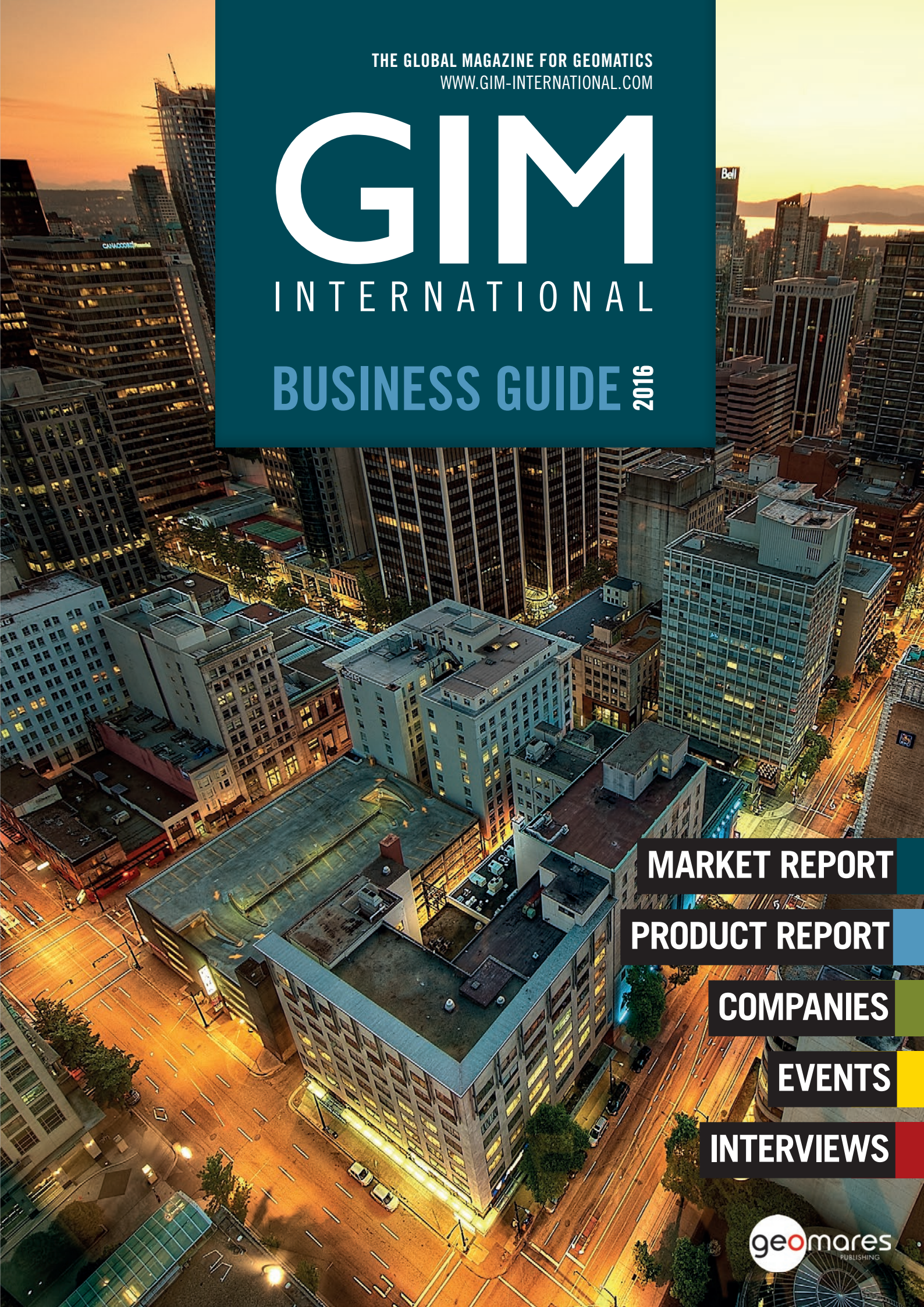
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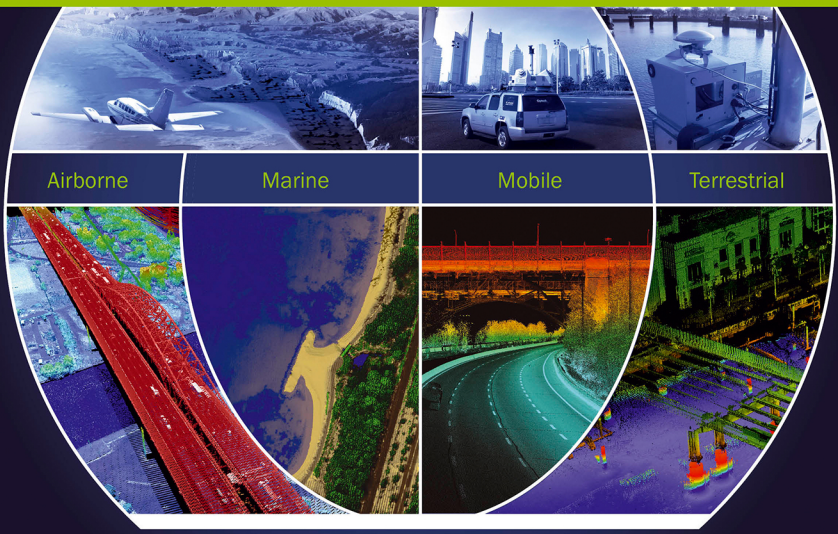

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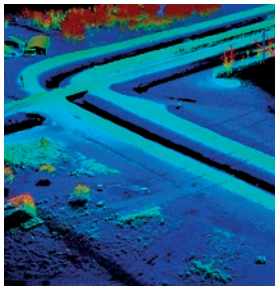
No Information without Data

Recent Advances in Geodata Acquisition Technologies



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Much More Than Just Producing Maps

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Company Guide

Cutting-edge Geomatics Companies

This is the first edition of the GIM International Business Guide which replaces the traditional Buyers Guide. We are very keen to hear your thoughts about this publication, so please feel free to send your comments and feedback by e-mail to editorial manager Wim van Wegen: wim.van.wegen@geomares.nl

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BPA WORLDWIDE BUSINESS

New Format for Business Guide 2016

This is the first edition of the Business Guide, which is the successor to our traditional Buyers Guide. We've chosen this new format to keep pace with the changing times. We want to make sure we provide you with the best possible guide for the coming year. To see a long list of manufacturers, dealers and service providers, for example, please visit our revamped website: www.gim-international.com. The beauty of the internet is that it is so dynamic; our online Companies Directory is changing virtually every day as new companies are added and others highlighted. Our website is also the perfect place for you to double-check contact details and read the latest news from companies about product launches, software releases and other interesting developments. I encourage you to make extensive use of it.

So what does this new Business Guide bring you instead of that long list? Well, we are of course still highlighting quite a few companies in this publication, but we've also compiled an overview of the industry from the perspective of top decision-makers within companies, universities, our long-standing partners and learned societies like ISPRS, ICA, FIG, GSDI, IAG and more. They each provide their views on what they believe will be the most exciting developments of the year ahead, where challenges will lie and which opportunities will arise. Included in this Business Guide from the world of academia are Prof Peter van Oosterom from the Technical University of Delft, The Netherlands, and Prof Abbas Rajabifard from the University of New South Wales, Australia. The high-profile decision-makers and thought leaders from the industry include Ron Bisio, vice president of Trimble Geospatial, and Dr Johannes Riegl, while Chryssy Potsiou, president of FIG, and Menno-Jan Kraak, president of ICA, introduce their respective learned societies. And there's a lot more too: senior editor Mathias Lemmens has written a feature on state-of-the-art geodata acquisition technologies and Canadian geomatics professional Ted MacKinnon provides his outlook on market trends in 2016.

If you are relatively new to our industry, this Business Guide will provide a good starting point by helping you to identify the major players. Meanwhile, if you have been in the geomatics field for longer, this publication offers you a useful update on today's sector. No matter how experienced you are, we hope you will keep it close to hand and refer to it throughout the year. Let me end by wishing you a successful 2016 – and hopefully this Business Guide will contribute to that in some way!

▲ *Durk Haarsma, publishing director*

RECENT ADVANCES IN GEODATA ACQUISITION TECHNOLOGIES

No **Information** without

Today's geodata acquisition technologies combine microprocessors, computer power, solid state drives, complementary metal-oxide-semiconductor (CMOS) sensors, miniaturisation and many more developments. But demand is just as important as supply and that is rapidly increasing in a world where metropolises cluster to form megalopolises, climate change threatens humans, land and livestock in low-lying areas, river deltas and valleys, and massively populated areas are prone to earthquakes and landslides. This article details recent advances in geodata acquisition technologies.

This article starts with total stations, continues with developments in GNSS positioning and navigation and proceeds with airborne Lidar and unmanned airborne systems (UASs). It then looks at the functionalities of point cloud processing software and the possibilities of dense image matching, before ending with recent advances in optical image sensors in space. The sources used include conference papers, brochures, factsheets, white papers, industry websites and Geo-matching.com, the product comparison website for hardware and software.

TOTAL STATIONS

A total station (TS) is a theodolite integrated with an electronic distance meter (EDM). The basic concept of using one device to measure distances and two angles – horizontal and vertical – has not changed over time (Figure 1). The revolution has taken place inside and stems from rapid technological advances which have boosted automation. Added to this, industrial designers are increasingly defining the look of total stations, with a prevalence of striking colours and robust lines. One day the dealer may ask: 'Where do you want me to fix your headshot?'. Over time the basic components have been extended with many features being added to ease operation and reduce surveying costs. Stepless magnetic servomotors quickly and silently move the telescope along the horizontal and vertical. The surveyor just needs to aim the prism at the target and the telescope positions itself, which saves time when staking out coordinates. The prism is pinpointed through either radio signals or imaging. Since radio links enable the device to be steered by a pole-mounted external controller, a robotic TS can be operated by one person alone. TSs require reference points for positioning and orientation. To meet this need a GNSS receiver can be mounted on top of the TS or on the prism pole. However, signals may be too weak in the vicinity of trees or buildings (Figure 2), in which case the total station takes over. This dual configuration increases the efficiency of massive data collection conducted by one person. A digital camera, mounted into the telescope coaxially with the optics and the EDM, allows snapshots documenting the site and notes to be written on the TS screen using a 'digital pencil'. This supports office-based processing, may avoid trips back to the field and allows the creation of orthoimagery. Imaging also enables the prism to be tracked and relocated when the connection is lost due to objects passing through the line of sight. Automatic target recognition allows automated deformation studies of dams and other structures. Terrestrial laser scanners (TLSs) have gained wide applications. A TLS and an EDM unit have much in common: a TLS operates without prism just as a TS can do, and both employ either pulsed laser or phase shifts. It therefore makes sense to extend a TS with the TLS ability to collect a point cloud. For example the Trimble S9, introduced in 2015, combines scanning, imaging and surveying. Depending on object reflectivity, the ranges vary from 1km to 2.2km.

GNSS RECEIVERS

The number of GNSS satellites is steadily growing. Galileo satellites numbers 5 and 6, named Doresa and Milena, were launched on 22 August 2014 but ended up in the wrong orbit. Two further Galileo satellites, numbers 9 and 10, lifted off on 11 September 2015, raising the number of satellites in the

▲ *Figure 1, Evolution from theodolite to total station. From left to right: Wild T3, introduced 1925; Aga Geodimeter 14, manufactured 1970; EDM mounted on theodolite, HP 3820A; Leica FlexLine TS02plus (2013); Spectra Precision Focus 35 (2014); Ruide RIS and Trimble S9, both from 2015. (Courtesy: M. Lemmens)*

Data

Figure 2, Pole equipped with external controller, prism and GNSS (left) and GNSS antenna on top of total station. (Courtesy: Leica Geosystems)

constellation to 10. One and a half months later, on 31 October 2015, the USA GPS constellation was enriched with the eleventh GPS IIF series satellite. IIF-12, the last of the series, has been scheduled for launch on 3 February 2016. The GPS IIF satellites feature a new third civil signal, L5, which provides improved signals and delivers higher accuracy through improved atomic clocks. To date, the GPS constellation consists of two GPS IIAs, 12 GPS IIRs, 7 GPS IIR-Ms and 11 GPS IIF satellites. Today's GNSS devices are able to track all four GNSS constellations that are either completed or still under development. Some are capable of tracking Quasi-Zenith Satellite System (QZSS) signals, a Japanese constellation which will consist of four satellites. QZSS is primarily aimed at increasing the number of GNSS signals in Japan's numerous urban canyons, where only satellites high above the horizon are in line of sight. The first – and so far the only – such satellite was launched on 11 September 2010. Survey-grade GNSS receivers allow access to satellite-based augmentation systems (SBASs) to support wide-area and differential GNSS. The publicly funded SBAS facilities for improving GNSS precision include: the Wide Area Augmentation System (WAAS) exploiting base stations widely distributed above the USA; the European Geostationary Navigation Overlay Service (EGNOS), the Japanese Multi-functional Satellite Augmentation System (MSAS) and India's GPS Aided Geo Augmented Navigation (GAGAN) technology demonstration system. To enable receipt of all the signals today's GNSS receivers are equipped to track up to hundreds of channels simultaneously (Figure 3).

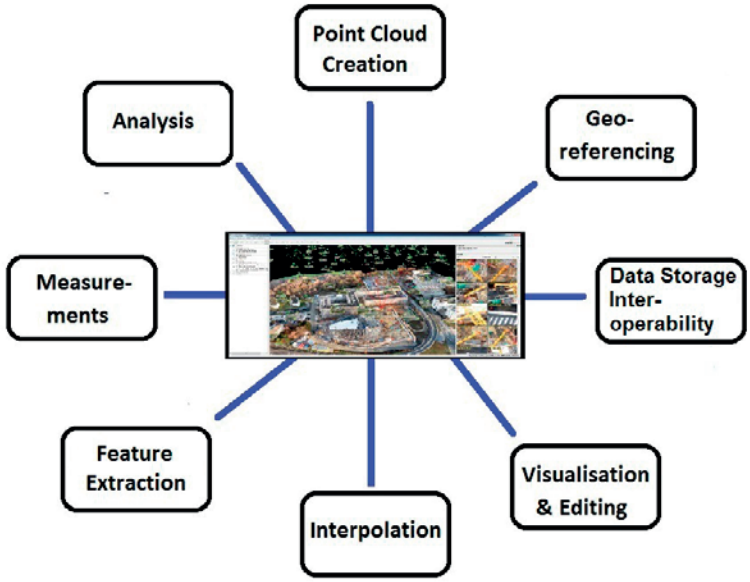
TODAY'S GNSS RECEIVERS ARE EQUIPPED TO TRACK HUNDREDS OF CHANNELS SIMULTANEOUSLY

AIRBORNE LIDAR

Airborne Lidar has matured into a mapping technology routinely used for 3D modelling of urban areas for capturing boreal forests, seabed mapping and many other uses. The frequency of firing laser pulses continues to soar and has reached over one million pulses per second. Multiple pulses in air and (full) waveform digitisation are other recent achievements and the possibilities for advancement are not yet exhausted. In December 2014 Optech introduced the world's first multispectral airborne Lidar: Titan. Three independent pulses – wavelengths 532nm, 1064nm and 1550nm – are emitted, each with a 300kHz effective sampling rate for a combined ground sampling rate of 900kHz. The flying height for both topographic and bathymetric surveys is at least 300m while the maximum height over water is 600m and over land is 2,000m. The envisaged uses include topographic surveying, 3D land cover classification, environmental modelling, vegetation mapping and shallow water bathymetry. Since the three pulses do not follow the same path through air the footprints of the pulses do not hit the same spot, i.e. the reflection value of just one spectral band is assigned to one x,y position. The three reflections can be combined through gridding, which transfers to the point cloud to a raster. RIEGL's

Figure 3, Some of the GNSS receivers introduced in 2015 which can track hundreds of channels at the same time. (Courtesy: M. Lemmens)

▲ *Figure 4, Looking like a fixed wing, this hybrid UAS combines the pros of a fixed wing with the VTOL ability of a copter. (Courtesy: Aerolution)*



▲ *Figure 5, Functionalities of point cloud processing software categorised in 8 main groups. (Courtesy: M. Lemmens)*

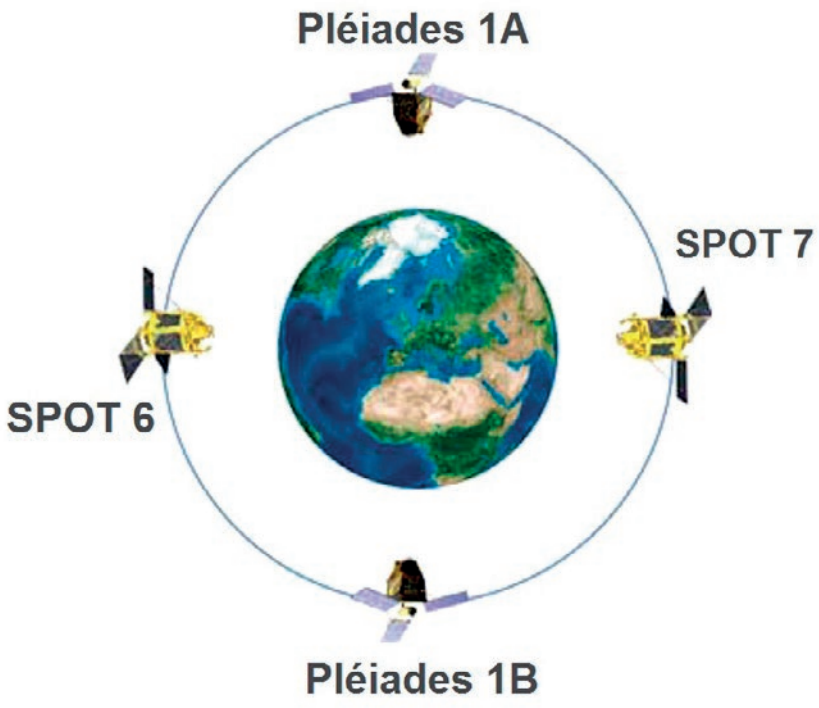
VQ-880-G has been designed for combined topographic and bathymetric surveying. The measurement rate is up to 550kHz while 160 scans per second can be made. In March 2014 Swedish Airborne Hydrography AB (AHAB), which has been part of Leica Geosystems since October 2013, launched the Dual Head consisting of two scanners each emitting up to 500,000 pulses per second, totalling a pulse rate of 1MHz, and joined by an RCD30 80MP camera recording RGB and near infrared. When flying at a height of 1km, the point density is 16 points/m^2. The scan pattern is circular enabling the receipt of up to four returns per ground point. One sensor is pointing forward and one backward; the resulting oblique view enables the recording of facades on both sides of buildings. Bathymetry can be captured by two oblique systems: one for shallow water (max. depth 15m, pulse rate 35kHz) and one for deep water (max. depth 50m, pulse rate 10kHz); penetration depth depends on how clear the water is. Both systems can be combined with the DragonEye to seamlessly capture the seabed and adjoining land.

UNMANNED AIRBORNE SYSTEMS

Unmanned airborne systems (UASs) have found use in many 2D and 3D mapping, inspection and monitoring tasks. They are steered by remote control or autonomously follow a pre-specified air path. The flight is guided by GNSS coupled with an IMU, and during processing GNSS and IMU data is used for georeferencing the sensor data. The sensors on board include RGB cameras, near-infrared (NIR) cameras, thermal infrared (TIR) sensors and Lidar. Some UASs allow two or more sensors as payload. In the *GIM International UAS Special* in 2014 I grouped UASs into two categories: fixed wings and multicopters. The first type uses the uplift abilities of wings, thus reducing energy consumption and remaining airborne for longer compared to a copter with the same dimensions. The wings allow high-speed flying and the capture of larger areas per flight. Copters can hover and, in contrast to fixed wings, need only small spaces for take-off and landing as they can ascend and descend vertically. Hence, a copter is ideally suited for capturing single buildings and small areas. Is the choice limited to either a fixed wing or a copter, as my tagging suggests? No, because a third type emerged recently: the hybrid UAS. Aerolution from Berlin has recently brought out the Songbird 1400, which is basically a fixed wing but the four rotors are not mounted rigidly on the wings; instead, the blades can rotate from the vertical pose, which is normal for a fixed wing, to horizontal (Figure 4). The horizontal pose gives the fixed wing a vertical take-off and landing (VTOL) ability as if it were a copter. The UAS can stay in the air for over one hour, i.e. two to three times longer than a copter, provided that the copter facility is only used for launch and landing. Hovering and other copter-like manoeuvres consume copter-like energy, reducing air time. Meanwhile, the hybrid does not require a runway, catapult or parachute, which reduces the risk of damaging on-board sensors and other components.

POINT CLOUDS

A point cloud is a set of data points represented as a duplet of x,y coordinates, height/depth values and possible other attributes, including reflection intensities or RGB from a colour image. The x,y duplet and its attributes form the nucleus of the point cloud and the number of nuclei may run into billions. Processing software may be general purpose and handle point clouds from a diversity of sensors or may be dedicated to specific outputs from TLSs, airborne Lidars or mobile mapping systems, for example. Some packages are proprietary, developed to process the outputs of the manufacturer's sensors. A generic package able to handle all types of sensor output and to generate all types of end product does not yet exist. Vendors have recognised that clients need



▲ *Figure 6, SPOT 6 & 7 and Pléiades 1A & 1B operate in the same orbit, each phased 180°.*

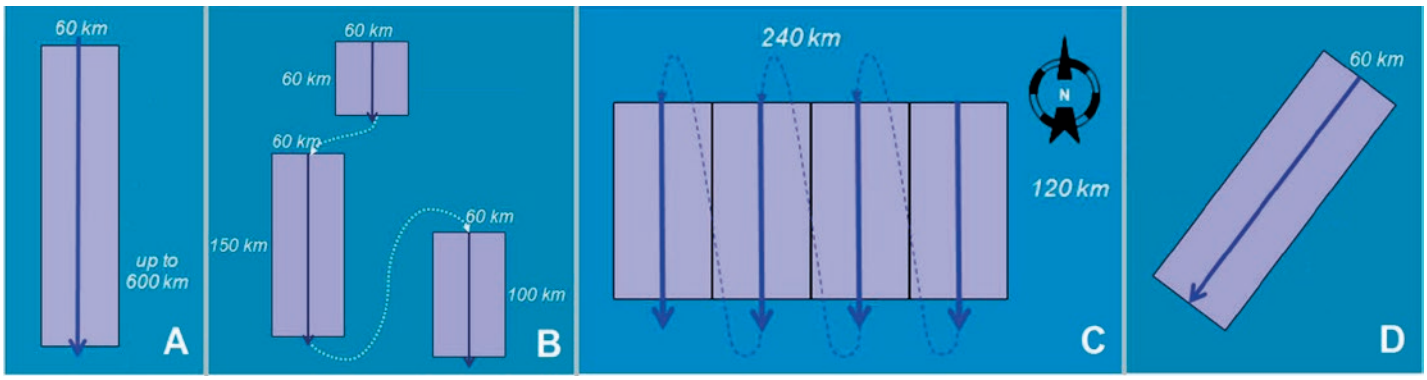
BRAND	COMPANY	COUNTRY
3Dsurvey	Modri planet	Slovenia
Correlator3D	SimActive	Canada
DroneDeplo	DroneDeplo	USA
EnsoMosaic	MosaicMill	Finland
Inpho	Trimble	USA
Orbit Softcopy	Orbit	Belgium
Pix4Dmapper	Pix4D	Switzerland
Photomod	Racurs	Russia
RapidStation	PIEneering	Finland
SURE	nFrames	Germany
UnlimitedAerial	Meixner Imaging	Austria

▲ *Table 1, Photogrammetric software packages providing dense image matching (DIM) facilities (information partly sourced from Geo-matching.com).*

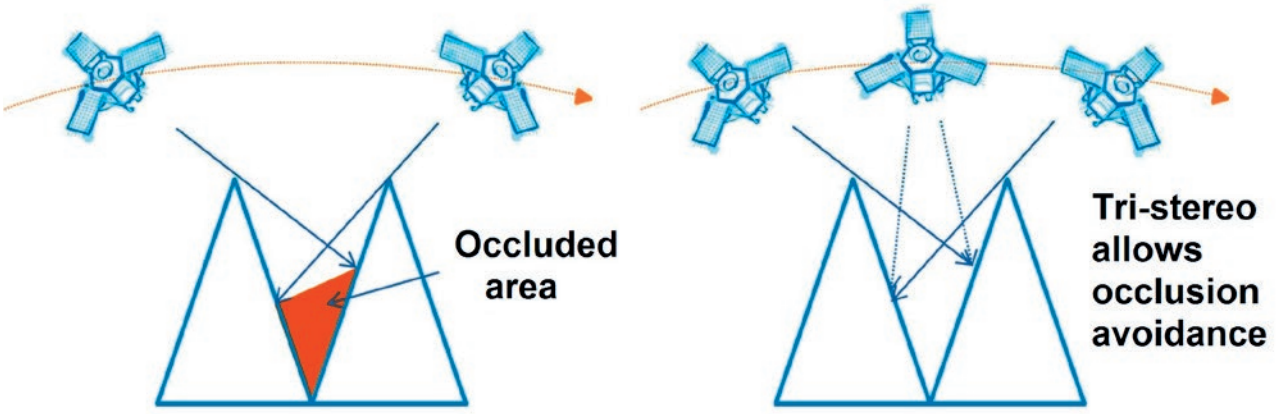
to process the outputs of their sensors and have complemented their hardware with proprietary software for managing, georeferencing, visualising, editing and exporting the outputs to dedicated software. Some software builders have spotted potential in offering tools for creating a pallet of end products from Lidar or other sensors possibly combined with pixel data, from pixel data alone or from sonar. Other packages stem from the application domains, e.g. constructors used to a CAD system started to appreciate TLS point clouds and asked vendors to add modules for processing them. Some manufacturers discovered new opportunities and built dedicated modules on top of one or more base modules aimed at, for example, the mining industry or 3D models of crash sites. This process is far from complete, and new tools are being added all the time. Before purchasing software, one should examine its functionalities as well as its design ideas, any current or planned extensions, its ability to join modules into one workflow and its interoperability with other software and services. Figure 5 categorises the functionalities.

DIM

Today's photogrammetric software enables high automation of the chain, from flight planning, self-calibration of consumer-grade cameras and aero triangulation up to the creation of DEMs and orthomosaics as well as their confluence: 3D landscape and city models. A recent development is dense image matching (DIM), which enables computation of a height or depth value for each and every pixel, thus producing high-resolution digital surface models (DSMs) and – by filtering out points reflected on buildings and vegetation – digital elevation models (DEMs) in automatic or semi-automatic workflows. The ground sampling distance (GSD) of the DSMs and



▲ *Figure 7, High agility allows various coverage scenarios. (Courtesy: Airbus Defence and Space, and M. Lemmens)*



▲ *Figure 8, Difference between stereo and tri-stereo. (Courtesy: Airbus Defence and Space, and M. Lemmens)*

DEMs is similar to the imagery from which they are derived, so that an image with a GSD of 5cm may deliver a density of up to 400 points/m^2. A package specifically for creating true orthos, DSMs and DEMs is called SURE, which has been developed at the University of Stuttgart and distributed through its spin-off nFrames. Its core is a variation on the semi-global matching algorithm. Today, a variety of packages provide DIM facilities (Table 1).

HIGH-RESOLUTION OPTICAL EO SENSORS

Over 200 optical Earth Observation (EO) satellites are in orbit, run by over 30 countries. France and the USA take the lead. The French SPOT 7 lifted off on 30 June 2014 and DigitalGlobe's WorldView-3 was launched on 13 August 2014. SPOT 7 completes the constellation of four satellites operating in the same orbit consisting of its twin sister SPOT 6 and Pléiades 1A and 1B. Each of the twins is phased 180o (Figure 6). The nadir revisit rate is 26 days, but the pointing agility allows each site to be captured once a day if SPOT 6 and 7 operate in conjunction and off-nadir areas to be captured on the same pass; the sensors can point to areas within a 1,500km-wide corridor. Through rapidly switching views up to 750km to the right or to the left of nadir, 11 scenes of 60km by 60km can be captured within an orbit segment of 1,000km. More than one target on the same pass at the same latitude can be captured too (Figure 7C), while elongated objects such as power lines, rivers or other corridors may be followed (Figure 7D). The agility enables along-track stereo images as well as tri-stereo. The latter reduces occlusions, thus improving DEM quality (Figure 8). The 12 bits (4,096 values) per band enable enhancement of details which suffer from overcast, (cloud) shadow or little texture such as dunes and ice. By default the images are oriented north to south, i.e. the scan lines are not perpendicular to nadir. To maintain the north to south direction the sensors have to be slowly moved away from nadir, but at a certain moment the sensors have to rotate to their start positions. Therefore, the maximum length of one north-to-south strip is 600km (Figure 7A, B). The incorporation of weather forecasts in the mission planning avoids capturing of scenes hidden by clouds. Table 2 shows spectral and spatial features of SPOT and Pléiades.

OVER 200 OPTICAL EARTH OBSERVATION SATELLITES ARE CURRENTLY IN ORBIT

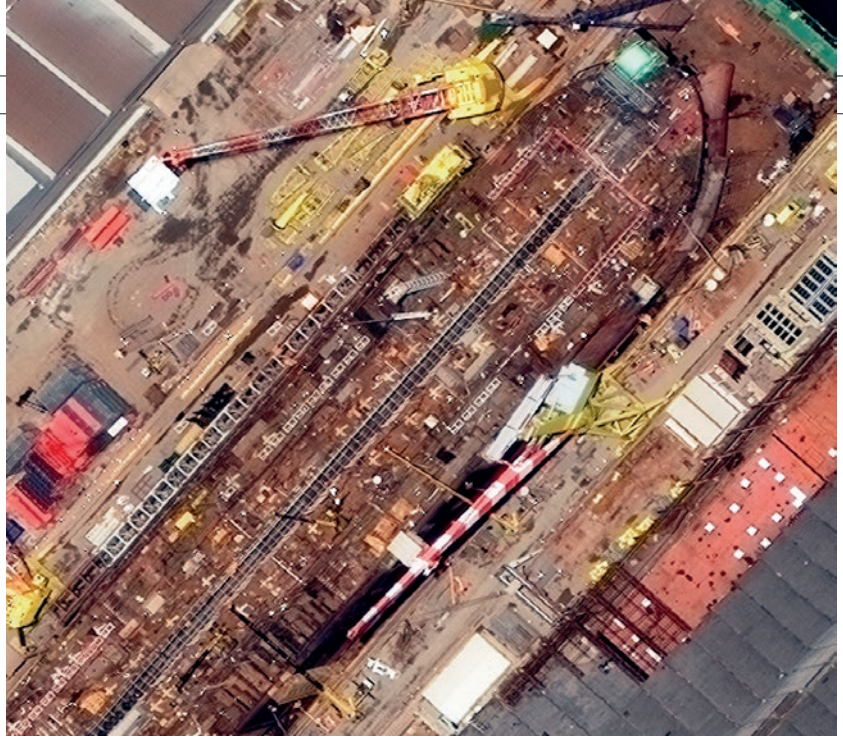
WorldView-3 has the same spectral characteristics as WorldView-2 (Table 3), launched 8 October 2009, but acquires the images with a higher GSD: 31cm instead of 46cm in the panchromatic (Pan) mode and 1.24m instead of 1.85m in the multispectral (MS) mode (Figure 9). All figures refer to nadir. WorldView-3 also adds to its spectral sensing abilities 8 shortwave infrared (SWIR) bands with a GSD of 3.7m and 12 CAVIS (Clouds, Aerosols, Vapours, Ice and Snow) bands with a GSD of 30m. The coverage capacity of WorldView-2 is 1 million km^2 per day, and for WorldView-2 this figure is 680,000km^2. In other words, increasing

	SPOT 6 & 7	PLÉIADES 1A & 1B
Panchromatic	0.450 - 0.745	0.480 – 0.830
Blue	0.450 - 0.520	0.430 – 0.550
Green	0.530 - 0.590	0.490 – 0.610
Red	0.625 - 0.695	0.600 – 0.720
Near Infrared	0.760 - 0.890	0.750 – 0.950
Swath width	60km	20km
GSD Pan	1.5m	0.5m
GSD MS	6m	2m

▲ *Table 2, Spectral bands (µm), swath width and GSDs of SPOT 6 & 7 and Pléiades 1A & 1B.*

	µm
Pan	0.45 – 0.80
MS	
Coastal	0.4 – 0.45
Blue	0.45 – 0.51
Green	0.51 – 0.58
Yellow	0.585 – 0.625
Red	0.63 – 0.69
Red Edge	0.705 – 0.745
NIR1	0.77 – 0.895
NIR2	0.86 – 1.04

▲ *Table 3, Spectral bands of WorldView-2 and WorldView-3.*



▲ *Figure 9, This 40cm WorldView-3 image of a ship unloading in the docks of Rio de Janeiro, Brazil, shows the steel lattice structure of the cranes. (Courtesy: DigitalGlobe)*

the GSD by a factor of 1.48 decreases the daily coverage by the same factor. The constellation of the four satellites with a GSD better than 50cm allows 60% of the Earth's surface to be captured monthly and intraday revisits of the same areas.

CONCLUDING REMARKS

Data cannot be created out of thin air. To hearten those surveyors who may unfairly fear that their profession is in danger of extinction, I finish with a quote from Digital Globe: "You cannot create data from nothing and the laws of physics cannot be conquered via software enhancements." ◀

FURTHER READING:

- Fleming, S., Woodhouse, I.H., Cottin, A. (2015) Bringing Colour to Point Clouds – Developments in Multispectral Lidar Are Changing the Way We See Point Clouds, *GIM International*, 29:2, pp. 22-25.
- Lemmens, M. (2014) Point Clouds (1) & (2), *GIM International*, 28:6, pp. 16-21 and 28:7, pp. 27-33.

MATHIAS LEMMENS

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5 Questions to...

Jürgen Dold

President of Hexagon Geosystems

▲ *Jürgen Dold*

Technology and societal needs are changing rapidly. How is your company adapting to those changes?

Leica Geosystems has a long tradition of innovation which has kept us energised throughout our 200-year history. With a diverse workforce containing a unique combination of skills and experience, we have been able to remain nimble and proactive in our approach to the industry and our customers' needs. We employ those we feel will lead our business successfully, whether that be a recently graduated engineer who shows promise creating the next industry-revolutionising software or a seasoned business analyst who has proven skills in making processes more efficient. If we feel someone else in a specific domain is ahead of us, we are willing to acquire companies to jointly provide leading solutions to our customers. In combination, we adapt to change every day as we are conceptualising, creating and testing the solutions that are shaping our world for the future.

On which applications is your company focusing its research and development activities?

We are focusing on many exciting applications right now. With many forward-looking experts in their respective fields on our staff, we are keen to develop solutions that help our customers overcome the next obstacle on the horizon. For us, that is currently UAVs to help measurement professionals access any project quickly and safely. We are also developing more service-based business models, such as our Hexagon Imagery Program. This is a crowdsourcing imagery programme to collect nationwide aerial images in the Americas and Western Europe with our Leica Geosystems airborne cameras, providing multiple industries with an unmatched database of high-quality and consistent imagery. Lastly, we remain focused on our roots and how we can always strengthen our offerings in traditional surveying instruments. For example, our latest software, Leica Captivate, enables professionals to create the most realistic 3D models in the field on their total stations for accurate and current modelling.

What is your company's growth strategy?

We believe in constant innovation – not only in terms of the technological solutions we create, but also in how we approach the market. Throughout our organisation, we have various industry specialists who carefully watch and listen to users' experiences and needs in the field, which leads us to develop the most relevant solutions to overcome their challenges. We also keep a vigilant eye on developments around the globe. We remain nimble so we can proactively enter markets that show potential.

How would you describe the geomatics market these days?

I would describe it as 'changing'. We are certainly in an exciting time of change right now in the market. Digital disruption is shaping how we do everything, from mobile phones to driving our cars, and we're seeing this acutely across geomatics. Measurement professionals today depend on digital representations of project sites to accurately model and ensure the best results. In these digital realities we're working in, we're improving our businesses. For example, in Building Information Modelling (BIM), architects have the right assumptions of the space to best plan how that structure should be designed. Engineers can then develop building plans that will result in the safest and most efficient build. Construction professionals then work from the most precise plans, reducing costly reworks and waste. Finally, facility managers can run the facility efficiently and cost effectively for the best return on investment. So, this change and evolution across geomatics presents many prime opportunities.

Which new or emerging markets do you foresee in the coming years?

This is the exciting, yet challenging, part of our industry. We're beginning to see applications with our solutions we never thought possible, and we're constantly in awe when we start to see the potential for our technologies in emerging markets. To be able to do this, we've reinvented the way of doing business – not only by following the trends but, more importantly, also by setting the trends in the industry. We're especially excited about the rail industry where we're no longer merely monitoring but also supporting the design and construction through ground penetrating radar and 3D laser scanning. We're also seeing our airborne solutions adopted at a tremendous rate where 3D city modelling is a critical need with megacities. There are great opportunities ahead for our business and, with our keen ability to listen and predict, we plan to be at the forefront of each one.

WE'RE SEEING THE EFFECTS OF DIGITAL DISRUPTION ACUTELY ACROSS GEOMATICS

www.leica-geosystems.com

5 Questions to...

Dr Johannes Riegl

Founder and CEO of RIEGL Laser Measurement Systems

Technology and societal needs are changing rapidly. How is your company adapting to those changes?

As we all know, change is the only constant. An example is the current uncertainty within the market about the future of linear Lidar due to the introduction and appearance of Geiger Mode and Single Photon Counting Lidar to the market. We respect this technology, which is now being promoted in the market more than extensively, and value its benefits. However, for topographic airborne mapping, we see the tremendous supremacy of linear Lidar sensors, and our chief technical officer will be discussing the reasons behind this in detail in his presentation during ILMF in Denver, USA, in February.

On which applications is your company focusing its research and development activities?

We are continuously raising the bar in all our fields of activities. We have recently introduced the evolution of our highly successful VZ-400 terrestrial laser scanner, which is the new RIEGL VZ-400i. This powerful sensor – with an improved range of up to 800 metres, dramatically increased measurement speed, more user friendly interface and forward-looking cloud connectivity – is the most advanced and versatile TLS sensor on the market. In unmanned scanning, we unveiled the first fully integrated UAV for survey-grade mapping, the RiCOPTER, in 2014. Last September, we introduced our new BathyCopter , which is a UAV developed for bathymetric surveying purposes. With ever-improving software tools for efficient field-to-office workflows, more innovations have emerged on the software side, such as our unique data alignment tool RiPRECISION for mobile scanning, which is also now available for UAV-based scanning. The groundbreaking improvements that RIEGL continually introduces to the market highlight the broad scope of research and development happening within our company.

▲ *Dr Johannes Riegl*

What is your company's growth strategy?

We are a leading global provider of advanced Lidar solutions for demanding applications. Our sensor portfolio is the most comprehensive that the market has to offer. RIEGL provides solutions for manned as well as unmanned topographic and bathymetric airborne laser scanning, mobile scanning, terrestrial scanning and industrial scanning. With headquarters in Austria and offices in the USA, China and Japan in addition to a worldwide partner network, we serve all international markets. We continuously work on further expanding this network and our own international presence through collaboration with new business partners to grow even closer with our customers.

How would you describe the geomatics market these days?

The geomatics market is highly competitive these days, with new players constantly trying to enter the market. As with GNSS, it is the improved accuracy and precision of systems as well as acquisition speed that brings new applications and growth. Our customers are well informed about the offerings in the marketplace and expect the ultimate performance, customer service and support out of their instruments. RIEGL is renowned for outstanding technical performance and true customer service, support and dedication. With our growing worldwide partner network, we are able to reach new customers and make them part of the RIEGL community – a community that together strives for the best performance, quality and reliability in carrying out their jobs.

THE GEOMATICS MARKET IS HIGHLY COMPETITIVE THESE DAYS, WITH NEW PLAYERS CONSTANTLY TRYING TO ENTER THE MARKET

Which new or emerging markets do you foresee in the coming years?

First and foremost is definitely the UAV market. With the rapid growth of the UAV industry, we see amazing potential for our instruments to be used for both current applications and unexploited markets. Such newer applications will include the forensics sector, as well as rapid response applications. These will quickly deliver valuable geospatial information to first responders in scenarios such as Earth-changing events: earthquakes, landslides or flooding. In events like these, UAVs will also play a growing, more significant role in the disaster relief efforts. RIEGL has a strong position in these fields, offering turnkey UAV systems equipped with state-of-the-art, ultra-high-performing Lidar sensors. In addition, we work with global partners in streamlining the data flow from the UAV acquisition platform straight into GIS environments to support users in basing their reactions and decisions on current, highly accurate geospatial data.

www.riegl.com

5 Questions to...

Michel Stanier

COO of Teledyne Optech

Michel Stanier

Technology and societal needs are changing rapidly. How is your company adapting to those changes?

Since its inception 41 years ago, Teledyne Optech has always worked in collaboration with forward-thinking clients to co-develop Lidar-based solutions to suit their specific needs. These early adopters were often the forerunners of entire industries, and we have been fortunate to be the catalysts that spawned markets such as airborne and mobile Lidar surveying. Four decades later, Lidar sensors are no longer novel prototypes for early adopters. Lidar is now a very mature technology and users expect a complete end-to-end solution that is seamlessly integrated all the way through to their end products. As a result, co-development with clients and distributed development with specialised downstream partners are required to manage risk and ensure success. Another radical technology change is the cloud. Clients are looking for ever-faster data processing, minimal capital investments and the ability to make data readily accessible from anywhere in the world. With the broad availability of high-bandwidth internet access and the ever-lower cost of server and data farms, moving very large datasets to the cloud for ultra-fast processing and dissemination is finally achievable and increasingly compelling. Teledyne Optech is at the forefront of this move with our LMS software, which uses multi-core, multi-threaded processing to take full advantage of the gigantic computing power made available in the cloud.

On which applications is your company focusing its research and development activities?

In line with our strategy, our R&D is focused on enabling our clients to do more and to do it faster and more easily. We are applying this thinking to all the applications and markets that we currently serve – from wide-area mapping to corridor and asset management, from bathymetry to environmental modelling, from engineering to defence applications, and even space. We are driven to break through long-accepted Lidar limitations, not only through sensor innovations but also with software improvements. For example, we are developing increasingly smart processing software that can adapt to the mobile Lidar project conditions and optimise processing parameters to yield the best accuracy for the data acquisition conditions. We want our clients to be able to operate just as easily in complex, very challenging urban settings as in open environments, without sacrificing accuracy and without requiring a PhD! We are also taking the experience and rigorous mindset that we have developed in the mapping space to new, uncharted territories for Lidar: applications on the fringe of geomatics. These are areas where Lidar would not have been considered an obvious choice and yet where we have demonstrated that we can deliver a great deal of value – even enabling novel studies.

What is your company's growth strategy?

Teledyne Optech is known as the market innovator and we wish to continue to lead through innovation with game-changing sensors such as the ultra-efficient Galaxy, the highly versatile multispectral Titan and the upcoming Eclipse, which offers a new level of ease of use. Indeed, we are once again pushing the boundaries of operational efficiency and productivity with groundbreaking features such as the Galaxy's SwathTRAK technology and our LMS processing software. These products are continuously lowering operating costs for our clients without ever sacrificing our data quality. In the process, by eliminating blind zones on the Galaxy, we are making flight planning simpler than ever before, regardless of terrain type/relief and aircraft altitude, all while delivering seamless, full-density data where the industry had come to accept gaps or half-density transitions as a fact of life. Finally, with the Eclipse, we are creating a new level of simplicity by providing autonomous sensor operation. So our strategy is to enable our clients to keep doing more for less.

How would you describe the geomatics market these days?

Geomatics is in the middle of a radical transition. The demand for geospatial data is at an all-time high and will continue to grow. The large tech companies are making an ever-wider array of geospatial data widely available, generally for free. This drives new applications and new demand, creating growth in the entire industry. But this democratisation also drives prices and margins down, forcing survey companies to be ever more efficient and productive or to differentiate themselves from the competition with custom/tailored offerings. As a result, an increasing number of topographic survey companies are evaluating expanding into bathymetry and inland water surveying. This trend is further supported by the increasingly severe climate fluctuations leading to rapid coastal erosion and frequent flooding. It is in response to this trend that we have developed the multispectral Titan Lidar, a sensor that enables airborne survey companies to expand their scope of business beyond topographic mapping and into seamless shallow-water bathymetry, land cover classification, forest inventory, etc. The same market forces are also driving disruptive emerging technologies and processes such as UAS, and are further impacting the expectations for geospatial data in terms of both cost and quality.

Which new or emerging markets do you foresee in the coming years?

At the macro level, we are already seeing Lidar moving rapidly into the general consumer space. Autonomous vehicles, video games and immersive virtual reality are driving the mapping of not only specific assets but of the whole indoor and outdoor world around us, and to a very high resolution and accuracy. Within the survey industry, we expect the move to offer bathymetry services to rapidly pick up as a result of climate change and the new Lidar capabilities that we are bringing to the market, such as riverine bathymetry. By the same token, we expect forest inventory and carbon mapping to finally move out of the academic world and into the realm of industry. Finally, we expect Lidar technology to be applied to increasingly dynamic and complex settings, generally as a high-accuracy complement to existing reality-capturing technologies.

www.teledyneoptech.com

5 Questions to...

Ron Bisio

Vice President of Trimble Geospatial

▲ *Ron Bisio*

Technology and societal needs are changing rapidly. How is your company adapting to those changes?

The need for data about the world's natural and built environment is nearly universal. Trimble is heavily involved in the effort to capture, manage and use this data. Many of our solutions focus on the immense volumes of data that need to be captured and put into rich geospatial context. This work relies on the ability to manage mass data and use it to develop actionable information. From there, information must be easily accessible to a host of users and applications. In many instances, the method in which information will be utilised determines the technologies and processes best suited to collect it. Today, Trimble's core technologies extend far beyond our roots in positioning. In addition to capturing a wide array of traditional geospatial data (positions, attributes and georeferenced imagery), our technological leadership in software, communications and information management provides solid foundations on which solutions can be constructed. To most effectively leverage these core skills, Trimble has developed comprehensive knowledge of the workflows and decision processes used in our targeted applications segments. We draw from this knowledge and then work backwards, selecting and blending appropriate technologies to produce integrated solutions that are optimised for the work at hand.

On which applications is your company focusing its research and development activities?

New products and services are essential to success, and Trimble works hard to produce technological advances. Historically, the company spends approximately 13 percent of its annual revenue on research and development. We have a portfolio of approximately 1,100 patents and operate R&D centres on four continents. Our R&D work focuses on developing new products and technologies as well as refining and improving existing solutions. Trimble's core research and technologies are shared across the company's multiple divisions, where we leverage domain knowledge to create solutions for targeted applications markets. This method provides strong return on R&D investments and the ability to blend multiple technologies to efficiently create optimised solutions. Trimble's approach reflects the diversification in our customers' practices. For example, Trimble has defined vertical segments in markets such as forestry, utilities, rail and more. This structure enables us to maintain expertise in a segment's business workflows and best practices, which we combine with core technologies to produce industry-specific products and services.

What is your company's growth strategy?

Trimble focuses on applications and markets that can benefit from geospatial and related technologies. We work to identify industry trends and then address them through innovation and technology. We believe that many markets have not realised the value of increased utilization of geospatial technologies. Much of our growth emerges from deep understanding of our markets and customers. Trimble development teams blend software and hardware to create solutions tailored to specific processes and work environments. This approach enables us to expand into new geographic and applications markets while meeting local and regional needs.
Trimble has invested time and resources to increase our focus on software and services. In addition to providing applications software for a broad cross section of users, Trimble has adopted an approach of open application programming interface (API). This philosophy enables customers and vendors to incorporate Trimble technologies into specialised solutions, which leads to increased adoption of our software products. Our users propel and guide our growth. Trimble customers in traditional geospatial applications – surveying, GIS, construction and related disciplines – are diversifying. For example, a surveying company may find that it can expand its business by adding 3D scanning to its list of services. By creating solutions that enable customers to grow by leveraging their existing skills and client base, Trimble supports the long-term health and growth of the geospatial arena.

How would you describe the geomatics market these days?

The geospatial industry is broadly focused on capturing, processing and analysing geospatial information. Geospatial technology is becoming a component of other industries' business infrastructure. The pace of change – both within the geospatial industry and in the industries it serves – is accelerating. The change is occurring in two ways. First, the utilisation of geospatial information is growing. Businesses, government agencies and individuals are incorporating positioning into daily routines. From personal navigation and location-based services to managing fleets of delivery trucks, the use of geospatial information is becoming increasingly commonplace. Second, changes to geospatial technologies are enabling more users to capture and apply geospatial data. For example, advances such as unmanned aircraft systems (UAS), imaging analysis and instant communications have transformed work in data acquisition and information management. As a result, information can be acquired more rapidly and at lower cost. It can then be quickly processed and delivered to downstream users. By embracing these trends, geospatial professionals can play a larger – and more valuable – role in their clients' success.

Which new or emerging markets do you foresee in the coming years?

In developing markets there is an important need for effectively establishing procedures and approaches to land administration. From there, work can evolve to build infrastructure, agriculture and economic development. As the markets develop, geospatial systems can transition from basic land management towards productivity-oriented solutions. These places potentially can experience a technological leapfrog. Rather than migrating from tape and transits to total stations,

markets can jump directly to GNSS, UAS and mobile mapping. In developed nations, applications such as infrastructure, agriculture and asset management offer important opportunities for geospatial information. Geospatial information is increasingly tied to back-office operations, transforming the way people work to optimise the utilisation of resources, reduce emissions and fuel consumption, and improve customer service. Many municipalities are incorporating geospatial information to provide effective links between citizens and city assets and services. This trend, which encompasses and expands on GIS, enhances its citizens' well-being as well as the city's overall efficiency and performance. As cities evolve to meet growing demands on services due to globalisation, urbanisation and climate change, they will turn to information technologies and geospatial information to more efficiently evaluate existing and future conditions to improve levels of service. The role of the geospatial professional is evolving as well. Rather than simply providing data, geospatial professionals will work with clients to understand how and where geospatial information can improve an organisation's processes and efficiency. More and more, we are seeing businesses and governments calling on geospatial professionals, either as consultants or as in-house staff, to serve as trusted advisors to capture, analyse, model and visualise spatial information.

www.trimble.com

5 Questions to...

Chao Ma

General Manager, SOUTH Surveying & Mapping Instrument

Technology and societal needs are changing rapidly. How is your company adapting to those changes?

Despite 26 years of development and several successes in this area, SOUTH is still not satisfied with the results so far. We have reinvented our approach to management, innovation, commercial operations and other commercial aspects. Firstly, with the rapid developments in recent years, the network and scale has made SOUTH one of the highest-ranking companies of its kind in the world. During this period of rapid development, SOUTH made a number of major adjustments including the change of management from top-down to bottom-up and reviewing HR, financial and material management. Meanwhile, in order to address the market requirements for new technology, we have adjusted the whole business system and also reinforced our strategic direction to achieve a number of breakthroughs. Furthermore, to meet the demand for development into a larger enterprise, we achieved great improvements in our manufacturing base. In addition to SOUTH's five existing production facilities, we also built a 40,000-square-metre modern equipment centre in Beijing, over 30,000 square metres at BeiDou Industrial Park in Shanghai, and a 36,000-square-metre Geographic Information Building in Guangzhou. This extra support is essential and represents a new industrial phase for SOUTH which will support our future growth.

On which applications is your company focusing its research and development activities?

Our R&D activities have several areas of focus. One priority is our series of automatic high-precision total stations and high-precision total stations specifically designed for different applications in the field. Another focus is the BeiDou high-precision main board and intelligent application terminals, as well as the foundation enhancement system and software system. We are exploring a diverse range of applications for BeiDou such as precision agriculture, drive testing, vehicle scheduling, health monitoring and other fields, and we are continually striving for a wider application scope. Last but not least, we are focusing on low-altitude photogrammetry and mobile 3D laser measurement.

What is your company's growth strategy?

We are currently focusing on three main directions: 1, to manufacture Chinese surveying and mapping equipment for the high-end segment of the global market; 2, to promote the application of BeiDou high-precision navigation and positioning system; and 3, to promote the highly efficient operation of geographic information data and application software systems. South is dedicated to marching forwards to become a world-class supplier of measuring instruments for the geographic information industry.

▲ *Chao Ma*

How would you describe the geomatics market these days?

At present, there is a very large need for surveying and mapping equipment but there is still potential to improve in high-end manufacturing. The application has not yet reached sufficient maturity in the downstream industry chain. We believe that in the future there will be more financial and policy support pouring into the market. At the same time, we expect to see the emergence of more big and robust enterprises in each link of the industrial chain.

Which new or emerging markets do you foresee in the coming years?

The field of surveying and mapping equipment, BeiDou high-precision applications, UAV low-altitude photogrammetry and 3D laser measurement are all very hot topics right now which offer tremendous potential for development. ◀

www.southinstrument.com

5 Questions to...

Chryssy Potsiou

Dr Chryssy Potsiou is the current president of the Intertational Federation of Surveyors (FIG), serving a four-year term of office from 1 January 2015 to 31 December 2018.

Please describe your organisation in a few sentences

The International Federation of Surveyors (FIG) is the premier international organisation representing the interests of surveyors worldwide. It is a federation of the national member associations and covers the whole range of professional fields within the global surveying community. It provides an international forum for discussion and development aiming to promote professional practice and standards. FIG was founded in 1878 in Paris and was known as the Fédération Internationale des Géomètres, which became anglicised to the International Federation of Surveyors. It is a UN-recognised non-government organisation (NGO) representing more than 120 countries throughout the world, and its aim is to ensure that the disciplines of surveying and all who practise them meet the needs of the markets and communities that they serve.

Who are the members of your organisation?

FIG draws its membership from practitioners working in communities with both the public and private sectors, from the scientific, research and academic community as well as from the spatial technologies and services community. FIG functions with the goodwill, resources and contribution of its memberships and their corps of volunteers from around the world.

The FIG membership base consists of:

- member associations – national associations representing one or more of the disciplines of surveying
- affiliates – groups of surveyors or surveying organisations undertaking professional activities but not fulfilling the criteria for member associations
- corporate members – organisations, institutions or agencies which provide commercial services related to the profession of surveyor
- academic members – organisations, institutions or agencies, which promote education or research in one or more of the disciplines of surveying. An individual may be appointed as a correspondent in a country where no association or group of surveyors exist that is eligible to join FIG as a member.

What role does your organisation play in the geomatics industry?

It is within the surveyors' task to determine the size and shape of the Earth, to map its surface and to manage it in a sustainable way. FIG is globally recognised as the leading international professional NGO on geospatial information collection, processing, management and dissemination, as well as the management of land, the sea and the built environment. FIG supports the role of a prosperous and sustainable profession of surveyors to provide functional geospatial solutions, reliably and affordably for the good governance of a complex and rapidly changing world that cannot wait, and to translate a sustainable development agenda into action. FIG supports international collaboration among its members for the progress of surveying in all its fields and applications and has a close cooperation with the relevant United Nations bodies, the World Bank and its sister associations who may produce and/or use geospatial information.

How is capacity building strengthening your strategy in order to achieve your goals?

In the globalisation era, a globalization of science is taking place in the field of geospatial information supply and usage. FIG provides the forum by organising workshops and conferences and through the work of the FIG Commissions, Task Forces, Networks and the FIG Foundation, where surveyors share experience and continuously upgrade their capacity to meet the global challenges. FIG supports all its members to develop better education and high-level technical skills, not only to provide the world with a reliable and affordable supply of good-quality geospatial information, but also to be capable of assessing the quality of information derived from various sources and defining the best solutions. FIG prepares 'global surveyors' who

▲ *Chryssy Potsiou*

are able to undertake a leading role within a multi-disciplined cooperation scheme to develop fit-for-purpose solutions in support of the global Sustainable Development Agenda. FIG systematically provides additional support in continuing professional development (CPD) and research in the areas most in need.

Do you foresee any developments that will significantly change the geomatics sector?

Today, mobile devices are accessible to more people, the cost of high-resolution satellite imagery is falling and there is a renewed awareness of the importance of authoritative spatial data at all levels of government. There is a fast-growing civil demand and a changing culture for authoritative spatial information published on the web – a culture that changes the administrative concept. The use of data derived from various providers may be supportive in satisfying such great demand, but there is a need for increasing capacity development in assessing the value of data derived through crowdsourcing. Authoritative data can be provided and assured by government agencies but also by crowdsourcing and the engagement of surveyors. Technology is addressing many past challenges of system cost, intermittent internet connectivity and distributed service centres. Spatial platforms, security cloud mapping and app technologies can be used for collecting AAA information from crowdsourced models.

www.fig.net

5 Questions to...

David Coleman

▲ *David Coleman*

Dr David Coleman is president of the Global Spatial Data Infrastructure Association (GSDI). The purpose of the GSDI is to promote international cooperation and collaboration in support of local, national and international Spatial Data Infrastructure research, education, capacity building and implementation challenges, issues and good practice from around the globe that will allow nations to better address social, economic, and environmental issues of pressing importance.

Please describe your organisation in a few sentences

Springing from the GSDI Conferences that began in 1996, members of the Global Spatial Data Infrastructure Association (GSDI) share a vision of a world where everyone can readily discover, access and apply geographic information to improve their daily lives. GSDI's purpose is to encourage international cooperation that stimulates the implementation and development of national, regional and local spatial data infrastructures. We do that by advancing – through conferences, workshops, projects and capacity-building initiatives worldwide – geoinformation best practices, knowledge sharing and capacity building for the improved sharing and application of geographic information.

Who are the members of your organisation?

Our members include leading representatives from national and regional government agencies, commercial technology and services firms, academic and research institutions and NGOs. We are also proud to offer full membership privileges to interested individuals from around the world.

What role does your organisation play in the geomatics industry?

It's a symbiotic relationship for which we are very grateful. The GSDI Association provides its industrial members with real and virtual venues in which they can interact with their peers in government and academia. In return, our industry members provide us with a perspective, with the energy and with an often potent international network of human resources to support and help us conduct our capacity-building activities.

How is capacity building strengthening your strategy in order to achieve your goals?

Capacity building is crucial to our mandate and evident in our conferences, workshops and presentations every year. Thanks to generous support from our members and partners – in particular the US FGDC, the GISCorps and, most recently, Natural Resources Canada – we have been delighted to continue our GSDI Small Grants projects. For over a decade, these impressive SDI-related projects in emerging nations have ranged from provision of consulting services for SDI planning and implementation through to geoportal pilot projects and on into SDI applications development and assessment. Our Small Grants recipients are amazing people who make relatively small contributions go a very long way. Brief descriptions of their projects can be found at http://gsdiassociation.org/index.php/projects/small-grants.html.

Do you foresee any developments that will significantly change the geomatics sector?

Standards-based, location-enabled services, appliances, wearables and even vehicles have transformed the way we work and play, and have certainly heightened user expectations with respect to data availability and quality. In terms of 'authoritative' data collection, we have seen the transition from in-house production… through outsourcing and then off-shoring… and on to the crowdsourced solutions we see today. Institutions do not move as quickly as technologies or markets, but we are seeing a change in the types of background, skills, capabilities and experience demanded by technology and service organisations across the geospatial community. New users and employees from different backgrounds bring new perspectives and viewpoints which are already changing the nature of our products, practices and even institutional cultures. That change will continue to accelerate.

www.gsdi.org

GSDI Global Spatial Data Infrastructure Association

5 Questions to...

Menno-Jan Kraak

ICA ACI

Prof Menno-Jan Kraak is president of the International Cartographic Association (ICA).

Please describe your organisation in a few sentences

The International Cartographic Association (ICA) is the world authoritative body for cartography. Its objective is to promote the discipline and profession of cartography internationally.

Who are the members of your organisation?

Our membership base consists of national members and affiliate members. The first category comprises national cartographic or geographical information organisations, national mapping and cadastral institutions or coordinating national cartographic committees who represent their nation. The second category is made up of organisations, institutions or companies wishing to support

the mission and activities of the International Cartographic Association.

What role does your organisation play in the geomatics industry?
ICA has industry partners as affiliate members and offers a platform for cartography knowledge exchange via its activities such as conferences and workshops.

How is capacity building strengthening your strategy in order to achieve your goals?
We consider capacity building to be a key element of ICA's activities. This is realised via outreach programme and dedicated workshops organised by our Commissions with their specific expertise.

Do you foresee any developments that will significantly change the geomatics sector?
The core role of the geomatics discipline, i.e. supporting decision-making related to global and regional problems using geospatial information, will not change. However, the way it is done will be influenced by developments in information technology and rapid growth in the importance of crowdsourcing.

www.icaci.org

▲ *Menno-Jan Kraak*

5 Questions to...

Harald Schuh

Prof Dr Harald Schuh is president of the International Association of Geodesy (IAG), a scientific organisation in the field of geodesy. The IAG promotes scientific cooperation and research in geodesy on a global scale and contributes to it through its various research bodies.

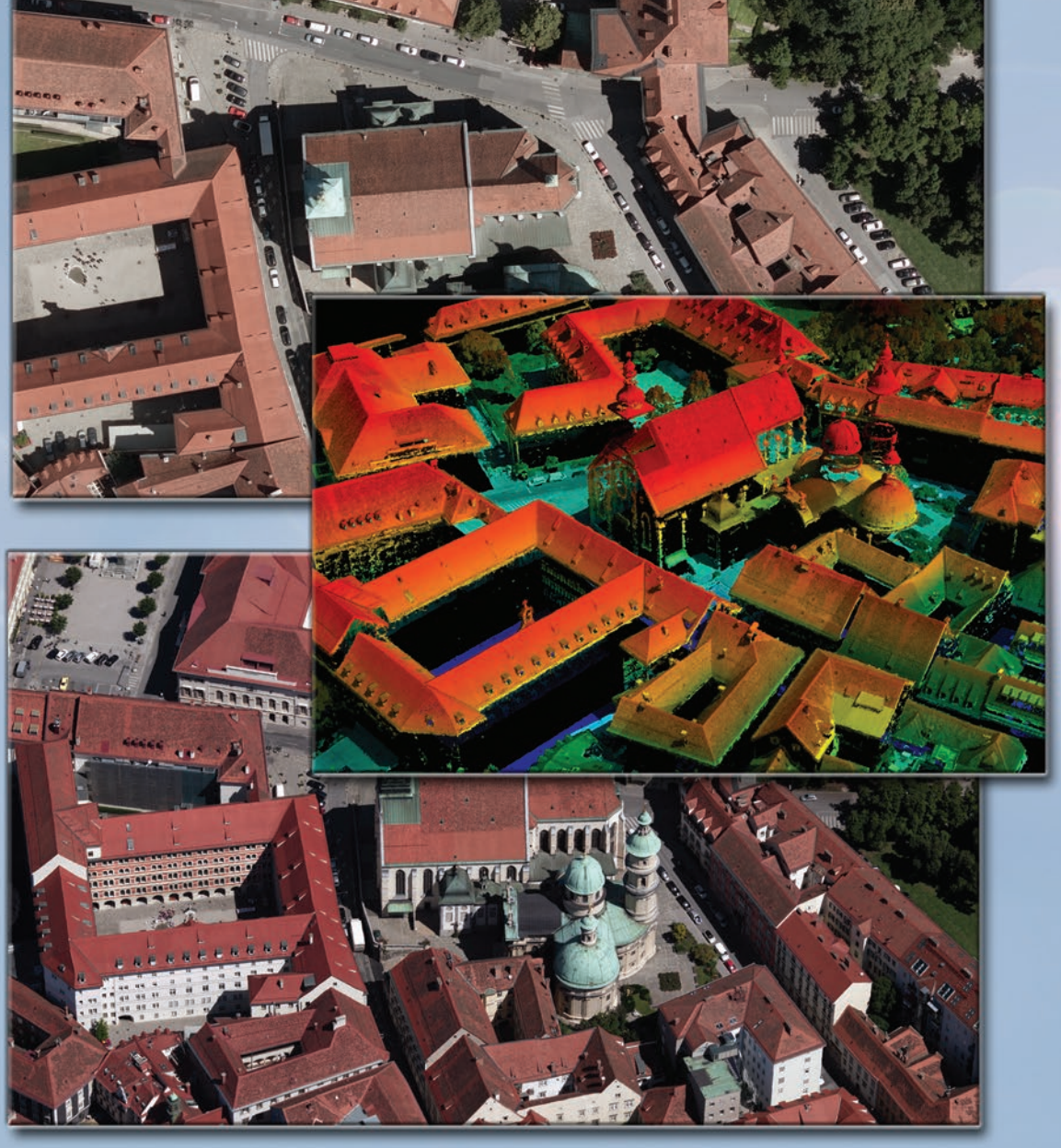
Please describe your organisation in a few sentences
The International Association of Geodesy (IAG) is a scientific organisation that promotes scientific cooperation and research in geodesy on a global scale and contributes to it through its various Commissions and services. One of our most important permanent activities is to monitor the coordinates of points on the solid and fluid Earth surface through a global system of satellite tracking stations, using a variety of space geodesy techniques, within a stable reference frame. This helps to detect, for example, deformations of the solid Earth, changes of the sea level, and variations in the Earth's rotation. IAG was created in 1864 under the name of Europäische Gradmessung. In 1886 it became the Association Géodésique Internationale. At the 1st General Assembly of the International Union of Geodesy and Geophysics (IUGG) in Rome in 1922, IAG became one of five constituent sections of IUGG. Today, IAG is one of eight Associations under the IUGG umbrella.

Who are the members of your organisation?
IAG offers national and individual membership. Each paid-up IUGG Member Country which is represented by an Adhering Body (typically a principal scientific academy or its national research council) is an IAG National Member and entitled to appoint a national IAG Council delegate. The IAG Council consists of approximately 40-50 members and is responsible for the governance, strategic policy and direction of the IAG. In addition, IAG has approximately 200 Individual Members who, in return for an annual membership fee, receive a reduction in registration for each IAG symposium attended and a discount on subscription to the *Journal of Geodesy*. Student membership is free of charge. Individual members do not have voting rights but they can propose candidates for IAG office-bearer positions.

What role does your organisation play in the geomatics industry?
Traditionally, geodesy has been responsible for two primary functions: (i) contributing to Earth science research through its studies of the geometry of the Earth's surface, Earth rotation and Earth gravity field, and (ii) providing the datum that underpins all geospatial (i.e. mapping) data. It is the latter, through the maintenance of the International Terrestrial Reference Frame (ITRF), for which IAG is best known in the geomatics industry. The ITRF is nowadays the accepted reference frame to which national and regional geodetic datums are aligned. However, IAG also contributes to the geomatics industry in several new ways, as a result of the revolution in precise positioning that global navigation satellite systems (GNSS) such as GPS and other satellite systems have brought about. Precise GNSS positioning techniques are being improved and high-quality services are being offered; IAG, through its Commissions and services, is contributing to these advances.

▲ *Harald Schuh*

We have you covered



from all angles.

Need a large format camera system for low-altitude, corridor missions? High-altitude ortho collections? Something in between?

Need to be able to collect oblique imagery? How about oblique and nadir imagery in panchromatic, color and near-infrared all in the same pass?

Need a software system that will allow you to take that aerial imagery and create point clouds in LAS format, digital surface models, and orthomosaics? **No problem.**

The UltraCam series of large format photogrammetric digital aerial sensors includes systems of varying image footprints and focal lengths. Whether you need multi-spectral nadir imagery or obliques—or both from the same camera—we have a system for you.

Meanwhile, our highly automated UltraMap photogrammetric workflow software enables you to process UltraCam data to Level 3, radiometrically corrected and color-balanced imagery, high-density point clouds, DSMs, DSMorthos and DTMorthos.

We've got you covered.

iFlyUltraCam.com ULTRACAM Microsoft

How is capacity building strengthening your strategy in order to achieve your goals?
The major goal of IAG is to promote scientific cooperation and research in geodesy on a global scale. Our strategy for the implementation of this goal is: (i) to foster knowledge exchange through science events, publications and other means of communication, and (ii) to foster the development of geodetic activities and infrastructure in all regions of the world, taking into consideration the specific situation of developing countries. IAG organises science educational events worldwide. IAG has established an IAG Fund which is used to support young scientists from developing countries to attend IAG-sponsored meetings. Together with Springer, IAG publishes the monthly *International Journal of Geodesy*, a major peer-reviewed journal publishing research in geodesy, as well as the Geodesist's Handbook with information about IAG itself, conference proceedings, etc. IAG plans to further support scientific initiatives in developing countries, to centralise information and educational material online, to strengthen its cooperation with universities (including giving internet-based courses) and to assist with the establishment of a geodetic reference system for Africa.

Do you foresee any developments that will significantly change the geomatics sector?
GNSS will continue to be a critical positioning, navigation and timing (PNT) technology used by all sectors of society. The geomatics industry will continue to benefit from advances in precise GNSS positioning technology, primarily being driven by the deployment of new GNSS constellations from Europe (Galileo) and China (BeiDou). A new form of 'geodetic mapping' or 'geodetic imaging' is emerging and includes various Lidar, vision and radar systems deployed on satellite, airborne and terrestrial platforms. These systems can determine the 3D (or even the 4D) coordinates of dense networks of points on the solid Earth, ice and ocean surfaces to a very high fidelity within a geodetic reference frame.

www.iag-aig.org

5 Questions to...

Chen Jun

Chen Jun is president of the International Society for Photogrammetry and Remote Sensing (ISPRS). The ISPRS is a non-governmental organisation devoted to the development of international cooperation for the advancement of photogrammetry and remote sensing and their applications.

Please describe your organisation in a few sentences
ISPRS (the International Society for Photogrammetry and Remote Sensing) is an internationally leading society devoted to promoting the extraction and utilisation of information from imagery. We do so by encouraging and facilitating research and development in our areas of scientific activity, advancing knowledge through scientific networking, stimulating international cooperation, pursuing interdisciplinary integration, facilitating education and training, enhancing and exploring new applications, and developing public recognition of photogrammetry, remote sensing and spatial information science.

Who are the members of your organisation?
We are a global society of societies with five types of members: ordinary members, associate members, regional members, sustaining members and individual members. Our ordinary members are scientific and/or technical organisations representing geographic areas, such as national scientific societies, national mapping agencies, national remote sensing centres, etc. Regional members are multinational associations of photogrammetry, remote sensing and/or spatial information science organisations, such as the Asian Association on Remote Sensing (AARS), the African Association of Remote Sensing of the Environment (AARSE) or EuroSDR.

What role does your organisation play in the geomatics industry?
Unlike many other learned societies, the ISPRS has a three-pronged constituency: science, technology and operational applications. We not only represent the scientific voices of academia and marry academia with user communities as many other learned societies do, but we also liaise with and support the geomatics industry. For example, we organise a large technical exhibition during the ISPRS Congress every four years and we co-organise many commercially oriented conferences, plus we promote interaction between academia, user communities and industry. Recently, we have been working to establish an International Industrial Advisory Committee to encourage more geospatial companies and industrial players to join and benefit from ISPRS.

▲ *Chen Jun*

How is capacity building strengthening your strategy in order to achieve your goals?
ISPRS has a long tradition of promoting the use of imagery to other professions, attracting young scientists and practitioners, engaging a new generation of researchers and users, educating our partners about our strengths, and developing innovative international

partnerships between researchers and operational agencies. ISPRS Summer Schools, student consortiums, young authors' sessions and paper awards are examples of our education and outreach efforts. The ISPRS Commission on Education and Outreach plays a central role in this regard and deals with education, training, capacity building and outreach in all areas related to ISPRS. It is also the home commission for the ISPRS Student Consortium.

Do you foresee any developments that will significantly change the geomatics sector?

The application of imagery is now ubiquitous, playing an important role in many aspects of life and work today. We are now facing significant scientific challenges, with some sub-disciplines evolving gradually and some moving at a very fast pace. The major trends can be summarised as follows: 1) the model of integrated sensors has replaced the traditional model of a single imaging sensor; 2) satellite constellations comprising multiple satellites will provide high-resolution imagery of every corner of the globe in near real time, once or multiple times per day. It will thus become possible to monitor dynamic processes on the Earth surface; 3) the integration of image matching, tracking and object extraction is replacing the traditional model of independent processing of individual objects; 4) the modelling and understanding of real-world and online communities and their interaction are becoming crucial for the emerging convergent cyber-physical world (CPW); 5) the key concerns about geospatial service have shifted from information provision to geospatial knowledge delivery, from chance mapping to dynamic monitoring and the prediction of future trends, and from traditional desktop solutions to cloud platforms using web services; 6) the dividing line between close-range and aerial photogrammetry has become increasingly blurred; 7) remote sensing and spatial information science are more closely integrated in many operational systems, and more domain-specific knowledge and principles will be incorporated into traditional geometry-dominant geospatial data processing and analysis. In order to address these challenges, ISPRS has prepared a collective scientific vision and research agenda in the run-up to the 2016 Prague Congress. It has recently been published online in the *International Journal of Photogrammetry and Remote Sensing* as an original article with the title 'Information from imagery: ISPRS scientific vision and research agenda'. The paper is accessible now as a free-to-access, in-press article at: bit.ly/1OhXspO. ◀

www.isprs.org

CHC Navigation

CHC Navigation designs, manufactures and markets a wide range of competitive and reliable GNSS receivers and provides complete positioning solutions for surveying, construction, GIS and marine applications in more than 80 countries. CHC is today one of the fastest growing manufacturers and providers of GNSS products and solutions, developing a significant international presence and employing more than 800 professionals worldwide. CHC has already provided thousands of advanced GNSS receivers worldwide, combining high performance and features all at an extremely affordable price.

Quality issues are at the forefront of CHC's philosophy. CHC received ISO 9001 certification from the International Standards Organization applying to all aspects of CHC's development and manufacturing work, from initial design through to delivery of final products to customers.

CHC's GNSS receivers are widely used in all regions, from the Americas to Europe, the Middle East, Africa and Asia-Pacific. CHC's international partner network brings dedicated and professional support to end users regardless of where they are located in the world.

As the smallest receiver on the market incorporating dual hot-swappable batteries, the i80 GNSS receiver represents a future-proof sub-centimetre RTK solution, tracking all five constellations and packing a full array of sensors into an ergonomic package. Without the need of a data collector, the i80's LCD GUI allows for common workflow operations.

CHC Navigation, 599 Gaojing Road, Building C, Shanghai, 201702, China, phone: +86 21 5426 0273, sales@chcnav.com, www.chcnav.com

ComNav

Located in Shanghai, China, ComNav Technology Ltd. develops and manufactures multi-constellation, multi-frequency GNSS measurement engine boards and receivers for ultimate high-precision positioning applications. It is the very first Chinese company to develop, design and produce combined GNSS boards. With its fast-paced business growth, ComNav is making waves in the global high-precision GNSS industry. ComNav believes that the quality, performance and reliability will make the difference, and always gives priority to quality rather than merely price. ComNav strictly manufactures every piece of board/receiver based on the ISO standard, using a total of two testing processes to certify product quality. For the international market, ComNav applies a complete testing cycle after the initial QC to assure overseas customers that ComNav is very serious about delivering excellence.

As an R&D-driven company, more than half of the 200 employees have extensive experience in high-precision GNSS or engineering. In addition, ComNav invests at least 10% of its annual revenue into R&D every year. ComNav keeps focusing on the GNSS core technology with ever-changing GNSS OEM board-integrated abilities (sensors, 4G, Bluetooth, Wi-Fi, embedded applications, etc.), new satellite systems, new processing schemes and other advanced positioning technologies.

On 10 October 2015, ComNav Technology became the first domestic company dedicated to developing core technology and manufacturing OEM boards to be listed on the National Equities Exchange and Quotations (NEEQ). This milestone breakthrough was closely followed by the company's move to the ComNav GNSS Industrial Park.

ComNav Technology, Building 2, 618 Chengliu Middle Road, 201801 Shanghai, China, phone: +86 21 64056796, sales@comnavtech.com, www.comnavtech.com

Delair-Tech

Delair-Tech designs, manufactures and markets solutions for aerial observation in industrial and agricultural sectors using unmanned aerial systems (UASs). The company offers a range of observation systems for customers looking for long-endurance, robust, autonomous and safe products. Delair-Tech also offers training and maintenance contracts for its systems. The company was founded by four multidisciplinary engineers from the oil and aerospace industries. Their expertise in production, safety and industrial processes guarantees that Delair-Tech products are of high quality. The company employs more than 50 people and has customers in more than 20 countries.

Delair-Tech manufactures two major products: the DT18 and the DT26X. The DT18 is perfect for linear infrastructure monitoring, precision agriculture and GIS applications. It is the first small, civilian UAS to be approved for beyond-line-of-sight operations by an official rule-making body (the French DGAC). Its telecom abilities include video transmission, 20km command control transmission and a 3G/4G data link. Full autonomous flight is enabled by the Delair-Tech autopilot system. The DT26X is designed for extended-time operations such as linear infrastructure monitoring, surveillance and reconnaissance and GIS. It boasts a flight time of 2.5 hours and an enhanced payload capacity of 4kg. It comes equipped with full autonomous flight capabilities courtesy of the Delair-Tech autopilot system and features a vision-based navigation module.

Delair-Tech, 395 Route de Saint-Simon, 31100 Toulouse, France, phone: +33 5 82 95 44 06, contact@delair-tech.com, www.delair-tech.com

Geo-allen

Geo-allen Co. Ltd. was founded in 2002 in Suzhou, Jiangsu Province, approximately 80km from Shanghai, China. Suzhou is a beautiful city, nicknamed 'Heaven on Earth', with more than 2,500 years of history. After more than 13 years of continuous expansion, Geo-allen now has an R&D team, a trading department, manufacturing workshops and an after-sales-service team. Thanks to the DNV's ISO9001 certificate and the company's 13 years of experience, Geo-allen is gaining more and more recognition in this field.
Geo-allen's market almost covers the entire world, including Western and Eastern Europe, North and South America, Asia, Africa and Oceania. By strictly adhering to its policies of best service, best quality, best prices and punctuality, Geo-allen has built up a high reputation among all its customers.

Geo-allen never stops expanding and developing. Its products now include UAVs, GNSS items, total stations, theodolites, auto levels, laser instruments and all kinds of accessories. Its R&D department has the capability to design and produce new products based on either customers' special inquiries or its own ideas in a very short period of time. Geo-allen is in the process of applying for patents for some of the products it has recently designed and others have already obtained approval. Based on the company goals of Punctuality, Quality, Rigour and Service (P/Q/R/S), Geo-allen has a vision of an even more beautiful future. Geo-allen is looking forward to a bright new year in 2016 with all its customers and partners around the world.

Geo-allen, Room 1806, Building no. 1 Runje Mansion, 9 Dengwei R oad, New District, Suzhou, 215011 China, phone: +86 521 68026320, geoallen@vip.163.com, www.geoallen.com

ITC, University of Twente

Are you looking for a university offering you the perfect programme and environment for a master's degree in Geo-Information Science and Earth Observation? The Faculty of Geo-Information Science and Earth Observation (ITC) at the University of Twente (UT) in The Netherlands provides international postgraduate education, research and project services in the field of geoinformation science and Earth observation using remote sensing and geographic information systems. ITC is recognised worldwide for its achievements in teaching, research and capacity development. It concentrates on Earth observation, generating spatial information, and developing data integration methods. It also provides tools designed to support planning and decision-making processes aiming at sustainable development and poverty alleviation in developing countries and emerging economies. The key words characterising ITC's activities are: geoinformation management, worldwide and innovative.
As a master's student at ITC, you will be uniquely equipped to tackle one of mankind's greatest challenges: balancing the development of natural resources with the preservation of our Earth by providing geoinformation and geoinformation management tools. You will learn to take a multidisciplinary approach to problem solving, benefiting from the UT's pioneering position in an exciting new field of research: the interaction between new technologies and society. You will be encouraged and trained to break through existing academic boundaries. Study at ITC and become a savvy, internationally confident professional, capable of developing new knowledge and translating it into practical solutions for real-world problems. With capacity building and institutional development at the heart of its activities, ITC offers you the perfect environment for preparing yourself to go out and make a difference.

ITC
UNIVERSITY OF TWENTE.

ITC, University of Twente, Hengelosestraat 99, 7514 AE Enschede, The Netherlands, phone: +31 (0)53 487 44 44, info-itc@utwente.nl, www.itc.nl

Leica Geosystems

Revolutionising the world of measurement and survey for nearly 200 years, Leica Geosystems creates complete solutions for professionals across the planet. The company is known for its premium products and innovative solution development and professionals in a diverse mix of industries, including surveying & engineering, safety & security, building & construction and power & plant, trust Leica Geosystems to capture, analyse and present smart geospatial data. With the highest-quality 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

Leica Geosystems, Heinrich-Wild-Strasse, 9435 Heerbrugg, Switzerland, phone: +41 71 727 3131, www.leica-geosystems.com

Microsoft

Microsoft's UltraCam business group offers state-of-the-art photogrammetric products based on the latest and most-advanced technological developments. Its family of award-winning aerial and terrestrial sensor systems includes the UltraCam Hawk, UltraCam Falcon, and UltraCam Eagle digital photogrammetric sensors, the UltraCam Osprey nadir/oblique photogrammetric digital aerial sensor and the UltraCam Panther and UltraCam Mustang terrestrial sensors. UltraCam systems are complemented by the UltraMap photogrammetric workflow software.
In 2016, the Microsoft UltraCam team will continue its innovative software roadmap with several new releases of the single, most efficient aerial workflow package UltraMap for generating higher-value data products from aerial imagery. Supported by the world's first simultaneous nadir and oblique colour balancing and de-hazing engine, seamless radiometry will add even more value to data across multi-mission aerial projects. One of the key innovations will be a 3D city engine, capable of generating extremely dense, colourized point clouds as well as textured 3D meshes at unmet geometric quality. The offered features will be operated from the well-established, user-friendly UltraMap interfaces allowing easy software interaction for both non-experts and veterans of photogrammetry. They will robustly compute rich data products from aerial projects of any size in a fully autonomous and highly efficient manner through distributed processing on a scalable UltraMap Framework infrastructure.
Additionally, UltraCam systems are also highly compatible with third-party software systems, IMU/GPS/FMS products and camera mounts. Furthermore, Microsoft also offers its UltraMount-branded line of OEM GSM gyro-stabilised mounts.

Microsoft ULTRACAM

Microsoft UltraCam/Vexcel Imgaging, Anzengrubergasse 8, 8010 Graz, Austria, phone: +43 316 84 90 66-0, mpsinfo@microsoft.com, www.microsoft.com/ultracam

RIEGL

RIEGL Laser Measurement Systems specialises in the research, development and production of laser scanners and scanning systems. Complemented by innovative RIEGL software packages, RIEGL has created powerful solutions for a variety of applications in surveying.

In terrestrial scanning, RIEGL has set the benchmark again with the new VZ-400i, the fastest end-to-end terrestrial laser scanning system on the market. It is the evolution of RIEGL's well proven VZ-400 ultra-versatile 3D laser scanner, combining innovative new processing architecture, internet connectivity and a suite of MEMS sensors with RIEGL's latest laser scanning engine technology.

In mobile scanning, RIEGL provides application-specific solutions – from single high-performance scanner engines to the high-end VMX mobile mapping system. The RIEGL VMZ Hybrid Mobile Mapping System, with a fully integrated IMU/GNSS unit, supports VZ-line terrestrial scanners for kinematic data acquisition.

In airborne scanning, RIEGL offers a wide range of laser scanner engines and systems for different applications – from power line inspection to wide-area/high-altitude mapping. RIEGL's latest innovation in airborne mapping, the VP-1 Helipod equipped with the VUX-1LR Lidar sensor, is ideally suited for surveying missions from helicopters.

For unmanned scanning, RIEGL provides the VUX-1UAV survey-grade Lidar sensor, easily mountable to professional UAS, UAV, RPAS, etc., as well as the RiCOPTER, a high-performance X-8 array foldable octocopter, which is the first fully integrated Lidar system solution for professional UAS surveying missions from one manufacturer. With the new BathyCopter, RIEGL now additionally offers a small-UAV-based surveying system for hydrographic applications.

RIEGL

RIEGL Laser Measurement Systems, Riedenburgstrasse 48, 3580 Horn, Austria, phone: +43 2982 4211, office@riegl.co.at, www.riegl.com

SATEL

The globally operating high-tech Finnish company Satel specialises in the development, production and marketing of private mission-critical data-connectivity radios. Customers include various types of industrial operators and high-tech system providers that use extremely reliable radios in their solutions. A major part of Satel's business is connected through a global network of high-calibre value-added distributors. Key application areas for Satel radio technology include control of smart utility networks, GNSS support systems (e.g. in land surveying, precision farming and machine control) and intelligent traffic systems.

SATEL, Meriniitynkatu 17, P.O.Box 142, 24101 Salo, Finland, phone: +358 2 777 7800, info@satel.com, www.satel.com

Septentrio

Septentrio is a leading provider of GNSS solutions. Thanks to the company's combination of easy-to-use technology with robust hardware, users in the marine, mining, construction and surveying industries – along with many more – have put their trust in Septentrio to provide them with accurate and reliable GNSS positioning anywhere.

Working with customers on a wide variety of projects over many years has allowed Septentrio to develop a range of GNSS solutions adaptable to any project. Septentrio's renowned product lines – Altus, AsteRx and PolaRx – are noted for their flexibility and ease of use allowing fast and seamless integration into a user's existing workflows.

Septentrio's expert knowledge and wealth of experience in the GNSS industry has earned it the reputation of being an innovator in GNSS technology. The company's Advanced Interference Mitigation (AIM+) technology counteracts the worst effects of interference. AIM+ allows users to obtain accurate and reliable GNSS positioning even in times of extreme radio interference and elevated ionospheric activity.

One of Septentrio's latest innovations is PinPoint-GIS which turns GNSS data collected by a Septentrio receiver into actionable GIS data. At the touch of a button, feature parameters are available directly to users from any device. Furthermore, PinPoint-GIS's unique accuracy widget allows horizontal and vertical accuracy monitoring at a glance.

A dedicated team of 100 employees across three locations as well as a partner network located around the globe support thousands of satisfied customers to realise the full potential of their projects by maximising productivity, enhancing quality and reducing costs through advanced accurate and reliable GNSS solutions.

Septentrio, Greenhill Campus 15I, Interleuvenlaan, 3001 Leuven, Belgium, phone: +32 16 30 08 00, www.septentrio.com

SOUTH

Established in 1989 and headquartered in Guangzhou, China, South has developed into a professional manufacturer and supplier to the geographic information industry with fully integrated R&D, marketing and other services.

Building on its solid foundation of more than two decades of experience, with South Navigation, South high-speed railway and five affiliated factories in Beijing, Wuhan, Changzhou and Guangzhou, South has expanded its coverage to 30 provincial branches and over 110 municipal offices in China. At the same time, its footprint has spread to more than 120 countries all around the world, resulting in the establishment of a close-linked distribution network at international level.

For many years, South has been underpinned by a powerful sense of mission to further revitalise the national industry. By remaining creative and innovative, South has progressively made the distant meter, electronic theodolite, total station, GPS and CORS localisation a reality. It has accumulated numerous independent intellectual property achievements and ranks itself number 4 in the global surveying manufacturing industry.

Committed to promoting the development of China's surveying and geographic information industry, South continues to strive to become a world-class surveying instrument and geographic information industry supplier.

SOUTH, S2/F Surveying Building (He Tian Building), 26 Ke Yun Road,Guangzhou 510665, China, phone: +86 20 23380888, www.southinstrument.com

Teledyne Optech

With over 40 years of experience, Teledyne Optech is dedicated to providing the most advanced Lidar and camera 3D survey instruments. Teledyne Optech strives to empower mapping professionals worldwide with fast, accurate and cost-effective solutions for airborne mapping, airborne Lidar bathymetry, mobile mapping and static laser scanning. Now a full part of the Teledyne Technologies family, Teledyne Optech has access to the deep remote-sensing expertise of its sister companies.

Teledyne Optech's airborne Lidar systems provide complete sensing solutions through integration with the CS-Series of aerial cameras and an end-to-end LMS workflow that combines camera and Lidar processing. The breakthrough Optech Galaxy uses SwathTRAK technology to reduce survey costs in variable-elevation terrain, while the multispectral Optech Titan vastly improves target identification and enables simultaneous topo/bathy collection.

For surveying the crucial near-shore marine environment, the Optech CZMIL Nova airborne Lidar bathymeter maps deep, even in turbid waters, and fuses Lidar, RGB and hyperspectral data into unprecedented deliverables. The CZMIL is already in use by multiple government agencies, and now smaller academic and government groups can use it on a short-term basis via the CZMIL Project Programme.

As the most accurate, efficient and long-range mobile 3D mapping solution, the Optech Lynx family of mobile survey solutions leverages the same LMS workflow used to optimise airborne operations with productivity-enhancing automation and consistently accurate data.

The Optech ILRIS terrestrial laser scanner is a complete, portable 3D imaging and digitising solution with a comprehensive new workflow and integration options for UAV photogrammetry and sonar.

Teledyne Optech, 300 Interchange Way, Vaughan, Ontario, L4K 5Z8, Canada, phone: +1 905 660 0808, inquiries@teledyneoptech.com, www.teledyneoptech.com

Trimble

Founded in 1978, Trimble is headquartered in Sunnyvale, California, USA. Trimble's Geospatial Division provides solutions that facilitate high-quality, productive workflows and information exchange, driving value for a global and diverse customer base of surveyors, engineering and GIS service companies, governments, utilities and transportation authorities. Trimble's innovative technologies include integrated sensors, field applications, real-time communications, field-to-office processing and software for modelling and data analytics. Using Trimble solutions, organisations capture the most accurate spatial data and transform it into intelligence to deliver increased productivity and improved decision-making. As elements of everyday living continue to evolve and shift, so too does the decision-making process – as well as the technology used to guide decision-making. These technological changes require geospatial information to be not only specialised, but also readily available and cost-effective for a wide variety of applications. The people at Trimble understand that there will always be a need for both integration of technology to streamline the workflow and specialisation for particular applications pertaining to specific industries. Trimble places a great deal of emphasis on developing technology and solutions to seamlessly connect workflow processes with software applications. Whether to achieve more efficient use of natural resources or to extend the life of civil infrastructure, reliable information is at the core of Trimble's solutions to transform the way work is done.

Trimble, 10368 Westmoor Drive, Westminster, CO 80021, USA, phone: +1 720 887 6100, www.trimble.com/survey

Zoller+Fröhlich

Z+F, known for its innovations, has introduced a new, so-called 'blue' workflow in which all scans are registered automatically, right on the spot and right on site. After each scan, the data is quickly streamed to a tablet and it is automatically registered to any prior scan position. The user can also open the scan and inspect it live on site to make sure all details are covered in sufficiently high resolution. This workflow is realised with new hardware and software: the Z+F IMAGER 5010X and Z+F LaserControl Scout.

Current cloud-to-cloud registration algorithms require a rough initial alignment of two scans. The algorithm will then take this preliminary registration to refine it. To get a rough placement, Z+F has now integrated additional navigation sensors into the Z+F IMAGER 5010X scanner to estimate the user's current position. While carrying the scanner from one position to the next, the current track is recorded and a position estimate can be shown at any point. This solution works not only outdoors via GPS but also – as an industry first – indoors with internal sensors.

Users are able to identify issues on site, where they can still intervene, and make use of the time waiting for the next scan to finish or to resolve more important issues in the scanning workflow. As a result, users will become more productive and return with the peace of mind that they have everything they need.

Zoller+Fröhlich, Simoniusstrasse 22, 88239 Wangen im Allgäu, Germany, phone: +49 7522 9308-0, info@zofre.de, www.zf-laser.com

GEO BUSINESS 2016

GEO Business 2016, the geospatial event for everyone involved in the gathering, storing, processing and delivery of geospatial information, will be held from 24-25 May 2016 at the Business Design Centre, London, UK. Launched in 2014, the annual geospatial show has grown year on year and is now firmly established as the must-attend event in the industry.

THE TWO-DAY SHOW INCORPORATES:

- Cutting-edge conference presenting the latest developments from leading industry experts from across the globe, keeping delegates one step ahead in this fast-moving industry.
- International exhibition showcasing 200 of the world's leading suppliers of geospatial technology and service providers, all under one roof.
- Commercial workshops demonstrating the latest products and services first hand, offering visitors the unique opportunity to see them in action.
- Networking opportunities providing visitors with the opportunity to develop successful business relationships at the welcome drinks and gala dinner.

The event is organised in collaboration with the Association for Geographic Information (AGI), the Royal Institution of Chartered Surveyors (RICS), the Chartered Institution of Civil Engineering Surveyors (ICES), the Institution of Civil Engineers (ICE) and The Survey Association (TSA).

For further information visit www.GeoBusinessShow.com, email info@GeoBusinessShow.com or call +44(0)1453 836363. For the latest news follow @GEOBusinessShow #geobiz on Twitter or join the GEO Business LinkedIn group.

XXIII ISPRS CONGRESS

The International Society for Photogrammetry and Remote Sensing – a non-governmental organisation devoted to the development of international cooperation for the advancement of photogrammetry and remote sensing and their applications – will be holding the XXIII ISPRS Congress in Prague, Czech Republic, from 12-19 July 2016. The ISPRS Congress is the most important ISPRS meeting and is organised every four years. Each Congress is an assembly of several thousand scientists and professionals. ISPRS's role in promoting international cooperation for the advancement of photogrammetry, remote sensing and spatial information sciences has significantly expanded over the past years. ISPRS is associated with many organisations such as the United Nations (e.g. COPUOS, OOSA, UNESCO), UN-related organisations (e.g. ICSU) and others (e.g. JBGIS, GEO, CEOS, IAA, ISO and OGC).

THE CONGRESS IN BRIEF:

- ISPRS welcomes all papers presenting new results, achievements, methods and theory committed to helping to forward the present level of knowledge.
- All interested organisations are welcome to participate at the Congress as exhibitors. Profit from the opportunity to present your products and services to the leaders in the field.
- The programme structure is split into several session types: Technical Sessions, Theme Sessions, Special Sessions, Plenary Meetings, Exhibitor's Showcase Sessions and Commercial Sessions.
- Two main submission options are available: abstract and full paper.
- Each submitted abstract is reviewed and will be published in the ISPRS Archives.
- Each submitted full paper is double-blind reviewed and will be published in the ISPRS Annals.

For more information about deadlines and conditions, please visit www.isprs2016-prague.com.

JANUARY

SKYTECH 2016
London, UK
From 27-28 January
For more information:
W: www.skytechevent.com

FEBRUARY

TUS EXPO
The Hague, The Netherlands
From 2-4 February
For more information:
W: http://tusexpo.com

GIM INTERNATIONAL SUMMIT
Amsterdam, The Netherlands
From 10-12 February
For more information:
W: http://gimsummit.com

INTERNATIONAL LIDAR MAPPING FORUM
Denver, Colorado, USA
From 22-24 February
For more information:
W: www.lidarmap.org/international

MARCH

AUVSI'S UNMANNED SYSTEMS EUROPE
Brussels, Belgium
From 22-23 March
For more information:
W: www.auvsi.org/unmannedsystemseurope/home

AAG ANNUAL MEETING
San Francisco, California, USA
From 29 March - 2 April
For more information:
W: www.aag.org/cs/annualmeeting

APRIL

RSCY 2016
Cyprus
From 4-8 April
For more information:
W: www.cyprusremotesensing.com/rscy2016

SPAR INTERNATIONAL 2016
The Woodlands Houston, Texas, USA
From 11-14 April
For more information:
W: www.sparpointgroup.com/international/

ASPRS 2016 ANNUAL CONFERENCE
From 11-15 April
Fort worth, Texas, USA
For more information:
W: www.asprs.org/ASPRS-Conferences/blog.html

GIS-FORUM
Moscow, Russia
From 13-15 April
For more information:
W: www.gisforum.ru/en

GEOPROCESSING 2016
Venice, Italy
From 24-28 April
For more information:
W: www.iaria.org/conferences2016/GEOProcessing16.html

GISTAM 2016
Rome, Italy
From 26-27 April
For more information:
W: http://www.gistam.org/

MAY

FIG WORKING WEEK
Christchurch, New-Zealand
From 2-6 May
For more information:
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W: http://hxgnlive.com/anaheim

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From 15-16 June
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W: http://wgdc2016.3snews.net/en.html

ESRI UC 2016
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W: www.isprs2016-prague.com

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THE COMMERCIAL UAV SHOW ASIA
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For more information:
W: www.terrapinn.com/exhibition/commercial-uav-asia/index.stm

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W: www.interdrone.com

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W: www.geobia2016.com

2ND VIRTUAL GEOSCIENCE CONFERENCE
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From 22-23 September
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W: http://virtualoutcrop.com/vgc2016

INSPIRE CONFERENCE
Barcelona, Spain
From 26-30 September
For more information:
W: http://inspire.ec.europa.eu/events/conferences/inspire_2016

OCTOBER

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

COMMERCIAL UAV EXPO
Las Vegas, Nevada, USA
From 31 October - 2 November
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W: www.expouav.com

NOVEMBER

FORESTSAT 2016
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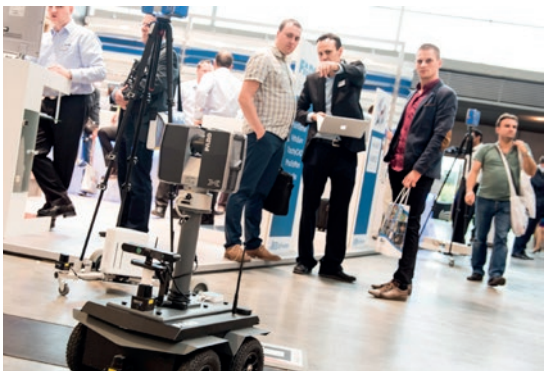
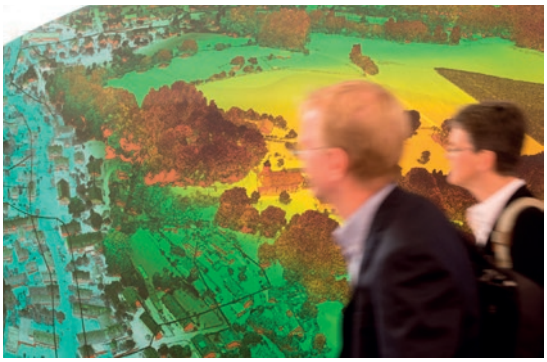
MUCH MORE THAN JUST PRODUCING MAPS

Trends in the Geomatics Market for 2016





Combined with advancements in the way spatial information is collected, processed and shared with the geospatial community, increased demand for geographic data has helped the geomatics sector become one of the fastest-growing technology markets. Geomatics technology and geographic data are changing very rapidly and now appear regularly in virtually every sector.

Back in 2006, Natural Resources Canada defined geomatics as the science and technology of gathering, analysing, interpreting, distributing and using geographic information. They said it incorporated a wide range of spatially related disciplines including geodesy, photogrammetry, remote sensing, satellite positioning, cartography and geographic information systems, all of which could be brought together to create a detailed, understandable picture of the human and physical world. Geomatics is also used across a variety of industrial sectors, focusing heavily within the physical resource, environmental and engineering domains. Over the years, that definition has often been simplified to 'geomatics deals with producing maps' to make it easier for the general public to understand.

Now, ten years later, it could be argued that Natural Resources Canada's definition still accurately describes the geomatics sector, except that geospatial data and geomatics technologies are now having a substantial impact far beyond traditional industrial sectors. During that time, there has also been significant change and improvement within location-based technology, allowing more people to appreciate the real value and power that spatial information really has in society.

Advancements in mobile devices along with improvements to the internet caused a surge of location-based services that have in turn helped the geomatics branch as the use of geospatial information continues to increase rapidly. More people in the geomatics sector have started to recognise this trend. As a result, they have begun to market products and services beyond the traditional geomatics sector and instead target a much larger geospatial community.

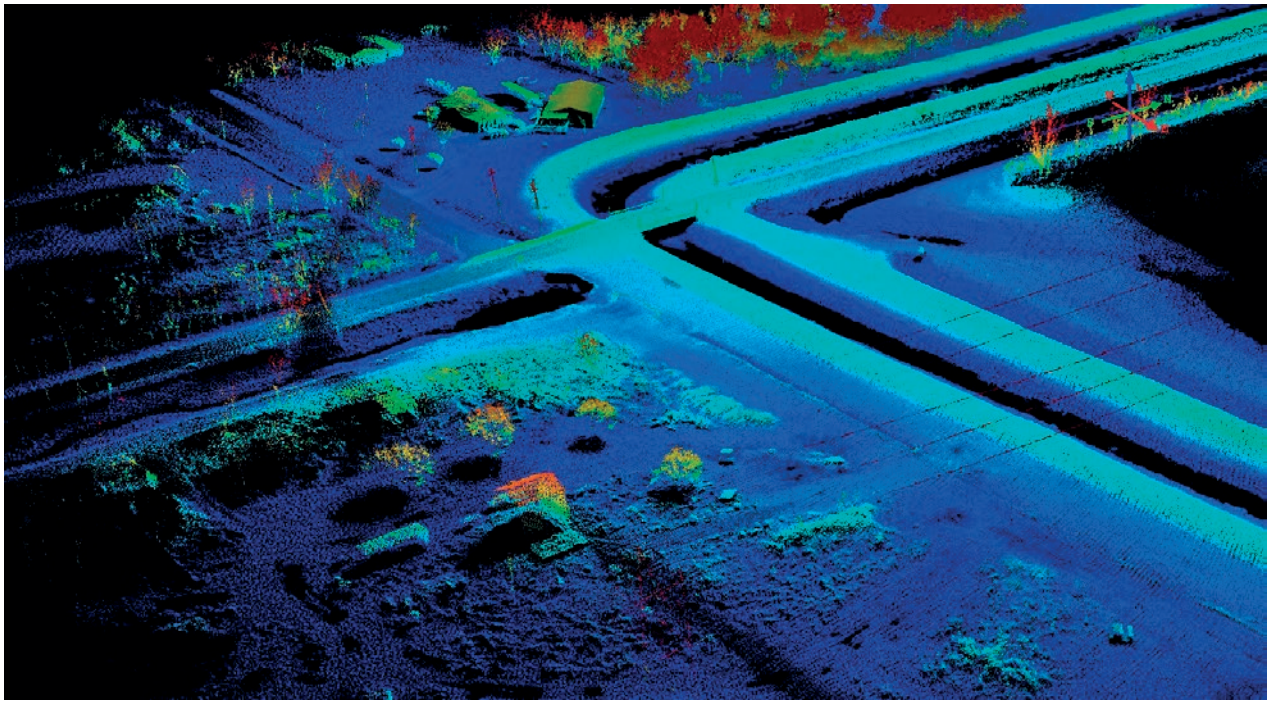
Here are some of the hottest geomatics trends (Figure 1) that will grow exponentially over the next year:

DEMAND FOR LIDAR DATA

An increased demand for detailed mapping from other sectors such as transportation, natural resources, power transmission, mining and construction has helped make Lidar one of the hottest market trends in geomatics over the past few years. Allied Market Research (a global market research and business consulting firm from Portland, Oregon, USA) published a report in 2015 claiming that the Lidar market will reach USD625 million by the year 2020.

Lidar has been used in the geomatics sector for more than a decade and has come a long way over the years. At first, it was used by just a small portion of the geomatics sector and mainly only for large-scale aerial mapping projects where the return on investment

Figure 1, The geomatics world gathers annually at Intergeo – the industry's largest trade show – to learn about the latest geospatial technologies.



▲ *Figure 2, Lidar scanning from manned copters is an effective method for 3D modelling of levees, riparian boundaries and railways. The image shows a dense point cloud of raw data (elevation colour-coded).*

could justify the large costs of equipping an aircraft with specialised equipment and trained personnel. In addition it required the best computer hardware, highly specialised software and disk storage with large data capacity. Since then, vast technological improvements, innovations, economics and increased public demand have helped make Lidar much smaller, more portable, more affordable and more accessible. There are now more software choices available, computer technology is cheaper and data storage is more affordable. Lidar sensors are still most commonly used in aerial surveys (Figure 2). However, Lidar is now also used with coastal surveys, mobile surveys, terrestrial surveys and even with some unmanned aerial vehicle (UAV) surveys.

All of this has helped open up the market, putting Lidar data within more people's reach. Gone are the days when it required specialised data acquisition companies and was mainly used by governments, specialised research institutes or larger companies with big budgets. Today, finding Lidar-based images on the internet is almost as common as finding satellite imagery.

This dramatic shift also allows more and more companies to purchase Lidar equipment themselves, hire qualified personnel and collect and process Lidar data in-house without the need of contracting out the data acquisition component. This practice of cutting out specialised data acquisition companies may not be great for the geomatics sector; however, it does show how changes in technology and public demand can easily affect the industry.

Although aerial Lidar surveys still remain the preferred acquisition method, other methods of Lidar data acquisition are gaining in popularity as more sectors outside of geomatics discover new ways to incorporate Lidar data. This is especially true for mobile Lidar applications that have become very popular over the past few years. Therefore, we can expect to see more vehicles driving around with Lidar technology attached to them. The geospatial community can now retrieve better spatial data more quickly and easily than ever before.

CUTTING OUT SPECIALISED DATA ACQUISITION COMPANIES SHOWS HOW CHANGES IN TECHNOLOGY AND PUBLIC DEMAND CAN EASILY AFFECT THE INDUSTRY

USE OF UNMANNED AERIAL VEHICLES

UAVs, also commonly known as 'drones', have been around for almost a century, dating back to the early 1900s when unmanned aerial combat drones were used in various armed conflicts. The flight paths of UAVs are controlled either autonomously by onboard computers or remotely guided by a user on the ground or in another vehicle.

For decades, UAVs were mostly used by the military or with special applications, and they were often preferred for missions that were considered too dangerous for manned aircraft. Over the years, however, they have increasingly been finding uses in other applications. Changes in technology and an increase in demand beyond the geomatics sector have helped lower the price of UAVs to the point where drones are appearing everywhere and becoming available to anyone.

Much like Lidar, aerial photo acquisition has traditionally been relatively expensive. Digital aerial photo collection has nearly replaced traditional analogue methods, so it is no longer necessary to pack a truckload of equipment, multiple film rolls and much more into the aircraft. However, specialised aircraft, sophisticated geomatics technology and trained personnel can still make aerial photo acquisition expensive. Increased UAV use for aerial photo acquisition of smaller areas is making high-resolution imagery more affordable and technological improvements are allowing for larger coverage areas.

▲ *Figure 3, YellowScan, an ultralight laser scanner system for UAVs. This Lidar sensor allows data to be collected cost effectively in projects which are too small for traditional airborne surveys and too large for terrestrial laser scanning.*

While the recent flood of UAV technology on the market has helped bring down acquisition costs, it has also posed challenges for the sector. Meanwhile, governments are struggling to prevent the skies from getting crowded and causing problems with commercial aviation. Although most people have the principal skills needed to operate basic UAVs, not everyone will consider the consequences of operating a UAV without proper planning.

Everyday use of UAVs, especially in the geomatics sector, will definitely increase as cheaper equipment continues to become available with the ability to be controlled by smartphones. Related to this trend, more commercial UAV-related services will be launched to offer a better return on investment once users realise that there is more involved in obtaining good-quality and accurate spatial data.

Geomatics companies will also start to make greater use of commercial UAV technology and many companies will add UAVs to their services. We can expect to see UAVs gain even more popularity as Lidar technology and other external sensors continue to get smaller, allowing more geomatics technology to become equipped to commercial UAV units (Figure 3).

DEMAND FOR WEB APPLICATIONS

The popularity of digital mapping has grown rapidly and the widespread presence of the internet has helped make web mapping applications one of the most universally utilised types of spatial digital products. These days, most people are familiar with basic online maps and how easy they are to use for everyday tasks like locating businesses, finding directions and navigating, and adding photos with data to create custom maps.

The geomatics sector has been increasingly turning to web mapping applications because they offer extra advantages, including the ease of sharing data, improving communication, reducing costs and providing new tools for data analysis and decision-making. On-demand internet-based computing with shared resources and data storage, also known as 'the cloud', continues to evolve and is further changing the way web mapping applications operate.

Last year, Google – one of the early pioneers of online mapping – celebrated ten years of Google Maps (Figure 4). Google remains the leader when it comes to popular online maps, although alternative online mapping technologies have recently been established and continue to gain in popularity. Low-cost and free geographic data has been rapidly changing digital mapping. New services like OpenStreetMap, an open-source service maintained by more than 400,000 registered volunteers worldwide, create and distribute geographic data from all over the globe at no cost. Therefore it is not

WE CAN EXPECT TO SEE UAVS GAIN EVEN MORE POPULARITY AS LIDAR TECHNOLOGY AND OTHER EXTERNAL SENSORS CONTINUE TO GET SMALLER

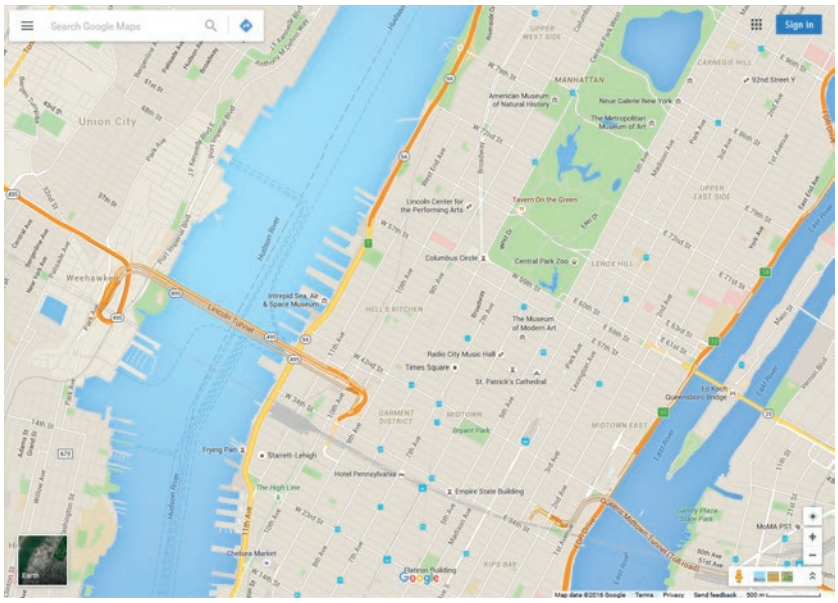
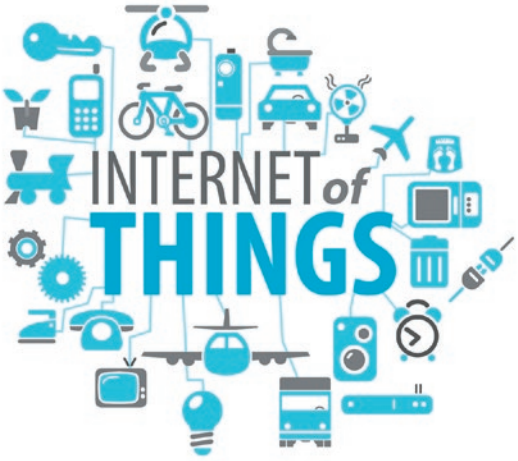


Figure 4, Google Maps showing Manhattan Island in New York, with locations such as Central Park, Times Square and the Empire State Building visible.

Figure 5, The Internet of Things.



surprising that web mapping applications have become a standard feature in smartphones, tablets and vehicles. More and more users everywhere are turning to these mapping sources to help them design custom interactive and beautiful static digital maps for a wide range of audiences. People are becoming tired of plain, basic online maps and they now want to incorporate other information to help generate maps that are both useful and fun.

It is hard to say what the future holds as the geospatial community continues to gradually shift away from commercial map services towards free and open-source alternatives. As online web mapping continues to rapidly evolve, with new applications and technology emerging on an almost daily basis, we can expect to see the demand for spatial data increase further.

Figure 6, Today's consumers expect 'anytime, anywhere positioning', which generates a greater need for accurate indoor positioning without additional infrastructure. (Courtesy: Qualcomm Technologies International)

GOING BEYOND SMARTPHONES AND TABLETS

As more people rely on smartphones for everyday tasks, the 'power of location' has helped mobile applications to become dominant in the geomatics market. Mobile application development is thriving and will continue to be one of the hottest trends in geomatics. Over the past few years, mobile applications have expanded from smartphones and tablets into wearable devices, vehicles and a wide range of other possibilities often categorised as the Internet of Things (Figure 5).

In reality, a smartphone can be regarded as another sensor platform or another piece of technology, but better hardware technology has opened the door to more sophisticated mobile applications which allow users to go beyond basic street map use and towards complex real-time geospatial applications. Many of today's smartphones and tablets can easily compete with most desktop computers and provide users with more than enough computing power to handle geospatial applications on the go. By adding better sensor and networking technology to products, companies are also creating new ways of gathering valuable insights about their users.

A study rereleased by Juniper Research stated that advertising in mobile applications alone generated over seven billion US dollars. This will continue to grow as mobile advertising networks start to move beyond monetisation of basic banner ads and towards intelligent geotargeted advertising with in-app purchases. Geotargeted marketing using the 'power of location' helps businesses

to specifically target certain goods and services at customers, thus providing a much higher return on investment (Figure 6). By gathering and analysing data, mobile applications are providing consumers with new recommended products based on user preferences and location – often before they even decide to shop for them – and creating improved, tailored experiences for users. This is fuelling the need for companies to focus more on handling big data and on analytics to combine it with geographic data.

We can expect to see more mobile applications expanding beyond smartphones as more users start experimenting with wearable devices such as smart watches. Mobile applications will also require more spatial data which also ties into the demand for better and more accurate web mapping applications.

GEOSPATIAL AWARENESS

As UAV innovation and technology continues to evolve, there will be an increasing shift away from traditional aerial photography acquisition towards more efficient UAV methods. The markets for Lidar and UAVs will increase substantially and eventually cross over, at which point we will start to see the combined use of UAVs and Lidar applications. With an increased demand for real-time data, it is also only a matter of time before the geomatics sector starts using mobile applications created for UAVs that collect Lidar and update web mapping applications, all at the same time. That may sound a little far-fetched, and in reality it may not happen in the near future, but the possibility is definitely there.

The biggest changes in the geomatics sector over the next year may not come from technology directly but from the geospatial community's increasing capability to take geographic knowledge and transform it into components of everyday life. This is an exciting time for the geomatics sector; as the geospatial community continues to evolve and grow, an increasing number of people are going to realize that geomatics is about much more than just producing maps. ◀

TED MACKINNON

Ted MacKinnon is a Canadian geomatics professional with over 12 years of experience in GIS, GPS/GNSS, Lidar, remote sensing and web design. His experience, knowledge and achievements have been recognised by the Canadian Institute of Geomatics which granted him the title of Certified Geomatics Specialist. Some of MacKinnon's key strengths and skills include project management and employee training, Lidar data collection, data processing, QC/QA and terrain modelling, GIS spatial database and geodatabase design, orthorectification, image analysis and photogrammetry, GPS control survey planning, and surveying and validation with various GPS hardware.

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5 Questions to...

Abbas Rajabifard

▲ *Abbas Rajabifard*

Prof Abbas Rajabifard is a professor and the head of the Department of Infrastructure Engineering in the Melbourne School of Engineering at the University of Melbourne, Australia.

Attracting sufficient students is a first priority at universities. What is the situation at your university?

At the University of Melbourne, we have always prioritised our quality of teaching and learning experiences and therefore we continue to attract world-class students both locally and internationally at undergraduate and graduate levels. Our Department of Infrastructure Engineering (which comprises geomatics, civil and environmental engineering) is no different. The university has a specific curriculum model called the 'Melbourne Model' which, when implemented in 2008, restructured most of our geomatics subjects as part of new master's-level degrees. Similar to our international counterparts, we also faced some challenges in raising awareness of our geomatics degrees, but we have been pleased to see continually increasing enrolment numbers over the past five years. We are also in the fortunate position of receiving a high number of graduate research applications on a weekly basis and entry to our research programme is very competitive.

What impact does the increasingly important role of geomatics have on education?

Over the past decade, we have witnessed an increasing demand for and appreciation of spatial information, both in government organisations and the private sector. We have incrementally introduced spatial information in fundamental subjects at the undergraduate level and this has proven to be well-received by students and exposes them to a whole range of opportunities. It has also impacted on the nature of our own engagement. With spatial information playing a key role in many multi-disciplinary projects, we now engage with a far broader range of partners than in the past. This is evident in our continually growing relationship with industry. We are now involved in a number of very large industry projects, working closely with our partners to deliver innovative spatial solutions that assist in effective decision-making and better planning of future cities. As such, the work of our students on higher research degree programmes has significant real-world applications. The current shortage of spatial expertise in many jurisdictions is also indicative of the important role of education in ensuring there are sufficient graduates to meet the increasing labour demands of industry.

How do you cooperate with manufacturers of geomatics hardware, software and geodata?

Our department has a proud history of applied teaching and research and we have always had close ties with industry and manufacturers of geomatics hardware and software and also spatial data providers. Our programmes have many practical components and we have a fully equipped geomatics technical lab. We also enjoy demonstrations and seminars given by various manufacturers and geomatics practitioners who visit our department from all around the globe. Many of our research projects have been in collaboration with leading manufacturers, who provide hardware and software and play a key role in our projects. Access to the most current and often real-time geodata is often provided to us by government organisations who have strong ties with our university and play a critical role in collaborative research. We are always looking to involve state-of-the-art technologies and are keen to develop new relationships with all relevant hardware, software and data providers. In addition, through our inter-disciplinary projects, we are involving a wide range of new practitioners and collaborators. This is creating more opportunities and a richer and better platform for learning and applying research.

What do you regard as the biggest challenge in the geomatics sector and how can universities contribute to tackling it?

Providing spatial solutions can be complex. The applications are endless and there are often many parties involved. I believe the greatest challenge is effective stakeholder management and delivery of clear project outcomes and clear impact. Without proper management of the varying parties involved, it is easy to stray from the objectives of the project and not meet the brief. We sometimes try to tackle problems that are too large, with too many components, making project delivery and completion almost impossible. With this in mind, I think universities need to spend more time on training and educating students in effective stakeholder management and project design, management and delivery, with a particular consideration of the impact of the digital age on collaboration. It is the responsibility of our universities globally to provide future spatial leaders with the right toolkit and mindset to tackle the spatial challenges posed by this increasingly complex environment, both in academia and in industry.

UNIVERSITIES NEED TO SPEND MORE TIME ON TRAINING AND EDUCATING STUDENTS IN EFFECTIVE STAKEHOLDER MANAGEMENT AND PROJECT DESIGN

If students from your university plan to start their own company, what do you advise them?
It is an exciting time to be in the spatial industry. There are opportunities for our graduates to start an innovative business and be competitive. At the Melbourne School of Engineering, we have initiated the Melbourne Accelerator Program (MAP) which supports the conversion of new ideas into viable businesses by providing support and a mentoring network, facilities and resources to students, staff and recent alumni. This hugely successful initiative has stimulated a culture of entrepreneurship within the school and our community. More broadly, I would advise students to find their niche. They need to be clear and specific about their company's products and services and ensure projects are delivered with a high level of professionalism, on time and within scope. I would also advise them to constantly think about interdisciplinary collaborations, as the world's problems are increasingly complex and we can do so much more when we bring together expertise from different people and organisations. Above all, it is imperative that the students exhibit high ethical standards and deal with all data capture, analysis and delivery with the highest level of integrity.

More information
www.ie.unimelb.edu.au

5 Questions to...

Bharat Lohani

Dr Bharat Lohani leads the Lidar teaching and research group at the Indian Institute of Technology Kanpur (commonly known as IIT Kanpur).

Attracting sufficient students is a first priority at universities. What is the situation at your university?
My institute, the Indian Institute of Technology Kanpur (IIT), is one of India's top five institutes. In India we have a large population of youngsters who are highly motivated and keen to study engineering and who dream of joining IIT. In view of this, we do not currently have much difficulty in attracting very talented undergraduate students. However, our challenge lies in attracting students for our postgraduate courses as it is the first choice of most students from India to study for a postgraduate degree at a reputable institute abroad. In order to attract students from this group, our institute encourages undergraduate students to do summer internships at our institute and also sends senior PhD students and faculty members to talk to undergraduate students in various colleges and universities. Furthermore, we motivate our own undergraduate students to convert their undergraduate degree into a dual degree (both bachelor's and master's degree).


▲ *Bharat Lohani*

What impact does the increasingly important role of geomatics have on education?
A large number of our own students regard geomatics as an attractive option for pursuing their career. Thanks to the higher visibility of geomatics in day-to-day life (Google Earth, mobile navigation, GPS, etc.) a good number of students from diverse engineering and science backgrounds are becoming interested in geomatics education. We also notice the efforts that are being made by India's central government to include geomatics education at primary and higher-secondary level in order to attract pupils to a career in geomatics at an early stage.

How do you cooperate with manufacturers of geomatics hardware, software and geodata?
There are a few ways in which we interact with such manufacturers. The first is by procuring their hardware and software. We have a very good geomatics laboratory for which we have purchased state-of-the-art instruments and software in all domains of geomatics. We interact a lot with manufacturers when buying and receiving training for these instruments and software. In addition, we invite them to hold talks for our students to make them aware of technological trends. Last but not least, we cooperate with manufacturers by exploring areas of joint research and development work. We have also explored options for our laboratory to become a research centre or feedback mechanism for these manufacturers. In turn, we gain access to their hardware and software plus their practical expertise.

What do you regard as the biggest challenge in the geomatics sector and how can universities contribute to tackling it?
In my opinion, especially in India, we have dearth of experts in the field of geomatics. We have a large number of professionals who are trained in using software or hardware, but far fewer individuals have solid fundamentals in geomatics. Similarly, geomatics education in

India lacks balance as there is significant focus on remote sensing data analysis and GIS development but not much focus on basic subjects like geodesy, adjustment and computation, photogrammetry, laser scanning, land surveying, etc. A further lacuna is that most of the people trained in geomatics in India have only one or two years' worth of training behind them. There are no institutions that provide high-quality three- or four-year-long dedicated training programmes for geomatics. Furthermore, while there are quite a few universities in India which offer PhDs in geomatics, in most of the cases these research studies are limited to exploring the application of geomatics rather than the development of the technology. The net effect of these lacunas is that there are only a few experts in core domains of geomatics. This is a big challenge and a limiting factor for exploring the full potential of this technology. I believe that Indian universities can play a really important role in improving this situation.

If students from your university plan to start their own company, what do you advise them?
A good number of students from our institute intend to start their own company. This has become a very strong trend nowadays, thanks to the positive signals from the government. One spin-off company from our institute is now a leading Lidar company in India; a further company currently being incubated has developed UAV-based solutions for mapping and other applications; and one more company that was recently incubated is developing 3D solutions in the field of geomatics. I interact a lot with these students and mentor and advise them. My advice to them is to understand the market. India – and a large part of the rest of the world – is a very special market for geomatics as these countries were never mapped at large scale, while there is a high demand now for such data due to modern applications. I advise students to leapfrog in terms of technology to provide data solutions. Furthermore, my advice is to remain focused on research and development while providing services as, in order to remain competitive and relevant, the service-only model will not be sustainable.

More information
www.iitk.ac.in

5 Questions to...

Peter van Oosterom

Peter van Oosterom has been a full professor and head of the section GIS Technology at Delft University of Technology, The Netherlands, since 2000, where he presently teaches Geo Database Management Systems within the redesigned MSc in Geomatics for the Built Environment.

Attracting sufficient students is a first priority at universities. What is the situation at your university?
In general over the last 5 to 10 years there has been an incredible increase in student numbers at TU Delft, from about 13,000 to more than 20,000 students today. That is probably due to a variety of reasons such the Dutch government's campaign to promote technology to primary and secondary-school pupils, the good job opportunities in most technical professions, etc. Our geomatics student numbers are more modest, but these too have developed very positively in recent years; this year we've welcomed 23 new MSc Geomatics students and 37 new MSc GIMA students (a joint master with Enschede, Wageningen and Utrecht), and our colleagues at TU Delft (Geo track within Civil Engineering), Wageningen (Geo-information Science) and Twente (Geoinformatics) have noticed a similar positive trend. This might be explained by the support activities of the Dutch foundation called Stichting Arbeidsmarkt Geo, the very good geomatics-related career perspectives, the increased visibility of geomatics and, specifically for our own educational programme, the name change from Geodetic Engineering to Geomatics and our new position within the Faculty of Architecture and the Built Environment.

What impact does the increasingly important role of geomatics have on education?
Ongoing technological developments make our field more visible, more attractive and more recognisable. Examples of such developments include improved positioning technology (including the EU's Galileo satellites), sensor technology and social media producing ever more data (big geodata and data analytics), spectacular drones for capturing data, very visible web-based (geoinformation) systems, many mobile (map-based) apps, attractive and useful 3D models becoming increasingly popular, more geodata becoming open and used, mainstream ICT better supporting spatial data (including spatial databases), etc. All of this makes geomatics more visible to the general public and to potential new students, which partly explains the increase in student numbers. Needless to say, a technical university plays a very important role in further technological advancements and innovations. These research activities are reflected in the master thesis phase of the degree. Of course, we also have to continuously update our education to include these latest developments. A few years ago the national GI minor was introduced for non-geomatics students: half a year of geoinformation education within the 3-year bachelor of another programme.

How do you co-operate with manufacturers of geomatics hardware, software and geodata?
In our Geoinformation Technology and Governance (Geo-TG) research programme we have two centres in which we collaborate explicitly with these partners. One is the Geo-Database Management Centre (GDMC) with partners such as Oracle, Bentley and Safe Software, and the other is the Knowledge

Centre Geoinformation Governance (KC Geo-Gov) with partners such as TNO, Ministry of Infrastructure and Environment, Municipality of Rotterdam, Kadaster, CBS, KNMI and RIVM. We have long-term partnerships with Geonovum, Rijkswaterstaat and Kadaster (including staff exchange). We also quite often involve partners in research projects. The massive point cloud project is done in collaboration with Fugro, Oracle, MonetDB, Rijkswaterstaat and Netherlands eScience Center, For example, and in our vario-scale geoinformation project there is an explicit user board with members from 1Spatial, Esri, the municipalities of The Hague and Amsterdam, and some above-mentioned partners such as Oracle, Rotterdam, Kadaster and Rijkswaterstaat. Last but not least, there is an important role for and close collaboration with manufacturers via the education programme: internships (GIMA, GI minor), MSc thesis projects and guest lectures. There is a long tradition within the MSc Geomatics for open guest lectures. These have included representatives from Google, Microsoft, Oracle, Deltares, Geodan, Rijkswaterstaat, Geonovum and Kadaster as well as guest lecturers from foreign universities.

What do you regard as the biggest challenge in the geomatics sector and how can universities contribute to tackling it?

Given that the developments in our field are happening at increasing speed there are many R&D challenges, so it is very difficult to name the single biggest challenge. Semantic technologies are needed for better machine processing of geodata, including real-time GIS applications (such as during disaster management), but also to obtain better results for 'classic problems' such as automated map generalisation. Clearly, the processing and use of sensor network data is crucial for smart cities, smart dikes, smart highways, etc., and results in significant geodata processing challenges. The big geodatasets include point clouds (from laser, multibeam echosounders, dense-matching stereo images, etc.) for spatiotemporal modelling, which should be as well-supported (in terms of functionality) as the regular gridded/raster and the object/vector representations. For this to happen, standardisation is crucial but that in itself is a major challenge; it should stimulate and enable new developments, rather than slowing them down by favouring the status quo. A good innovative standardisation example is the ISO 19152:2012 Land Administration Domain Model standard which included support for 3D parcels (well before they were used in practice).

▲ *Peter van Oosterom*

Internationalisation is also a big challenge. We have been cooperating with leading geoinformation universities across the globe for a long time. Three years ago, TU Delft developed the policy of a limited number of strategic alliances which resulted in the Joint Research Centre (JRC) Wuhan-Delft. The activities include student and staff exchanges, joint projects, publications, events, etc. It is becoming harder to attract research funding as government budgets for education and research are under pressure in The Netherlands and the percentage of funded projects available for research proposals is declining every year. And despite the current success of our educational programmes, it remains a challenge to further boost student numbers and transform them into the young professionals that are so needed and wanted in our field. In summary, there are many 'biggest challenges'…

If students from your university plan to start their own company, what do you advise them?

In general I advise the students to broaden their career development options and not just follow the obvious path by staying within their familiar environment. For example, even if a student enjoys university research it is very good to first work in industry or government. And if a student wants to do PhD research directly after finishing their master, I advise them to switch universities and/or look abroad to change their perspective, which in turn will enable them to learn more. Although many of our geomatics graduates do indeed start their own companies, I don't give them specific advice on that aspect but I always hope that they will stay within the field (and 95% of them do). The geomatics graduates who have already started their own companies are probably much better advisors. Our students have set up the student association called GEOS, which also involves alumni, and TU Delft's annual Geomatics Day is another great opportunity for students to gain inspiration from small start-ups and larger companies alike (and vice versa). ◀

More information

- Geo-Database Management Centre: www.gdmc.nl
- Geoinformation Governance Knowledge Centre: www.otb.tudelft.nl/opendata
- MSc in Geomatics: http://geomatics.tudelft.nl
- Massive point cloud project: http://pointclouds.nl
- Vario-scale geoinformation: http://varioscale.bk.tudelft.nl
- GEOS student association: www.geostudelft.nl
- Wuhan-Delft Joint Research Centre: http://jrc.tudelft.nl/spatial-information

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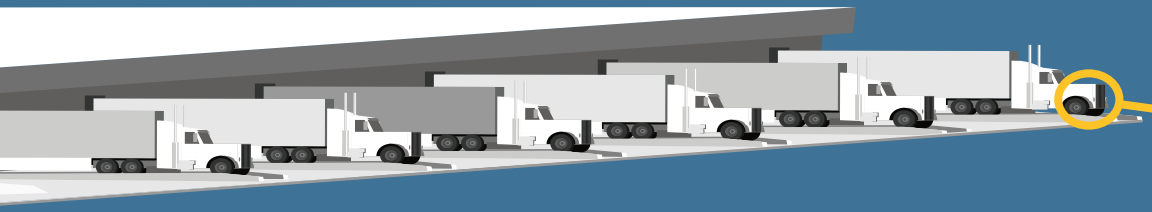

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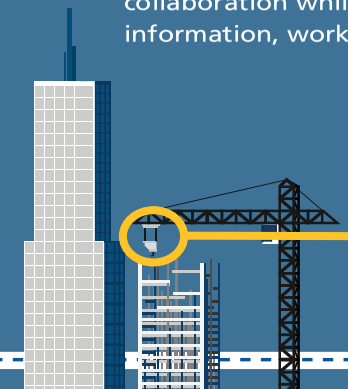

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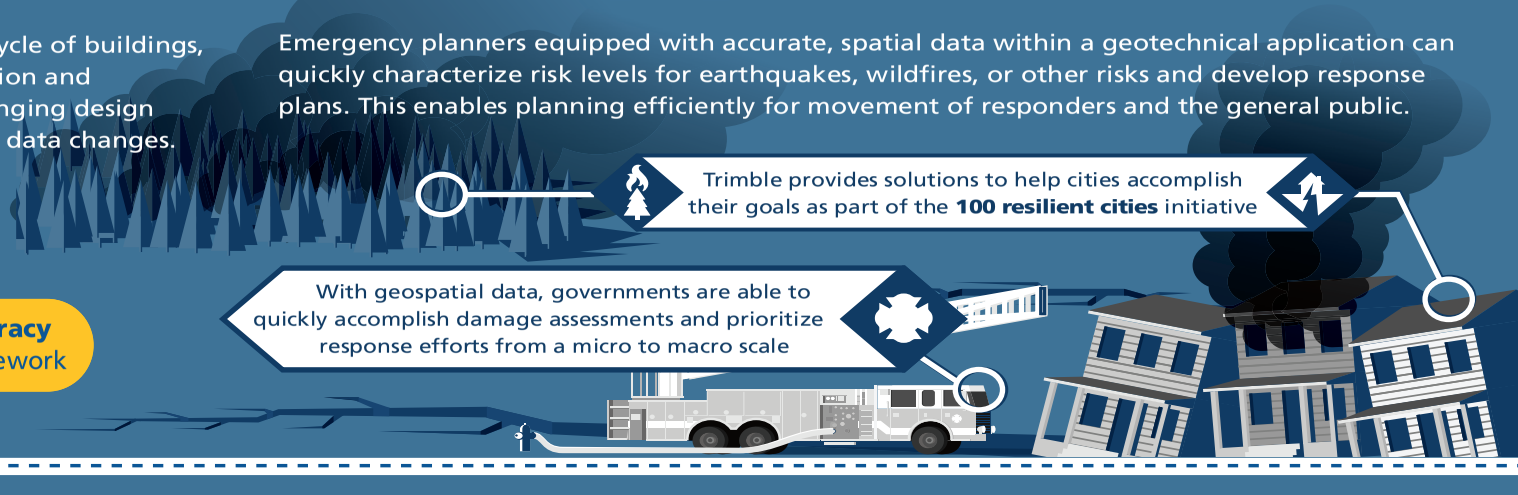

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