure". By doing this, e-navigation is building upon GIS data standards.

He introduced the pyramid of competency in which competence is built upon intelligence, then knowledge then information and finally data. The key to knowledge is the combination of static and real-time information data streams, which is where common standards are essential. Knowledge is the foundation of situational awareness, which is needed to make intelligent decisions.

Hole in the Humber

Andrew Hinton from the UK Hydrographic Office discussed the problems of charting the Humber estuary. Its bathymetry changes so rapidly that chart printing could not keep up, so the area was left blank. With ECDIS the challenge was on to develop a work flow that would fill this, one of the few 'holes' in UKHO's charting of the coast around the UK.

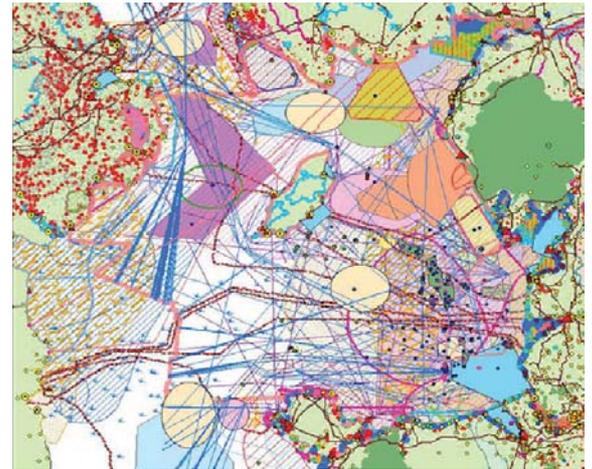
Don Ventura, hydrographic survey manager for Fugro-Pelagos Inc, delivered a paper entitled "Intelligent Exploitation of the Blue Economy". He makes the point that benefits from the blue economy are only realised when they reach land, so the land-sea interface is critical. Many might not realise that there has been a dramatic growth in shipping in the past few decades – three-fold in forty years. Ships are also larger. The Maersk E class vessels can carry 18,000 containers, the equivalent of a train 108km long. Efficient navigation is clearly crucial and it is most critical at the coast. Now the seabed is used for mineral extraction, power transmission and generation – activities that have to take place whilst conserving the delicate marine environment. There are many stakeholders and so the interface between land and sea has to be seamless.

Send in the crowds

Brendan Mason from Envitia Ltd spoke of the role of crowdsourcing for hydrographic mapping. TeamSurv is one of several companies doing this and he describes a ground-truthing exercise comparing TeamSurv data with reference data, presented as 10m bathymetric contours. Perhaps unsurprisingly, the results are not very conclusive. Nonetheless, he suggests that crowd-sourced data has a role in areas where authoritative data does not exist or is unreliable.

Helen Needham is hydrographic director

Irish Sea waterspace management issues with only 15 stakeholders represented - Source: Defra



with Proteus Europe Ltd. She examined the use of multispectral satellite imagery for hydrographic surveying in the coastal zone. The advent of high resolution sensors and particularly 8-band WorldView-2 data has made this technique more practical for coastal bathymetry. Vertical accuracy continues to improve and is currently about 10% of water depth. In ideal conditions better than this. When this technique is suitable it wins hands-down, as it avoids the costs associated with mobilising a vessel and personnel to sea.

Training needed

The final session focused on training. Captain **Zakirul Bhuiyan**, senior lecturer at Warsash Maritime Academy spoke about ECDIS display management. One of the problems is familiar to land surveyors: that of spatial data being scaled by unwary users to larger than the scale at which the chart was produced. ECDIS employs safety settings, which must be set correctly. One such is the safety contour, which marks the division between 'safe' and 'unsafe' water. Clearly not something to get wrong.

The final paper was also on a topic familiar to surveyors in general – maintaining professional standards. There are a number of bodies involved in setting standards and assessing hydrographic surveyors. The International Hydrographic Bureau publishes the Standards of Competence for Hydrographic Surveyors. In the UK the CICES and RICS assess applicants against hydrographic surveying competencies and the International Marine Contractors Association works to ensure that courses cover the skills required and has also produced a list of competencies for individual hydrographic surveyors. The authors, Dr **Richard Thain** and **Jo Holmes** from Plymouth University, argue that this may be a satisfactory situation for graduates, but it unfairly treats those who want to advance in mid-career. They stress the need for a clear career pathway to encourage surveyors to maintain and build upon their qualifications. They conclude that professional registration of individual hydrographic surveyors is needed.

“There are many stakeholders and so the interface between land and sea has to be seamless.”

• *Published papers are available from the International Federation of Hydrographic Societies: www.hydrographicsociety.org*

Factory calibration and field verification of Leica scanners



Hans-Herbert Tuexsen, left, describes the factory calibration of Leica Geosystems scanners and a unique procedure that allows the user to check his ScanStation for systematic deviations and to update the calibration parameters.

Terrestrial laser scanners are complex multi-sensor systems. The measurement results are 3D point clouds but, in addition to distance and angle measurement modules, other devices such as a camera, inclinometer, GNSS, compass, barometer and temperature sensors are incorporated into some models. The data record for each point in the point cloud includes 3D coordinates corrected using calibration values and inclinometer readings, intensity values of the return signal and, for images taken with a camera, RGB values.

Although the generation of the 3D point clouds is mostly hidden from the user, the expectation is that the instrument meets the required stability and robustness in daily use and that the accuracy of the measurements is within the manufacturer's specifications. Here the factory-provided calibration, i.e. the determination of systematic deviations from an ideal design and the permanent storage as correction values on the instrument, plays an important role by enabling modules of the scanner to be calibrated individually and harmonisation of mathematical calibration models with the design of the instrument.

However, users also want to be able to check the instrument themselves at regular intervals to eliminate systematic deviations or

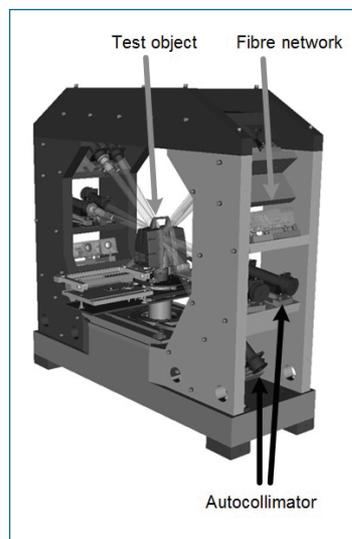
defects which could originate, for example, from improper handling during transport or extreme stress during operation. For this purpose it is undesirable to send the instrument away for calibration due to lost production time. It is instead preferable for users to be able to run a comprehensive accuracy check on instruments themselves.

Factory calibration

Factory calibration yields instrument specific values (known as calibration parameters) which are used to convert the basic sensor data into the measurement data required by the user. Provided that the instrument remains stable the calibration parameters guarantee measurements within the specified accuracy. As is generally known, the mechanical and electronic properties of measuring instruments vary with temperature changes. For this reason it is essential to perform the factory calibration of every single instrument over the full specified temperature range. To ensure a consistently high quality the calibration process has been automated to the greatest possible extent. Thereby user errors are minimised and reproducibility is increased.

Leica Geosystems has developed a new calibration rig (Figures 1 and 2) which allows the company to calibrate scanners fully-automatically over the complete temperature range. In this machine the angle, distance and inclination parameters are determined. For a calibration over the full temperature range it is very important to allow the scanner enough time to acclimatise before the measurements are taken. The calibration of the eccentricity of the angle circles and the adjustment of the single modules (laser power, tilt sensor and so on) is done beforehand in specific processes. The calibration process presented here refers to the calibration of the completely assembled scanner.

“Factory calibration yields instrument specific values which are used to convert the basic sensor data into the measurement data required by the user.”



Above left, Figure 1: ScanStation P20/C10 calibration facility.

Above right, Figure 2: diagram of the ScanStation P20/C10 calibration rig.

Angle calibration

Angle calibration includes determination of the deviations

of the axes, equivalent to the collimation error and the tilting axis error of a total station, as well as the deviation of the vertical index and the deviations of the laser beam direction.

Angle calibration is separated from range calibration to avoid negative interrelated interferences or a correlation of the parameters. During angle calibration the light of the laser is used as a target beam but the distance information is not used.

Conventional angle calibration methods typically utilise targets with known coordinates or which are simultaneously observed with a reference instrument. The disadvantage of such an approach is that the reference targets need to be a sufficient distance from the scanner to achieve the necessary angular resolution.

The approach used by Leica Geosystems gets along without a reference instrument and without any reference targets. Instead of targets, autocollimators are used, which leads to two important advantages. The collimators can be placed very close to the scanner, which results in a significant saving of space, and angle calibration is independent from distance calibration since the measurements on the autocollimator are made at infinity.

The principal installation for the angle calibration is shown in Figure 3. It consists of two opposing autocollimators and a laser scanner centred between the collimators. Measurements are made over the full temperature range of the scanner, therefore the scanner is placed in a climate chamber. But the measurement accuracy of the autocollimators would be negatively influenced by huge temperature changes, so they are placed outside of the climate chamber. This means that the laser beam aims through glass panes with a special optical quality on to the collimators. Reflections of the laser are avoided by skewing the glass panes. To avoid condensation the glass panes are heated.

Prior to placing the scanner between the autocollimators the relative direction of the optical axes of the collimators has to be determined. For that purpose the reticule plate of one collimator is projected on to the CCD camera of the other collimator and vice versa. From the position of the two images of the reticule plates on the CCD camera it is possible to determine the angles between the optical axes.

Now the scanner is placed between the autocollimators and the scanner starts scanning. In doing so several laser pulses hit the CCD cameras of the autocollimators. When this is done the following measurements are available:

- **angles between the optical axes of the autocollimators**
- **angle measurements for every single laser pulse**
- **position of the laser pulses on the cameras of the autocollimators**

Figure 3: Laser scanner centred between two autocollimators

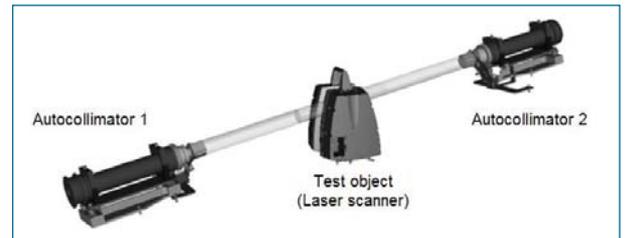
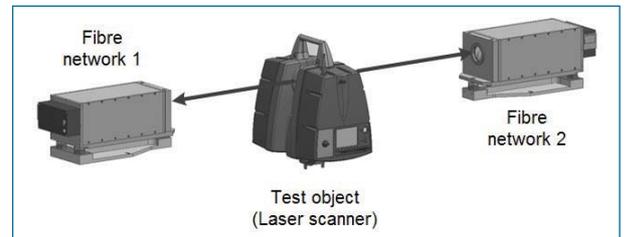


Figure 4: Laser scanner centred between two fibre networks



With the given measurements, the known parameters of the autocollimators and the physical model of the laser scanner, it is possible to determine the angular deviations of the scanner.

EDM calibration

Calibration of the EDM includes the determination of the additive constant and the scale factor. Known standard procedures require distances over the full operating range of the scanner and are inappropriate for a high degree of automation. In addition, external factors such as refraction, are difficult to control and account for. To achieve a continuous high quality during production a method that allows a high degree of automation and reproducibility has to be implemented. The EDM calibration procedure developed by Leica Geosystems fulfils the above mentioned criteria completely. As with the angle calibration, sets of measurement equipment are arranged opposite each other with the scanner in between (see Figure 4). The calibration equipment consists of two fibre networks on which the laser can measure. By means of these fibre networks a variety of different optical path lengths can be simulated. To eliminate temperature influences the fibre networks are stabilised over temperature and placed outside of the climate chamber.

The measuring process involves measurements on both fibre networks on both faces of the scanner. Thereby possible axis errors are eliminated and redundancy is increased. By means of the measured distances on the fibre networks the additive constant and the scale factor can be determined. Because the measurements are carried out at different ambient temperatures not only can the absolute parameters be determined but also the characteristics of the instrument over temperature can be modelled and permanently stored on the scanner together with the calibration parameters.

Camera calibration

A digital camera which can take photos via

“... it must be possible to match every single pixel in an image with the direction of the laser beam in the scanner coordinate system.”

the rotating mirror is integrated in the Leica ScanStation P20/C10. To be able to colourize a point cloud it must be possible to match every single pixel in an image with the direction of the laser beam in the scanner coordinate system. The objective of camera calibration is to determine the relative orientation of the camera to the scanner and the lens distortion parameters. To achieve this, familiar calibration techniques from photogrammetric applications have been extended, so that the deflection by the rotating mirror is included in the mathematical model.

Spatially distributed targets, which are measured with the laser (scanned) and the camera (photographed), are used to determine the calibration parameters of the camera. A pre-condition for camera calibration is that the laser measuring system is already completely calibrated (angles and distances). It is important that the targets are evenly distributed over the complete image area. This is easy to achieve since the direction of the camera can be controlled via the two axes of the scanner. Now the camera parameters can be determined by a least squares adjustment.

“... similar to the known ‘Check & Adjust’ functions in Leica total stations...”

Verification by the user

Terrestrial laser scanners are often transported over long distances and are exposed to harsh environmental conditions in the field. Hence it was a very important request from users to be able to exclude mechanical and systematic changes of their instrument so that they can continue to guarantee that the required accuracy is achieved. Until recently the only option for the user was to send his instrument for a recalibration to the manufacturer. To enable the user to check a scanner, some basic approaches for test procedures have been put forward during the last few years. Some of these procedures (e.g. Heister 2006, Kern and Huxhagen 2008, Lindstaedt et al 2011) mainly investigated range noise and resolution whilst others (e.g. Gottwald et al 2008, Feldmann et al 2011) presented field test methods which were able to uncover systematic angle and distance deviations and consequently advise when the scanner had to be sent to the manufacturer for recalibration.

The Leica ScanStation P20 and C10 models

offer the capability to run a field test and a field calibration, similar to the ‘Check & Adjust’ functions in Leica total stations, directly in the scanner onboard software. With this function it is possible to determine whether mechanical or systematic deviations exist when compared to the factory calibration. If appropriate, the deviations can be stored permanently as correction values in the instrument and thus will be applied to all future measurements. It has to be mentioned that the field test does not completely replace a factory calibration. If the deviations exceed a certain threshold, e.g. after an instrument drop, it is advisable to send the scanner back to the factory for calibration.

The Check & Adjust application fulfils the two main requirements:

- **Detect deviations to the factory calibration**
- **Correction of the calibration parameters, within the accuracy limits of a field test**

The following checks can be made with the P20/C10 Check & Adjust application:

- **Check and correction of the angle calibration parameters**
- **Check and correction of the EDM calibration parameters**
- **Check and correction of the tilt compensator**

It is always possible to delete the correction parameters which have been determined by the user in the field. This means that the factory calibration can be restored at any time.

Angular parameter field check

With a scanner like the P20/C10 it is possible to scan targets at different elevations in both faces and to analyse the respective deviations in order to check the calibration parameters of the axes as well as the vertical index. In addition, the deviations of the laser beam relating to the projection on the rotating mirror has to be considered. These deviations cannot be detected by simple two-face measurements. For a comprehensive check of the angular calibration parameters it is necessary to scan identical targets from at least two positions. The angular parameter check as implemented in the onboard software in the Leica ScanStation P20/C10 requires the measurement set up shown in Figure 5.

Before the measurement starts, enough time has to be allowed for acclimatisation of the instrument. The onboard software guides the user through each step of the process. The complete measuring process takes only 25 to 30 minutes, during which an internal quality check of every target scan is done. If required, a target scan will be repeated automatically. Intermediate results are displayed on the screen. The computation of the parameters starts automatically when the measuring process is finished. The results of

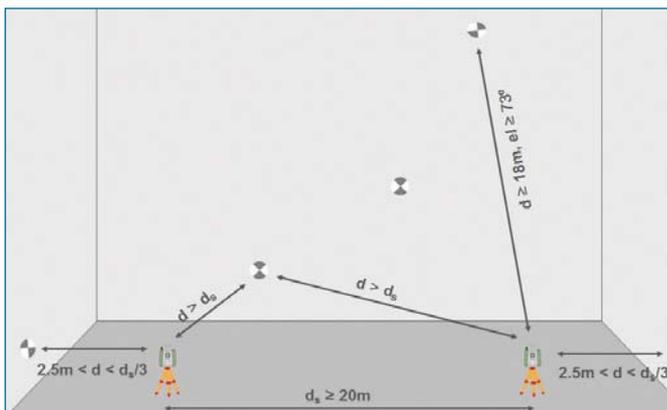


Figure 5: Measurement configuration for the ScanStation P20/C10 Check & Adjust procedure

the computation are deviations to the current angle calibration parameters of the scanner and quality indicators for these deviations. If the quality indicators are acceptable, it is up to the user to decide whether he or she wants to store the determined deviations as correction values permanently in the scanner.

EDM field check

The EDM in a terrestrial laser scanner can be checked by different well documented methods. A comparison measurement on a reference baseline with known distances is one option to determine the correction parameters. The onboard software of the Leica ScanStation P20/C10 offers the possibility to store these correction parameters permanently in the instrument so that they are automatically applied to future distance measurements.

Tilt sensor field check

A check and calibration of the tilt sensor can be done at any time, provided that the instrument is set up horizontally on stable ground. The check runs through fully automated within a few seconds. After the start of the process the scanner turns horizontally and reads the inclination values in several positions. On the basis of these readings new correction values of the fine index are computed and presented to

the user. These corrections can be stored permanently and will then be applied to all future measurements.

Summary

The described techniques and tools for a factory calibration of a terrestrial laser scanner illustrate the complexity of the measuring system. Furthermore they show that the possibilities of a factory calibration are manifold compared to a field calibration by the user. In the factory it is possible to access raw measurements and the design of the instrument is known. Under these circumstances it is possible to examine single components and to calibrate them individually. Newly developed calibration techniques allow us to simulate measurements over long distances. Ambient conditions, such as temperature and stability of the measuring setup, can be kept constant. These conditions are the basis for very high and reproducible quality and accuracy.

Beyond that, the user should have the possibility to regularly check his instrument in order to eliminate deficiencies in the accuracy of the measurements. The Check & Adjust procedure in the onboard software of the Leica ScanStation P20/C10 provides the user with the means to run such a check and, if necessary, to correct the calibration parameters of their instrument. The process is easy to use and takes only about half an hour.

About the author

Hans-Herbert Tuexen graduated in 1988 from the Technical University in Berlin with a degree in geodesy. He worked for two years as a software engineer in a small company where he developed photogrammetric applications and software for the Wild BC3 analytical plotter. In 1990, he joined Wild Heerbrugg (today Leica Geosystems) as a software engineer in the GPS department. He took over a position in the GPS product management team in 1996 and led the team for ten years. Since 2006 he has been product manager for scanning products.

The Leica ScanStation P20 is the only laser scanner to incorporate a valuable "Check & Adjust" program. This easy-to-use field procedure checks and updates the system parameters improving reliability and accuracy saving service time and cost. For more information contact the Leica High Definition Survey Team Manager, Paul Burrows, on **07786 168445**

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- when it has to be **right**

Leica
Geosystems

market for existing buildings and presents a big opportunity. He enlarged on the Beverley Center in one of the breakout sessions (see also *GW* Jan/Feb 2014).

Nick Blenkarn also noted that specification is important, and that this needs discussion with the client and with the QS. Specialist knowledge is needed to do the modelling and although Revit is not ideal, the operator can work around problems. He noted the potential of augmenting the BIM data with the SEEABLE software which allows non-technical access to complex 3D data in an intuitive environment.

The emphasis in these two presentations was on survey of existing buildings, although BIM was mainly for design and construction. As-built survey of new building was also mentioned by Martin Quinn and discussion in the refreshment breaks indicated that it is used in a number of projects, by Plowman Craven and Severn Partnership for example, but is still in the development stage. Gray asked the question 'should as-built survey be done as work completed?' The effective use of BIM models for FM requires as-built data, so when FM becomes more involved in BIM as-built survey of new buildings will become essential. Crossrail, a big user of BIM, uses as-built survey to adjust the tunnelling machine to be more efficient.

The first plenary was followed by two breakout sessions, each with three strands. The first breakout followed by your correspondent was about the transition to level 3. It was emphasized that BIM involves technology, process and culture and that Level 3 BIM requires collaborative commercial arrangements and a focus of the whole life cycle of a building. New concepts such as the Internet of things should be incorporated to provide information on individual items of plant for example. Legal liability across a team is a major issue in collaborative contacts. Anne Kemp also emphasized the need to change the culture and the importance of people. She noted that Level 3 is about making decisions and looking at the whole life cycle and that organisations such as the Environment Agency, Network Rail and the Highways Agency are already taking this approach.

Ian Chapman, director of the National BIM

Library noted the importance of the cloud and asked 'Is Google planning a BIM busting app for construction?'. He also emphasized the need for common terminology and a data dictionary and advocated moving beyond the technology to enable integration. **Brendan Patchell** of Bouygues UK, described his company, which combines design, construction and management of buildings.

The second breakout was entitled "The know-how of BIM, managing the life cycle of buildings".

Reid Cunningham of BAM FM showed how BIM models can be used for FM by working around the current software. He particularly mentioned Autodesk BIM360 which uses Revit on a tablet which can be used by maintenance engineers to prepare a site visit in advance. The use of Revit to remove some components allows a comparison of the model with reality and a quick identification of a problem. This could mean that as-built survey is not necessary but could also be used to identify areas where as-built is required. He suggested that a laser-scan survey at a cost of £4-5/m² would show return on investment in three years. The following speaker, **Trevor Miles** from IBM, also suggested that laser-scan surveys were a very small part of the overall budget and were well worth while. Another point is keeping the BIM model up to date was a challenge.

The final plenary discussed the use of BIM in SMEs and the RICS BIM Manager certification.

There was a small exhibition at the conference with geomatics featuring in stands from Leica, Maltby Surveys, Plowman Craven, Excitech and Mollenhauer. Trimble Building had a stand but did not feature geomatics.

In summary, the message taken away from the conference was that Geo has a small input to BIM but an important and growing one. Issues which were discussed at length are the use of the BIM models for QS and FM and integration of design, build and management. The substantial effort by government to promote BIM will ensure that it does become accepted and part of the culture of the whole construction industry, but this may take some time. It is however fairly certain that there will be work for geomatics in this area.

“Legal liability across a team is a major issue in collaborative contacts.”

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The journey from nautical chart to digital marine mapping

By Dr Mike Osborne and John Pepper

Digital marine mapping became possible with the arrival of the electronic chart. The authors, who pioneered the re-engineering of this data for use in GIS, question whether the requirement has been fully met or whether fundamental issues still exist.

It has been over ten years since UK marine environmental and engineering consultancy, Metoc, started to re-engineer UK Hydrographic Office data to make it suitable for use in GIS. Mike Osborne and John Pepper, who pioneered this work and are now directors of marine data management and GIS specialist, OceanWise, consider how the requirement for digital marine mapping has changed over this time, whether this requirement is now fully satisfied, or whether fundamental issues still exist, despite the presence of more open data and the INSPIRE Directive.

The nautical or navigational chart

There is no equivalent to Ordnance Survey for UK seas. Similar to most countries, the primary remit of the UK's Hydrographic Office (HO) is to ensure the safety of life, property and the environment through the creation and maintenance of navigational products and services. For over 200 years, this has meant the compilation and publication of navigational charts, notably the ubiquitous Admiralty Chart (Figure 1). Used by over 60% of the World's shipping, the Admiralty Chart is designed and created purely with the mariner in mind and rightly so, as it is trusted and relied upon by many people globally.

This situation means that geographic feature types depicted on navigational charts match those required for safe navigation. Individual features are included, omitted and sometimes modified to ensure charts provide the minimum amount of information required for safe navigation. They need to be clear to read and understand in often difficult circumstances, so unnecessary 'clutter' is avoided. For safety, depths are minimum

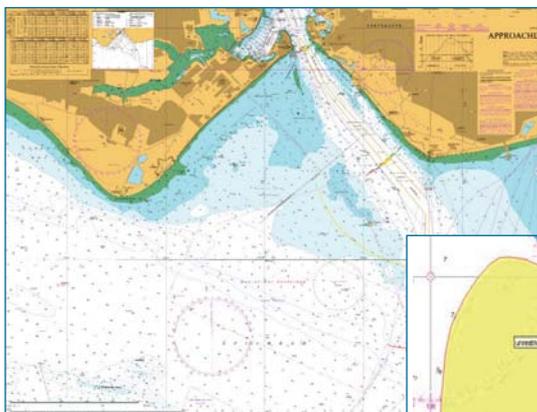
depths and may depict the seabed as being shallower than the mean depth by several metres; known as 'shoal-bias'. The chart is not therefore in the land mapping sense a map of the sea, i.e. a consistent, comprehensive, accurate, authoritative depiction of the real world designed and maintained for a multitude of different purposes.

Furthermore, navigational charts are compiled on an individual basis and, unlike land-based map sheets, overlap at the edges. The chart scale is determined to match the area of interest to the mariner, e.g. the Approaches to Portsmouth, and hence there are many more scale levels for charting than for land mapping. There is no consistent projection per country or zone; each chart often has its own projection. The same features may be present on one chart and missing from an adjacent chart. Features crossing chart boundaries, e.g. depth contours very often do not match, especially when comparing charts that border neighbouring countries.

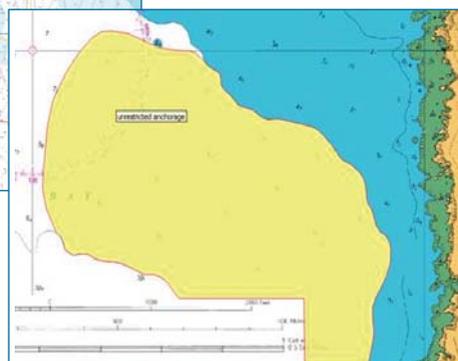
Electronic or Digital Charts

The International Hydrographic Organisation (IHO) introduced the Electronic Navigational Chart (ENC) in the 1990s, with the aim of creating a world-wide ENC database (WEND) and providing the standards and other instruments to support it. Since that time HOs worldwide have been digitising paper charts to create ENCs. It should be noted that in parallel, a number of private companies began digitizing charts and creating unofficial electronic copies that were sold to the mariner under licence, and the UKHO launched the Admiralty Raster Chart Service (ARCS) containing scanned and geocoded copies of paper charts. However, in all cases the issues of content inherent in the paper originals were and are still present in these digital equivalents.

The reason for this is that the source of information for HOs from which to create ENCs was (and still is) the original paper chart. This is because HO's generally manage the majority of their data at a product level, i.e. the data only exists within the product; in this case the paper chart. It also had to be done relatively quickly, so even if there was a desire to change this to a more data centric approach, the time involved would have been prohibitive. The downside is that this arguably short-sighted approach has led to a patchwork of ENCs being created (the ENC 'scheme') and all of the problems with content and discontinuous boundaries being transmitted from paper charts to ENCs. Further, certain decisions about how some features should be captured have led to some anomalous results (Figure 2). However, at least now all of the data captured is in the same coordinate reference



Left: Figure 1 – Admiralty Chart.
© Crown Copyright and/or database rights. Reproduced by permission of the Controller of Her Majesty's Stationery Office and the UK Hydrographic Office (www.ukho.gov.uk).



Right: Figure 2 – Anchorage Area in an ENC overlying the Original Chart.

system, i.e. WGS84, as mandated by the ENC specification – or a local coordinate reference system that could be used as a compliant surrogate, e.g. ETRS89.

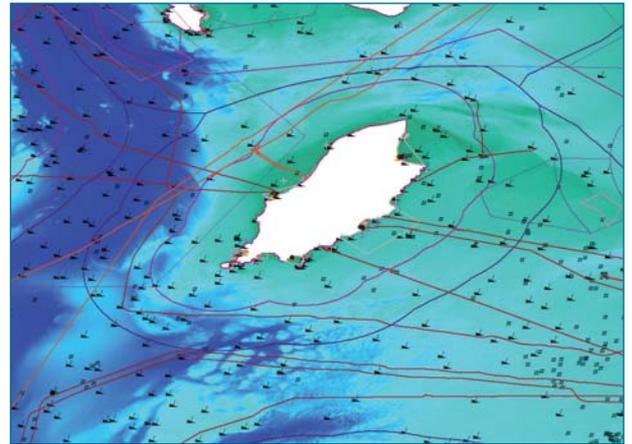
Whilst this paper chart approach to ENC production created effective 'charts on screens', it did very little to address the need for seamless layers of data required for more advanced navigational type applications, such as command and control and more recently electronic or e-navigation. It also did little to address the need for wider uses of HO data in response to extending the change in the IHO's constitution from purely being to protect life at sea to include economic growth and protecting the environment. This wider remit is being addressed through the IHO's Marine Spatial Data Infrastructure (MSDI) Working Group, which the authors helped establish and are now technical advisors. It is also being addressed through the marine data management courses that OceanWise has been running internationally since 2011 with the support of individual HOs, Regional Hydrographic Commissions and the IHO.

The Move to GIS

Metoc began re-purposing data derived from navigational charts by converting data captured by 'private producers', as they are called by HOs, into proprietary GIS formats (e.g. CM93 to Esri shapefile). After some convincing, and drafting, Metoc was granted a licence to allow this re-use, which is distinct from a navigational licence and attracts up to ten times the royalties. Although 'Charted Vector', as the data product was called, could be read directly into GIS, each chart was provided as an individual dataset and none of the content issues described above were addressed. Moreover, use of the data relied a lot on how the data was portrayed, not only on content, thus emphasising the point that a successful mapping project requires input of the system developer, data provider and the end user. At least users now had the ability to load nautical charts into GIS, with an appropriate legitimate licence in place, rather than self-digitizing, which was commonplace but expensive in time, inaccurate and often illegal.

The next step was to create a continuous layer of data from the chart derived content. It also meant adding source data where it existed to provide much more complete and comprehensive datasets that did not just rely on charting. An example is wrecks and obstructions, which UKHO did manage at source, albeit in an unfriendly text format. This continuity was achieved by 'cookie cutting' smaller scale data and inlaying larger scale data. This meant that the best available geometry for any given area was made available but it also meant that some features that were depicted on smaller scale charts, but were missing from larger scale charts (and yes there are some), were removed from the dataset altogether. Although the launch of 'HydroSpatial' in 2005

Right: Figure 3 – Marine Themes Features and Seabed DEM.



marked a major step forward, the dataset and its derivatives, which is still being used in a few places, still suffer from all of the discontinuities in geometry of the paper chart and containing multiple superfluous features as a result.

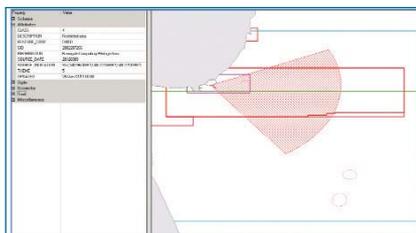
At the same time as UKHO data was being repurposed by licensees, many organisations also responsible for marine datasets started to make their data available in GIS compatible formats. This included British Geological Survey, with DigSBS250 and DigRock250 and JNCC with marine protected areas. Some of these datasets initially suffered from the same issues as charting but the original paper sheet boundaries were soon dissolved and new seamless datasets published. Many but not all of these datasets were made publicly available at no cost to the end user (there is no such thing as free data, only who pays for it). With the advent of INSPIRE, open data and open standards (e.g. Open Geospatial Consortium standards) more and more data is being made available in ways that make it usable in desktop GIS and web GIS, and looking to the future in enterprise, national and regional SDIs. However, while a lot has been expended on Technical Standards and Information and Communication Technology (ICT) not so much effort has been put into the other two 'cornerstones' of SDI, namely Policy and Governance (People) and Geographic Content (Data – and Metadata).

“... not so much effort has been put into the other two 'cornerstones' of SDI, namely Policy and Governance (People) and Geographic Content (Data – and Metadata).”

The Marine Science Strategy and MEDIN

The Marine Environmental and Information Network (MEDIN) has been encouraging organisations responsible for marine datasets to make them available publicly in ways they can be easily downloaded and consumed in accordance with INSPIRE Guidelines, and ideally under an Open Government Licence. The datasets are being collated on the MEDIN

Below, Figure 4 – Restricted Area (Left) and Depth Area (Right) Features, de-conflicted and combined across ENC Boundaries (Red, Green and Purple Lines) in Marine Themes.



SOURCE_DATE	20120309
SOURCE_INDICATION	S57;540-967489-1;540-2225889-1;540-2210390-1
THEME	5
UPDATED	26/Jan/2013 00:00

Above: Figure 5 – Attributes include details of the source ENC (S-57) Identifier or Identifiers, which are concatenated when ENC boundary issue have been resolved.

website under 'Reference Layers'. However, numerous problems still exist. In the absence of a clear strategy and funding model to 'strengthen' existing data and to create new data products and services, which according to the agencies responsible for Marine Spatial Planning are sorely needed, many organisations, including the UKHO, do not have the remit from Government nor the resources to move in this direction. This situation is frustrating, inefficient and ineffective but shows little sign of being resolved, even though the need for improved data management is identified in the Marine Science Strategy, for example.

Marine Themes

Marine Themes was developed by OceanWise as a third generation digital marine map in 2011 and includes several key improvements over its predecessors, Charted Vector and HydroSpatial:

- Carefully selecting appropriate features and geometry from different scale or use bands of ENCs, thus including the features missing from HydroSpatial
- Addressing and, where appropriate, combining the fragmented geometry inherent in paper charts across ENC boundaries, and addressing discrepancies in attributes wherever possible
- Incorporating source data from UKHO and other agencies and more carefully merging this data with the chart derived data to create a much more comprehensive and reliable dataset
- Providing persistence links to source data, which includes concatenating source identifiers where multiple geometries have been combined, thus presenting total provenance to the user and laying the foundations required for change only updates.

In addition, a seabed Digital Elevation Model (Marine Themes DEM) was created that uses original hydrographic survey data rather than chart derived data as its input wherever possible. The result is a much higher resolution and accurate surface model of the seabed suitable for multiple applications, including as input to habitat modelling. Other advantages include a rule based de-confliction method that ensures that overlapping surveys are selected on merit rather than being averaged, which can be misleading, and the inclusion of a height attributed coastline, meaning that the creation of an integrated land-sea surface model becomes much easier; an important consideration in response to recent storm events and adverse weather patterns.

The Future

There are many benefits to HOs moving from a product centric approach to a data centric one, something that OceanWise and the IHO MSDI Working Group is promoting as readily as possible. Managing themed layers of data in this way and using it in multiple products and services, rather than updating ENCs individually, means that HOs are able to support numerous other applications, including e-navigation, realise additional value from their data holdings and deliver significant operational efficiencies. HOs rely on a lot of third party data, for example, aids to navigation from ports and national lighthouse authorities, sensitive sea areas from environmental agencies and coastlines and onshore features from land mapping agencies. The data centric approach means that HO data not only contributes properly to an SDI but that HOs benefit from more efficient and accurate data exchange mechanisms to obtain this data from suppliers.

By managing data as seamless themed layers, the discontinuities inherent in paper charts – and by association in ENCs – will be addressed at source. The next step is then to consider the provenance and hence efficacy of this data. Many features only exist historically on a paper chart and they are drawn there to be illustrative only to the mariner. Consequently, they are not – and were never meant to be – a definitive reference. To be so requires the HO, the organisation responsible for each feature type, if it can be identified, or a third party to undertake data 'strengthening' work by modifying that feature to ensure that its geometry is correct, e.g. it relates to a statutory or other instrument that initiated it, and to incorporate attributes required for multiple users. Examples in the UK include harbour areas and anchorage areas but there are many more. All are required to be as authoritative as possible for marine spatial planning, for example, otherwise their very existence will be open to legal challenge.

Finally, HOs must address the issue of licensing and that navigational products are being used, and potentially abused, for purposes for which they were never intended. It is possible to access navigational products directly in GIS, contrary to their intended use or permitted licence. The reasons for this include users not being able to access more appropriate data due to licensing restrictions and availability, and price; navigational products are cheaper to licence. This practice must stop, as it is misleading, potentially dangerous and detracting from many of the real issues described above. Only when HOs actively support the wider uses of their data, and realise the benefits as a result (many of which are internal benefits), and put in place a licensing system that supports all of these uses favourably, will the real issues have been addressed.

“By managing data as seamless themed layers, the discontinuities inherent in paper charts. . . will be addressed at source.”

Authors

Dr **Mike Osborne** is MD of OceanWise Ltd, Fellow of the Institute of Marine Engineering, Science and Technology (IMarEST) and expert contributor and trainer to the International Hydrographic Organisation (IHO). **John Pepper** is marketing director of OceanWise Ltd and has over 35 years' experience in both the terrestrial and marine GI industry with Ordnance Survey GB and the UKHO. He is also a chartered marketer with the Chartered Institute of Marketing.

Policy Watch: Africa Rising – RICS in Ghana



A trip to Africa finds surveying thriving in Kenya, South Africa and Ghana where an historic MOU was signed, reports Land Group Director **James Kavanagh**.

IN A HISTORIC WEEK of activity in Africa (16th-22nd February), with events and meetings held in South Africa, Kenya and Ghana, RICS reiterated its commitment to building strong and lasting relationships with national professional surveying bodies and collaborative working on capacity building, best practice guidance and international standards.

Almost a year has passed since RICS welcomed the Ghanaian Institution of Surveyors (GhIS) to its London HQ and started a process of engagement that reached fruition during the 9th Surveyors' week and conference in Accra. GhIS professional members packed out an afternoon (Tues 18th Feb) of workshops on measured survey specifications and mapping, valuation standards and valuation of unregistered land (based on the RICS Research (<http://www.rics.org/uk/about-rics/commitment-sustainable-development/practice-sustainability/valuation-of-unregistered-land/>)) from James Kavanagh MRICS Land Director and **Ben Elder** FRICS Global Valuation Director.

The workshops resulted in an excellent debate on the

similarities and nuances of the Ghanaian situation as compared to Kenya (an average land dispute in Ghana can call in Alternative Dispute resolution from tribal chiefs and can cost the average annual salary in fees to all parties). Issues of unregistered land and the difficulties of obtaining title were openly debated with some GhIS members talking of the practice of speculative building being carried out without knowing if the land title was valid. GhIS and RICS are set to explore the possibilities of extending this research to Ghana in conjunction with UN-Habitat and FIG/CASLE.

Wednesday 19th saw over 200 new members gaining entry to the ranks of GhIS – GhIS operate in three divisions: Land Survey, Valuation and QS – the new entrants were spoken to by the three divisional chairs, President **James Dadson** FGhIS and former GhIS presidents on the need to uphold the ethics, standards and reputation of GhIS and its motto 'service with integrity'. James Kavanagh also spoke to the new recruits on the global profession and the new MOU and Direct Entry agreements between RICS



Left: Louise Brooke Smith and James Dadson ratify the historic MOU and DE between RICS and GhIS

and GhIS. More information on GhIS can be found @ <http://www.ghisonline.org/151/Welcome>. GhIS were founded by RICS in the 1960's and operate a very similar model of assessment, training, regulation and membership structures.

The conference then moved to the campus of GIMPA, the Ghana Institute of management and public administration, where a packed audience of 600+ delegates listened to excellent speeches from Hon Surv **Owusu Agyapong**, Dr **Mrs Matilda Fiadzibey** and Prof **Adei**. Speeches from two government ministers followed: Minister of Local Government and Rural Development – Hon. **Akwasi Opong-Fosu** (MP) and Minister of Lands and Natural Resources Hon. **Alhaji A.B. Inusah Fuseini** (MP) who underlined the status of GhIS and the primary importance to the future of Ghana's economic development of the ongoing land Administration Project LAP

<http://www.ghanalap.gov.gh/> This project is being led by **Jones Ofori-Boadu** FGhIS, who also took the opportunity to introduce the RICS delegation to a local Accra Land Survey company Geo-Tech.

RICS president elect Dr **Louise Brooke-Smith** addressed the conference on RICS, Africa and the future and also ratified the MOU between RICS and GhIS by signing a certificate with GhIS president

James Dadson FGhIS reaffirming both institutions' commitment to last November's memorandum of understanding. **Rob Mahoney**, HonSec RICS, also addressed the conference on importance of standards and professional practice and his thoughts on future collaboration between the two bodies. Dr **Diane Dumashie** FRICS gave a presentation on Africa, Ghana and the future needs of the surveying profession before the Young Surveyors took over the conference venue for an interactive session on Futures and the RICS Futures initiative.

The ratification of the MOU and Direct Entry agreements are the 1st major milestones of the Land & Resources Global Strategy and RICS Africa Strategy. Under last year's MoU, both organisations agreed to work together to promote the need for international standards in property, as well as issuing guidance as to how these can be used and be of benefit to local markets.

Dr Louise Brooke-Smith, RICS President-elect, said: "It is an honour to be addressing the delegates here in Accra and to demonstrate our combined commitment to enforcing property standards across the world in the public interest. The GhIS is a fine institution and to be working collaboratively in this way is excellent news."

More info can be sourced @ www.rics.org/ghis



Right: Post workshop shenanigans.

RICS Geomatics Evening Lectures 2014

RICS Geomatics lectures are CPD relevant and count towards your CPD/LLL quota as specified within RICS regulations. All lectures are free and open to all (especially students) unless otherwise specified. All lectures take place at RICS Great George Street lecture hall and are timed at 17.30 for 1800 unless otherwise stated.

Thursday 27 March 2014

SnakeGrid and Network Rail - Dr Jon Iliffe FRICS UCL, and Chris Preston FRICS, Network Rail.



Christi makes a splash

‘– you can’t steal software, you can only copy it!’

This year’s GeoForum lecture was delivered by **Arnulf Christi** at the RICS, 12 Great George Street on January 23rd. The subject as advertised was SplashMaps, but the audience was treated to a great deal more from this buzzy and inspiring speaker.

Arnulf Christi is a passionate advocate of anything ‘open’. He was a founding director and past president of the Open Source Geospatial Foundation (OSGeo) and is now a consultant on all things geospatial, or as he says – ‘metaspatial’.

Much of his talk took us at a gallop through the development of computers. Most of the audience would have known a fair bit about hardware and software but Christi’s viewpoint is so quirky that all of us must have left the event having learnt something new, or at least with an improved understanding. His (unsaid) point was that open source is part of the natural development of computing. The first computers consisted of hardware only – no software. The term ‘software’ was only actually coined by John W Tukay in 1958. Christi argued that software is untouchable, unbreakable and does not degrade but, most significantly, it multiplies when shared. You can’t steal software, you can only copy it. He has a point but it’s probably one with which Microsoft would not concur.

Open fosters innovation

He then took us through the evolution of open source. Key to this was the Unix operating system, which was developed in the mid 1960s, and the ‘C’ programming language associated with it. Unix was developed by AT&T who tried to commercialise it. It is now owned by The Open Group and exists in a number of variants – notably Apple’s OSX and Linux. The point is that it is easy to commercialise software that is proprietary for particular hardware but software development will be held back by the fact that it is tied to hardware. Microsoft took advantage of the best of both worlds by shipping its software with hardware produced by PC manufacturers. The move towards open

standards, software and data has been an essential prerequisite for the software development needed to make the knowledge economy happen.

Christi’s talk then took a turn through the development of ‘geospatial’. A key moment on this journey was the foundation of the Open Geospatial Consortium in 1994 – now in its twentieth glorious year. Shortly afterwards, the internet was born and eventually tapes, disks and CDs were no longer necessary to deliver software and the capacity of the web even increased to the point where data could also be transferred almost instantaneously. Not just copying, but instant copying!

Paying for data

The ‘Open’ revolution firstly encompassed standards, then software and latterly data. Concerning data, Christi reckons open data is in the ‘chasm’ between visionaries and pragmatists on the innovation development pathway. He sees two sources of open data: government data and community data (through crowd-sourcing). Some government data is already open and there was a hint that he expects more to become so: “MasterMap isn’t – yet!” he said, but was he joking about the possibility? “How do you ensure the quality of authoritative data?” asked one member of the audience. Christi is sure that authoritative data has a vital role to play and that it has to be paid for. He took examples from Germany and the USA, where some government data has been made completely free, with adverse consequences. He suggested that the cost of data collection (as-built surveying) is a negligible proportion of the cost of development and should be paid for by the developers. Perhaps developers should pay a levy to the OS to have their development added to MasterMap. The beauty of micro-charging is that you barely notice it.

SplashMaps

The lecture finished with SplashMaps. These are printed maps for the outdoors that are washable, waterproof and wearable and do not smash like mobile phones. The idea gained its initial funding through the Kickstarter website, which invites entrepreneurs to invest in start-up projects: one thousand backers raised £8000. Its expansion has been such that from one map in 2013 there are now thirty-five and the product has been taken on for a number of high profile events such as the Tour de France UK in 2014 and the route of a 100-km night time cycle ride around London – Nightrider, which demanded special cartography for reading in the dark.

No, it’s not for blowing your nose! Splashmaps in action. (Photo courtesy of David Overton)





A piling rig pierces a railway tunnel. Could the contractor or developer reasonably have foreseen this? The full story is on page 6 (News) of this issue. Here **Carl Calvert** sets out the legal issues that arise.

“... a landowner's title extends to everything to the centre of the earth and the heavens above.”

• Carl Calvert MA MSc PgDLaw FRICS CIPM MBCS, is the sole principal of Calvert Consulting, specialising in Boundary litigation. He also lectures part-time in GIS law. www.calvertconsulting.co.uk Email: carlcalvert@aol.com or 023 8086 4643.

Don't keep digging. . .

By Carl Calvert

A 43-page report was published by the Rail Accident Investigation Branch (RAIB 3/2014) in February 2014. It deals with the unfortunate incident of a pile driver drilling 13m down and into a rail tunnel operated by Network Rail.

I shall look at two separate points. The first relates to the question of how much land below the surface does the surface owner have? The second question concerns the penetration of the Old Street Tunnel and possible liabilities.

So, what are the possible ways of doing this? The law has, historically, answered this question with the assurance that a landowner's title extends to everything to the centre of the earth and the heavens above. (The Latin maxim *cujus est solum, ejus est usque ad coelum et ad inferos*, usually translated as meaning that the rights of the surface owner extend upward to the heavens (*ad coelum*) and downward to the centre of the Earth).

I have turned to the UCLA Review of 2008 and a paper by Professor **John G Sprankling** to consider this maxim.

The US Supreme Court's 1946 decision in *United States v. Causby*, [328 U.S. 256 (1946)] where the Court observed:

“It is ancient doctrine that at common law ownership of the land extended to the periphery of the universe—*Cujus est solum ejus est usque ad coelum*. But that doctrine has no place in the modern world.”

Do the US courts uniformly recognize that the surface owner owns the sub surface region, as the theory would dictate? The answer is 'no'.

In 1843, the case of *Acton v. Blundell* 172 [(1843) 12 M. & W. 324, 152 Eng. Rep. 1223] concluded that ownership of groundwater “falls within that principle, which gives to the owner of the soil all that lies beneath his land.

But the Acton court then leaped to the conclusion that the surface owner could remove as much groundwater as he wished, even if this “intercepts or drains off the water collected . . . in his neighbour's well.”

In *Boehringerv. Montalto*, [254 N.Y.S. 276 (Spec. Term 1931)] a New York court rejected the claim that a public sewer line 150 feet deep violated a deed covenant against encumbrances. After discussing the demise of

the *ad coelum* approach to airspace, the New York court concluded:

“It, therefore, appears that the old theory that the title of an owner of real property extends indefinitely upward and downward is no longer an accepted principle of law in its entirety. Title above the surface of the ground is now limited to the extent to which the owner of the soil may reasonably make use thereof. By analogy, the title of an owner to the soil will not be extended to a depth below ground beyond which the owner may not reasonably make use thereof. It is concluded that the depth at which the . . . sewer exists is beyond the point to which the owner can conceivably make use of the property”

So, the US courts have limited the depth to which a surface owner may claim title. The UK courts had similar views. In England and Wales Land Registry (LR) 32 Practice Guide 65 sets out how to register mines and mineral workings but railways are not mines.

Two years before the Rail Tunnel opened in 1902 the sub-soil to be displaced by the tunnel was transferred to the Great Northern and City Railway (GN&CR) who were building the line. The current Land Registry register of title for the site on East Street includes the phrase:

‘So much of the sub-soil as was vested in the Great Northern and City Railway is excluded from the registration.’

The transfer restricted the railway company's property rights or interests relating to surrounding land. The really important omission was the requirement for land owners (of the surface) to inform the rail company of any works which may affect the rail company's rights.

In this particular instance the vendor's solicitors were asked for information about the GN&CR entry in the Land Registry Property Register. The purchasers told the RAIB that it received no information regarding buried services or obstructions from the previous owners of the site or the owners' solicitors. The RAIB has confirmed that the GN&CR entry in the Land Registry Property Register was present at the time of the 2002 sale by the London Borough of Hackney. This devolves to a question of what was the understanding of

the phrase in the 1902 transfer by both vendor and purchaser.

There is plenty of room for conjecture about 'due diligence', 'professional negligence' or any other question relating to the decision to purchase without understanding the ramifications of any lawful use of the land.

Whatever the contractual position I am reminded of the case of *Rylands v. Fletcher* [1868] UKHL1 in which Ryland's contractors came across some old mine shafts whilst constructing a reservoir. The contractors piled debris into the disused shafts and continued building. On 11 December 1860, soon after the reservoir was filled with water the reservoir broke and flooded Fletcher's mine causing damage. Fletcher brought a case against Rylands. In a House of Lords ruling, Lord Cranworth stated:

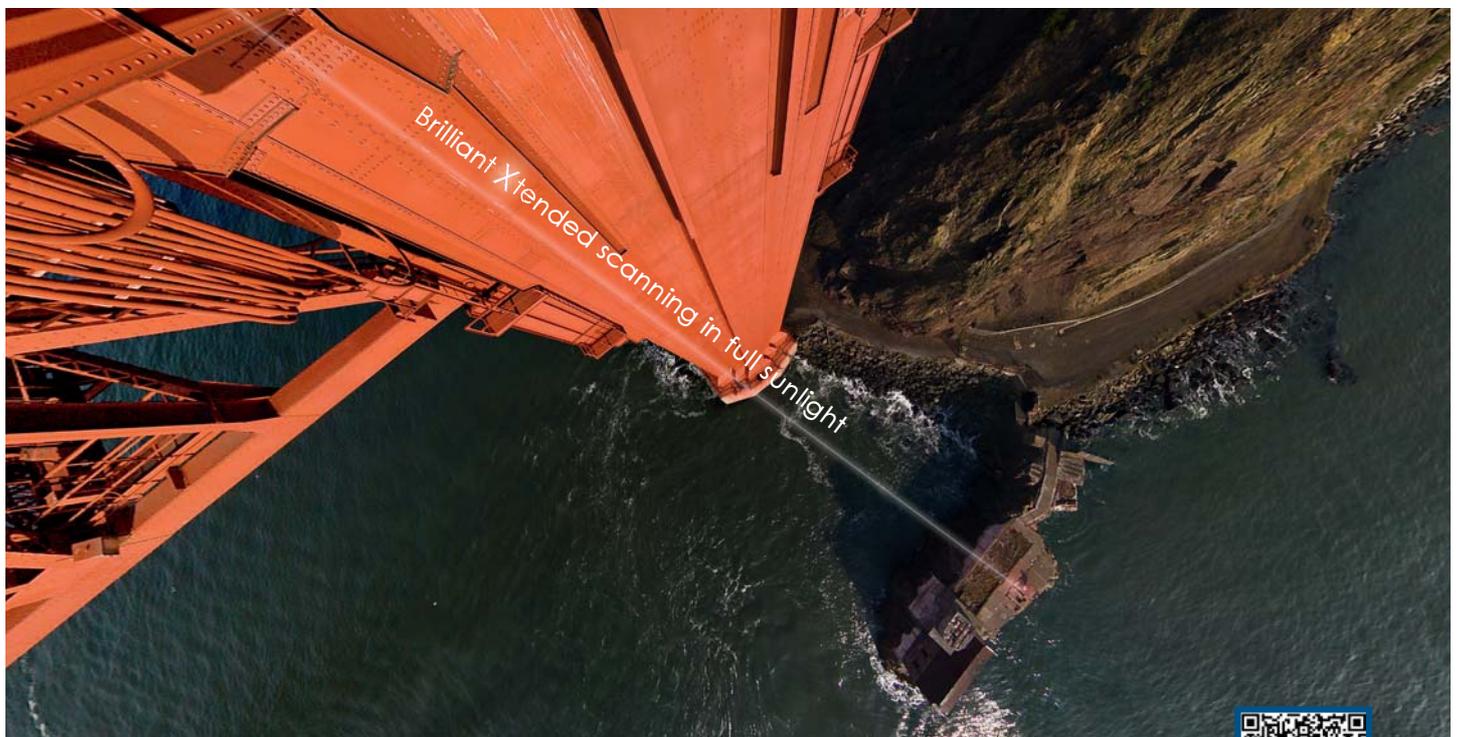
'The Defendants, in order to effect an object of their own, brought on to their land, or on to land which for this purpose may be treated as being theirs, a large accumulated mass of water, and stored it up in a reservoir. The consequence of this was damage to the Plaintiff, and for that damage, however skilfully and carefully the accumulation was made, the Defendants, according to the principles and authorities to which I have adverted, were certainly responsible.'

So, even if the law of contract is difficult there is the law of tort for which someone can claim. The question of who is negligent and for what, is not so easy to assess. Is it LR? Vendors, Purchasers, train company, the parties' solicitors? The RAIB report gave two learning points:

- 1 On this occasion, land ownership documentation provided the primary protection for the railway tunnels in the vicinity of the proposed piling works. There were no surface indications of the tunnel alignment. Clients and design teams should be aware of the importance of understanding and disseminating the significance of all information shown on land ownership records (paragraph 97a).
- 2 Desk study investigations should not assume that all railway tunnels are shown on Ordnance Survey mapping, and should always consider the need to approach rail infrastructure owners in urban areas with underground railway systems (paragraph 99).

However these points are addressed the outcomes need to be simple to apply and affordable.

“..land ownership documentation provided the primary protection for the railway tunnels in the vicinity of the proposed piling works.”



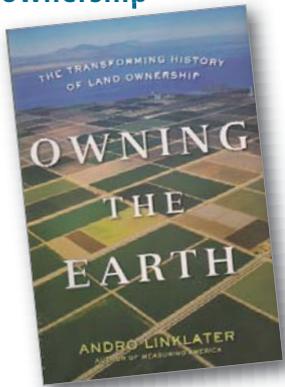
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Owning the Earth – the transforming history of land ownership



By Andro Linklater
Hardback, 482pp, ISBN 978 1
4088 1574 8, price (Amazon)
£13.40, £9.26 by Kindle.

Many readers of *GW* will be familiar with the author's *Measuring America*, the tale of how the United States was shaped by the greatest land sale in history. In that work Linklater, who died last year, did a brilliant job of tracing the origins of measurement systems as well as how the country was divided up into those neat rectangular parcels. Owning the

a wide ranging study examining politics and economics within the context of land

Earth however is a much more weighty tome.

The concept of individual land ownership protected by the rule of law is a comparatively modern construct. True, kings and rulers made grants of land to valiant soldiers after the battle but what the monarch gave could equally be rescinded. Today it is acknowledged that title protected by law can help an economy as well as fostering – although not in all cases – democracy.

From peasant farming, serfs, share cropping and slavery the individual exclusive land ownership emerged to be, in the author's words, "the most destructive and creative cultural force in written history".

Pre-Western civilizations ran many systems but they have nearly all withered. But in a way this book is not really about land ownership per se.: It is about the politics and economics of the last three or four hundred years and how events, driven by land ownership, have brought us to

where we are today.

In this extremely wide ranging study Linklater takes in topics like the Cold War, the rights and morality of property, Queen Elizabeth the First's astrologer (who went to Poland, then the largest country in Europe), Adam Smith, state capitalism and the related subject of intellectual property. The latter he reveals as a paradox: it only works if equal weight is given to the public interest; what Will Hutton calls "the public realm". Along the way Linklater examines the history of just about every system of land and property ownership in the world today. To see how economies can rapidly develop one has only to look at the so called Asian tigers. Although others have overlooked the impact of land reform and individual ownership in their success, Linklater cites the acknowledgement of this by the World Bank.

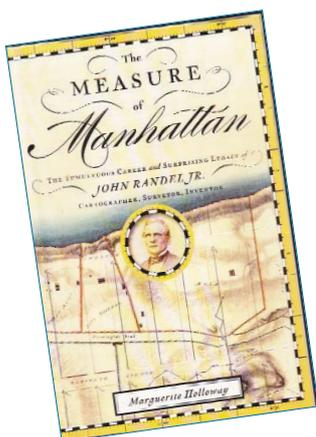
The book however is much more than a treatise on the history and benefits of land ownership. Linklater delves in

detail and depth into the politics and economics of the post world war two world, as a succession of dictators were backed by the US to bring about a "Green revolution" in agriculture. Sadly, the West too often believed that generals and dictators were the only ones capable of pushing through land and agrarian reform. In some places it worked, like The Philippines, paving the way for democracy but in too many others it failed, especially in Iran and the Middle East.

Linklater whilst acknowledging Bill Clinton's "It's the economy, stupid" concludes that if you take into account laws, rights and politics "It's the neighbourhood, stupid", whilst observing that by measuring success in an economy through growth "requires the accelerated consumption of limited natural resources, it is not a sustainable model in the long run".

Reviewer, Stephen Booth

The Measure of Manhattan – the tumultuous career and surprising legacy of John Randel Jr.



an unsung surveyor gets a fitting tribute in this enjoyably biography

By Marguerite Holloway
Hardback, 372pp, ISBN 978 0
393 07125 2 price (Amazon)
£18.44, £16.80 by Kindle.

The modern world has been shaped by many surveyors and engineers, especially during that great era of opportunity, the 19th century. None more so than in the US where surveyors, engineers, embryonic town planners and more than a few snake-oil salesmen contrived to design and build towns, roads, railways, canals and more, usually with other people's money.

John Randel, who was previously unknown to this

reviewer, was responsible for laying out the grid which defines modern Manhattan today. Some of the boundary markers he set down can still be found today with a little diligent searching and digging, as three American surveyors with the author discovered.

But Randel like the good surveyor that he was, had fierce eye for detail. He did not just draw out a grid; he walked almost every square foot of the territory that became Manhattan and in the process created an accurate terrain map (a world first?) and when he'd finished with the first Manhattan Project

he moved on to canals, railways and more, in between designing and building the odd surveying instrument or two.

There is much American history in this work, some of which, while interesting and enjoyable to discover as background, does not necessarily inform our knowledge of the subject. Nevertheless this is a fitting tribute to a significant surveyor.

The book is well illustrated (54 plates) and is an easy read with a commendable absence of footnotes.

Reviewer, Stephen Booth

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Obliques with senseFly



senseFly's eBee and swinglet CAM UAVs, both designed for mapping missions, are now also capable of taking oblique images to complement a mapping project or add additional documentation. The algorithms on board the UAV's autopilot automatically place and orientate the aircraft based on the defined image resolution and inclination (0-45°) selected by the operator. The drone then adapts its trajectory according to local wind and target altitude. This function is freely available to all eBee and swinglet CAM (late 2012 model) users with the new release of eMotion 2.2.

Skybox videos Earth

Skybox has posted the world's first high-resolution, high-definition video of Earth from space taken by a commercial remote sensing satellite. The videos were taken by SkySat-1, the first of Skybox's planned constellation of 24 satellites, and showcases high-resolution views of Tokyo, Bangkok, Baltimore, Las Vegas and Aleppo, Syria. SkySat-1 captures up to 90-second video clips at 30 frames per second, allowing Skybox's data platform to gather dynamic information about the world at an unprecedented scale.

Topcon UA

Topcon has announced the SIRIUS PRO powered by MAVinci, an Unmanned Aerial System (UAS) for automated mapping of construction sites, pipelines, disaster areas, mines, quarries and myriad sites without regard to terrain. The move is the result of a strategic partnership with UAS provider MAVinci GmbH and takes the user from flight planning, photo acquisition through to production of final orthophoto and digital elevation models. The aircraft is positioned using Topcon's RTK solutions, which the company claims can produce 5cm accuracy without ground control points. The system can operate in a wind speed of up to 50 kmph.

Large payload UA tested



Applanix Corp and American Aerospace Advisors Inc (AAAI) have completed a series of test flights of AAAI's RS-16 UA platform equipped with Applanix' DMS-UAV aerial photogrammetry payload. Applanix claim that this is the first successful mission for a long-endurance UAS capable of producing professional grade, directly georeferenced mapping imagery for civilian applications such as pipeline monitoring, power line and emergency response mapping. Tests were conducted over restricted airspace in the state of New Jersey. The RS-16 UA has a flight ceiling of 4500m, 3.9m wingspan and maximum take-off weight of 39kg.

Spatial management

GeoSpatial Experts' GeoJot+ field data collection system now runs on Windows Mobile devices. Companies can seamlessly transfer GeoJot's app component across Apple, Android, and now Windows Mobile 6.x devices such as Trimble and Juniper handheld GPS units. The software enables users to capture geotagged photos on mobile

devices along with descriptive attribute information for each photo. The data is then automatically uploaded to the cloud and processed back in the office.

Improved visualisation

New software from 3D Laser Mapping makes it much easier to access and view scanned data. The innovative Arena 4D software provides a common reference frame for a wide variety of data sources including point clouds captured by static laser scanners or mobile mapping systems.

Arena 4D, which was developed by Veesus, includes a point cloud rendering engine that can visualise billions of laser scanned points on standard office PC hardware. At its heart is an extensible plug-and-play architecture that allows the integration of multiple data types; including 2D and 3D data, imagery including video, audio and text. Arena 4D also accepts live data streams and can share its view across a network to any web enabled device.

Position-fixing

iXBlue, has launched its new ATLANS-C position and orientation system, developed in close co-operation with Septentrio Satellite Navigation. The system is designed to provide continuous and accurate positioning in urban environments, where GNSS signals may be obscured, intermittent, or subject to multipath. The system uses a fibre-optic gyroscope (FOG) based inertial navigation system and Septentrio's multi-constellation GNSS receiver technologies. The system uses 'smart coupling' which allows it to be used for land and air applications.

Access to six systems

Trimble's Spectra Precision division has introduced the SP80 GNSS receiver designed for mainstream surveying and construction applications such as cadastral, topographic, control, stakeout and network RTK. It features exclusive Z-Blade GNSS-centric technology running on a new-generation, 240-channel 6G chipset. The SP80 can utilize all six available GNSS systems (GPS, GLONASS, BeiDou, Galileo, QZSS and SBAS), but can also be

configured to use only selected constellations in an RTK solution (GPS-only, GLONASS-only or BeiDou-only). The SP80 is also the first GNSS receiver on the market to be compliant with the new RTCM 3.2 standard, including the recently approved MSM RTCM messages.

BRIEFS

■ **Chronos has announced the** CTL8200 eLoran GPS UTC Timing Receiver, a combined eLoran and GPS timing receiver. The CTL8200 automatically calibrates its own eLoranUTC using GPSUTC on first installation. Thereafter it outputs a UTC-aligned 1pps that is independent of GPS and immune to disruption of GPS by interference, jamming or spoofing. It can therefore be used to determine whether the GPS signal is being spoofed.

■ **Warwickshire Police have** been using the iSTAR camera to document crime scenes. They use the camera to take 360° images from the point of view of the people involved – even, for example, the passengers in a car. They can also produce walkthroughs and time-lapse videos to animate incidents.

■ **Aibotix has released an** upgraded version of its X6 UA. With V2, it is possible to start and land the Aibot by one touch of a button. The copter can also be flown in training mode, so that it cannot leave a virtual cage (geofence). Besides fully autonomous waypoint flights, the Aibot X6 can also set waypoints during a flight. Perhaps most significantly, the payload has been increased from 2.5kg to 3kg.

■ **CompassData, a worldwide** provider of Ground Control Points (GCP) for GIS, photogrammetric and remote sensing applications has announced that its archive now exceeds 26,000 points, collected in 100 countries across North and South America, Europe, Asia, Africa and the Middle East. Data and metadata is available for viewing and direct download in a reduced-accuracy format to review points and licence details before ordering the final data at the accuracy level required.

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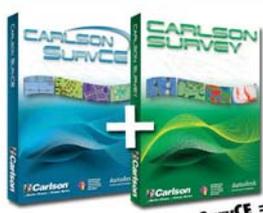
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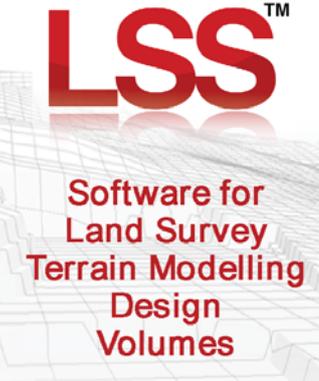
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March / April 2014 issue



MapAction deploys to The Philippines

MapAction deploys to the Philippines



"The waves just came so fast, but worse than that was the wind. There's no way that you could even look, because it was so strong that it practically pulled out your eyes."

Alfred Romualdez, Mayor of Tacloban

The vital role of mapping in disaster emergency response can be a race against time to save lives and bring relief supplies and medical help to people. **Nigel Woof**, MapAction's operation director vividly describes the response to super-typhoon Haiyan in the Philippines last November.

When super-typhoon Haiyan (Yolanda by its Filipino name) was beginning to smash through the Visayas island chain, a MapAction emergency mapping team had just landed in Manila, three hundred kilometres to the north of the storm's track. Even at that distance, the capital was being battered by high winds and torrential rain. As the team set up their equipment in the UN offices in a downtown tower block, global news wires buzzed with reports that Haiyan would be the most powerful storm ever logged as making landfall. But about its actual impact on those on the ground, in the typhoon's path, no-one could do more than speculate.

For the next 24 hours, the international relief community had to rely on Philippines government reports of areas and numbers of people known to be caught under the storm's track plus disjointed glimpses of its impact from news streams and social media. However, with electric power cut off in the worst affected areas, tweets and texts could not contribute to detecting actual needs in any actionable way. Instead, the MapAction team used the time to prepare base map data and to map computed storm surge levels; knowing from previous tropical storms that the sea itself would be likely pose the greatest threat to life in coastal communities.

In the air next day

On the morning of 9th November – the day after the storm's first landfall – the UN disaster assessment team, which MapAction had been tasked to support, was in the air again. The first group of UN personnel managed to land at the airport at Tacloban. They reported by satphone scenes of near-complete devastation. It took six hours for them to travel the few

kilometres from the airport into the city because, the roads were blocked by debris.

Under well practised disaster response protocols, an On-Site Operations Coordination Centre (OSOCC) was rapidly set up in Tacloban to provide a focal point for international aid response in the worst-hit region, the islands of Leyte and Samar. The sports stadium in Tacloban city, battered but still standing and located just down the road from the civil and military coordination hubs, was an ideal site for the OSOCC. The soccer pitch, once cleared of zinc roofing sheets that had been torn and twisted like tissue paper, served as a heli-pad. A Swedish technical support team swung into action to create a tented ops 'room' with electric generators and vital satellite communications.

With the OSOCC up and running, MapAction could contemplate moving at least part of its mapping operations from Manila to the field, to serve the growing contingent of aid agencies already working on the ground. After arriving at the remains of Tacloban airport on a military C130 aircraft, MapAction's operations director **Jonny Douch** noted: "The scene was like something out of a disaster movie. The journey into town was eerie. The car headlights showed glimpses of a shattered landscape, which the storm surge had created in an instant. Everything was still now, just a few lonely soldiers waving us through road blocks. It was hard to imagine how anybody could have survived here. By the roadside were rows of body bags waiting for collection."

Immediate demand for mapping

Demand for mapped information was immediate. Basic reference maps were essential to help aid teams find places reported as having people with critical needs. Rapid thematic mapping took many forms: for example tracking where initial damage assessments had taken place, and the coverage of local radio stations that had somehow managed to start transmitting again somehow and thereby provide a virtual lifeline to communities starved of reliable information, as well as lacking pretty much everything else.

With extensive physical damage of unknown extent, there was an obvious opportunity to use remote sensing to identify priority areas for on-the-ground needs assessments. As well as the usual civilian space agencies supporting disasters, military satellites were also pointed at the Philippines, and the analysis shared. A lot of imagery was acquired by various agencies (civilian and military) during the first days after the storm.

Tossed like a child's toy, this truck must have been thrown off the road.



However, as there is no 'clearing house' for such data it can be difficult to keep track of who is acquiring or processing what imagery. UNOSAT triggered various mechanisms for imagery, foremost the Space Charter, and performed a detailed infrastructure damage assessment of certain areas, releasing its first image maps on 11 Nov. Meanwhile, the US Government made some over-flights and shared initial results with UNOSAT.

It is important for damage assessments derived from imagery to cross-analyse with other data, to answer key operational questions and focus on-the-ground assessment and response at field level. For that reason, MapAction typically asks for derived, vector-format data to be provided, which can be incorporated as layers into the operational-level GIS. UNOSAT provided these to our team in the Philippines, and it was used in some of our map products (specifically for Tacloban city) from 14 Nov.

Although cloud cover and other constraints meant this took ten days to become available in a useful form, it was valuable as a triangulation of information reported from the field.

What about UAVs?

UAVs are ideal for detailed mapping of small areas very quickly but in the early stages of an emergency such as this the priority is for information for the collective coordinated response geared towards characterising the overall extent/impact of the disaster (how big, how bad) rather than looking in detail at small sections of real estate, unless they are known to be pivotal to the planning of the overall response.

Haiyan tracked across an area of tens of thousands of square kilometers, through an island archipelago. In such an emergency, the real headaches were determining the extent and nature of impact on communities in outlying areas, including isolated islands. This would, in principle, be a suitable application for drones, if they had sufficient range of operation. But long range implies large vehicles, which have not yet been developed to operate safely when sharing airspace with other manned aircraft.

Paper products

Paper maps were, as usual, the most popular format among front line users. In the Philippines, when travelling around the field, aid workers could not even rely on getting access to generators to charge their gadgets (and there was no mains electricity anywhere). In such circumstances, the NGO emergency professionals may bring their tablets and smartphones but they were not going to rely on them when they are in the field. Most information was gathered using notebooks and pencils and shared through face-to-face meetings at the coordination hubs.

There was a demand for hundreds of maps per day at the Tacloban response centre and, to cover

Working conditions were tough for the MapAction volunteers but at least they had safe water and a tent with a bed.



the initial requirement, MapAction volunteers carry as much paper with them as possible. Despite the difficulties, some users did have their electronics with them, so MapAction provided many soft copies of maps. Indeed, the organisation is currently testing a system to provide online, interactive mapping for users while they are in wifi range of a coordination centre, and potentially over the internet, assuming it is functional. The big challenges for this development are to make it flexible enough to cope with unpredictable emergency situations and durable enough to survive in the field environment.

Help from home

Most data prep and map production work is still carried out by the team in the field, who have both the situational data and (importantly) contextual understanding of the users' needs. Often, new maps or revisions are turned round within an hour or so of receiving new data and it is that rapid response, working directly with the user agencies, that is MapAction's hallmark. However, the charity also operates a 'Support Base' system continuously during emergency deployments. One volunteer acts as a focal point for requests from the the field team for support work, which is then picked up by other support volunteers working from home. Tasks include liaising with global data providers (eg satellite imagery providers, and the OpenStreetMap community), georeferencing, posting map products on partner websites and so on. At all times it is the overseas team that sets the requirements and priorities for support.

Data flood

Within a few days the information trickle became a data flood. MapAction, meanwhile, concentrated on anticipating the crucial decisions that the aid community would need to answer in coming weeks to achieve an effective collective response. A coordinated needs assessment was being planned, and initial aid activities needed to be mapped against those identified needs, to show newly-arriving aid organisations where to target their resources. Just mapping physical damage was insufficient; relief agencies were seeking a picture of specific needs, which varied between communities and often depended on

“It was hard to imagine how anybody could have survived here.”

the geography of rural livelihoods: for example which farmers need to replace lost seeds to make possible next season's rice crop?

Variable boundaries

The MapAction team, and the information management specialists in the group from the UN Office for the Coordination of Humanitarian Affairs (UN OCHA) in Manila, knew the importance of establishing a spatial data framework to ensure that situational data could be mapped and compared consistently. This starts with the prosaic but essential business of 'common operational datasets'. For example, having everyone working to the same version of administrative boundaries. The Philippines, a country of nearly 100 million people, has four admin levels: regions, provinces, municipalities and barangays. But changes to boundaries are frequent and local and central government's records may not tally; as was the case in Tacloban, where the city authority was, it turned out, working to a completely different set of local boundaries from those used in the census.

Another often-used routine in humanitarian information management is to establish a 'p-code' system (p is for place) to positively identify the 'where' component in tables of reported data. Frequent past disasters in the Philippines have led to a 9-digit p-code being established; crucial for the Haiyan response. The UN OCHA team even developed a p-coding tool (an Excel macro) to code up new data quickly. However, much of the data shared between government and aid agencies had the p-code already included as a field, enabling the data to be joined simply to the admin geography, and hence mapped. In fact, the Philippines government's approach to data sharing was in many ways exemplary; early in the emergency they asked international aid agencies which government datasets could usefully be made open.

Heat, noise, tents were luxuries

Communications between the relief communities in Manila and Tacloban – and in five other coordination hubs – improved dramatically during the first three weeks of the response. Despite Tacloban having no mains electricity, a commercial internet provider re-established a working fibre connection using its backup generator. From there, microwave links were set up to give broadband communications to both the city hall and the OSOCC. The MapAction team, working from the sports stadium, was thereby able to contribute to mapping the situational pictures at both local and national levels. With the even greater workload this implied, the mapping team had to work long hours through the incommensurable heat and humidity, and the incessant din of helicopters taking off and landing just metres away. But the volunteers were conscious that their freeze-dried rations, purified water and tents in which to grab a few hours sleep, were luxuries

denied to hundreds of thousands of people around the city and in the countryside, whose very existence remained precarious.

The collective humanitarian decision-support effort in the Haiyan response was built on accumulated experience from previous major emergencies. One success was the rapid establishment of an effective information management network linking the eleven pre-configured 'humanitarian clusters', each responsible for one dimension of the response: food, emergency shelter, and so on. Spatial data gathered through the clusters was shared and aggregated. One crucial output was the who-what-where ('3W') matrix of aid agency activities and plans, district by district. This was turned, by MapAction, into an atlas of more than a hundred 3W maps, updated twice a week, to facilitate coordinated response by the several hundred NGO's.

MapAction's vital role in the response continued for six weeks after the typhoon. Several 'rotations' of field personnel, and unflagging support from the charity's non-deployed volunteers working from their home bases, enabled an enormous catalogue of mapped information to be made available to responders. Thousands of map copies were printed in the OSOCC for aid workers, while countless numbers of maps were accessed online, especially through the information portal set up for the emergency.

As in other major disasters, MapAction's emergency mappers returning from the Philippines reported mixed emotions about their role and achievements. One volunteer, **Vickie White**, whose first disaster mission with MapAction had been in response to the Asian tsunami operations back in 2004, reflected on the Philippines mission: "It was tough but also hugely motivating to work alongside the front-line aid agencies who we knew were racing against time to save lives and livelihoods. We and they knew that aid in the wrong place would be no help at all, so mapping was vital. Our colleagues in the UN and other humanitarian decision makers told us our work behind the scenes made a real difference."

"... the Philippines government's approach to data sharing was in many ways exemplary..."

MISSION KITS

MapAction maintains standard mission kits at its ops centre in Buckinghamshire for emergency deployments. The contents are continually being distilled and refined from experience in dozens of countries and situations. The team typically carries (in addition to their personal kit, which is also subject to standard procedures) two equipment boxes, plus hand-carry items. The kits include, among many other things on a five-page list:

- Laptops with standardised software builds (Esri ArcGIS, other GIS tools, lots of other favourite tools/utilities).
- Field networking kit
- Satellite data modem (BGAN) and hand-held satphones (Thuraya or Iridium, depending on destination)
- A3 inkjet printer...and a large supply of ink cartridges!
- GPS units
- Team sustainability items - everything from water purifiers to first aid kits.