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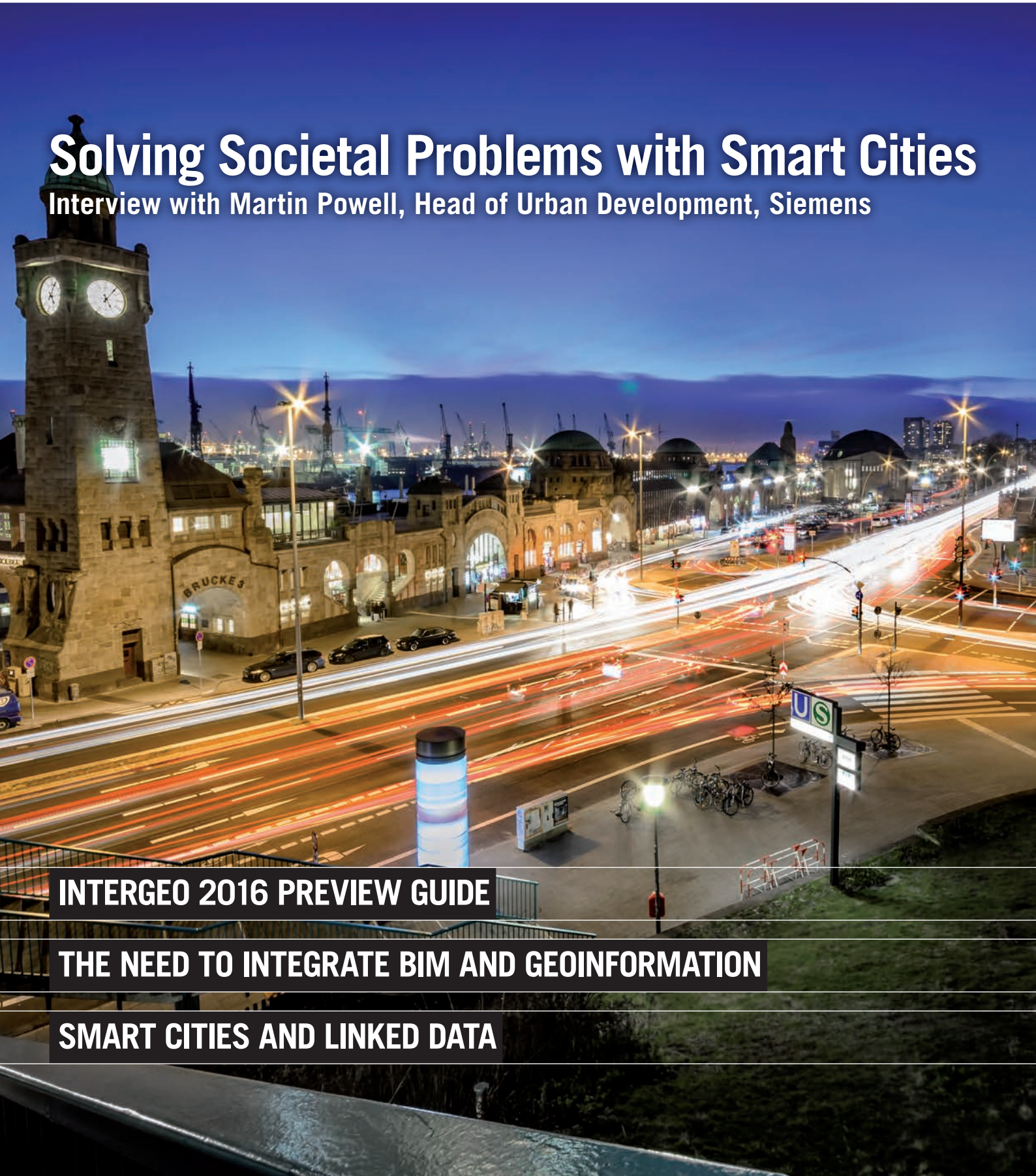
Solving Societal Problems with Smart Cities

Interview with Martin Powell, Head of Urban Development, Siemens



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		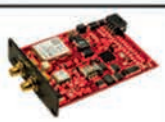					
							
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				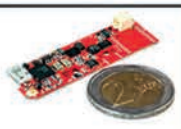	
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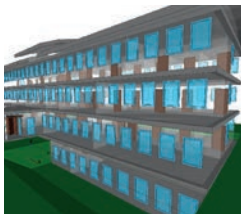

SMART CITY SOLUTIONS

The front cover of this double-thick issue of *GIM International* shows Hamburg, the host city of Intergeo 2016. Hamburg is leading the way in Germany when it comes to the smart city concept, which makes it an excellent venue for the world's largest trade show and conference on geomatics. 'Smart City' is one of the key topics at this year's edition of Intergeo. (Courtesy: NEC Fotografie)

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BPA WORLDWIDE BUSINESS

A Round of Applause!

It's time for a round of applause! That applause is meant for all of you – professionals working in geomatics, the pioneers at national mapping agencies, NGOs, learned societies and in the private sector. 'What for and why now?', you may be wondering. Well, there are many reasons that our sector deserves a pat on the back, but the main one I'm referring to now is the success achieved by the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) this summer, and the long-term consequences it will have for geomatics and thus for all of us. The United Nations Economic and Social Council (ECOSOC) has reviewed the work of UN-GGIM and adopted a resolution acknowledging the fundamental role that geospatial information plays in global sustainability and development. At the highest possible global governmental stage, geospatial information is now identified as being key in supporting policymaking (although we've already been aware of this key role for a long time, of course…). This acknowledgment now means that governments all over the globe will have to invest time and money in gathering and implementing geoinformation as a pillar for their decision-making. Some governments will be early adopters and others laggards but, one way or the other, geoinformation will become more established as a tool for governments at national, regional and local level. The success of UN-GGIM at ECOSOC is the culmination of five years of continuous effort by a group of enthusiastic and professional specialists – not only in UN meeting rooms in New York, but also on their home turf – to establish the role of geospatial information. These specialists were supported by just as many professionals behind the scenes, which is why I regard this as a victory of many – with a positive influence on the work of everyone in geomatics – and why I see fit to congratulate the Committee of Experts of UN-GGIM.

You will find an overview of this summer's Sixth Session of UN-GGIM in this issue of *GIM International* (on page 48). Furthermore, this edition has a special focus on 'Smart Cities', which is also the theme of this year's Intergeo (being held from 11-13 October in Hamburg, Germany). To tie in with this theme, our editor Wim van Wegen has interviewed Martin Powell of Siemens (see page 16), and our contributing editor Frédérique Coumans reports on the interdependence between spatial data and smart cities, including input from Dr Chirine Etezadzadeh, expert on smart cities (see page 31).

The autumn is always an exciting time of the year as we gear up for the industry's biggest annual show: Intergeo! If you will be there, please come and meet the *GIM International* team – we'll be out in force on the show floor, during the conference and at our stand (No. C1.076). And if you can't make it to the event in Germany, read up on all the latest developments in this extra-thick issue of *GIM International*. After that, you will hopefully join me in congratulating yourself and your peers – all geomatics professionals – on the great strides that have been made over the past months and years. Give yourselves a round of applause!

▲ *Durk Haarsma, publishing director*

Regional SDIs Advance as UN-GGIM Moves Ahead

Recently, from 1-5 August, the Committee of Experts of the United Nations Global Geospatial Information Management (UN-GGIM) met at the UN headquarters in New York, USA, for the sixth time since its establishment in 2011. The event was preceded by several related workshops. The Americas contributed with a workshop on the Caribbean SDI and a new UN-GGIM:Americas meeting at which a second edition of the Joint Plan for the Development of Spatial Data Infrastructure of the Americas was adopted, now scoping the period 2016-2020. With this tool, the key regional SDI leaders (PAIGH, SIRGAS, UN-GGIM:Americas and GeoSUR) are harmonising their respective action plans to avoid duplication and to promote further SDI development. Also, this Joint Plan gives attention to new regional initiatives, consistent with UN-GGIM aims, as in the cases of the Geospatial Statistical Framework of the Americas (MEGA) and the proposed 'Atlas of Gender' in the Americas.

Also in New York, a recent ECOSOC resolution was approved to empower the GGIM Group of Experts and to provide the necessary institutional arrangements on geospatial information management to accomplish UN-GGIM objectives. The resolution, dated 27 July 2016, includes a final verdict on the regional cartographic conferences to concentrate the efforts of the United Nations Statistics Division (UNSD), among other key activities, in support of the regional committees and their technical and substantive activities. The old instrument was clearly exhausted and time will demonstrate the benefits of such an adjustment. Written in streamlining mode, the Resolution also dictates a change to the item on the ECOSOC agenda, from 'Cartography' to 'Geospatial Information'. 'Mapping' is safe, for the moment.

▲ *Santiago Borrero.*

Anyhow, after a hiatus in UN-type meetings, I have witnessed the impressive work advanced by UNSD and the Expert Group. With more than 300 participants from 95 countries and the participation of international organisations, NGOs, and representatives from the private and academic sectors, UN-GGIM is advancing notably to properly locate the role of spatial information in the context of overall UN objectives for sustainable development. I still do not see clearly how UN-GGIM goals will be attained with the same limited geographic institutions operating in a vast number of UN member countries, but recognition has to be given to its key role in progressing a global geodetic reference frame, the set of global fundamental geospatial data themes, the integration of statistical and spatial information, a legal and policy framework and the application of spatial information to optimise territorial administration, among other purposes. These activities will take a lot of time and – to reach consensus, as is the nature of the United Nations – considerable effort.

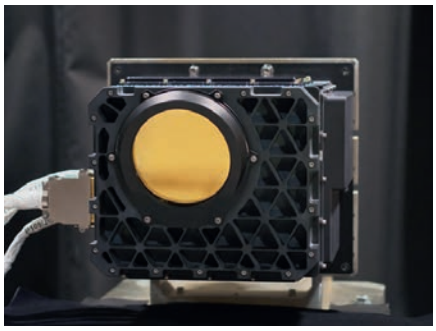
Precise UAV Camera Positioning for 3D Mapping

PPK camera positioning system.

Photogrammetric mapping is the new 'hot topic', although the concept has been around since Leonardo da Vinci's time and it has been in use in practice for over a century. Drone technology has now consumerised photogrammetry, introducing data acquisition and 3D model processing to thousands. From a surveying standpoint, accuracy is key. To build 3D models in a known spatial frame of reference requires some form of control, either on the ground, in the air or a combination of both, which is where ground control points (GCPs) come in. GCPs provide a solid tie to a real coordinate system with known coordinates on targets across a project. Accuracy of the project can be assessed in the aerial triangulation (AT) process, combining a weighted combination of data from the photo matching and the GCPs.

▸ **http://bit.ly/2d4M0c0**

Teledyne Optech Lidar Launched in OSIRIS-REx Asteroid Mission



Teledyne Optech OLA.

The OSIRIS-REx Laser Altimeter (OLA) was launched successfully from Cape Canaveral, USA, on Thursday 8 September. OLA was designed by scientists and engineers from Teledyne Optech and built by MacDonald, Dettwiler and Associates (MDA). It had been installed and tested aboard the OSIRIS-REx (Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer) spacecraft.

OSIRIS-Rex will reach the asteroid Bennu by 2018. Upon reaching Bennu, OLA will scan the surface to create a high-resolution 3D map of the entire asteroid, which will help scientists understand its morphology and select the best spot for OSIRIS-REx to collect a sample of its surface material. This sample will be collected in 2020 and returned to Earth in 2023. Because Bennu is a carbonaceous asteroid that has likely changed very little since the birth of the solar system, scientists hope that this mission will shed light on how the solar system developed.

▸ **http://bit.ly/2cKo4VW**

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Ford and Baidu Invest USD150 Million in Velodyne's Lidar Technology

Car-mounted Lidar.

Velodyne LiDAR, a global leader in Lidar technology, has completed a combined USD150 million investment from co-investors Ford and China's leading search engine company Baidu. The investment will allow Velodyne to rapidly expand the design and production of high-performance, cost-effective automotive Lidar sensors. This will accelerate mass adoption in autonomous vehicle and advanced driver assistance systems (ADAS) applications and therefore accelerate the critical, transformative benefits they provide. Over the last decade, Velodyne has developed four generations of hybrid solid-state Lidar systems. They each incorporate the company's proprietary software and algorithms that interpret rich data gathered from the environment via highly accurate laser-based sensors to create high-resolution 3D digital images used for mapping, localisation, object identification and collision avoidance. Velodyne's Lidar solutions are capable of producing between 300,000 and 2.2 million data points per second with a range of up to 200 metres at centimetre-level accuracy. The company's high-performance Lidar technology has been recognised by global automotive OEMs and rideshare customers as a critical element enabling the development of fully autonomous vehicles.

▸ **http://bit.ly/2cBKvwc**

European Space Imaging and Vricon Announce Partnership

Vricon 3D surface model of London, UK.

European Space Imaging (EUSI) has entered into an agreement with Vricon, a US-based producer of high-accuracy 3D data and digital elevation models with global coverage. This partnership gives European customers easy access to the globe in 3D and will be of particular benefit to government and security customers. EUSI always aims to give its customers and key partners access to the best technology and highest-resolution imagery solutions on the market, said Adrian Zevenbergen, managing director, European Space Imaging. The new agreement with Vricon brings accurate terrain data and 3D imagery of Earth to support defence and intelligence customers and will provide a huge benefit for anyone looking for complete, up-to-date 3D geosolutions, he added.

▸ **http://bit.ly/2crMa4u**

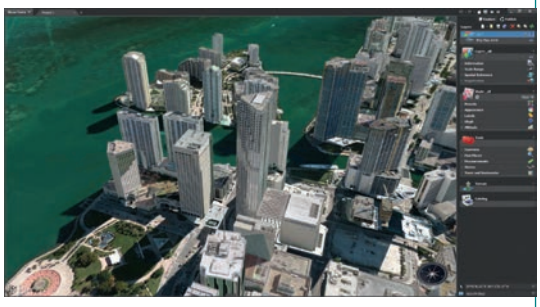
Lead'Air MIDAS Equipped with Phase One Cameras

MIDAS oblique camera system.

Lead'Air has recently developed a new MIDAS 300P with a Phase One IXU-R 1000 - 100mp nadir camera with a 50mm lens and four Phase One IXU 150 - 50mp oblique cameras with 80mm lenses. The combination of these two camera models creates a high-quality, medium-format imaging system for combination oblique/vertical image capture. In addition, another recent development is the MIDAS 300PC that incorporates a high-resolution Phase One IXU-R 1000 - 100mp nadir camera with a 50mm lens and four Canon 5DS-R - 50mp oblique cameras with 85mm lenses. This allows a high-resolution nadir camera to be combined with the economical, professional-quality small-format cameras for oblique image capture.

▸ **http://bit.ly/2c05V86**

Eternix Launches Blaze Terra 5.0



Blaze Terra.

Eternix has released Blaze Terra 5.0, the newest version of its flagship product, now including fully fledged symbolisation. Blaze Terra users now have a great variety of options to define and illustrate differences between feature values, such as height, distance or size, by selecting from a wide choice of range settings and colour themes. The Symbology feature enables users to create rules by defining the field and value of items in order to visualise them in a customised style, thus better illustrating assets or areas including points, lines and polygons. The customised styles can be saved and used later as a default setting. The addition of the style functions has remarkably increased the user's customisation options, yet, the user interface remains intuitive and highly user friendly.

▸ **http://bit.ly/2cvDDzA**

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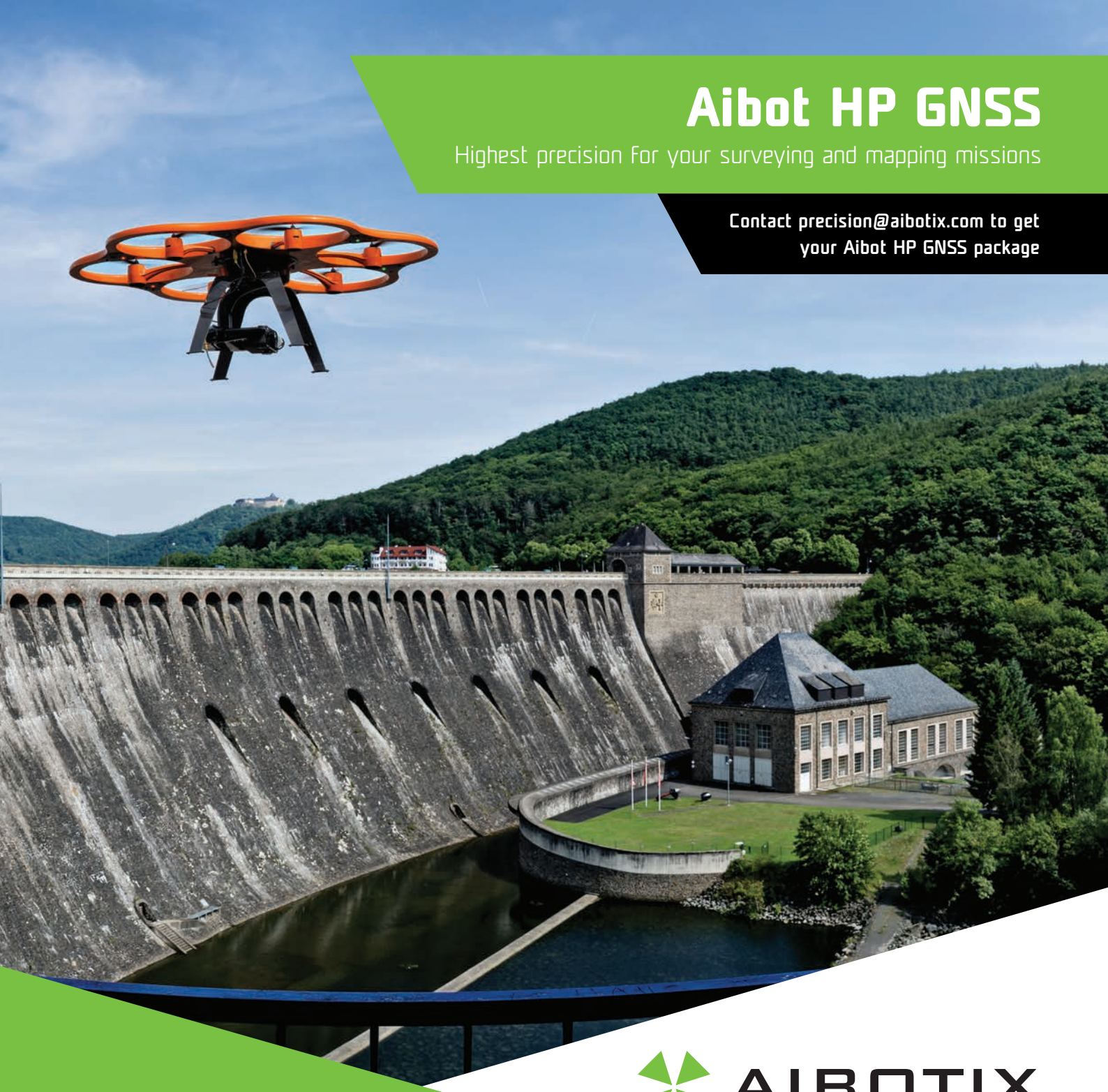

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At *GIM International*, we are always searching for great stories and the most relevant news. However, we are sure there is much more going on than our editorial team can cover alone. So we are encouraging geomatics professionals to share their insights too. Are you interested in writing a blog about an exciting or unusual survey or project? Or perhaps you would like to inform our readers about a game-changing innovation? If so, let us know! We're keen to expand our coverage with your blogs. Contact our editorial manager, Wim van Wegen (wim.van.wegen@geomares.nl), to discuss your ideas. He is looking forward to hearing what you would like to share with our extensive worldwide readership!

Successful CPCI Conference in Colombia

Medellín, Colombia.

Each year, the cadastres of Latin America, the Caribbean and the Iberian Peninsula ('Comité Permanente sobre el Catastro en Iberoamérica' or CPCI) meet to discuss new developments and the current state of affairs relating to the cadastres in the region. This year, the conference took place in Medellín, a vibrant, modern city in the northwest of Colombia. Delegates from many countries provided a broad overview on multi-purpose cadastres in the region (e.g. Colombia, Uruguay, Brazil, Mexico, Ecuador, Chile, Argentina, Paraguay, Panama, Costa Rica, Cuba and Santo Domingo, as well as Spain, Korea and The Netherlands). During the subsequent meeting, Kadaster International (Dutch Cadastre, Land Registry and Mapping Agency) became a 'socio observador' of the CPCI. A working group was established on the implications for cadastres of the FAO Voluntary Guidelines, with a strong link to fit-for-purpose land administration. The working group will be presided over by INCRA (Brazil) and be facilitated by the CEDDET online training platform.

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Young People and Geomatics: **Time to Act**

In an earlier contribution, I wrote about the strong necessity of making the geomatics discipline more attractive to students. In terms of careers, the geospatial sector is probably one of the best kept secrets. There is a startling lack of public awareness about the geomatics surveying profession – which goes a long way to explain why many universities find it difficult to attract new students to their geo-related programmes and why the ever-growing geomatics industry faces a lack of qualified young talent.

As I explained previously, it's of vital importance to make geomatics more attractive to young people. However, we can't do it alone – above all, we need the support of industry members, and it is also in their interests that this mission succeeds. We should work together on a strategy to encourage talented youngsters to choose a career in the geospatial business. But how?

Thanks to ongoing innovation and technological advancement the geospatial sector is getting more and more exciting every year, which is in turn improving universities' chances of attracting students to their geomatics programmes. But this still requires considerable efforts from the stakeholders; simply sitting back and waiting is clearly not enough. In a nutshell, the mission is as follows: people need to know what geomatics encompasses.

We will only make major strides forwards when the public realises the extent to which geomatics is crucial to our daily lives, and where better to start than with school children? After all, it is young people in particular whom we must encourage to join our industry. We can show them numerous examples of society's dependence on geomatics. From vehicle navigation systems and online maps to the construction of roads and other infrastructure, and from agricultural applications to parcel deliveries, and even in sports – geomatics is everywhere.

Furthermore, the cadastral system forms a country's backbone, and spatial representation plays a key role in securing land rights and land management as the basis for economic development. I'm sure that many young people want to work to make their country better and stronger and to contribute to the future of society as a whole. Such noble intentions can be leveraged to influence their study choices. I'm also certain that geomatics potentially has wide appeal thanks to its numerous and diverse fields of application. Our discipline offers so much variety that it sparks the interest of almost everyone, so there is absolutely no reason for this to be a 'mission impossible'.

So what concrete steps can now be taken to get things moving in the right direction? Teaching materials, brochures, student tracks at trade shows and conferences, and guest lectures are just a few ideas that immediately spring to my mind. Are you willing and able to get involved with us on this? Let's team up!

▲ Wim van Wegen
Editorial manager *GIM International*
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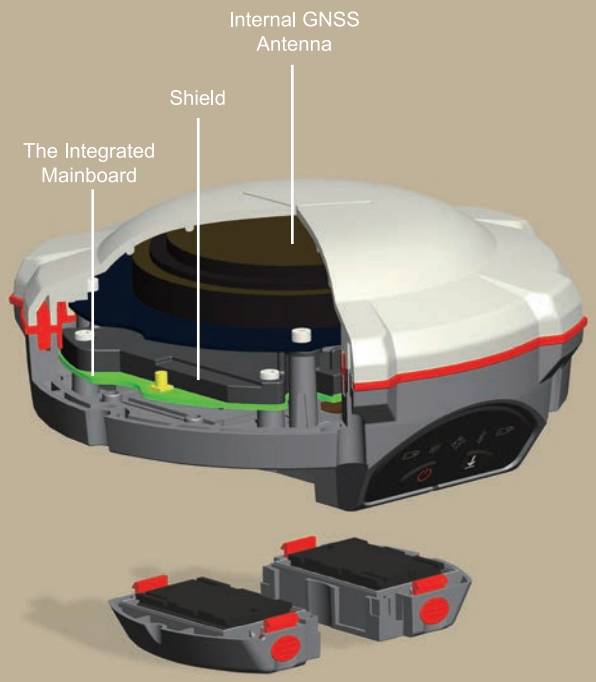

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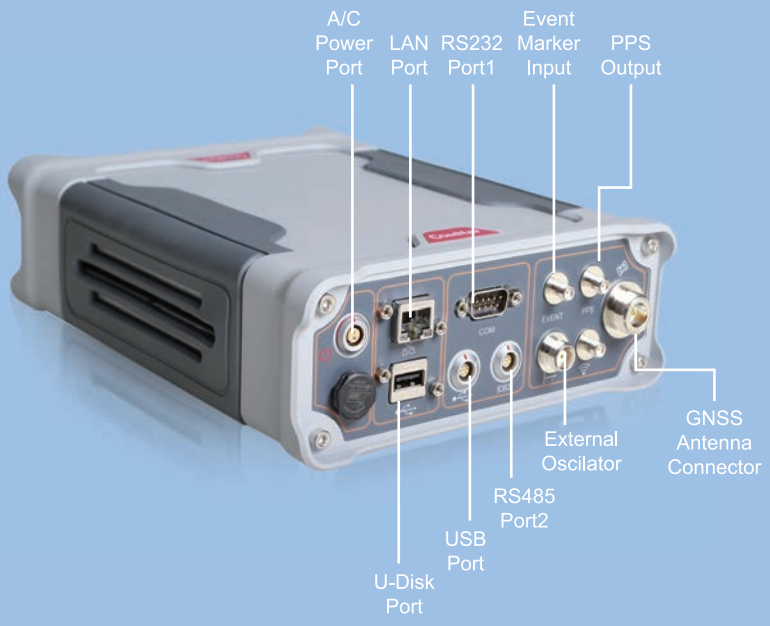

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FIG Working Week 2017: Call for Papers

The overall theme of the FIG Working Week 2017 – to be held in Helsinki, Finland, from 29 May to 2 June – is 'Surveying the world of tomorrow – from digitalisation to augmented reality'. FIG is witnessing the first beginning of a development leading towards services which not only describe the visible world around us, but also simultaneously bring up other information connected to our place of interest. One step is to become digitalised and to use the digital information; the next step is to combine information and be able to collect the data intelligently and to take further steps into the intelligent use of digital information. This year's theme was chosen to highlight the opportunities and open a view into a future where the information we produce is, again, put to more efficient use. The FIG Working Week 2017 is the main event of the year for all ten FIG technical Commissions. Therefore proposals for papers are requested in all topics of interest of the various Commissions.

▸ **http://bit.ly/2ciK5KJ**

Satlab Introduces SLC RTK Handheld with Tablet or Phone as Display

Satlab SLC handheld.

Sweden-based survey and GIS equipment maker Satlab Geosolutions has launched its multi-purpose SLC RTK handheld solution. The SLC brings professional high-precision positioning in a new design concept with Bluetooth connectivity for Android, Windows and iOS BLE smart devices. The SLC handheld sends centimetre-level NMEA position data to the user's tablet or phone via Bluetooth. Alternatively, it can be used as a fixed sensor for any compatible NMEA-driven positioning application. The design includes a mounting plate to attach the user's tablet device so it acts as the SLC's display, or connectivity is available via a USB/RS232 port. With built-in wireless modem and optional remote antenna and pole or fixed mount accessories, the SLC can be configured as a sensor for machine control or other mobile applications.

▸ **http://bit.ly/2d2QmbX**

INTERVIEW WITH MARTIN POWELL, HEAD OF URBAN DEVELOPMENT, SIEMENS

Solving Societal Problems with **Smart Cities**

The world population is growing rapidly, putting urban planning under increasing pressure. Cities are facing challenges such as how to improve the environment and how to reduce the impact of congestion. The smart city concept seems to offer a solution. Reflecting the fact that smart cities are built on geospatial foundations, Intergeo – the world's largest annual trade show for the geomatics industry – has chosen smart city as its key theme this year. To gain insights from an urban planning insider, *GIM International* interviewed Martin Powell, head of urban development at Siemens.

'Smart city' is a frequently used term, but its definition is not always clear. How would you define a smart city?

There are so many different definitions out there. Siemens wanted to be very clear about what it believes smart cities to be. And actually they are all different; every city has a very unique smart city definition and its own criteria. For example, the Ministry of Urban Development in India is very clear about what it wants to achieve. Obviously, a city like London would have a very different baseline and aspiration than Mumbai. But, in broad terms, a smart city optimises the infrastructure that it has and maximises the efficiency and services that it provides to the citizen. It uses digital connectivity between the systems and the resulting data to deliver those services and to respond in real time. So that's our core ethos at Siemens: ultimately driving efficiency, optimising the infrastructure and putting a much deeper focus on the citizen and providing services to them.

How does a city become smart?

Well, that's the big question and the one that we ask ourselves on a daily basis here. We have a whole team of people in our centre of competence for cities, with 70 dedicated city directors covering the whole world. We coordinate the data they collect to come up with a unique smart city strategy for each of these cities. In fact, in some cases, we're asked to do a smart nation strategy that is founded on smart cities. For example, in Saudi Arabia, our CEO Joe Kaeser spoke with a number of senior government officials and they asked if we could prepare a smart Saudi strategy. This entails us looking at each city individually and then coming up with a dedicated strategy for each of them. We then look at if each of those cities deliver their smart solutions and what can be done to connect the cities to get even more benefit economically or environmentally – for example, by improving the airports, improving the ports, the rail systems, the roads…how the cities are connected. In Saudi Arabia they have big aspirations to increase the number of pilgrims from nine million to 30 million per year. It's already incredibly crowded – 1.5 million people go to Mecca during the hadj alone (which is one or two weeks per year). So you can imagine that each city has very unique problems to solve. It's all about the connectivity between the cities.

Telling a story is also quite key; we want government officials to support what we're doing and the kinds of technologies that we provide. They must realise that a smart city is founded on good basic infrastructure, a good basic electrification footprint. The way to optimise that is by automation – this is the 'big ticket item' for the next five years: making train systems driverless, automating traffic control systems, low-emission zones, congestion charging – all tools that enable a city to plan itself into the future. Getting people off the roads and onto public transport – we are very focused on that – and then obviously this new layer of digitalisation and optimising each piece of infrastructure, connecting them and getting even more value from them.

Do you have any innovative examples?

There are definitely immediate improvements that nearly every train station in the world could make. Here in London, whether at King's Cross, Liverpool Street or Waterloo – every morning I get off the train and I have to queue to leave the station, I have to put a ticket into a machine and then pull it out again, then I have to find my way to the station and then I go down onto the Northern Line and find out that the Northern Line is not running, so I have to go to another line…this whole process could be simplified just about everywhere. We can have entirely ticketless systems, we can have open barriers. At Munich train station there are no ticket barriers; you just get on and off trains. It's free flowing, it's much easier, it's actually less stressful for the citizen, especially a commuter that does it twice a day. We can direct people down to train stations more easily, we can cope with technology for bomb scares, for fires, for major events that could happen in these public spaces. The key to a smart city is to find local solutions within the city that are going to improve people's lives. So in my case King's Cross station could be improved with smart technologies, better

wayfinding, better information pushed to my smartphone – things that will always have a huge benefit. If the journey itself, to my office, can then also be improved, with driverless trains that are smoother and more energy efficient, that can travel closer together so that more trains can operate on the same line during rush hour, and then make the building I work in smart too – lower energy consumption, cleaner air, nicer working environment – then you've got yourself somebody who is a lot happier than before. That's how you deliver a smart city strategy; you think about your citizens, the different demographics, the different people and their needs with respect to the city and you solve those problems one at a time.

I recently read an interview with the Australian professor Chris Pettit, who said we need to put people and place front and centre when realising a vision of smarter cities. What are your thoughts on that?

I absolutely agree in terms of everything we look at, all the tools that we use to model cities. At Siemens, we have a city performance tool which can take the whole city and analyse the way it operates. Then it can run dynamic scenarios showing how different technologies could impact environmental KPIs [*key performance indicators, Ed.*] such as CO2 reduction and air quality. So we can model all sorts of technologies – both Siemens technologies and good-old classics like insulation and double glazing, all of the things necessary to deliver the smart cities of the future. All of our modelling does this, based on the needs and wants of the citizens and the objectives the city is trying to achieve. So yes, we always put that front and centre in terms of the analysis we do.

Intergeo, the world's largest geomatics trade show, has chosen smart city as key topic this year, and the event's motto is 'Knowledge and action for planet Earth'. In your view, how can the geospatial sector contribute to making cities smart?

I think it can play a huge role in helping to understand what cities – the spaces that we live, work and play in – look like. For example, the Regional Planning Association of New York is responsible for the long-term planning for New York City. This is all about understanding how people move through the city's spaces and how accessible these spaces are. If you have a deep understanding of how people use the city, where and how they move about, you can begin to plan

transport networks, housing and places of work and really think much more cleverly about how the city can be used. Ultimately our cities are growing, we're urbanising at a faster rate than ever before, so the pressure is on to achieve big energy reduction targets or big improvements in air quality. And the results have to come through using these spaces more cleverly.

THE GEOSPATIAL SECTOR CAN PLAY A HUGE ROLE IN HELPING TO UNDERSTAND WHAT CITIES LOOK LIKE

Siemens is looking to make its mark in the smart city space of tomorrow, and the company slogan is 'Ingenuity for life'. What is Siemens' objective?

We have always seen cities as a key part of our strategy. For the past five years we've had a dedicated team looking at how to tackle some of the big problems in cities. Cities can respond quite quickly, lessons can be learned – which helps in making national policies. At Siemens we are very keen to help come up with the solutions and answers to these sorts of problems. 'Ingenuity for life' can mean whatever you want it to mean. For me, the Siemens objective here is about a sustainable future for cities – making infrastructure investments that are going to work for the long term, that ▸

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will allow people to get to work more quickly without being on crowded trains. And it's about being able to do all this using less energy while keeping the energy flowing to our houses and buildings. The other meaning of the slogan for me is solving the very problems that we're seeing in cities like Beijing, Moscow and Riyadh: really poor air quality as a result of controllable emissions, transport emissions, the build-up of gas in our buildings and boilers. We want to help cities overcome this and really improve the quality of their air. Over 5,000 people die prematurely every year because of poor air quality in London alone. We have modelled London with our modelling tool and we're actively working with the Mayor's Office, the Greater London Authority and Transport for London to come up with solutions that will tackle such problems. So in this case 'Ingenuity for life' is very much about preserving people's lives.

Smart cities are often associated with high costs. Is that assumption correct?

No. We are very active with the Smart Cities Mission in India, the government-led initiative to develop 100 smart cities across India. The amount of public funding is relatively small but the government is setting up some very interesting investment vehicles to allow the private sector to invest via public/private partnerships. The government is pushing through the projects that make financial sense, i.e. low capital costs, high return. For example, in the case of retrofitting of public buildings, the savings made on energy pay for the work to be done. So this is all about thinking what you can do with small amounts of money for quick wins, what you can do to leverage private-sector finance for longer-term or difficult projects, and just building that sequence together. Government backing, as is the case in India, gives the private sector – companies like Siemens – the confidence to go there, to invest and to get behind such initiatives. And it's proving very successful; we've already won our first Swiss challenge tender under the smart city programme, so we're very pleased with that.

This year marks 200 years since the birth of Werner von Siemens, founder of the Siemens company. Would he be a passionate smart city evangelist?

That's a great question – Werner von Siemens actually invented the smart city! He brought the very first electric street lighting to London. Back then, his vision was this: the smart city is one that enables people to travel, to live, to turn the lights on, to have a better quality of life than they had before, and to communicate. This is everything you hear in a smart city definition today, and Werner von Siemens was doing it 160 years ago.

There are many cities across the globe with poor urban planning. How can those cities be made smart?

There are indeed many examples of poorly planned cities, ones with huge areas of inner-city slums, relatively poor transport connections, relatively poor supplies of energy, water and so on. I think places like this have been approached quite badly historically, also by the multilateral banks and by organisations like UN-HABITAT. They tend to try to move people into better communities rather than focusing on improving the existing communities without moving them. One example of what can be done is in Medellín, Colombia where the government built a cable car to connect the favela to the city centre. The beauty of this is that it's low-cost transport infrastructure. It enabled people who previously couldn't access the job market in central Medellín to get jobs, earn money and improve their homes. This has also led to the emergence of community groups that are now trying to improve the quality of water, directing government funding towards improving basic sanitation and basic water services, in other words making incremental improvements to the quality of life. I think this is very key, rather than trying to come up with some amazing solution that tries to transform a city, like in Rio de Janeiro by moving everybody and building brand-new communities – that's just unrealistic. The best way forward is to incrementally improve peoples lives as in the example I just mentioned, and that's true anywhere. Here in London, if you can make my journey to work five minutes quicker I'm very, very happy. I think this is what we often forget; if we can just incrementally improve people's lives by making smart decisions using smart technology to help people access the job market or access basic services, then we're going to make a really big difference in many of these cities.

What's your message for members of the geomatics industry regarding the smart city concept?

The combination of technologies and good city spatial planning makes up the smart city concept. Over the last 20 years, the geomatics industry has provided city planners with invaluable geospatial data that has helped them understand the environmental, social and economic profiles of buildings, streets and entire neighbourhoods. Smart cities, with their endless source of live sensors, will simply accelerate the process. I see the geomatics and smart cities technology industries providing mutual co-benefits. Processing this vast amount of geo-linked information is the next frontier in good city planning, helping city officials diagnose and predict current and future urban phenomena. ◀

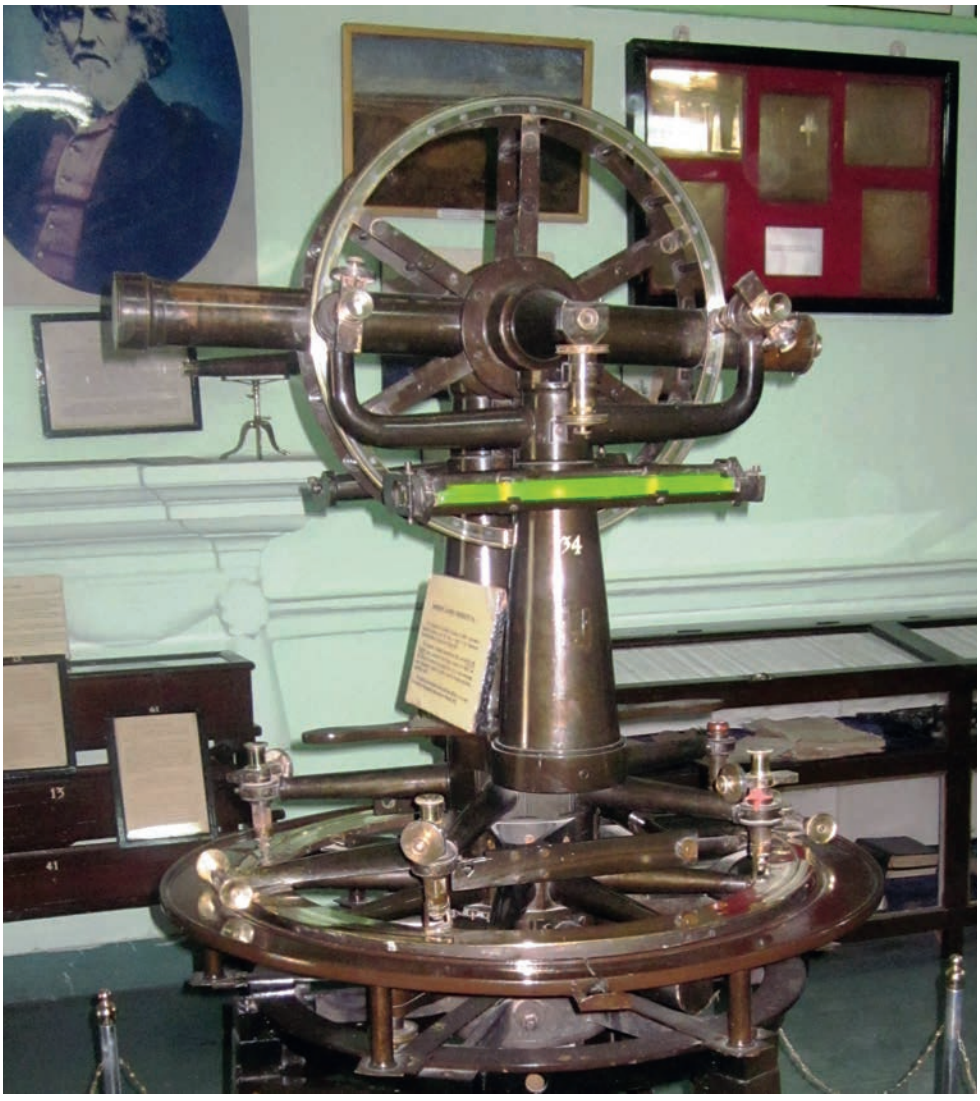
THE COMBINATION OF TECHNOLOGIES AND GOOD CITY SPATIAL PLANNING MAKES UP THE SMART CITY CONCEPT

MARTIN POWELL

Martin Powell has global responsibility for the Urban Development practice in the Siemens Centre of Competence Cities. This involves working with mayors and leaders providing advice and support to cities as they strive to meet tough economic, social and environmental targets and looking at economic and technical models of delivering solutions at scale. Prior to this, he was the environment advisor to former Mayor of London, Boris Johnson, responsible for policy in water, waste, air quality, energy, climate change mitigation and adaptation and biodiversity. Powell was also the executive director for the design and delivery of the City of London's environmental programmes. As managing director of Cambridge Management & Research he was also a special advisor to the C40 Cities Group under the chairmanship of former Mayor of New York, Michael Bloomberg. An engineer, Martin Powell built his career working with organisations to structure their projects, programmes and project management approach. He is an editor of several books including *Better Cities, Better Life* and, most recently, *Smart Cities – Cities in the Digital Age.*

Total Stations: the Surveyor's Workhorse

A total station is an angle measuring device, also known as a theodolite, integrated with an electronic distance measurement (EDM) unit. The integration provides the ability to measure horizontal and vertical angles as well as slope distances using the same device at the same time, which benefits the surveyor in terms of portability, convenience and speed. Today, total stations have a wide variety of capabilities and are extensively exploited in cadastral surveying, civil engineering and on construction sites. The author provides a synopsis of features, status and trends.



▲ *Figure 1, Theodolite made in the UK by Barrow used in the triangulation of India between 1848 and 1873. The instrument weighs, when packed, 364kg (802lbs) and is exhibited in the Survey of India Museum, Dehradun.*

For many decades, and up until the 1960s, theodolites were the major surveying instruments for collecting geodata referenced in an Earth-fixed coordinate system. Figure 1 shows a theodolite used to measure the geodetic backbone of India in the 19th century, an endeavour which took many decades and to which the name of the Welshman George Everest (1790) is inextricably connected. Indeed, the highest mountain on Earth – Mount Everest with a height of 8,848m above sea level – is named after a land surveyor. George Everest was surveyor-general of India from 1830 to 1843. Figure 2 shows a modern surveyor in India in action using a total station to map a rural area which is scheduled for urbanisation.

FROM THEODOLITES TO TOTAL STATIONS

Theodolites measure angles, and the computation of coordinates also requires distances which in the past were measured with chains or measuring tapes. Without careful precautions, the chains and tapes produced inaccurate results. An important innovation that made distance measurements

▲ *Figure 2, Indian surveyor at work.*

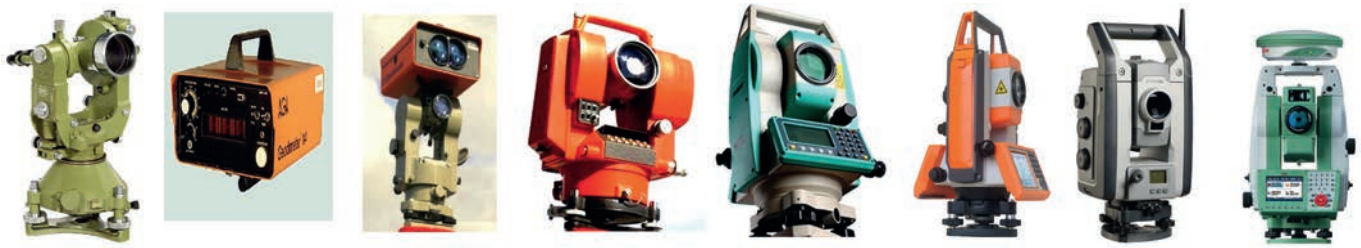


Figure 3, Evolution from theodolite to today's total station.

less cumbersome was electronic distance measurement (EDM). Developed around 1940, EDM became commercially available in the 1960s. Figure 3 demonstrates the evolution from theodolite to today's total station and displays from left to right: Wild T3, a theodolite introduced in 1925; Aga Geodimeter 14, a commercial EDM device manufactured in 1970; EDM mounted on a theodolite, the HP 3820A; Ruide RTS R5, introduced in 2009; Linertec LGP300, introduced in 2014; Trimble S9, introduced in 2015; and Leica SmartStation provided with GNSS receiver on top. To the naked eye there are no striking differences, and this is not really surprising as the basics of operation have remained the same; since their emergence, total stations have always measured two angles – horizontal and vertical – and the range, or slope distance, to a target point. The revolution resides inside: microprocessors, solid-state memory, sensor technology and wireless communication. These innovations have been gradually incorporated in the devices over time, and all of them further improved the efficiency of surveying workflows and the quality of the resulting data.

EDM PRINCIPLES

EDM units employ electromagnetic (EM) energy for measuring the slope distance to a target point. Two principles are in use: phase shift and pulse – also called 'time of flight' – measurements. The EM energy may be emitted as infrared carrier signals, generated by a small solid-state emitter within the instrument's optical path and modulated as sine waves. The phase of the returning signal is compared to the phase of the emitted signal. This can be done with a precision at the millimetre level. However, the total number of full cycles is still unknown and multiple wavelengths are used to obtain them. The other method uses laser pulses. The travel time of the pulse forth and back (Δt) is measured and, by multiplying that by the speed of light (c) and dividing the result by two, the distance (d) can be accurately calculated (Figure 4). This is why the laser pulse method is also called time of flight (ToF) measurement. Some total stations combine both measurement principles in one and the same instrument. With a precision ranging from sub-millimetre to sub-centimetre level, the phase shift method is the most accurate one but its measuring range is limited to around 100m. ToF EDM units can measure distances of up to 10km or more, depending on atmospheric conditions and the type of prism used, but their precision usually ranges from sub-centimetre to centimetre level while the accuracy deteriorates with increasingly shorter ranges.

PRISM

The EM signal will be reflected by any surface it meets. The strength of the return will depend on how the incident signal interacts with the surface; it may be reflected, absorbed or transmitted. Only reflected beams will reach the instrument and thus will be of use, but some types of reflection are better than others. Ideally, a surface behaves as a diffuse reflector: reflections are of the same strength in all directions and thus the energy level reaching the instrument is highest. In contrast, however, when behaving as a specular surface, which acts as a flat mirror, the reflection is deflected and little or no signal will be received by the total stations. Only when the mirror is perpendicular to the path will most of the signal reflect in the direction of the instrument (see Figure 5, top). To overcome this issue, three mirrors or reflective prism faces, which are mutually perpendicular, reflect beams back in the direction of the source, but shifted (see Figure 5, bottom). Several prisms can also be combined to increase the reflected energy and thus to increase the distance to be bridged and/or to improve accuracy. For example, with one

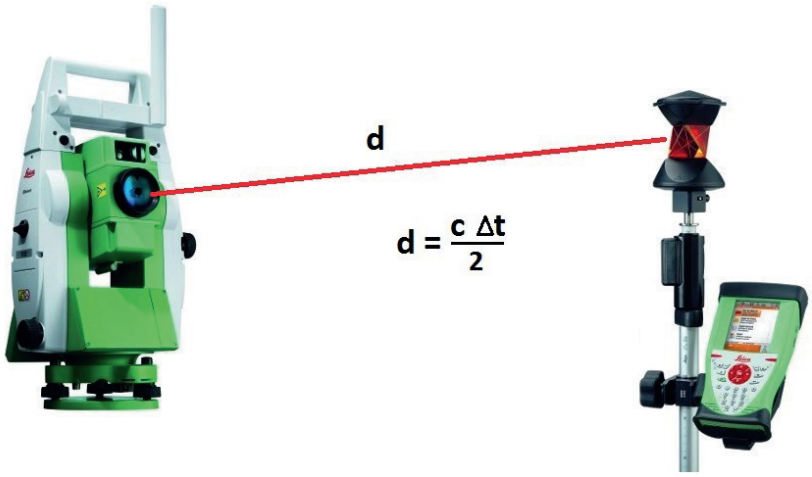


Figure 4, Principle of time of flight (ToF) distance measurement.

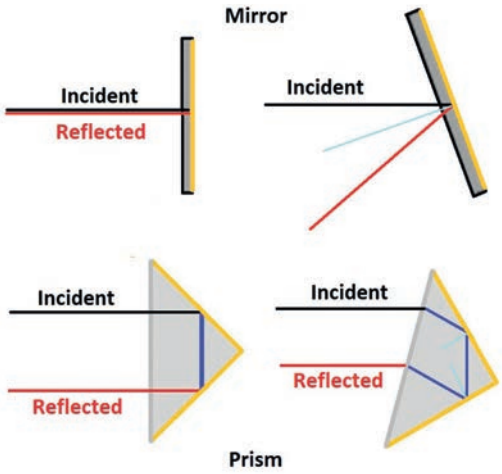


Figure 5, Sketch illustrating how an EM beam reflects on a mirror (top) and on a prism.

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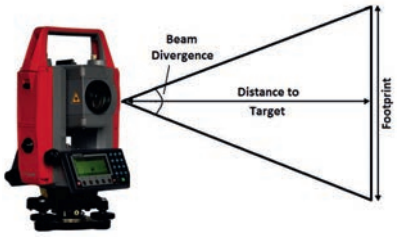
▲ *Figure 6, The surveyor may select from a great variety of prisms on the market*

prism Topcon's IS has a reach of 3km, with three prisms 4km and with five prisms 5km. Prisms are used for both ToF and phase shift EDM units. Depending on the application, the surveyor can choose from a large variety of prisms (Figure 6).

REFLECTORLESS EDM

Reflectorless EDM has become standard in surveying. Today, up to 1km can be bridged without using a prism. This ability of EDMs eliminates the need to access the target. The range depends on the strength of the emitted signal and the reflectivity and geometry of the target. Inaccessible objects or targets located at dangerous sites can thus be mapped easily. The detection of returns from bare surfaces, i.e. using no prisms, requires laser pulses with a high energy level, typically in the range of 1 to 20 watts. In contrast, most phase-based EDMs using prisms emit signals at a level of a few milliwatts. Since the signal may reflect upon any surface present in the line of sight, blunders may easily occur. For example, the signal may be reflected by a leaf that whirls through the line of sight. Another concern is beam divergence, i.e. the increase in beam diameter with distance from the source: the greater the distance, the larger the footprint (Figure 7). This may cause errors or decrease accuracy.



▲ *Figure 7, Beam divergence, instrument shown: Pentax R-1500N, introduced in 2014.*

SINCE THE SIGNAL MAY REFLECT UPON ANY SURFACE PRESENT IN THE LINE OF SIGHT, BLUNDERS MAY EASILY OCCUR

INTERNAL PROCESSING AND STORAGE

If the total station is equipped with an inbuilt microprocessor the initial observations – horizontal and vertical directions and slope distance – can be further processed to angles, horizontal distances and x,y,z coordinates of the target point in a preferred Earth-related reference system. If it is equipped with sensors which measure atmospheric temperatures and pressures the processor can calculate corrections to the initial measurements. The data collected is stored in an inbuilt electronic notebook which usually has sufficient capacity to store the data points collected during an entire working day. Once uploaded to a processing computer or server, the data can deleted from the notebook so it is ready for re-use. However, losing data after a productive day is not only frustrating, but also and above all a waste of time and hence money. It is therefore advantageous when the data stored in the notebook can be regularly exported to external data storage media such as a USB flash drive or an SD memory card.

WORKFLOWS

The observations collected in the field can be imported into a (ruggedised) laptop and processed on site to check the survey for completeness and sufficient redundancy and to perform other quality-related procedures. When the results are satisfactory they can be uploaded to the server at the office via the internet, or even be stored in the cloud. A visit to the office can thus be avoided and the field surveyor can download his next assignment on his laptop while in the field or at home. Use of the internet thus enables a significant productivity improvement. On the other hand, this flexibility introduces a management problem: how does the chief surveyor in the office know where the equipment is, if it has been stolen or if it requires recalibration or maintenance? Some of the latest total stations are equipped with software which allows managers to check where the total station is and the status of the firmware and the software.

At some construction sites, e.g. where tall buildings have to be driven in the vertical direction to within the millimetre, the number of prisms may be so high that the total station may become confused and pick the wrong prism. Some total stations have provisions so that they know which prism is their 'mate'. Another additional functionality which makes life easier for the surveyor, especially when surveying tunnels or underground mines, is a laser pointer which visualises targets that are further away from the instrument.

EVOLUTION

The total station was first introduced to surveyors under a variety of names, including electronic tacheometer and EDM theodolite. Initially, Total Station was a proper noun introduced by Hewlett-Packard (HP) to promote its Model 3810A around 1980. Probably because of its tunefulness to the ear, surveyors soon applied the term to all theodolites with a built-in EDM unit and total station became a common noun, written without capital letters. Over time, and keeping pace with the microelectronics revolution, the primal design of the total station has been extended with features which have made surveying faster and more convenient. Servomotors enable horizontal and vertical angle movements, thus saving time when staking out coordinates as the telescope aims itself and the surveyor just needs to put the prism in the relevant position. The prism is pinpointed through either radio signals or imaging. The first motors were mechanically geared but today's stepless magnetic motors operate quickly and silently. A next step was to employ wireless communication so that operation can be steered by an external controller mounted on the pole. Such robotic total stations enable surveys to be conducted by just one person, thus saving labour costs. At least two known points in line of sight of each other are required: one for positioning the instrument above and the other to determine the azimuth. To eliminate the need for known points it is logical to extend the total station with a GNSS receiver. The GNSS unit can also be mounted on the prism pole for fast data capture, although signals may be too weak in the vicinity of trees or buildings or if high accuracy is required. Here, the total station takes over. The dual configuration increases the efficiency of massive data collection, while surveys can be conducted by one person.

A PROVEN METHOD TO INCREASE THE ACCURACY IS MEASURING THE SAME TARGET MANY TIMES AND AVERAGING THE VALUES

IMAGING AND LASER

Digital cameras have also been mounted into the telescope, coaxial with the optics and the EDM. The snapshots allow the site to be documented and notes to be written using a digital pencil on the total station's screen. This reduces the need for office-based post-processing and may also avoid trips back to the field. As the image is stored together with the coordinates of both station and target points, orthoimagery can be created. Imaging also enables tracking of the prism and its recapture if it becomes lost due to objects passing through the line of sight. A proven method to increase the accuracy is measuring the same target many times and averaging the values. Using software based on computer vision research, the same

▲ *Figure 8, A selection of the broad range of total stations available on the market.*

feature can be automatically detected in a series of images gained during repetition measurements. This enables automatic improvement of accuracy – it just takes a little time. Today, terrestrial laser scanners (TLSs) have gained wide acceptance. A TLS and an EDM unit have much in common: a TLS also operates without a prism, and both employ either pulsed laser or range measurement through phase shifts. Therefore, it makes sense to extend a total station with the TLS ability to collect a point cloud. The part of the scene is indicated as a window on the screen by the surveyor in real time together with the specification of horizontal and vertical intervals. The rate of data capture of grid scanning is just a thousandth of what a TLS can accomplish as it is merely an additional facility on the total station. The results can be processed in the office using point cloud processing software.

NO MATTER HOW ADVANCED A DEVICE MAY BE, IF IT IS NOT IN THE HANDS OF A SKILLED PERSON THE OUTPUT WILL BE GARBAGE

CONCLUDING REMARKS

The broad range of different types of total stations may appear dazzling if you intend to renew your equipment (Figure 8). Which one should you select? The latest and most sophisticated one? There are so many functionalities to choose from. Which brand should it be? As usual, the more functionalities a tool has or the more sophisticated it is, the higher the price. Before making your purchase decision, it is wise to make a list of the types of surveys to be conducted and the accuracy required (Figure 9). It will often become apparent that a simple device will meet your needs, or even that a ten-year-old second-hand device is good enough for staking out enumeration boundaries for census purposes in a developing country. And one thing is for sure: no matter how advanced a device may be, if it is not in the hands of a skilled person the output will be garbage. ◂

▲ *Figure 9, 'Will this total station meet my needs, now and in the near future?'*

All images, courtesy: M. Lemmens

MATHIAS LEMMENS

Mathias Lemmens gained a PhD degree from Delft University of Technology, The Netherlands. He is an international consultant and is the author of the book *Geo-information – Technologies, Applications and the Environment* published by Springer in 2011.

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BUILDING INFORMATION MODELLING: ESSENTIALS AND ISSUES

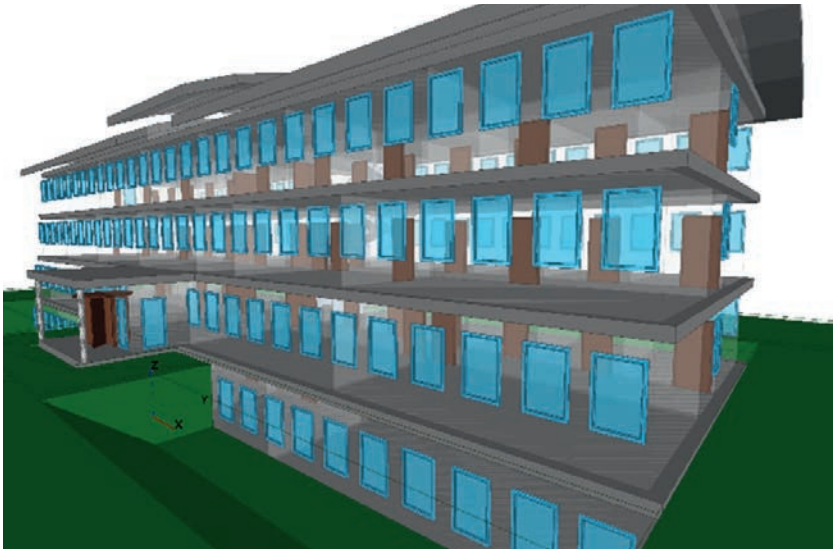
The Need to Integrate BIM and Geoinformation

In the construction industry, business relationships are often short-term and one-off. There are many unique processes and activities. The resulting complexity and fragmentation may obstruct quick and effective exchange and integration of information and thus hamper project progress. Building information modelling (BIM) is aimed at preventing mismatches in information exchange between the many stakeholders. Although BIM has come a long way in this respect, there are still challenges to overcome. The authors explain the essentials of BIM and discuss issues.

Building Information Modelling (BIM) evolved from supporting the design and construction of facilities, such as buildings, bridges and tunnels, to a research area in domains ranging from construction to urban planning and management. In parts of Europe, North America and southern Asia, BIM-based design and construction has been legally enforced. In the UK, for example, since 2016 public-sector projects require BIM for representing, sharing and exchanging information.

BIM

NBIMS (2006) defines BIM as "a digital representation of physical and functional characteristics of a single building. As such, it serves as a shared knowledge resource for information about a building forming a reliable basis for decisions, during its lifecycle from inception onwards". Therefore, all volumetric and parametric base components contain the smallest possible details. The location of a smaller component in a larger one, such as a window in a wall, is also indicated. Such base components serve manufacturing of, for example, prefabricated parts of walls including doors and windows. The information consists of dimensions, material type and much more. For example, a window may be characterised by the number of glass layers, thickness, colour, thermal transmittance and lamination. Windows and other building components may be extracted from BIM through semantic selection (Figure 1). Utility elements, such as gas pipelines, are also contained in the building information model. Companies manufacturing the components often play a role in the design. Stakeholders can collaborate across the life cycle of a facility and perform create/read/update/delete (CRUD) operations. Stakeholders can include designers, manufacturers of building elements, constructors, facility managers and software developers of applications. The terminology and data needs of each stakeholder differ and standards have been developed to avoid the need to remodel the same facility for different stakeholders.

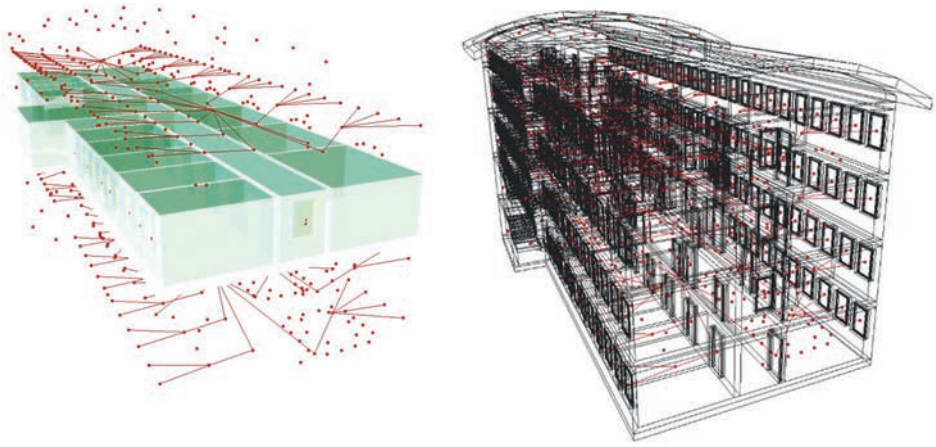


▲ *Figure 1, Example of a semantic selection of windows from a building information model.*

BIM DOES NOT APPLY ABSTRACTIONS OR SIMPLIFICATIONS; ALL COMPONENTS ARE REPRESENTED WITH THEIR TRUE 3D SHAPE

IFC

Sharing information across organisations, departments, IT systems and databases requires standardisation on semantics, geometry and topology. Such standards have been developed since the mid-1990s and one widely accepted standard is Industry

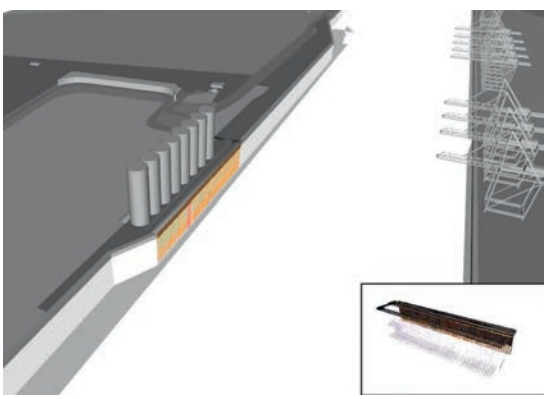


▲ *Figure 2, Automatically generated connectivity networks.*

Foundation Classes (IFC). IFC facilitates the cost-effective sharing of information without becoming dependent on file formats, which are product- or vendor-specific. IFC is semantics-rich and object-oriented. The latter means that each component can be uniquely identified regardless of its size. IFC is also truly 3D in which all geometries are topologically valid solids with no daggling edges or unclosed polygons. The hierarchical maintaining of spatial relationships ensures correct 'inclusion' and 'part of' relationships. IFC is also data-rich and thus enables a comprehensive, detailed description of all physical and functional features of a facility. These characteristics of IFC allow for quick selection and query of parts of the facility as well as creation of views of the facility to serve stakeholders.

INFORMATION MANAGEMENT

Information management can be done by either the transitional approach or the central-database approach. In the transitional approach, a building is represented as a loosely coupled collection of sub-models, each providing a portion or a state of the BIM; the representation can either provide a part of the whole model, such as two of the four stories of a building, or a state of the whole model, such as the scheduled construction in the first two weeks. Next, these sub-models are aggregated in a single, shared BIM. In the central-database approach the building model is stored on one server, which allows users to query and immediately see any component and its properties or any design revision made. Both approaches have benefits. The first approach allows stakeholders to exchange their sub-models or domain-specific model parts during design and construction, specifically when the workload is divided between many short-term contracts; a subcontractor can work independently of others without needing a detailed view of the entire project. The second approach suits maintenance and facility management in which the changes are less critical and a general view is more important.



▲ *Figure 3, Integration of a newly designed quay (BIM) with surrounding existing objects stored in a GIS.*

FACILITY MANAGEMENT

Once the facility is erected, in use or in operation, BIM offers many advantages for monitoring and maintenance. For example, doors and windows overdue for maintenance can be identified; walls, slabs, stairs and elevator shafts can be analysed for necessary repair or replacement work. Air conditioning systems or other new components can be ordered precisely tailored and the associated detailed information can be brought into the BIM immediately. A central-database approach facilitates quick, easy and reliable updating. From these models, connectivity networks can be generated for computing an optimal path from a present location to a desired location (Figure 2).

INTEGRATION

In the design stage, a BIM represents a forthcoming reality through detailed geometry also representing the internals of objects. The BIM is not yet connected to a location represented in x,y,z coordinates. In contrast, geoinformation describes the reality of the broader area around the projected location of the new facility through x,y,z coordinates. GIS models apply abstractions and simplifications, which leads to relatively fewer objects, details and properties compared to BIM. While IFC provides an easy determination of 'inside' relationships, GIS models are oriented towards neighbourhood relationships. Added to this, objects in GIS models are derived and interpreted from data captured from cameras or laser sensors resulting in representations in the form of bounding surfaces, while the internals of the objects are only modelled if required as this is labour intensive and thus costly. City model standards such as CityGML also provide more detailed interior representations such as LOD4 but these are not as detailed as in IFC. For example, a wall in CityGML is only the surface of the wall, while IFC would describe the 3D solid of the entire wall. Hence, one physical wall in IFC would be represented by two surfaces in CityGML. The value of integrating BIM information and geoinformation becomes apparent in 'BIM Execution Planning', which formalises the design, construction and maintenance activities of a facility. 'Site Planning' together with 'Design Authoring' and 'Cost Estimation' are BIM uses and these define a series of tasks related to the intended use of the facility. The construction industry appreciates the benefits of BIM uses but seems to underestimate the value of BIM information integrated with geoinformation. To respond to all stakeholders' demands, BIM is expanding towards integrating information

BIM FACILITATES THE AUTOMATIC GENERATION OF MODELS FOR SUPPORTING INDOOR NAVIGATION AND POSITIONING

from the surroundings stored in a GIS, as has been carried out in a large study conducted in Rotterdam, The Netherlands (Figure 3).

CONVERSION

As IFC contains more detailed and more complex information than CityGML, the conversion from IFC to CityGML is relatively straightforward and stable. However, the other way around requires additional rules and information resulting in complex and as yet unsolved problems. These issues have triggered academic research on seamless conversions, producing the recommendation to follow first semantics mapping and then geometry and relationship transformations – but further in-depth investigations are still much required.

METADATA AND BIG DATA

The spatial data infrastructure (SDI) provides a framework for organising and managing spatial data and its associated metadata. In contrast, BIM is a data and information model without accompanying metadata, although the value of metadata is slowly penetrating the construction industry. Recently, discussions on the role of BIM as a part of big data started to emerge via international networking platform LinkedIn. This is encouraging since BIMs will remain unconnected, isolated islands of information as long as there is a lack of awareness about their role in the bigger picture of GIS and big data.

CONCLUDING REMARKS

The role of BIM will continue to grow but, besides the opportunities, there are many challenges. Once the challenges and issues have been identified, they will have to be discussed with the GIS communities to increase awareness and develop solutions.

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BY **FRÉDÉRIQUE COUMANS**, CONTRIBUTING EDITOR, GIM INTERNATIONAL

NEW ELEMENT ADDED TO INTERGEO

Spatial Data and Smart Cities are Interdependent

A new element is being added to Intergeo, Europe's largest geo-IT conference and exhibition this year: Smart Cities. This new part of the conference is being developed by the Intergeo team in cooperation with Dr Chirine Etezadzadeh and her colleagues. She is a German expert on 'smart cities' and believes strongly that an interdisciplinary approach, certainly together with the geo-IT sector, is crucial for real results. But efficiency should not be the only goal; social cohesion is also essential to ensure the future viability of cities.

▲ *Dr Chirine Etezadzadeh: "The major challenge will be to identify who should get access to which data and to what extent."*

Hinte GmbH, the organiser of Intergeo 2016 in Hamburg, Germany, invited the SmartCity. institute and the German Federal Smart City Association to help develop a new format, referred to as 'Smart City Solutions'. The format will exemplify the connections between geo-IT and cities of the future in an exhibition and a small conference. Over the coming years at Intergeo, this theme will be further extended to effectively address this issue in Europe.

Most smart city data is geo-IT related because a smart city solution always includes the question of 'where?'. Accurate, complete, up-to-date, and object-oriented geodatabases are crucial. "Shared, partially open databases are the basis for any smart development," states Dr Etezadzadeh, who leads both of the German organisations that helped the Intergeo team and is experienced in the fields of energy, mobility and city development. A simple example: "Think of 'robo-taxis', which are a central aspect of current smart city visions. The use of fully automated cars is impossible without high-resolution maps and other shared geoinformation databases."

ENGAGED URBANITES

The precise definition of 'smart city' is the topic of much debate. Is it not the case that many projects with the smart city label are merely a re-branding of existing IT and other technological services with a 'smart' twist? Dr Etezadzadeh agrees that true smartness requires more than just a technical upgrade. Cities have become aware of this and are

beginning to think about what smartness really means for them. Sensors and digital communications deliver big data to local governments and urban stakeholders who use the resulting information to do things better, faster and/or cheaper. But efficiency is only half the story. "Reasonable urban development is inextricably linked to autonomous citizens who stand up for their interests, sovereignty, quality of life and sustainability goals." In her opinion, social cohesion is essential for the realisation of viable smart cities. That requires broad cultural change to offset the urban trends towards anonymity and singularisation.

SOCIAL COHESION IS ESSENTIAL FOR THE REALISATION OF VIABLE, SMART CITIES

"I don't think that consensus is the target. It's more the direction of impact we should agree upon. Municipal authorities should encourage and incentivise opportunities for urbanites to become engaged and participate in shaping the future of their cities and to actively assume responsibility. Such a culture builds the basis for resilient cities. The prerequisites for this transformation are more awareness and education so that people develop an interest in their environment. This will help to activate and encourage them to assume responsibility. Tools based on digitisation can indeed facilitate this process."

INTERDISCIPLINARY APPROACHES

One focal point at Intergeo will be the high demands placed on geo-IT systems by smart cities. Just imagine the amount and the complexity of data, the management of data ownership and the required access rights. Then consider the correlation-based algorithms designed to achieve outcomes that serve the decision-making process. This system needs to be managed and kept reliably functional. Problems in these vulnerable systems lead to disruptions that can be experienced immediately. Resilience strategies in this regard are real challenges and need to be integrated through intelligent design. Dr Etezadzadeh: "Don't think about smart city solutions, products or processes without creating them to be resilient against all kinds of imaginable threats. And we won't be able to tackle the growing complexity without using interdisciplinary approaches."

Interoperability – the ability of products, systems and processes to be integrated in today's and future systems – is key to smartness. In order to create interoperable system features, a cross-sectoral exchange of (spatial) data, knowledge and strategies is needed. One example in which many Intergeo participants are actively involved are the smart grids that are being developed by energy companies, in cooperation with GIS developers, municipalities, housing companies, home owners and suchlike to provide neighbourhoods and industrial parks with energy based on decentralised energy production. "A revolutionised energy sector forms the basis of a smart city," Dr Etezadzadeh remarks. Concerning the need for interoperability, she gives an example from the mobility sector: "If someone developed a car in his garage without considering urban technical developments that are currently being planned, it wouldn't be possible to integrate that car in future traffic systems. Its on-board systems, for instance, would likely be stand-alone solutions, car-to-car communication wouldn't work, and car-to-infrastructure communication would be unthinkable."

PROTECTING AUTONOMY

Some things are easy. As a minimum, topographic data distributed by the national mapping agency can be commonly used so that everyone uses the same spatial 'single source of truth' as a basis. But if you delve into complex policy issues, many efforts to share data and information systems are thwarted in practice by people's desires to protect their organisation's, their department's or their own autonomy and power. "Sectoral thinking is a challenge, even within companies or municipalities," confirms Chirine Etezadzadeh. "Structural, organisational and process change is a prerequisite for overcoming a 'silo mentality'. People need to realise that one person's or company's knowledge lacks power without information from others. New ways of thinking are required, new cooperative business models and new regulations. While the old economy is gradually becoming aware of this reality, the new economy creates sources of knowledge that nobody could ever imagine before. Unfortunately, these sources won't be used collaboratively. Data security, ownership and distribution is an enormous and challenging task."

In general, Industry 4.0 – with its intensive automation in manufacturing, the Internet of Things and cloud computing – is not imaginable without sharing. The major challenge will be to identify who should get access to which data and to what extent. The smart city expert stipulates: "In my opinion, this is the core question that needs to be answered in the current digitisation process."

CONFLICTING NEEDS

There are some other facets to this theme. Installing sensors in everything and asking citizens to do as much as possible via digital means generates big data for municipalities, energy companies, insurance companies, public transportation systems, etc. It is not the new infrastructure that makes the city smarter, but the data that flows through it. Most local governments do not have enough skilled personnel to make cities smarter; they insource the necessary expertise from the private sector. A concentration of power through those dataflows being in the hands of businesses might not coincide with citizens' needs. There is the risk that the big data collected through smart city projects might primarily be mined for the purpose of making businesses more profitable and for obtaining a better marketing profile of (individual) users in order to sell more products/services. And is there not a distinct possibility that a society of surveillance could arise, in which you can no longer be lost in a crowd and your behaviour could be tracked all day long, by all kinds of organisations? Chirine Etezadzadeh sees such downsides too. "Those aspects do in fact pose a real,

multifaceted threat. I have noticed that, for this reason, German cities are not blindly implementing all potential digital applications, but are beginning to think about this topic in a holistic manner. A problem associated with this is the speed at which technology is developing. In any case, new technologies will continue to proliferate. Nevertheless, we can assume that cities will not be the main gateway to our private lives; anybody who uses a smartphone does not have to give any thought to the upcoming digitalisation and to the potential threat it may pose in cities. We must consciously decide where we want to allow digitalisation to become part of our lives and where we don't. This is a task for autonomous consumers and it requires public discourse. We need informed participants in order to conduct an intelligent discourse. Digitalisation has the potential to do a lot of good. We need to tap into this potential and have the courage to create new opportunities in some areas. But you always need to be aware of where the next step can take you and then decide whether you want to take that step." ◀

SMARTNESS REQUIRES MORE THAN JUST A TECHNICAL UPGRADE

SMART CITY SOLUTIONS

DR CHIRINE ETEZADZADEH

Dr Chirine Etezadzadeh (economist) is the president and founder of the Germany-based SmartCity.institute and of SmartCityNews.global and is CEO of the German Federal Smart City Association. She regularly holds university lectures on product development for smart cities. Her book titled *Smart City – Future City?* is published by Springer Publishing in both German and English.

More information at:
www.SmartCity.institute
www.SmartCityNews.global
www.bundesverband-smart-city.de

A REVIEW OF CAMERAS POPULAR AMONGST AERIAL SURVEYORS

Selecting Cameras for UAV Surveys

With the boom in the use of consumer-grade cameras on unmanned aerial vehicles (UAVs) for surveying and photogrammetric applications, this article seeks to review a range of different cameras and their critical attributes. Firstly, it establishes the most important considerations when selecting a camera for surveying. Secondly, the authors make a number of recommendations at various price points.

While this list of consumer-grade cameras for UAVs is not exhaustive, it is intended to present a line of reasoning that practitioners should consider when selecting a camera for survey purposes and to highlight critical attributes.

WEIGHT, VELOCITY AND FLIGHT TIME

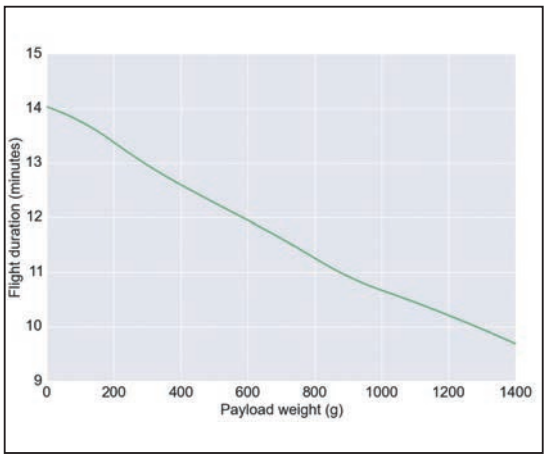
Weight is an important consideration for aerial imaging which is often not a limiting factor for terrestrial photography. The growth of newer, higher-spec, low-weight cameras is therefore the focus of this article. In addition, the potential areal coverage of a survey is controlled by flight height, flight duration and UAV velocity – these become more tightly constrained with increased payload (see Figure 1). In order to maximise flexibility in the selection of flight height, duration and velocity, weight must be kept to a minimum. A number of lightweight cameras for UAV use are reviewed below.

IMAGING PARAMETERS

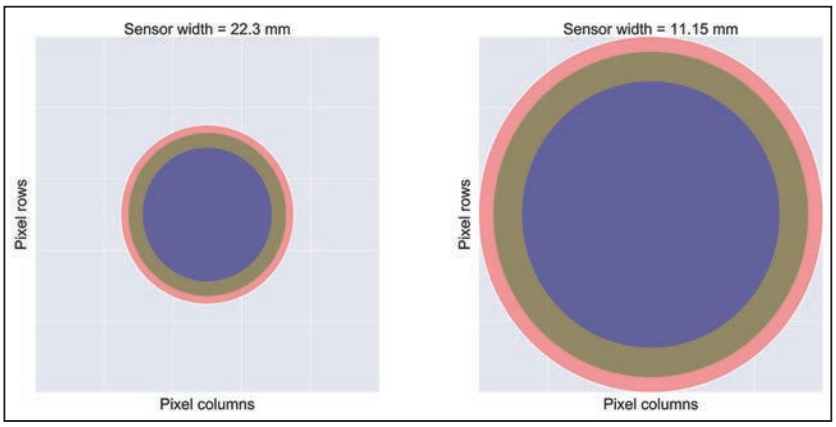
Sensor size is one of the key imaging parameters (see Figure 2) as this, along with focal length of the lens, is the core component in defining the ground sample distance (GSD) – the pixel size in the real world – of a survey configuration. While a full discussion of lenses is beyond the scope of this article, lens selection will have a significant impact on the quality of images and derivative products. For comparison, the effective focal length is presented – this is the actual focal length of the lens multiplied by the scale change of the sensor when compared to a full-frame (36 x 24mm) sensor.

Pixel pitch – the width of each pixel on the sensor – is also noted and is simply the sensor width divided by the number of pixels in a row on the camera sensor. This is intimately linked with the aperture – the size of the opening allowing light through the lens – as it will determine how big an effect diffraction will have on each image. Aperture is usually denoted by the 'f-number', the ratio of the focal length to the diameter of the opening. Thus, f/8 is an aperture with a diameter one eighth the size of the focal length of the lens. If the aperture is small (high f-number) or the pixels are small, diffraction effects will convolve the signal as light will fall on multiple pixels and sharpness will degrade.

Thus, while GSD might remain constant for two imaging configurations, one might be diffraction limited and therefore perform significantly worse in practice. To mitigate these effects, a higher pixel pitch is desirable.



▲ *Figure 1, Decrease in flight time with payload for a generic battery-powered multi-rotor UAV at a velocity of 6m/s (Bershadsky, 2016).*



▲ *Figure 2, How idealised wave signals fall on sensors with equal numbers of pixels at f/8 but with different sensor sizes. The smaller sensor will receive light from a point across multiple pixels, softening the edges within the image.*

GOPRO HERO 4 SILVER

GoPro has emerged as a household name over the last few years and its 'pint-sized' lightweight cameras have proven very popular – the cameras are renowned for their durability. One of their best features is just how light they are, coming in at well under 100g. Considering many modern aerial photogrammetric surveys can be undertaken using consumer-grade UAVs, the GoPro is an attractive option for those concerned with covering a lot of ground, or surveying in remote areas, as its weight can significantly increase flight time. GoPro has been the camera of choice for many consumer-level UAV manufacturers (e.g. 3D Robotics, www.3dr.com). Further, the extremely popular DJI Phantom series comes with a built-in camera of very similar specifications to the GoPro (albeit with a 20mm effective focal length). However, the trade-offs for these attractive attributes involve the limitations of having such a small sensor, with diffraction effects becoming very apparent when shooting at the highest resolution. This, combined with large lens distortions, can make photogrammetric mission planning tricky. The application of GoPro cameras is limited for scientific purposes. However, they remain a stalwart for hobbyists and can be useful for initial site surveys.

▲ *GoPro Hero 4 Silver edition (photograph by Jérémy-Günther-Heinz Jähnick, distributed under a CC-BY 3.0 licence)*

Price	EUR378
Sensor size	5.9 x 4.5mm
Lens type	Inbuilt (15-30mm effective)
Weight	83g
Pixel count	12 megapixels (4,000 x 3,000)
Pixel pitch	1.48 microns

RICOH GR2

The Ricoh GR2 is a good option for hobbyists looking to undertake higher-quality surveys, and has been successfully integrated into some companies' UAV packages (e.g. Smart planes, www.smartplanes.se). The low weight, at just over 200g, represents a good trade-off considering the large APS-C sensor. The inbuilt, fixed focal length lens shows good sharpness in benchmark tests (DxOMark, 2016) and its optimal performance at a wide aperture (effective aperture of f/4.5) is noteworthy. It therefore lends itself to application in scenes with low light, as a wide aperture will allow more light incident on the lens without degrading performance due to diffraction. This also simplifies potential diffraction effects, as a wider aperture means the wavefront of incoming light is spread over less of the sensor than at narrower apertures; at f/2.8 there will be no significant diffraction effects. One downside is the fixed lens, since the effective focal length of 28mm potentially does not offer a wide enough field of view for some technical applications. While you can always fly higher, flight height limits and battery limitations will always favour shorter focal lengths (as well as weight of the lens). Therefore, this does not offer the diversity of other cameras in this list, although at its price it represents a very good choice nonetheless.

▲ *Ricoh GR2 (photograph by Kārlis Dambrāns, distributed under a CC-BY 2.0 licence)*

Price	EUR625
Sensor size	23.7 x 15.6mm
Lens type	Inbuilt (28mm effective)
Weight	221g
Pixel count	16.2 megapixels (4,928 x 3,264)
Pixel pitch	4.8 microns

SONY A7 SERIES

Sony's A7 series of mirrorless interchangeable lens cameras (MILCs) represent a technological step forward as full-frame sensors become more affordable. The first version is very light, at 417g body only (769g with the 28-70mm f/3.5-5.6 kit lens), and is one of the most compact full-frame cameras on the market. ProDrone (www.prodrone-tech.com) has announced support for a range of compact cameras and MILCs, including both the Ricoh-GR2 and the Sony A7 series. The Sony A7 series camera therefore represents a good starting point for companies/consultants wishing to offer high-quality surveys to clients. The cameras in the A7 series have emerged as a significant competitor to Leica's M series, which have occupied the space of compact full-frame cameras for many years. This, combined with a wide selection of lenses, means that the camera system is highly versatile. The high-resolution, full-frame sensor and range of lens choices will likely make the weight trade-off worthwhile for long-term studies or those in which field of view is important.

▲ *Sony A7 (photograph by Jürgen Matern, distributed under a CC-BY 3.0 licence)*

Price	Starting at EUR959, body only
Sensor size	35.8 x 23.9mm
Lens type	Changeable
Weight	416g, body only, 769g with kit lens
Pixel count	24.3 megapixels (6,000 x 4,000)
Pixel pitch	5.96 microns

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technology. The medium-format sensor offers a field of view no other compact camera can compete with as it stands, and the price – while significantly higher than the other cameras outlined here – will potentially offer value for money for higher-end UAV practitioners. Currently only two lenses are available. However, the extra field of view afforded by the medium-format sensor will likely make up for this lack of choice, with effective focal lengths of 35mm and 70mm. Weighing just over 1kg with a lens attached, this is still practical to put on many low-payload UAVs. Further to this option, DJI – manufacturer of the Phantom UAV series – has announced a partnership with Hasselblad to offer a package including the Matrice-600 UAV combined with Hasselblad's A5D medium-format camera using a Ronin-MX mount. While the lens set for the A5D (Hasselblad H-mount) is different than that of the X1D, this bundle offers an 'out-of-the-box' medium-format UAV system which may be more convenient for users.

▲ *Hasselblad X1D*

Price	Starting at EUR7,900, body only
Sensor size	43.8 x 32.9mm
Lens type	Changeable (Hasselblad XCD lenses)
Weight	725g body only, 1,200g with 45mm XCD lens
Pixel count	50 megapixels (8,272 x 6,000)
Pixel pitch	5.3 microns

PHASE ONE IXU 1000

Phase One's suite of UAV cameras remains at the top end of the market, and the newest iXU 1000 offers an impressive solution for UAV surveying, with a large 100-megapixel sensor in a bigger format than that of the Hasselblad. With three different Rodenstock lenses available (at effective focal lengths of 28, 35 and 50mm), this camera offers everything a UAV surveyor can demand right now. It is the last step before entering the realm of manned missions using solutions such as Microsoft's large-format UltraCam range, although even then the image specifications are competitive with some of the earlier models (Microsoft, 2008). The Rodenstock lenses show extremely good contrast preservation out to the image edges, particularly at the higher apertures (f/5.6), which justifies their higher cost at around EUR4,000 (Rodenstock, 2016). Phase One also notes the potential for use in combination with Lidar technology. For this data, bigger sensors offer a much more convenient and accurate solution than the generation of large photomosaics as a result of their wide field of view.

▲ *Phase One IXU 1000*

Price	Contact supplier for details
Sensor size	53.4 x 40mm
Lens type	Changeable (Rodenstock lenses)
Weight	1,600g (with lens)
Pixel count	100 megapixels (11,608 x 8,708)
Pixel pitch	4.6 microns

CONCLUSION

The authors have presented a brief overview of what they believe to be sensible choices at various levels of expertise/cost for UAV imaging. This list is not exhaustive and the market is developing very rapidly. Whilst medium-format digital camera development has been dominated by products for traditional commercial photographers, the massive explosion in the use of UAVs has seen far greater interest in camera development by UAV companies, as evidenced by DJI's investment in Hasselblad and Phase One's industrial unit. In the coming years there is expected to be a shift towards larger-format sensors in compact forms and suites of lenses capable of integrating with bigger sensors. In addition, one can expect to see data fusion and parallel data capture with other data sources (such as Lidar). ◀

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TECHNOLOGICAL BACKGROUND

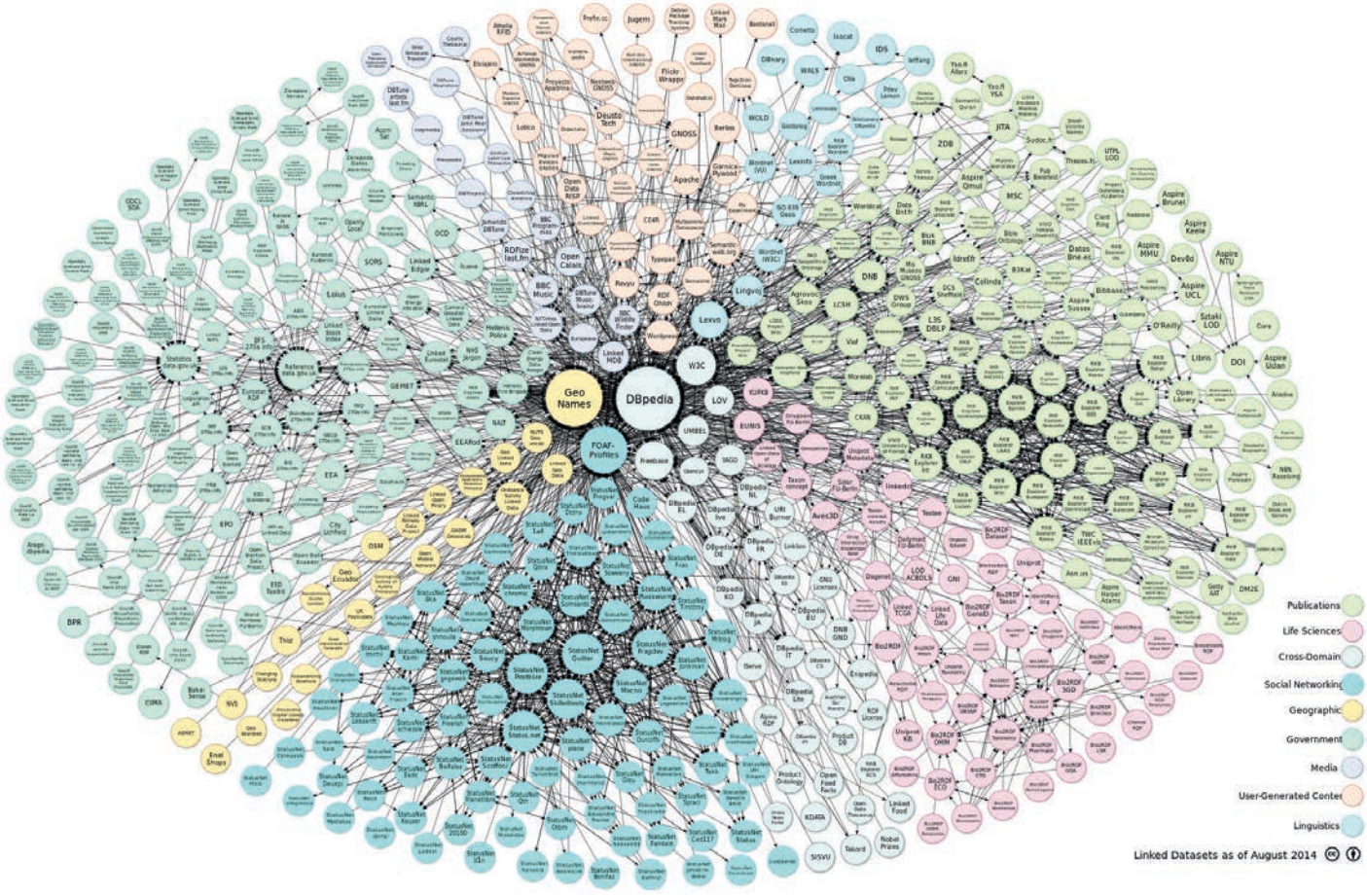
Smart Cities and **Linked Data**

The European Union defines a 'smart city' as "a city well performing in six key fields of urban development, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens". Amongst the key fields are smart mobility and a smart environment. Smart cities rely heavily on reliable, accurate and available data. Linked open data (LOD) is a way to make that data available and therefore to 'enable' the smart city.

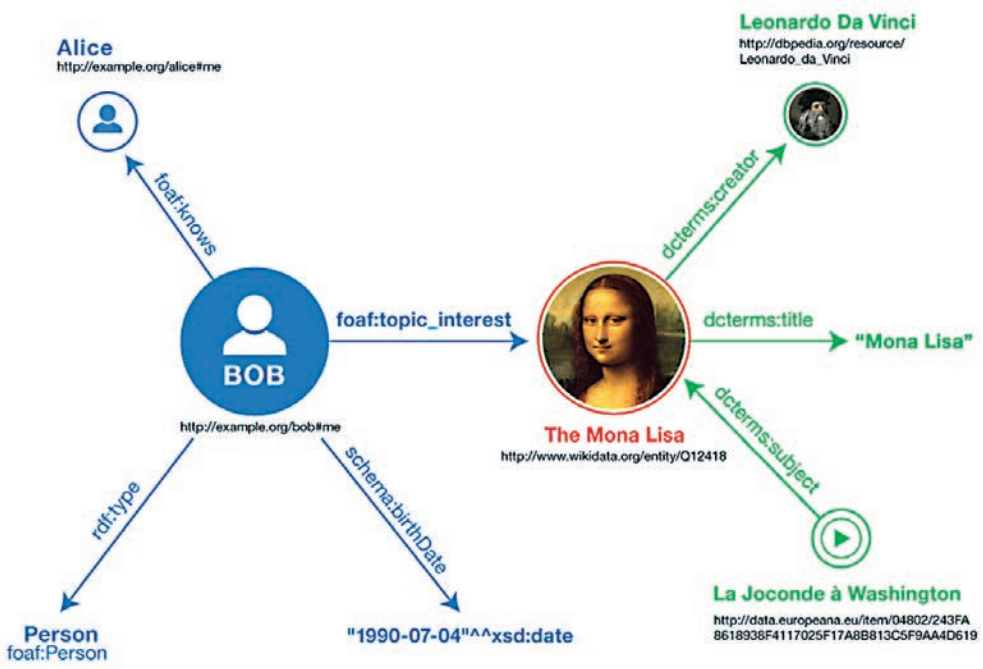
Linked data (LD) refers to data that is made available in a structured way through the internet. Linked open data (LOD) takes the linked data concept one step further and exposes the linked data to everyone on the internet. LOD is based on the 5-Star Open Data scheme which was developed by Tim Berners Lee, one of the founders of the internet in the early 1980s.

CREATING LOD

The first step (equivalent to one star) is to make information available on the web (in any format) under an open licence so that it can be reused. The second step or star is to make



▲ *Linked data sources cloud in 2014 (source: lod-cloud.net).*



▲ *Example of LOD using RDF and URIs (source: www.w3c.org)*

it available in a structured, computer-readable format such as the ESRI shape format or an MS-Excel file. Even better (three stars) would be to do this in an open, non-proprietary format such as GML. Most datasets that are available today adhere to one, two or three stars, including the large variety of web services making data available through, for example, WFS.

But it is only with four and five stars that one enters the realm of LOD. So what makes this different? In LOD all 'things' are uniquely identified. The final step is to link all these objects together in such a way that the data can be navigated and that additional context is provided. This can be done within a single dataset by creating a link between a house and a parcel, but can also be done between datasets. By naming the links between the objects, context can be provided about the relationship as well as effectively creating what is called the 'semantic web' or 'Web 3.0'. For example, when the municipality keeps track of new houses and the cadastre of the parcels on which they are built, there could be a link from the house to the cadastral parcel. Anybody interested in the house could not only see the information about the house but could also navigate towards the parcel data. And a wider context is also possible. If, for example, the house has featured in a movie, a link to the house (and as a result also to the cadastral parcel) could be established from the movie database.

LOD TECHNOLOGY

LOD requires the implementation of a number of standards that are not often used outside the LOD community, with the exception of object identification. Object identification is done by so-called universal resource identifiers (URIs). An example of a URI is the way universal resource locators (URLs, e.g. http://gim-international.com) are used to find web pages. In LOD, however, the URI identifies a specific geographical object (road, building, cadastral parcel) rather than a specific web page. The URI needs to be stable over time; changes in the data should not change the URI (otherwise, the network of links would crumble). To keep the URI stable, governments may adopt a URI strategy for their linked data which describes how URIs should be created and navigated.

Two further World Wide Web Consortium (W3C) standards are required to make LOD work, namely the Resource Description Framework (RDF) and the query language SPARQL. RDF defines the XML structure to use when describing objects and linking them. For the links, 'triples' are used which describe how object types (and therefore objects) are related by identifying a 'from' object and a 'to' object as well as the relationship between them. In the example above, the triple between the house and the cadastral parcel could be that the object 'House A' is related to the object 'Parcel B' as 'Located on': 'House A' - 'Located on' - 'Parcel B'. Between the movie and the house, the triple could become 'Movie C' - 'Features' - 'House A'. This would not only allow navigation between the objects but would also provide the context of the relationship; instead of people having to guess how the two objects are related, RDF identifies what type of relationship the two objects have. A special type of link in RDF is that of defining 'sub classes' which allow a hierarchy of objects to be created. For example 'House' is a 'sub class' of 'Building', which also defines House A as a building.

SPARQL was designed to navigate through RDF datasets and to query them for specific information. In that respect SPARQL is to RDF what SQL is to a relational database. Using SPARQL, it would be possible to perform the query 'On what Parcel is the building featured in Movie C located?'. SPARQL can translate the query, navigate the triples and arrive at Parcel B. By default, SPARQL does not support geospatial queries. To remedy this, the Open Geospatial Consortium (OGC) has extend SPARQL and RDF with a geospatial vocabulary; this extension is called GeoSPARQL. These extensions allow not only linking between identifiers, but also storing (and querying) coordinate information, thus giving even more linking options.

CREATING SMART CITIES

Over the last few years, LOD has slowly

▲ *W3C promotional mug with the 5-star LOD rating (source: www.w3c.org)*

become an accepted way of exposing data to the internet. One could also say that LOD, together with the Internet of Things (IoT) is one of the key requirements for smart cities. If governments would open up their datasets, and in particular their sensor networks, over the internet using LOD, then this could 'enable' smart cities. The 'things' such as sensors expose their data in a structured way and (potentially) linked to other datasets. This in turn may lead to applications that are not yet foreseen as data is not yet available in this manner. For example, a traffic intensity sensor not only exposes the traffic intensity itself to the internet but also the information about the road on which it is located. Using that road location, the information can be combined with other data such as road maintenance information, an air pollution sensor in the vicinity and/or meteorological information.

THREATS AND WEAKNESSES

Although the potential benefits could be huge, there are still some hurdles to be overcome. The first is that (even) more datasets need to be opened up based on at least a three-star approach. What may also be a potential threat is that RDF and GeoSPARQL are quite remote for today's app builders who rely on relatively simple and semantically poor API and JSON interfaces. Making the switch to full five-star LOD may be beneficial to data in general but detrimental to the actual use of that data by a wide audience. Whilst RDF and SPARQL were published over five years ago, mainstream IT has been slow to support it so far. Furthermore, the publication of LOD by organisations is not yet a common part of data management processes (although, considering that nor is publishing open data, perhaps this should not come as a surprise). A government-inspired community is experimenting with LOD in The Netherlands but, even with such a large force behind it, developments are relatively slow.

CONCLUSION

Linked open data (LOD) could be a key enabler for the smart city and has the potential to generate applications that are as yet unknown. However, the technical and organisational hurdles that need to be overcome should not be underestimated. ◂

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FURTHER READING

- www.smart-cities.eu
- www.w3.org/TR/rdf-primer
- www.w3.org/TR/sparql11-query
- www.opengeospatial.org/standards/geosparql

COMBINING STATE-OF-THE-ART REMOTE SENSING WITH COMPUTER ANALYTICS

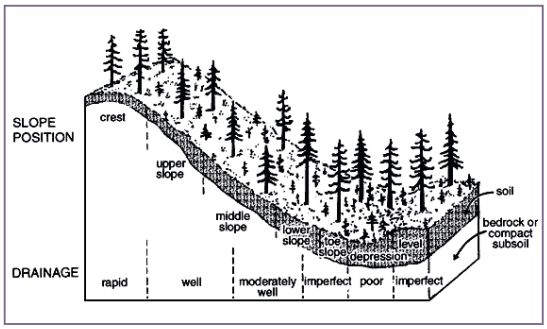
An Operational High-Resolution **Forest Inventory**

Forestry operations currently rely heavily on forest inventories that employ field plot data as a basis for estimating forest attributes. This labour-intensive approach provides limited information and has become a costly bottleneck in completing operations. Remote sensing can be used to obtain more accurate and comprehensive forest inventories with less effort. This article discusses high resolution forest inventory services (HRISs) which combine state-of-the-art remote sensing technologies and computer analytics to produce operational forest inventories that help to improve the efficiency of various forest management activities.

As a global economic activity, forest wood production is highly variable, ranging from single species plantations to low-impact, sustainable forest management projects in natural forests. In all cases, employing forest inventories to quantify existing forest resources within a given area is critical for scheduling forest management activities, valuation, planning, compliance with governmental regulations and decision support.

DATA DEFICIENCIES

In the province of Alberta, Canada, forestry inventories include estimates of land cover class, species composition, site productivity class and structural attributes including forest height, crown closure, density and stand structure complexity (e.g. indicators of single cohort or multi-storey stands). This approach to forest management is considered to be sufficient for high-level strategic management planning, but with its low resolution and high uncertainty it is unsuitable for use at the local scale. Additional reconnaissance and ground sampling are required to make up for these data deficiencies.



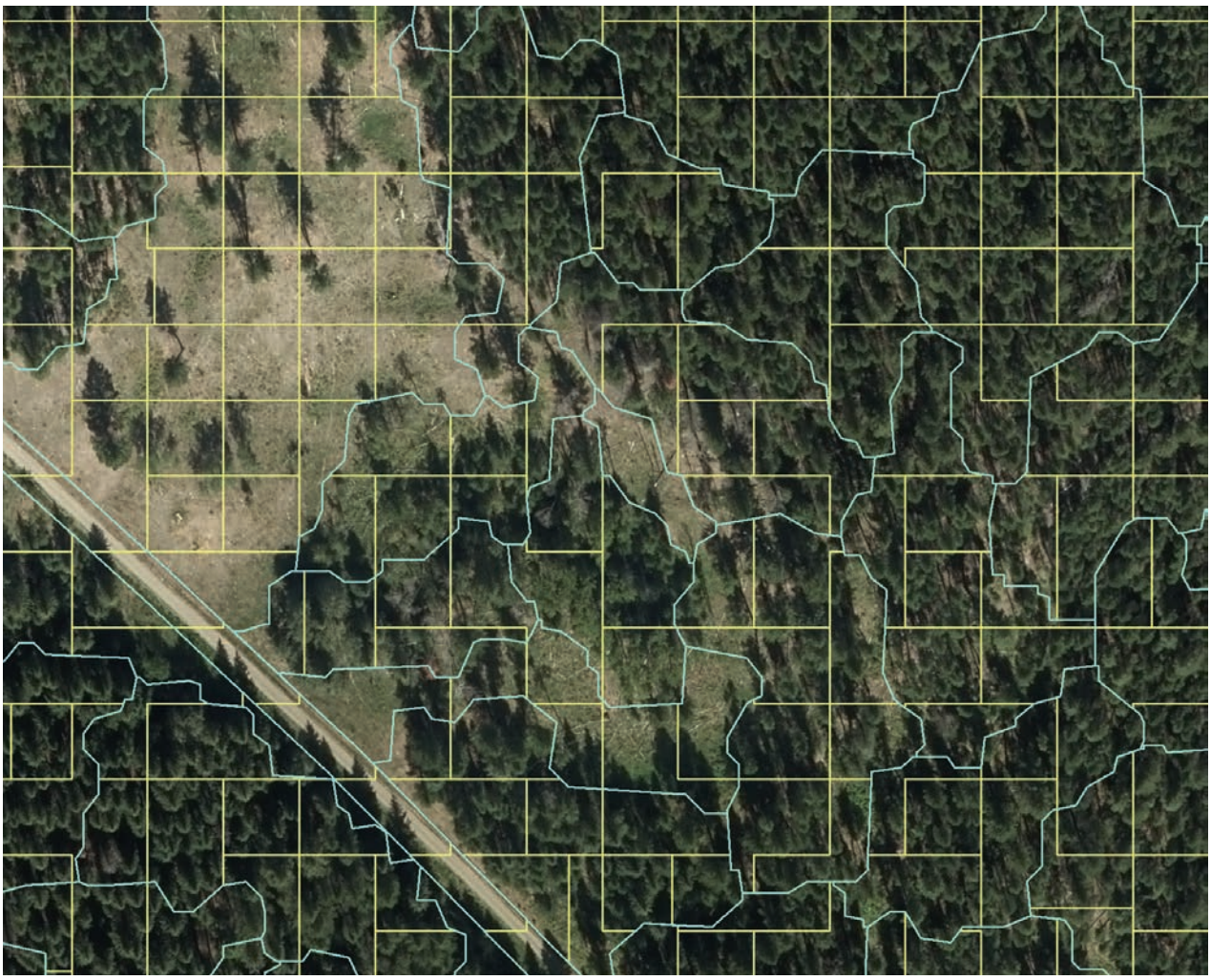
▲ *Figure 1, Illustration showing the concepts of slope position and multiple neighbourhood scales used in generating the terrain indices.*

INTENSIVE PLANTATIONS

A different approach is used in jurisdictions that are oriented towards more intensive plantation management practices. In Brazil, for example, more dense sampling is applied in eucalyptus plantations where plant growth rates are amongst the highest in the world; thousands of field plots are often established and/or measured to represent each and every plantation on an annual basis. Such heavy reliance on field crews can easily become a source of inefficiencies, resulting in high costs and long lead times to complete ground sampling tasks. In addition, as the number of ground samples increases, the level of uncertainty with respect to the representation of the attributes decreases. Expectedly, companies therefore want to reduce the number of field plots to a minimum, while maintaining a high quality of information about the state of the forest at the (local) scale of individual plantations.

LABOUR TO TECHNOLOGY

The potential of using a variety of remote sensing technologies has changed both of the aforementioned high-level and local-scale scenarios. Whether Lidar, radar, and/or optical imagery, airborne or satellite, and alone or combined, these sensors are becoming increasingly affordable and available all over the world. As remote sensing techniques are able to cover a large area for intensive sampling without the disadvantages that are inherent to labour-intensive ground sampling schemes done by field crews, they can provide observations and measurements at a fraction of the required time and effort. However, these advances from labour to technology require: 1) the ability to ensure that remote sensing data corresponds quantitatively with changes in landscape characteristics and forest attributes in both space and time; 2) that the large amounts of data generated for such forest inventories are handled in a timely and efficient manner with an operationally significant reduction in error;



▲ *Figure 2, HRIS microstands (blue/green zones) are derived using Lidar and CIR data to minimise 'within stand variation' and to produce more consistent attribute estimates. In this project microstand sizes ranged between 0.2 and 5 hectares. HRIS grid cells (yellow zones) were 400m^2. Grid cell boundaries are limited to the extent of microstand boundaries.*

3) that the results are consistent and can be reproduced; and 4) that the inventory itself becomes an integral part of forest operations taking maximum advantage of the new information. Tesera Systems Inc., a Canadian company, has been working with Blom Finland for companies in Western Canada to develop a high resolution forest inventory service (HRIS) that uses a combination of Lidar and colour infrared (CIR) imagery as well as available climate data to provide a complete commercial forest inventory that fulfils the four requirements listed above. Blom provides expertise in producing Lidar and CIR metrics while Tesera uses this data in combination with ground truth and other sources of data to complete a forest inventory.

SITE PRODUCTIVITY ANALYSIS

For the HRIS in Western Canada, Lidar data (of one pulse per square metre) and CIR imagery are obtained for entire project areas with resolutions in the order of 400m^2 (these being referred to as grid cells) and 15 to 30cm ground surface distance (GSD). The HRIS uses field plot data to develop models for predicting forest attributes as a function of remote sensing indices. These models are in turn applied to fused Lidar-CIR data plus other types of grid cell data to estimate the same attributes for the entire project area. The process for generating this data and estimating the desired attributes is highly automated. For example, it is well known that slope position is an important variable for explaining differences in forest site productivity. Tesera adopted algorithms for use within a cloud-based computing environment starting with Lidar-derived digital elevation models (DEMs) to characterise slope position at any given location and at multiple scales. The results of this process are a set of 'terrain indices' that describe whether the location lies on a peak, in a valley or somewhere in between (Figure 1). They also pertain to differences relating to slope, aspect and elevation including interactions amongst these variables that may be important for explaining differences in site productivity. Primary discrete Lidar plus CIR indices are also derived from first, last and all returns for the purpose of estimating species composition and stand structure characteristics (such as height, volume, density, crown closure and stand age). Any other existing or derivable variable, such as soil type, could also be added into the dataset if available.

CROSS VALIDATION

Because there is no a priori knowledge regarding the subset(s) of variables that best explain the forest attributes of interest, an automated variable selection algorithm is employed to obtain these variables. Once variables are selected, the HRIS develops

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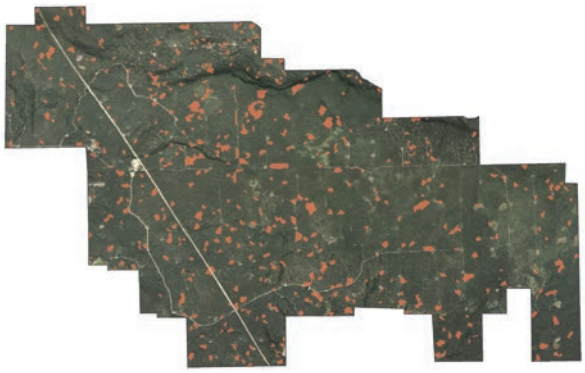
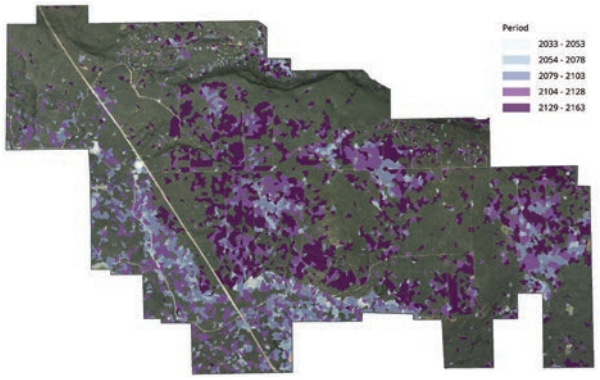


▲ *Figure 3, Stands > 50m³/ha and 15cm mean diameter at breast height (DBH).*



▲ *Figure 4, Timing and locations of stands > 200m³/ha and > 37.5cm mean tree DBH.*

predictive models to estimate the forestry variables of interest – e.g., basal area, tree diameter distribution, timber volume and merchantable volume – based solely on the selected variables. A series of computer routines are then applied to check for and remove any bias associated with attribute estimation. Before adopting any model, emphasis is placed on increasing the precision of estimates using statistical techniques such as take-one-leave-one and k-fold cross validation.

PRECISION AND EFFICIENCY ANALYSIS

Gains in precision and efficiency obtained with the HRIS over conventional inventory methods can also be estimated by comparing HRIS estimates of, say, merchantable standing volume with those volumes that are actually produced after harvesting. In one such analysis in southwestern Alberta it was found that, as the area harvested within any given unit increases above 25 to 30 hectares, the coefficient of variation associated with merchantable volume generally reaches below +/-10%.

MICROSTANDS

Another aspect of HRIS involves delineation of microstands, which typically are areas of 0.2 to 3 hectares in size (Figure 2). The polygons representing these areas are maximally homogeneous with respect to a set of key Lidar and CIR variables, for example with respect to canopy heights, and ratios of red to near-infrared reflections. Grid cells that cross microstand boundaries are separated along the boundary and then combined with another grid cell within the same microstand in an effort to reduce boundary effects. Once grid cells have been attributed with a complete set of forest inventory attributes, the results are summarised at a microstand level. Adjacent microstands may be further aggregated into larger units based on the degree of similarity in user-defined characteristics to produce the final inventory product. The outcome is a map with a population of microstands that can be themed based on the HRIS attributes to identify areas of importance for wildlife habitat or silvicultural treatments (Figures 3 and 4). This HRIS data can then be further extended to include associated growth and yield projections for operational, tactical and long-term strategic forest estate planning including net present value (NPV) and return on investment (ROI) calculations.

INDEPENDENT OF TECHNOLOGY

Remote sensing solutions are evolving over time and there are many different technologies available, each with its own advantages and disadvantages. HRIS is independent of a particular remote sensing technology; it can utilise any available remote sensing data provided it generates quantitative information about forest attributes. Forest companies can thus choose to incorporate a particular remote sensing solution without major modifications to their processing chain – and thereby close the loop between high-level strategic planning and local ground-level activities. ◀

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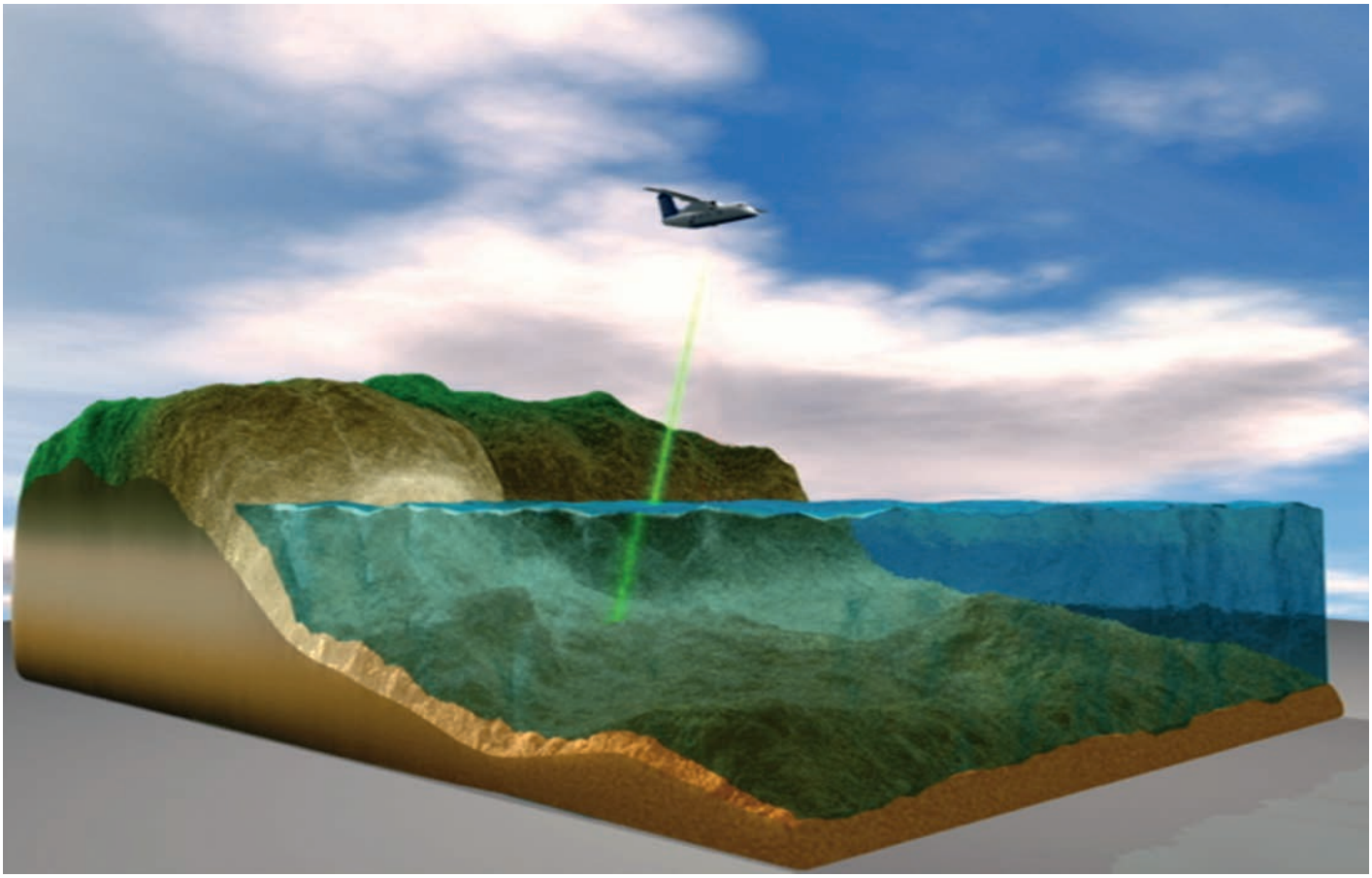
Technology in Focus: **Bathymetric Lidar**

With sea level rise and increases in the severity of extreme natural events, there has been a renewed push to further our understanding of the coastal zone. Fundamental to understanding risk in areas of high vulnerability is capturing the near-shore land and sea surface. Bathymetric Lidar is the most effective and cost-efficient technology to capture both the land and seafloor simultaneously to provide a continuous, detailed 3D elevation model along the coastline. Its ability to successfully capture elevation on both sides of the coastline, over areas stretching more than 100km along the coast, has made it the 'gold standard' for coastal vulnerability and near-shore benthic habitat modelling.



Bathymetric Lidar is an airborne acquisition technology. As opposed to airborne topographic Lidar, which uses an infrared wavelength of 1,064nm, bathymetric Lidar systems use a green wavelength of 532nm to penetrate the water column for measuring the seafloor. Bathymetric Lidar sensors can be simplified into four major components:

- the GPS receiver which gives the aircraft position
- the inertial measurement unit (IMU) which gives the roll, pitch and yaw of the aircraft
- the laser scanner which emits the signal in a particular pattern
- the sensor which reads the returning signal.

Knowing the position and orientation of all these components enables accurate

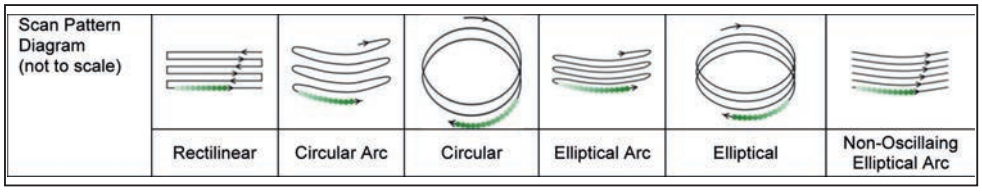
measurements to be recorded by the Lidar system. Some of these sensors can now measure more than 100,000 points per second, resulting in surveys with over 10 points per m^2 in shallow water. In a recent survey delivered for Samoa, over 1.8 billion points were captured in an area of just over 1,100km^2. The deepest of these measurements achieved a depth of just over 75m.

ENVIRONMENTAL CONSIDERATIONS

The addition of the water column in bathymetric Lidar surveys makes them more vulnerable than their topographic counterparts to the adverse impacts of environmental effects. These impacts can lead to data gaps, reduced data coverage and measurement quality. To minimise these impacts and achieve a successful bathymetric Lidar survey numerous factors need to be considered, such as weather for flying, air traffic controls, turbidity, tides, sea state, vegetation condition and ground control accessibility. Water clarity, or lack thereof, is a major hindrance for shallow-water penetration from bathymetric Lidar sensors. High turbidity, sea grasses and low-reflectance seafloors pose risks to the success of a survey. Understanding and managing these conditions can mean the difference between success and failure.

INDIVIDUAL CHARACTERISTICS OF BATHYMETRIC LIDAR SENSORS

Bathymetric Lidar sensors arguably tend to have more individual characteristics and differences than topographic Lidar sensors. Importantly, all modern bathymetric Lidar sensors can measure topography in addition to bathymetry. The most obvious split is between the shallow-water (<10m) and deep-water systems (>10m). The shallow-water systems tend to have less laser power per pulse, a higher measurement frequency (high resolution), smaller laser footprint diameter and a smaller receiver field of view, and can generally only measure water depths within the visible water column.



▲ *Figure, The scan shapes vary between rectilinear, elliptical arc, circular arc, elliptical and circular.*

The deep-water bathymetric Lidar systems use more laser power per pulse, a lower measurement frequency (low resolution), a larger laser footprint and receiver field-of-view. These deep-water bathymetric Lidar systems vary in depth penetration capability from between 2.0 to 3.0 times the Secchi depth measurement. To maximise detail and coverage, bathymetry survey operators are nowadays utilising both shallow-water and deep-water sensors simultaneously in twin optical port survey aircraft.

The scan patterns for sensors are composed of the shape, tilt and method. The scan shapes vary between rectilinear, elliptical arc, circular arc, elliptical and circular (see Figure). The circular and elliptical scanners are able to look forwards and backwards, increasing the number of times an area is sampled, although this can result in oversampling along the edges of the scan. The remaining shapes are usually tilted forward or backwards with respect to the aircraft. The scan methods vary between oscillating mirrors, rotating prisms, palmer scanners, rotating multi-facet mirrors and oscillating raster scanners. All of these methods result in subtle differences in the scan pattern and can be seen in the subsequent point cloud.

A major consideration when employing bathymetric Lidar systems is laser energy per pulse. Although factors such as the receiver telescope area and field of view influence depth penetration, the laser power combined with the pulse duration is the strongest influence on depth penetration. High laser power and pulse duration tend to result in deeper water column penetration. The downside of higher laser energy per pulse is that the measurement frequency is lower, resulting in a lower point density. However, full insonification of the seabed is still possible.

ADVANCES IN BATHYMETRIC LIDAR SENSORS

Recent advances in bathymetric Lidar sensors have been heading in a number of different directions. Some of these advances include multiple sensors in the aircraft, more integrated systems with additional sensors, faster throughput to data products, reflectance calibration between flight lines, greater point density, enhancements for fresh water capture, and enhanced classification of point clouds. Additionally, it is still early days for the use of bathymetric Lidar sensors in small unmanned aerial vehicles (UAVs), although this is likely to change in the next ten years. Advances in cloud computing and big data processing also hold a huge amount of promise for point cloud processing, and it will be fascinating to see how the industry utilises these advances to provide further value to the end users.

CONCLUDING REMARKS

When selecting and employing a bathymetric Lidar sensor it is important to consider the environmental factors as well as the individual characteristics of the system. Even then, the success of a survey is often determined by the knowledge and experience of the operator. That aside, the decision about the best system for a survey will depend on the survey area, environment, project requirements and sensor availability. The aspects which commonly determine the choice of sensor relate to the maximum depth, point density, coverage, final product requirements and, not unimportantly, the intended purpose for the data. ◀

Report on the Sixth Session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM)

The significance of geospatial information's contribution towards managing and sustaining our world was once again reaffirmed at the sixth session of the UN-GGIM Committee of Experts in New York, USA, from 3-5 August 2016. The 12 substantive decisions taken by national government delegations demonstrated this relevance and significance in sustainable development globally, regionally and nationally. The sixth session was attended by over 310 participants representing 93 Member States and a host of intergovernmental and international organisations, the academic and private sectors, as well as civil societies.

In its short history – from 2011 to the present day – the Committee of Experts, with the support of many national to global geospatial partners, has sought to raise awareness and understanding that geospatial data, information technologies, platforms and services have become critical tools to support national development, economic growth, improved evidence-based decision-making and policy formulation. These new capabilities have enhanced the ability for governments, international organisations and researchers to analyse, model, monitor and report on challenges related to humanitarian, peace and security, sustainable development, climate change, disaster and other development issues, at scales ranging from local to global.

The sixth session was set against a backdrop of an important signal issued by the United Nations Economic and Social Council (ECOSOC) the previous week. On 27 July, and following a five-year review of UN-GGIM's

work and operations, ECOSOC adopted resolution 2016/27 entitled 'Strengthening the institutional arrangements on geospatial information management'. ECOSOC acknowledged the considerable achievements of UN-GGIM in its first five years, including the establishment of a strong and streamlined regional infrastructure that reports to the Committee of Experts. It also recognised the role of UN-GGIM in the implementation of the 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction 2015-2030, the Paris Agreement on Climate Change, and the SAMOA Pathway, and that the Committee is well placed to continue to contribute to the work of the United Nations.

In his opening address, Mr Wu Hongbo, United Nations Under-Secretary-General for Economic and Social Affairs, underscored this relevance and significance when he noted that "the 2030 Agenda addresses the need for new data acquisition and integration approaches to improve the availability, quality, timeliness and disaggregation of data to support implementation at all levels. This includes a wide range of data, including Earth observations and geospatial information. As a consequence, this Committee of Experts has a valuable role to play".

Highlights of the sixth session included: unanimous recognition of the new and strengthened mandate provided to UN-GGIM by ECOSOC's resolution 2016/27 and the accompanying responsibilities; the strong support for the creation of an 'academic network' and a 'private-sector network' that further reinforces the Committee's existing architecture; the adoption of five guiding principles as the foundation of the Global Statistical Geospatial Framework in acknowledgement that the 2030 Agenda and the 2020 Round of Censuses are important drivers for the integration of geospatial and statistical information; the continued preparation of the Strategic Framework on Geospatial Information and Services for Disasters 2016-2030 in response to the Sendai Framework; advanced preparations towards a draft minimum list of fundamental geospatial data themes; endorsement of the road map for the global geodetic reference frame and elevation of the Working Group on the Global Geodetic Reference Frame to a UN-GGIM Sub-Committee on Geodesy, to provide the required stability and longer-term planning for the global geodetic reference frame; and an enhanced mandate to enable geospatial information and Earth observations to contribute to the global set of indicators for the Sustainable Development Goals (SDGs) through a new Working Group on Geospatial Information under the Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs) of the Statistical Commission.

UN-GGIM
UNITED NATIONS COMMITTEE OF EXPERTS ON GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

4TH FIG EUROPEAN YOUNG SURVEYORS MEETING IN AMSTERDAM

Together for Tomorrow's Challenges

Following the success of previous meetings, the FIG Young Surveyors got together again during the 4th European Young Surveyors Meeting that took place from 7-9 June in Amsterdam, The Netherlands. These meetings bring together young surveyors from a wide range of countries who seek to inspire, motivate and act together as a strong network to help and engage like-minded young professionals. The European Young Surveyors meeting was organised in connection with the Common Visions Conference, held by five of the leading cadastral agencies in Europe, giving the FIG Young Surveyors the opportunity to visit both events. The days were filled with inspiring keynotes on their role as agents of change, which was also the general theme for the meeting. The presentations were followed by workshops inviting young surveyors and guests to reflect on entrepreneurship, the future of the European branch of the FIG Young Surveyors Network and its cooperation with CLGE, and the development of the profession.

The presence of university professionals, representatives from the public sector and private start-ups generated an enriching environment for the sessions at the 4th European Young Surveyors Meeting. Interaction between participants was promoted in order to break down communication barriers and foster collective creativity and the expression of ideas. These meetings are an essential way to connect future leaders of the surveying profession at an early stage in their careers and are the engine of a well-functioning network across Europe.

YOUNG SURVEYORS READY FOR TOMORROW

The overall theme of the meeting was 'Together for Tomorrow's Challenges' in a broad international context. To shed light on this theme, agents of change were invited to present on worldwide challenges facing the profession. The journalist Maite Vermeulen, from Dutch journalism platform De Correspondent, held a captivating talk on how "saving the world is boring – and actually needs to be boring", in reference to the importance of strong institutions supported by a well-functioning bureaucratic system.

She presented the story of Tax Collectors Without Borders and their efficiency and personal experiences from Haiti, where people sought a land title system in order to properly rebuild after the 2010 earthquake. Christiaan Lemmen from Kadaster (The Netherlands' Cadastre, Land Registry and Mapping Agency) subsequently held a presentation on how Kadaster is addressing some of these issues, and urged the audience to participate in the future. The keynotes triggered interesting discussions on the concepts of property rights, tenure systems and tenure security.

▲ *Group photo at the Amsterdam Art Centre.*

▲ *Maite Vermeulen explaining why saving the world has to be boring.*

▲ *Kengo Okada from Ripro on survey markers.*

▲ *The participants exploring GeoFort.*

ENGINEERS WITHOUT BORDERS

The next sessions focused on initiatives by various stakeholders to address poverty and tenure security. Entrepreneur Jochgem Gunneman explained the concept and potential of 'Maptionnaire', an application that enables anyone to create a map through questionnaires. Another presentation was on Engineers Without Borders and Missing Maps, introducing their roles as agents of change and details of how to participate in their activities. The Engineers Without Borders initiative aims to serve the needs of disadvantaged communities and people through engineering projects. Examples include the development of a solar grid in remote villages, and teaching children and communities in developing countries how technology can benefit and improve their lives. The Missing Maps initiatives aims to help by mapping areas where humanitarian organisations are trying to meet the needs of vulnerable people. Since most of these places are missing on current maps, first responders lack valuable information to support decisions regarding relief efforts.

INSPIRATION AND ENGAGEMENT

Ripro, one of the silver sponsors, presented details of its survey markers and the effects of natural disasters on the profession and a national geodetic grid. The presentation was followed by a discussion on the future of survey markers and how smart markers could benefit – and be used within – the communities. The session was concluded with a talk about the 'Virtual Guidance Line' app that assists blind people based on surveying technologies. The core of any Young Surveyors Meeting, however, is always the group workshops where everybody is encouraged to present and communicate their own ideas to the audience. This not only leads to interesting discussions, but it also helps young professionals to improve their soft communication skills.

CAPTURING THE FORT

After two inspiring days the group headed to GeoFort, a former Dutch military fortress which has been redesigned as an education and science centre for all things 'geo'. GeoFort promotes the concepts of geomatics, earth sciences cartography and navigation to a large audience through activities and exhibitions that are both fun and informative. At GeoFort, the group was divided into smaller teams and set about the task of exploring the fortress. Participants learned about different cartographic projections, travelled to the centre of the Earth and tested their internal sense of direction by getting lost in an underground 'disorientation' tunnel.

UNTIL WE MEET AGAIN

The 4th European Young Surveyors Meeting was the last major event for Paula Dijkstra, vice chair of administration of the FIG Young Surveyors Network, as she is now set to pursue new challenges in the surveying profession. Paula has been one of the cornerstones of the network and has contributed immensely in getting the network to where it is today. The 5th FIG Young Surveyors European Meeting will take place prior to the FIG Working Week 2017 in Helsinki, Finland. All young surveyors attending the Working Week will be able to participate in this meeting and play an active part in the worldwide network. ◀

AUTHORS

Eva-Maria Unger, chair FIG Young Surveyors Network
Casper Fibæk, FIG European YS Organising Committee
Inês Vilas Boas, FIG European YS Organising Committee

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FOSS4G 2016

The Dynamic World of **Open Source**

With no disrespect intended to the other geomatics conferences around (and there are many with high-quality and extremely relevant programmes), the FOSS4G ('Free and Open Source Software for Geospatial') conferences are different. FOSS4G 2016 (24-26 August) was held in the former plenary chamber of the German Bundestag in Bonn yet, despite this prestigious setting, the atmosphere was very laid-back. Participants dressed in shorts and FOSS4G T-shirts, a beer (or two) in the (late) afternoon, a sense of humour throughout the whole event and a very vibrant social programme (the ice-breaker at the wonderful BaseCamp Hostel Bonn and the Rhine cruise were instant hits!) summed up the vibe at FOSS4G.

However, this was more than just a fun-packed event where everyone was having a jolly good time together. Open source is a movement within the geospatial sector that is full of exciting developments. People from all over the world had travelled to Bonn to become part of the worldwide FOSS4G community. Inspired by the location on the banks of the River Rhine, the organising committee had chosen 'Building Bridges' as this year's conference theme – and many bridges were built during the conference, where networking opportunities were plenty and delegates from the traditional geosector interacted with members of the progressive open source community. New insights and knowledge were gained; it became crystal clear that open source geospatial software has a tremendous amount to offer in overcoming many challenges our world is facing.

FOSS4G 2016 was held in the former German parliament in Bonn.

The key topics of the FOSS4G 2016 event were open data, remote sensing for Earth observation, land information and disaster management. Open source geospatial software offers excellent solutions to many challenges and this was well reflected in the conference programme. There was a very inspiring topic talk on the theme of 'Open Source Opportunities for Land Management' – the first of its kind at a FOSS4G event but undoubtedly not the last! The session evidently demonstrated the immense potential open source solutions can offer to cadastral organisations. The diverse group of FOSS4G participants, ranging from consultants and land surveyors to programmers and developers, perfectly demonstrated what's in it for everyone.

Although more and more government organisations are heading towards open source, one might wonder why the myriad possibilities of open source geospatial software with respect to a manifold of issues are still not on the radar of many authorities. Government bodies are involved in all kinds of relevant open source topics such as property rights, urban planning, food security, water & energy and climate change. Building bridges shouldn't just be the theme of the 2016 edition of FOSS4G, but should also be part of the community's core strategy. Any attempt to create awareness and heighten the visibility of the open geospatial community is worth the effort. ◀

More on FOSS4G 2016:
http://2016.foss4g.org
www.flickr.com/groups/foss4g

FOSS4G

FOSS4G is the annual global event of the Open Source Geospatial Foundation (OSGeo). The first edition was held in Lausanne, Switzerland, back in 2006. Although FOSS4G is widely recognised as the largest technical geospatial open source conference, the OSGeo community prefers to call it an 'event' because it is far more than just a conference. In addition to presentations and talks, a typical nine-day FOSS4G also includes code sprints, birds-of-a-feather sessions, workshops, topic talks and, of course, social events.

INTERVIEW WITH ARNULF CHRISTL

The upcoming November issue of *GIM International* will contain an interview with Arnulf Christl, a high-profile member of the open geospatial community. Christl is a geospatial systems architect and founding and charter member of OSGeo. Editorial manager Wim van Wegen met up with him at the relaxed, open-minded and thought-provoking FOSS4G 2016 event in Bonn. The interview will provide plenty of insightful information from the open source geospatial community.

FUTURE INSIGHT

‘CLEARLY’ to Improve Cooperation in Big Projects

To have all data in one place in a simple, structured overview, to have insight throughout the entire process and to know the exact point the project is at – with Clearly, the software tool by Future Insight, all of this is possible. Clearly provides organisations with the necessary oversight concerning the infrastructure of projects, which many projects tend to lack. Using Clearly, mutual understanding and teamwork can be optimised.

The foundation of the company was set by Rick Klooster and Bas Hoorn in 2014. They met during a project they worked on together and came to realise that they shared the same view of teamwork: teamwork in projects can be much better but it is usually neglected. The founders established Future Insight and created the software based on the data, process and tools (DPT) method. According to Bas Hoorn, most projects tend to focus on the data and tools but lack the necessary input on the process itself. Therefore, teamwork loses its effectiveness, resulting in wasted time and resources. Clearly focuses on both technical and organisational aspects of a project, which avoids this issue. The provided combination is unique in the world of software and provides the understanding stakeholders need in order to work optimally together.

WE WANT TO SHARE WITH OUR CLIENTS THE INSIGHT THAT ENERGY AND OPTIMAL TEAMWORK ARE CRITICAL FOR A PROJECT

CLEARLY

Clearly is an online software tool that structures the work process of projects. The different processes of the project are provided on the left-hand side of the screen, e.g. the conclusion of a contract or the status of the acquisition of land. On the right-hand side, the project is reflected in 2D and 3D (see Figure 1). This way, the location of the topics at hand are visualised. The option of being able to click on objects on the map provides enormous insight to the project (see Figure 2). As a result, stakeholders are all on the same page, which accelerates and qualitatively improves the decision-making process. As Rick Klooster states, “Clearly is able to streamline the processes within a project. As soon as a task is completed, Clearly automatically provides the following task on the to-do list for the next responsible actors.”
By structuring the data in an effective manner using this software, teamwork can be set up and performed effectively. This results in a smarter and faster way in which the data is generated. Once all data has been gathered and processed, a file is set into motion which can always be referred to and turned back to. This is also efficient for stakeholders who may wish to join the project at a later stage, as all data is gathered in one place.

THEMES

Clearly can be applied to (complex) projects with spatial impact (civil construction projects, urban planning projects), e.g. when extending roads or building bridges. In these projects different themes, like contracting, communication and smart cities, play a big role. The Future Insight organisation is built on these themes, ensuring the necessary expertise to guide projects within all these themes. The implementation of Clearly is therefore supported from the very beginning until the end of the project. In the beginning, Future Insight helps to clearly state all wishes and demands of an organisation and reflects its starting points. It is crucial to make use of Clearly at this early stage in order to provide insight for upcoming stages and prevent mistakes that could have major consequences in later stages. Furthermore, specialists will explain this data and will help by translating this data into information that the people concerned can comprehend. Additionally, different specialists work with different kinds of clients in order to provide customised knowledge and guidance.

The constant factor within this project is Clearly. Clearly is involved in the entire process, from the initial stage at which the ideas are developed until the delivery of the project. Clearly also adapts to the already existing software within a project and uses the output of that software in order to create the ‘big picture’ of a project, which makes Clearly so easy to work with. Moreover, the software is structured in a simple manner and can be used by anyone, meaning each stakeholder can obtain insight to the project.

PROJECT ASSISTANCE

In addition to Clearly, Future Insight also provides a three-layered set of specialists: a project leader, a specialist who optimises the teamwork and a specialist with technical background. This combination of specialists provides technical knowledge, helps with organisational aspects and brings fresh energy into the project. Thus, Future Insight not only provides the software, but is also a partner who assists in the project. Thanks to this varied expertise in various themes, it is possible to make rapid changes and hence increase the company’s flexibility.

ROLLING ENERGY

Future Insight is not just a standard IT company that provides software. It is different due to the

importance it places on flexibility, and this also applies to the company itself. The company aims to change the world by creating a new method of working together. According to the founders, this method is needed for the future. "We have to let go of strict rules and complicated systems. We believe in simple, flexible and freedom. In our office we call this 'rolling energy'," comments Bas Hoorn. This new method of working together also applies at the Future Insight office. The employees do not work according to strict shifts and everyone is equal, meaning there are no strict rules that provide various standards within the company. This freedom and flexibility creates an energy that people can feel as soon as they enter the office. As Rick Klooster explains: "There always has to be energy. If someone is not happy about what he or she is doing, he or she will never find the energy needed in order to create a successful project. We want to share with our clients the insight that energy and optimal teamwork are critical for a project."

CLIENTS

Future Insight is able to help any clients who are involved in (complex) projects with a spatial impact, such as civil construction projects and urban planning projects. Currently, Future Insight is working with numerous engineering bureaus and contractors as well as doing business with various cities, to create smart cities in 3D. Most recently, the firm has been working with the city of Rotterdam to create a 3D city model of Rotterdam in Clearly (see Figure 3). With this model, Rotterdam secured EUR18 million worth of EU subsidy to further develop the city.

Future Insight has big plans for the future. For now, it is working on some projects in Europe, but Future Insight wants to go even more international by the end of the year. There are plans to enter the American market and in November a delegation of the organisation will depart to Miami to talk about business with numerous companies. "We have been working on the functionalities of Clearly a lot. Since we have 3D totally integrated in Clearly, we are an interesting player for big companies. Projects in Europe are very cool to work on, but the rest of the world is even better, right?!" concludes Bas Hoorn.

More information
www.futureinsight.nl

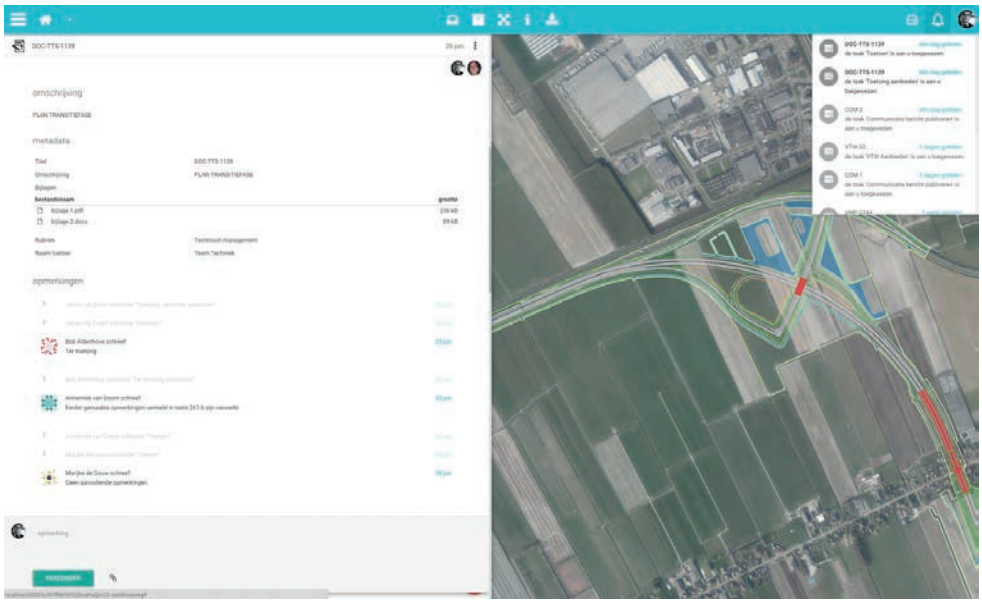

Figure 1, Clearly provides insight into the processes and an overview of action points.

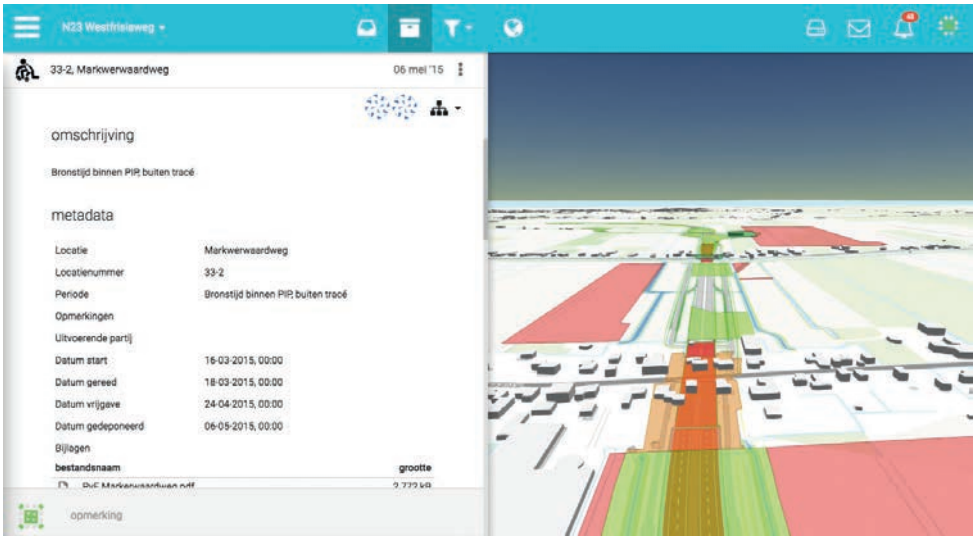

Figure 2, Look at a city via the online 3D city model and easily request information about every section of the project.

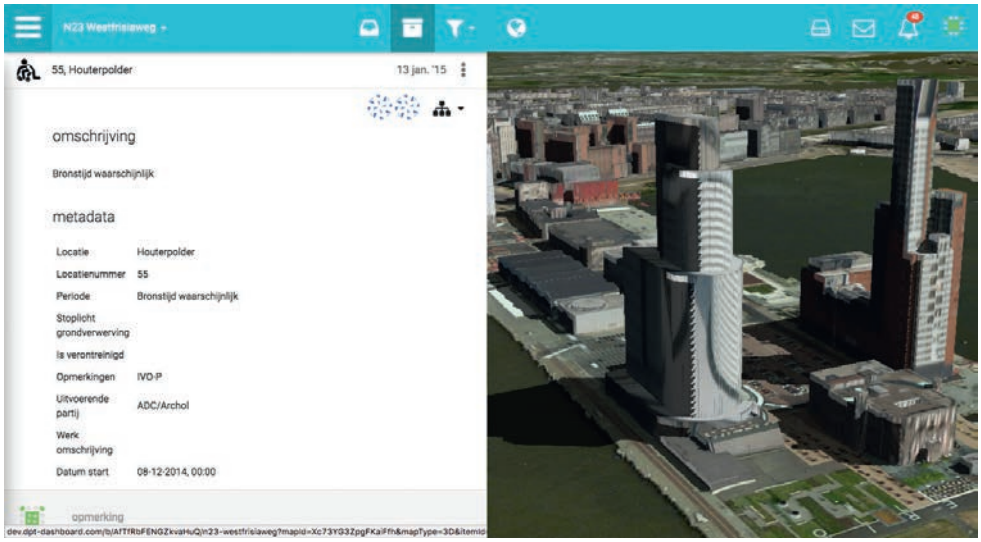

Figure 3, 3D city model of Rotterdam in Clearly.

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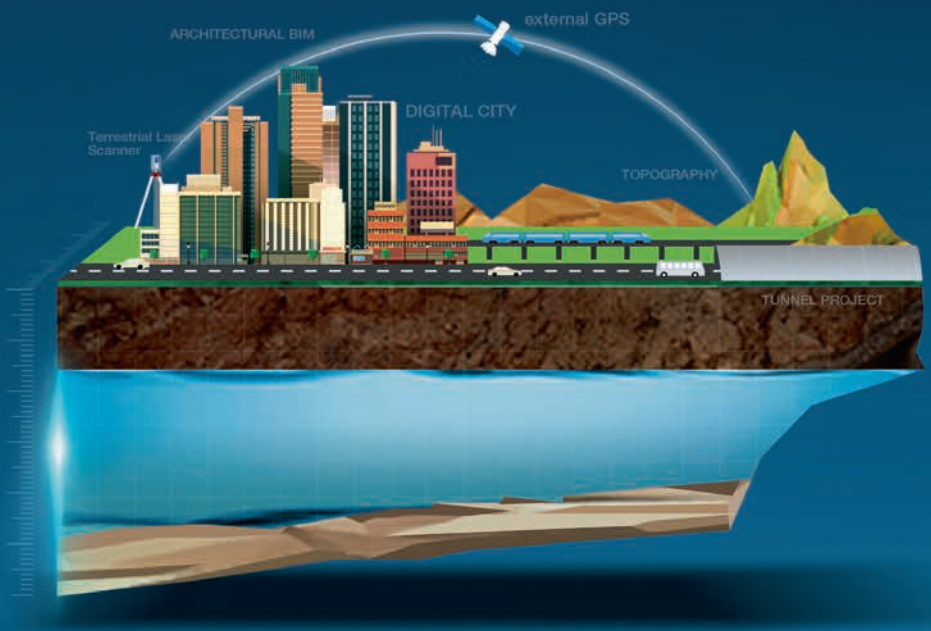

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STRONG FOCUS ON SMART CITY

Intergeo 2016

HAMBURG 2016 11 – 13 OCTOBER INTERGEO GLOBAL HUB OF THE GEOSPATIAL COMMUNITY

Welcome to Intergeo 2016, which this year is being held in the vibrant German port city of Hamburg. An excellent location, especially given the fact that this year's edition of the world's leading trade show and conference on geomatics has a very dynamic key topic: Smart City. Other key topics are big data and digital construction. All of this will be fuelled by new processes, solutions and business models – e.g. the Internet of Things (IoT), self-driving cars, virtual reality and much more. The world around us is evolving rapidly and, to handle all these challenges, spatial data is indispensable.

Daniel Katzer, project leader at Hinte GmbH, the company that organises Intergeo, explains enthusiastically about the choice for smart city as key topic of Intergeo:

"Smart city is a key topic at Intergeo 2016 because there is an obvious connection between this subject, geodata and the 550-plus exhibitors. As the agenda-setter for the conference, the German Surveying Association (DVW) always aims to cover socially relevant future topics. Geoinformation is used in several key areas and is thus also at the heart of smart cities and digital construction. Of course, Hamburg is the perfect venue for this topic since, in both Germany and Europe, it is one of the pioneers when it comes to digital cities. The port is one key feature of the city that is already well on the way to becoming 'smart'. Along with other cities such as Rome and London, Hamburg is involved in the EU's 'Smarticipate' project, which is also recognised in the conference and trade fair. The conference includes various fascinating sessions on the subject, most of which will be bilingual (English and German) to do justice to the European nature of the issue. The trade fair also includes an area on this subject, and new companies are finding their way to Intergeo all the time.

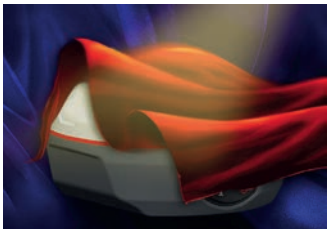
Smart city has brought drive into geobusiness and of course this works both ways, because geodata plays a vital role in the concept of a digitally networked city. Virtually all applications require some kind of spatial reference. Every major technological trend has a part to play in smart cities – IoT, digitalisation and Industry 4.0, cloud-based big data solutions and the huge issues of mobility and open data. In this regard, both the Intergeo conference and the trade fair – particularly Smart City SOLUTIONS, an Intergeo topic park – are specifically addressing solutions for the city of the future. Smart City SOLUTIONS, with its high-profile forum, will also highlight the requirements and opportunities for developing urban areas, both this year in Hamburg and in the future. The smart city will be a key focus

▲ *Daniel Katzer.*

of the conference, too, with topic slots such as 'Sustainability in the resilient city', 'Smart cities – supporting decision-making and involving inhabitants' and 'Pathways towards the digital city'. The presentations of numerous Intergeo exhibitors will show how geosolutions can speed up administrative processes. A thrilling growth field lies ahead! We're looking forward immensely to seeing this topic develop."

More information
www.intergeo.de

ComNav Technology



▲ *ComNav will unveil its new GNSS engine at Intergeo.*

In recent years, developing small-sized GNSS receivers has become a trend in the geodesy market. To differentiate itself from companies that concentrate on product appearance only, ComNav Technology continuously focuses on the core technology of GNSS. The company has developed a smaller-size GNSS engine with numerous built-in functions, as it believes that a smaller-size GNSS engine can expand the possibilities to make a perfect GNSS receiver. At Intergeo 2016, ComNav Technology will release the new-generation triple-system, multi-frequency small-size OEM board K706. In addition to the new GNSS engine, ComNav Technology has also developed a new-generation network RTK receiver that targets the countries with a CORS network. Visit ComNav Technology at Intergeo to see how small this GNSS receiver could be. Besides in the geodesy market, high-precision GNSS technology has been changing people's daily lives with various integrated technologies. Learn more from ComNav Technology during the show.

▶ **www.comnavtech.com** **Stand no. D1.018**

CHC Navigation

▲ *CHC i80 GNSS receiver.*

The CHC i80 GNSS receiver brings a future-proof sub-centimetre RTK solution to surveyors and contractors everywhere, with the ability to compute a true triple-frequency RTK pole solution using all four worldwide and multiple regional constellations. Without the need of a data collector or computer, the i80's LCD GUI allows for common workflow operations. Although small and lightweight, it is packed with a full array of sensors and modules: internal Tx/Rx UHF, multi-band cellular modem, Wi-Fi, Bluetooth, serial, USB, etc. Thanks to all these modules being integrated into an ergonomic package, GNSS users will realise their most productive day yet. CHC Navigation designs, manufactures and markets a wide range of professional GPS/GNSS solutions with a strong international presence and employs more than 800 professionals worldwide, including in China, USA, Hungary, India and Thailand.

www.chcnav.com **Stand no. E4.001**

geo-FENNEL

▲ *geo-FENNEL GPS system FGS 1.*

The geo-FENNEL FGS 1 was created for use in particularly challenging environments. The FGS 1 combines innovation and precision in one system – a robust all-rounder apparatus for every construction site. This ultra-modern GPS system can process all available GNSS signals, or select and assimilate user-defined sources. The integrated interference suppressor makes working at any location possible. The FGS 1 developed by geo-FENNEL is a lightweight, compact system which is easy to operate. Beneath the slim design lies innovative technology: a digital radio, a 3G-UMTS-GSM modem, hot-swap capable dual batteries and expanded memory capacity of up to 16GB with a mini-SD card. The geo-FENNEL FSG 1 antenna has a Bluetooth interface as well as a radio connection (Rx/Tx). In addition to all this, the system is compatible with third-party software and supports field applications like MicroSurvey FieldGenius and Carlson SurvCE. See for yourself and make your work day on the construction site easier with the geo-FENNEL FGS 1.

www.geo-fennel.de/en/ **Stand no. C3.001**

Hexagon Geospatial

Hexagon Geospatial will be at Intergeo at the Hexagon stand, showcasing its innovations in several thematic areas: surveying & engineering – mobile solutions for field data collection in various form factors, including Zeno 20, iOS, Android and Windows based devices; digital realities – data management, analysis and 3D visualisation solutions for asset management, as well as with incident analysis and decision support Smart M.Apps, focused on smart cities initiatives; and innovation – cloud-based app creation and solutions (M.App tools), as well as privately hosted sSmart M.Apps & solutions (M.App Enterprise and M.AppX). In addition, Mladen Stojic, Hexagon Geospatial president, will hold a workshop entitled 'Ignite Your M.App Experience' on Wednesday 12 October from 2:30 p.m. to 3:30 p.m.

www.hexagongeospatial.com **Stand no. D3.022**

HEXAGON GEOSPATIAL

Imajing

Imajing mobile mapping technology.

Imajing is a worldwide provider of innovative mobile mapping and GIS technologies. The product concept is based on capturing georeferenced imagery, used to enable simple, accurate and cost-effective asset mapping, monitoring and management of transportation infrastructure. Imajing has chosen to size and design its technologies to give flexibility and ease of use to its customers, both private engineering and public organisations responsible for transportation network maintenance. Various applications are possible, including map creation, asset inventory for GIS and infrastructure assessment and 3D reconstruction. The tool chain is composed of a portable mobile mapping system (imajbox), GIS data production software based on photogrammetry (imajview), a field data sharing web service (imajnet) and a complete web GIS platform (immergis web), all combined to provide a fully integrated end-to-end solution.

www.imajing.eu **Stand no. E4.018**

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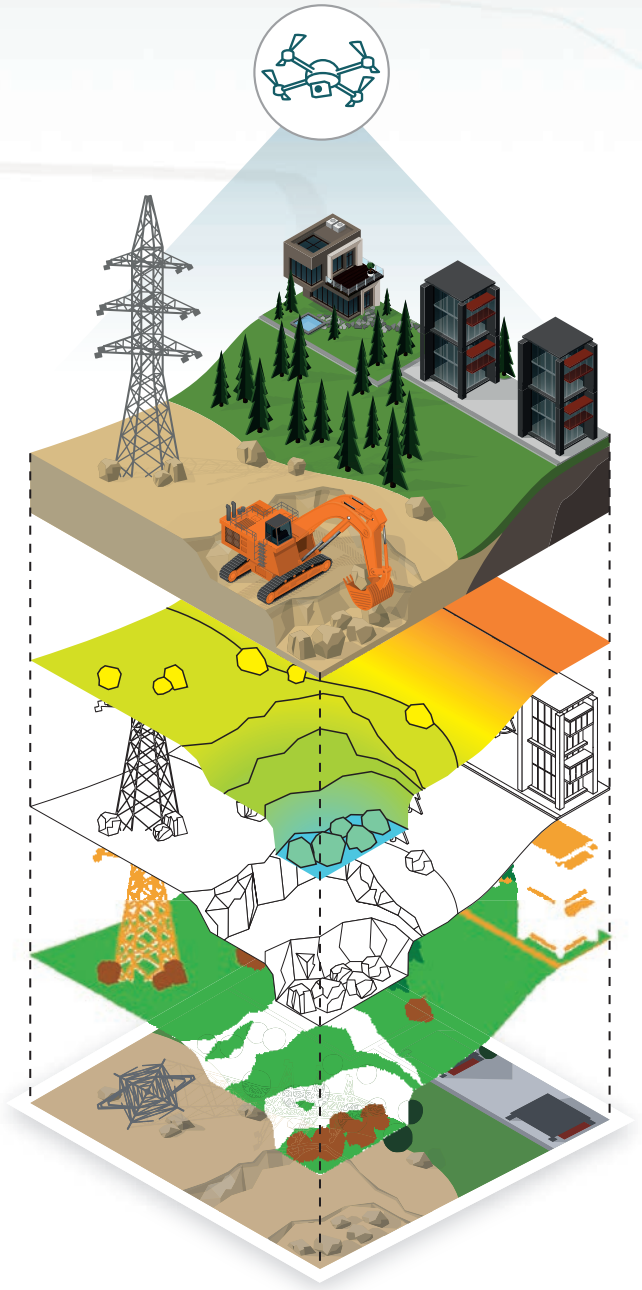

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Delair-Tech

▲ *Delair-Tech provides turn-key UAV solutions.*

Delair-Tech, a global leader in professional drones, supports corporate decision-making with its long-range DT18 and DT26X UAVs. This French start-up, founded by four engineers in 2011, provides unrivalled professional data, collected and analysed by the only drones in the world certified for flying operations beyond the pilot's visual line of sight. Delair-Tech also offers an integrated data-processing solution to support decision-making tools in all sectors of industry. Delair-Tech is already active in 30 countries and has more than 70 employees involved in many areas such as agriculture, infrastructure, energy, mining and construction.

▸ **www.delair-tech.com** **Stand no. D1.061**

Geneq

▲ *Geneq GPS receiver for survey and GIS users.*

For more than 15 years, Geneq has been a leading developer and manufacturer of the popular SXBlue GNSS family of sub-metre GPS receivers. The receivers are designed for survey and GIS users for applications such as: water, electric and gas utilities, transportation, mining, agriculture and forestry. The SXBlue connects via Bluetooth to all smartphones, PDAs, tablets and notebooks and runs on most types of software, including ArcGIS, Carlson Surveyor and MicroSurvey FieldGenius, etc. Geneq also offers a new generation of full-function GNSS receivers. Multi-satellite constellation and 30 degree tilt are just two of the G10 Smart Antenna's key features. Last but not least, a new standard is set with the new SXPro RTK all-in-one handheld, L1 and L2 from GPS and GLONASS plus the E1 from Galileo which delivers the quickest and most reliable RTK for 1-2 centimetre accuracy.

▸ **www.sxbluegps.com / www.geneq.com** **Stand no. E4.014**

KCS

KCS has upgraded its successful TraceME module TM-178, designed for tracing and controlling vehicles and other powered equipment. The TM-178/R9H7 module now has optional LoRa, Wi-Fi, Bluetooth Smart (BLE), ANT/ANT+ and proprietary RF, which enables easy integration with existing wireless networks and specific custom mobile apps on smartphones and tablets. The LoRa technology offers a communication range up to 60km line of sight. The module offers an advanced indoor and outdoor location-based positioning solution which covers a variety of IoT applications and enables stolen object/vehicle recovery. The TM-178 is equipped with external power and battery back-up connection, basic I/O connectivity and multiple onboard sensors. The unit contains multiple integrated antennas for GPS/Glonass, GSM (2G/3G) and RF functionality. The functionality of the module can be remotely programmed to fit any job. With a compact size of 91mm x 40mm, a battery lifespan of more than 10 years and weighing 30 grams, the module offers endless OEM integration possibilities. A robust IP67 housing is optional.

▸ **www.trace.me**

▲ *KCS TraceME upgrades TM-178 with LoRa technology.*

Leica Geosystems

▲ *Leica Geosystems creates complete geospatial solutions.*

Revolutionising the world of measurement and survey for nearly 200 years, Leica Geosystems creates complete solutions for professionals across the planet. Known for premium products and innovative solution development, professionals in a diverse mix of industries, such as aerospace and defence, safety and security, construction and manufacturing, trust Leica Geosystems for all their geospatial needs. With precise and accurate instruments, sophisticated software and trusted services, Leica Geosystems delivers value every day to those shaping the future of our world. Leica Geosystems is part of Hexagon (Nasdaq Stockholm: HEXA B; hexagon.com), a leading global provider of information technologies that drive quality and productivity improvements across geospatial and industrial enterprise applications. Leica Geosystems – when it has to be right.

▸ **leica-geosystems.com** **Stand no. E3.021**

Northrop Grumman LITEF

▲ *Northrop Grumman LITEF product range.*

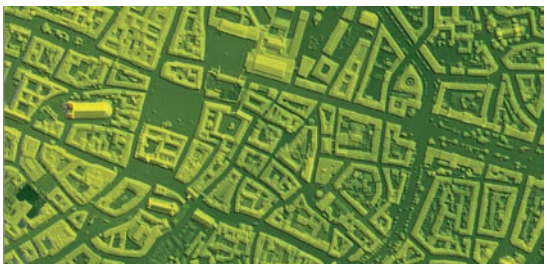
Its products may not always be visible, but its technology is all-pervasive: Northrop Grumman LITEF is a global leader in inertial sensors, reference and navigation systems. For over 50 years, the company's broad product range has been a stable player in the aviation, land, marine and space sectors. It provides customer-specific solutions for inertial measurement, inspection, stabilisation, north-finding and navigational tasks that require maximum precision and reliability, especially in challenging environments. The company's fully-integrated fibreoptic and micro-mechanical LCI, ISA and µIMU family are already applied successfully in mobile mapping, photogrammetry, survey and other industrial applications. The all-new LCI-500 lifts the performance to a next level of possibilities. Single-axis µFORS turn-rate sensors and the newest high-performance B-295 MEMS-based accelerometer generation will meet customer requirements. Visitors are invited to name their challenge at Intergeo and Northrop Grumman LITEF GmbH will provide the solution

www.northropgrumman.litef.com **Stand no. F1.070**

Racurs

Since its foundation in 1993, Racurs has been developing innovative digital mapping software for processing aerial, space and terrestrial imagery. Its flagship product PHOTOMOD was one of the first digital photogrammetric systems on the market. Today, DPW PHOTOMOD is the most popular photogrammetric software in Russia and well known all over the world. An international dealer network helps Racurs to market, sell and support its products in 70 countries. At Intergeo, learn about new PHOTOMOD 6.2 – stereovectorisation of oblique imagery, dense DSM for all sensors and automatic 3D modelling.

www.racurs.ru **Stand no. F4.030**



▲ *PHOTOMOD, Racurs' flagship product.*

RIEGL

▲ *RIEGL VZ-400i.*

At Intergeo 2016 RIEGL will showcase its comprehensive product range of high-performance Lidar solutions for airborne, unmanned, mobile and terrestrial-based laser scanning. Visitors can obtain detailed information on the latest 3D terrestrial scanner, the RIEGL VZ-400i. High-performance scanning technology provides very high pulse repetition rates and a high line scan speed. Pre-defined workflows and helpful apps support efficient data acquisition missions in the field. With a laser pulse repetition rate of up to 1.2MHz and a new standard in user friendliness, over 500 scans (50mdeg) of complex city environment in the historic downtown of Vienna, Austria, have been captured by just one operator in eight hours of acquisition time! In line with its slogan 'Innovation in 3D', RIEGL will be launching some exciting new products at Intergeo 2016, so don't miss it!

www.riegl.com **Stand no. C3.059**

Satel

▲ *SATELLINE-EASy Pro and SATELLINE-M3-TR4.*

Satel, a mission-critical connectivity partner, specialises in the design and manufacturing of radio modems for wireless data communications. Satel modems provide an easily installed solution and are an excellent choice for sending correction data from the base station to rover in precision farming, land surveying and machine control applications. Satel offers small, easy-to-integrate modules and powerful external radio modems, covering licence-free and licenced UHF and VHF bands. Satel is there where you are – providing reliable data connections and high-quality global services.

www.satel.com **Stand no. E3.043**

SOUTH

▲ *SOUTH total stations.*

SOUTH Surveying & Mapping Instrument has successfully evolved into a professional manufacturer and geographic information industrial group, fully integrating with R&D, marketing and services. SOUTH offers a complete product line with cutting-edge technologies, including GNSS positioning systems, total stations, electronic thedolites, laser instruments, etc. Over recent years, SOUTH has released new products and solutions to meet higher and more diverse market demands, such as a total station with 1" accuracy and 1km reflectorless range, one of the smallest GNSS receivers with intelligent functionalities.

www.southinstrument.com **Stand no. E3.051**

Teledyne Optech

▲ *Optech Eclipse.*

Teledyne Optech empowers mapping professionals with advanced Lidar and camera survey instruments for fast, accurate and cost-effective solutions. Teledyne Optech airborne Lidars such as the Galaxy and Titan combine with high-precision metric cameras to lead the market in efficient surveying platforms. The latest model, the Eclipse, drives down costs by eliminating the in-air operator. Teledyne Optech's airborne solutions include the CZMIL Nova bathymetric Lidar, which collects accurate data at unparalleled depths and is now available for rental. On the ground, the Lynx mobile survey system accurately scans at cruising speeds while the CMS V500 surveys mine cavities with a wireless controller and an integrated camera. Teledyne Optech workflows offer intuitive planning tools for efficient surveys, real-time LAS files and imagery for inspection during collection, and automated LMS processing for guaranteeing high-quality Lidar and camera data.

www.teledyneoptech.com **Stand no. A4.002**

Trimble Integrated Technologies

▲ *Trimble Integrated products.*

Trimble Integrated Technologies is a leading provider of high-performance UHF data links for the geomatics and remote sensing industries. Compact and lightweight, the radios are also watertight and rugged enough for the toughest environments. Easy-to-integrate modules are also available to system integrators seeking the best radio modems possible. The geomatics transceivers offer up to 35 Watts of power and over-the-air link rates as high as 19,200bps. These include the ADL Vantage and ADL Vantage 35, 4W and 35W base station radios; the XDL Micro, a board-level 2W transceiver; and the XDL Rover 2, a lightweight, ruggedised receiver featuring an internal battery and Bluetooth module for cable-free communication. The Trimble TMR1 is a dual-band (865-870 and 902-928MHz) networked transceiver supporting licence-free communications around the world. With throughput up to 2.6Mbps, the TMR1 supports both serial and Ethernet traffic while having enough throughput for video.

InTech.trimble.com **Stand no. E4.045**

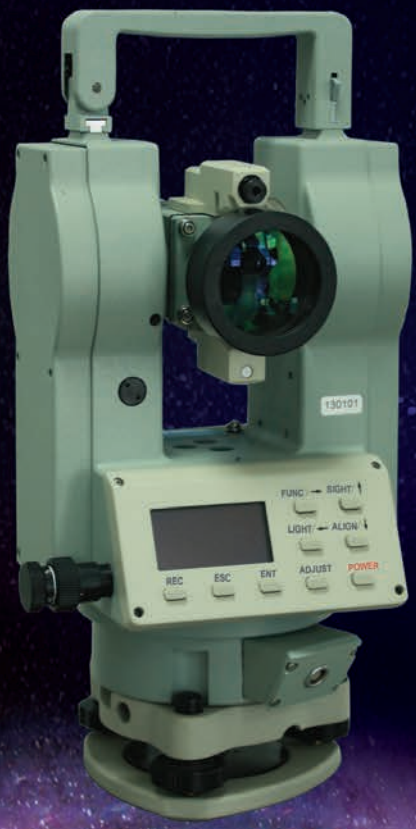
FOIF

RTS010 Total Station

1 " angle measuring accuracy

1mm+1ppm

distance measuring accuracy



DT010-Z
Auto-collimating Thodolite

1 " angle measuring accuracy

EL03 Digital Level

0.3mm standard deviation of 1km double run

WWW.FOIF.COM

SUZHOU FOIF CO.,LTD.

Welcome to visit FOIF at INTERGEO 2016
Stand No.:Hall A4 E4.032

Vexcel Imaging

▲ *UltraCam Mustang.*

Renowned in the geospatial industry for market-leading technical know-how and innovative approaches beyond well-trodden paths, Vexcel Imaging is committed to the success of its customers. As a leading provider of aerial and terrestrial sensor systems and fully integrated processing software, Vexcel Imaging offers cutting-edge technology combined with a progressive service concept for constant product upgrades, world-class support and one-stop solutions. At this year's Intergeo, Vexcel Imaging will be showcasing its latest product innovations such as the UltraCam Condor digital aerial camera system. Its expansive footprint allows it to capture large regions – even continents – in record time, efficiently producing imagery of the reputed UltraCam quality. With the UltraCam Mustang, Vexcel Imaging introduces its mobile mapping system for capturing geopositioned panoramic imagery and 3D data of street-level scenery. The system collected more than 5 million kilometres and was well proven under heavy environmental conditions during Microsoft's Bing Maps project.

▸ **www.vexcel-imaging.com** **Stand no. E4.024**

YellowScan

▲ *YellowScan Surveyor Lidar*

For professionals in need of detailed 3D maps in a snap, YellowScan offers turn-key lightweight Lidars for UAVs, enabling clients to use the appropriate survey instruments for the best results. Applications include archaeology, mining, civil engineering and corridor mapping. Whether for visualising ancient forts hidden under the vegetation, evaluating stockpiles, generating a digital terrain model of a quarry and surroundings to extend it, obtaining the topography of a wooded area to design a future road or railway, or surveying the vegetation corridor to prevent accidents, YellowScan Lidars are the right UAV payloads. The company's expertise lies in its field experience; the team has surveyed worldwide for years and knows precisely how to select the right instrument for the task. Discover YellowScan's latest feature to be launched at Intergeo, which enables live visualisation of the point cloud, and learn about the 'Surveyor', YellowScan's lightest and most precise Lidar yet.

▸ **www.yellowscan.fr** **Stand no. B1.035**

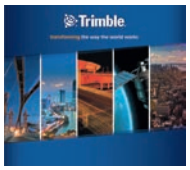
Trimble Integrated Technologies

▲ *Trimble's leading GNSS technology.*

Trimble Integrated Technologies is the leader in developing precision navigation and positioning technology that complements sensory technology to be easily integrated into any solution. Leveraging GNSS technology, Trimble Integrated Technologies complements imaging, wireless communications, inertial and other sensor technologies to provide robust and reliable accuracy. The Trimble D935-INS module features precision GNSS with an integrated MEMS inertial sensor package for 3D orientation to serve applications requiring position and attitude. The BD935-INS module's simple connectivity and configuration capabilities allow system integrators and OEMs to easily add GNSS and attitude to specialised or custom hardware solutions. The Trimble MB-Two GNSS module delivers highly accurate GNSS-based heading plus pitch or roll that uses all available dual-frequency GNSS signals equally, without any constellation preference, to deliver fast and stable centimetre-accurate position and heading information. The MB-Two is an ideal solution for a wide variety of applications such as unmanned, agriculture, automotive, marine and military systems.

▸ **InTech.trimble.com** **Stand no. E4.045**

Trimble Navigation



▲ *Trimble will showcase its survey, GIS and 3D solutions at Intergeo.*

Across industries, innovation by Trimble enables economic breakthroughs while enhancing safety, boosting compliance, reducing environmental impact and improving productivity. Trimble's solutions facilitate high-quality, productive workflows and information exchange, driving value for a global and diverse customer base of surveyors, construction, engineering and GIS service companies, farmers, mobile workers, governments, utilities and transportation authorities. Trimble's innovative technologies include integrated sensors, field applications, real-time communications and office software for processing, modelling and data analytics. Using Trimble solutions, organisations can capture the most accurate spatial data and transform it into intelligence to deliver increased productivity and improved decision-making. Whether enabling more efficient use of natural resources or enhancing the performance and lifecycle of buildings and civil infrastructure, timely and reliable geospatial information is at the core of Trimble's solutions to transform the way work is done. At Intergeo 2016 Trimble will be showcasing survey, GIS and 3D solutions that are designed for optimal productivity.

▸ **www.trimble.com** **Stand no. E4.045**

Zoller + Fröhlich

▲ *Z+F's 'Blue Workflow' allows the integration of handheld scanner data.*

For more than 20 years, Z+F has been developing and manufacturing phase-based laser scanners for various surveying applications. From the beginning, the company has put a strong emphasis on innovations. This led to numerous developments which were all industry firsts – such as the first stand-alone laser scanner in 2006, the first laser class 1 phase-shift laser scanner in 2010 and the first laser scanner with an integrated indoor positioning system as well as GPS in 2015. In addition to state-of-the-art 2D and 3D laser scanners, Z+F also offers potent software packages for processing point clouds and innovative accessories, such as the Z+F Smartlight and the Z+F T-Cam. At Intergeo 2016, Z+F will be presenting new hardware and software solutions, enhancing the applications and opportunities of laser scanning yet again.

▸ **www.zf-laser.com** **Stand no. D4.001**

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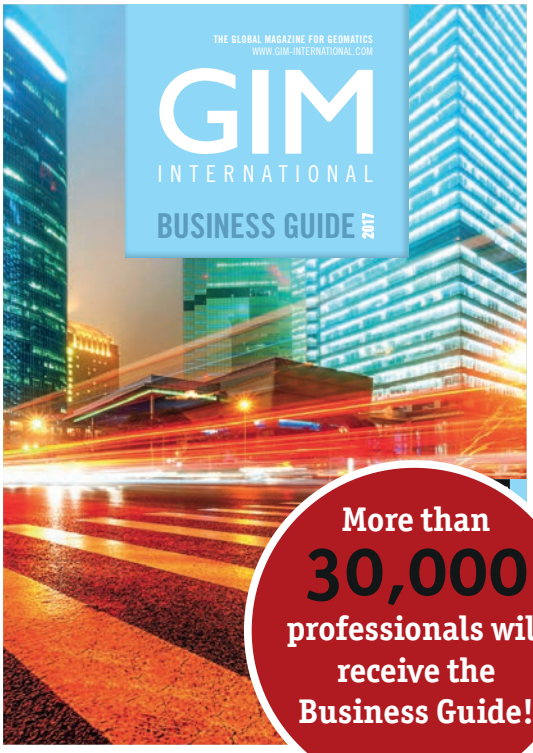

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FIG Working Week 2017

An expert group meeting was organised by FIG and UN-Habitat/GLTN (Global Land Tool Network) from 15-16 September 2016 in Athens, Greece. Over the two days, 20 experts working in various fields within land valuation worked on how to develop usable land tool that is affordable and accessible for all sections of the population in countries around the world.

About 70 percent of land ownership units in developing countries are not formally registered and the initiatives for land registration are not achieving the desired results. A certain part of the land is not registered in developed countries either. This adversely affects owners of unregistered land and properties. In most cases these are the disadvantaged groups who cannot access valuation services. Communities and individuals with unregistered land and properties are therefore unable to benefit from economic activities and to join the property ladder. The GLTN is thus working to develop a tool for valuation of unregistered land and properties that can benefit the vulnerable groups and support operationalisation of the continuum of land rights concept.

The development of the tool started in 2013 with a scoping study undertaken by Royal Institute of Chartered Surveyors, and has been followed up with discussions at FIG events since 2014. The report that was presented and discussed at the expert group meeting may result in an operational guide.

At the meeting three working groups were formed: 1. Barriers & Issues, 2. Compensation versus Market Value, and 3. Capacity and Implementation. Barriers in practice range from lack of market information to lack of valuers. Informal land valuation is complex but not impossible and purpose is key. Large-scale acquisition of informal land in developing countries was agreed as a strong focus for the document.

On compensation versus market value, the outcome was primarily focused on underlining the difference between the two terms and separating them in the document. FIG Publication 54 on 'Compulsory Purchase and Compensation – Recommendations for Good Practice' elaborates on the compensation issue. Capacity and development of regulated professional and technical valuation practitioners was highlighted as a major issue. Valuation sharing and practice should follow 'fit-for-purpose' criteria with thoughts on the development of a technical 'Para-valuer'. Adherence to international standards is key to reducing risk and increasing confidence of communities, and should be ingrained within the technical training to help implementation of the initiative.

James Kavanagh and Louise Friis-Hansen

More information
www.fig.net

GSDI Association Members Offering Workshops at GSDI 15

Several GSDI Association members are presenting workshops at the upcoming 15th Global Spatial Data Infrastructure World Conference (GSDI 15, http://gsdi15.org.tw/) in Taipei, Taiwan, from 29 November to 2 December 2016. The workshops will cover an array of topics pertinent to the conference theme 'Spatial Enablement in the Smart Homeland', as well as allowing conference participants to get to know each other.

DESIGNING AND DEVELOPING A GLOBAL DISASTER MANAGEMENT PLATFORM

Organised by staff from the Centre for Disaster Management and Public Safety, The University of Melbourne, this workshop will provide an overview of the design and development of a Global Disaster Management Platform, as well as a discussion on Smart Disaster Prevention. The four components which make up the overall platform include: the Intelligent Disaster Decision Support System, the RiskFinder, the Disaster Management Research Register, and the Disaster Management Education Portal. Each of the four components will be presented and demonstrated and then explored further with participant interaction.

TOWARDS A GLOBAL ASSESSMENT OF NATIONAL SPATIAL DATA INFRASTRUCTURES

Organised by colleagues affiliated with World Wildlife Fund (WWF-UK), Oxford University School of Geography and the Environment and the KU Leuven, this workshop will present an NSDI assessment index that has been developed to benchmark NSDI globally. Research carried out at Oxford University has confirmed how vital open, accurate and transparent spatial data is to land use planning and conservation. This led to development of the NSDI assessment index, which has been pilot-tested by the WWF-UK. The workshop will explore the validity of the index and qualifying guidelines for scoring in various sectors. GSDI, working with these and other partners, aims to complete an assessment of NSDI globally.

GSDI MARINE/COASTAL SDI CAPACITY BUILDING WORKSHOP

Presented by LETG-Brest Geomer, UBO, Institut Universitaire Européen de la Mer, KU Leuven and GSDI, this workshop will examine national and global marine SDI initiatives and successes, especially within national and regional SDI programs. Upon completion, workshop participants will better understand progress today in adopting Open Data principles in many geospatial information sectors, including the marine world. They will be introduced to the main challenges ahead in managing ever-growing marine information datasets in the realm of Big Data, and current EU research and projects in this field.

The GSDI 15 Organising Team encourages early registration for the conference: http://gsdi15.org.tw.

15TH GLOBAL SPATIAL DATA INFRASTRUCTURE CONFERENCE
2016 11/29-12/2 Taipei · Taiwan (Rep. of China)

More information
www.gsdi.org

Commission 2: Gravity Field

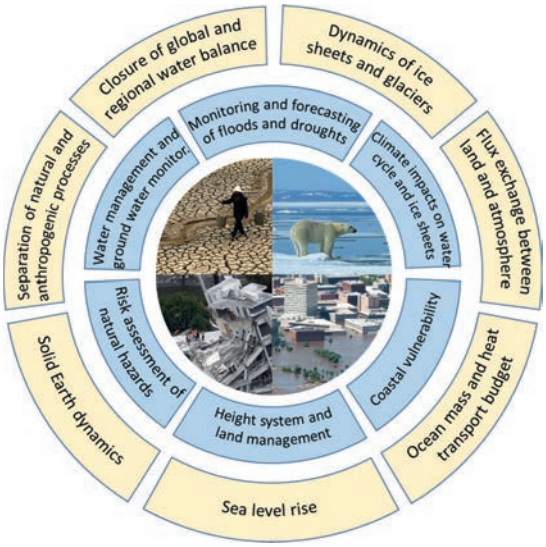
The accurate determination of the gravity field and its temporal variations is one of the three fundamental tasks of modern geodesy. This is essential for applications in positioning and navigation, civil engineering, metrology, as well as many geoscientific disciplines.

The static gravity field, represented by the geoid, serves as a unique physical reference surface – used to define height systems and for the prediction of satellite orbits. The mean dynamic topography is the difference between the geoid and the actual ocean surface from which geostrophic ocean surface currents can be derived. Furthermore, static gravity field models also provide boundary values for geophysical models of lithospheric suctures and dynamic processes in the Earth's mantle and crust.

Temporal gravity variations are a direct measure of mass transport processes in land hydrology, cryosphere and the ocean. Since 2000, the era of dedicated satellite gravity missions such as CHAMP, GRACE and GOCE has revolutionised our knowledge of the Earth's gravity field and its changes over time. Temporal gravity measurements quantify the melting rates of the large ice sheets of Greenland and Antarctica and their contribution to ongoing sea level rise. They also provide global observations of water storage variations for large and medium-sized catchments. Additionally, mass displacement in connection with large earthquake events can be measured, constraining the physical modelling of earthquake mechanisms.

Data from these satellite missions allows global Earth gravity field models to be derived with homogeneous accuracy and increasingly high spatial resolution but, due to signal attenuation with satellite altitude, they are still limited to spatial wavelengths down to 70-80km. Therefore, complementary detail information from terrestrial, air-borne and shipborne gravimetry is now even more important. This imposes challenges to develop methodologies for optimally combining different gravity data types of different signal content and with different specific features, and finally to derive gravity field and geoid models on all spatial scales.

Commission 2 will continue working to develop cooperation in observation, theory, methodology and computation of the Earth's gravity field. Commission 2 consists of six Sub-Commissions, seven Joint Study Groups and four Joint Working Groups. Emphasis will be given to addressing several recent IUGG and IAG resolutions, such as the establishment of a Global Absolute Gravity Reference System (GAGRS), the realisation of an International Height Reference System (IHRS), and the realisation of a Global Geodetic Reference System (GGRS).



Main scientific (yellow) and societal (blue) challenges addressed by a future sustained gravity observing system.

More information
www.iag-aig.org

Unbounded Mapping

From 26-30 April 2016, the ICA Commission on Mountain Cartography held its 10th Anniversary Workshop on 'Unbounded Mapping of Mountains', organised by Manfred Buchroithner and Benjamin Schröter (TU Dresden), at Carl-von-Stahl-Haus, a rustic mountain hotel on the Austria-German border. Access was only possible by hiking (or skiing) for 40 minutes from the summit

station of the Jennerbahn cable car. Two days of presentations attracted 46 participants from 18 countries. Many of those from across Europe as well as countries such as Canada, Chile, New Zealand and USA were familiar with mountain winter conditions, but it was a new experience for participants from India, Turkey and South Africa.

Opening remarks from the organisers and the Commission chair Dušan Petrovi preceded the welcome from the director of the Berchtesgaden National Park. During the next two days, 32 presentations were delivered covering a broad range of mountain cartography topics: 'relief' covered terrain data sources, shading techniques, laser scanning for DTM production and 3D mapping; 'mountain and hiking cartography' dealt with automated generalisation of contours, use of national topographic databases, analysis of rock glaciers, use of remote sensing in high mountain representation, along with practical examples of cartography from National Geographic and the Slovenian Alpine Association, amongst others. Topics discussed on the second day included 'ecology', 'glaciers', snow and skiing' and 'history'. Presentations ranged from visualisation of periglacial surface deformation to analysis of albedo using time-lapse photography; from mapping of emotions in mountains to innovative ski-map design; and from toponymic studies in mountain areas to geocommunication for avalanche awareness.

Research was reported on ecosystem mapping in Yellowstone, wildlife migration (also in Wyoming), submerged glacier mapping, landscape interpretation for understanding the past, historical accounts of French photographic surveying in Canada, orienteering maps and other cartographic products.

There was Commission-based discussion on the poster on Climate Action submitted to the UN Sustainability Goals and shown in August 2016, and on the locations of the next Commission meetings: in Washington (summer 2017) and in the snow-free coastal mountains on the Croatian island of Hvar (spring 2018). The group also participated (indoors) in an evening quiz and (outdoors) in various forms of mountain recreation. For the minutes, workshop presentations and photographs see the Commission website (www.mountaincartography.org).

▲ *Commission chair Dusan Petrovic kicking off the Mountain Cartography workshop.*

More information
www.icaci.org

ISPRS Prague Declaration

As a leading international society in the field of photogrammetry, remote sensing and spatial information sciences (P&RS&SIS), ISPRS is entering a new phase with more opportunities and big challenges. On 12 July 2016, a Declaration was ratified by delegates at the General Assembly of XXIII ISPRS Congress held in Prague, Czech Republic, as a statement setting out the ISPRS response to the challenges faced.

The members of The International Society for Photogrammetry and Remote Sensing (ISPRS) and participants of the XXIII ISPRS Congress in Prague recognise the ever-increasing application of imagery in many aspects of life and work today, and the urgent demands on deriving scientific evidence from imagery to monitor and understand global change, to support sustainable development and to confront global problems. This requires both technological innovations and a closer multidisciplinary and cross-board collaboration within the P&RS&SIS community and with other communities. The ISPRS Prague Declaration calls on international communities to work together and promote multidisciplinary collaboration towards providing reliable geospatial information to support societal transformations towards global sustainability. This statement emphasises the ISPRS commitment to realise the full potential of information from imagery through research and development, scientific networking, international cooperation, interdisciplinary integration and education and training. The declaration proposes the advancement of a global geospatial information framework/infrastructure to be formed through collaboration between ISPRS and other international communities in order to:

- engage in constructive dialogue among scientists, governments, public and private sectors, non-governmental organisations, citizens and society;
- continue providing reliable and standardised geospatial information and services to support global sustainability;
- develop a processing strategy, covering all elements from integrated sensing to spatio- temporal recognition and cognition for the automatic generation of information and knowledge, also in real time;
- share resources distributed across regions and disciplines for easy and open access to the massive quantities of available geospatial data and products;
- inspire and educate future generations in applying geospatial data for local to global sustainability studies and initiatives;
- confront global problems such as environmental change, pandemics, natural and anthropogenic disasters, displaced populations, malnutrition, water shortages, rising ocean levels and many others.

More information
www.isprs.org

FUTURE EVENTS

OCTOBER

INTERGEO
Hamburg, Germany
from 11-13 October
For more information:
W: www.intergeo.de

3D CONFERENCE ATHENS
Athens, Greece
from 18-21 October
For more information:
W: http://3dathens2016.gr

THE COMMERCIAL UAV SHOW
London, United Kingdom
From 19-20 October
for more information:
W: http://bit.ly/1XgZ3jr

THE COMMERCIAL GEOCONNECT SHOW
London, United Kingdom
from 19-20 October
For more information:
W: http://bit.ly/2bbN9EF

TOPCART 2016
Toledo-Madrid, Spain
from 26-30 October
For more information:
W: http://www.topcart2016.com

COMMERCIAL UAV EXPO
Las Vegas, Nevada, USA
from October 31 – 2 November
For more information:
W: http://www.expouav.com

NOVEMBER

FROM IMAGERY TO THE MAP
Agra, India
from 13-17 November
For more information:
W: http://conf.racurs.ru/conf2016/eng

TRIMBLE DIMENSIONS
Las Vegas, USA
from 7-9 November
For more information:
W: www.trimbledimensions.com

LOCATION BASED SERVICES
Vienna, Austria
from 14-16 November
For more information:
W: http://lbsconference.org

CHINTERGEO
Suzhou, China
From 24-26 November
For more information:
W: www.chintergeo.com

GSDI TAIWAN
Tapai, Taiwan
from 28 October – 2 December
For more information:
W: www.chintergeo.com

2017

APRIL

GISTAM 2017
Porto, Portugal
From 27-27 April
For more information:
W: www.gistam.org/?y=2017

MAY

GEO BUSINESS 2017
London, UK
from 23-24 May
For more information:
http://geobusinessshow.com

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