GIM INTERNATIONAL

THE GLOBAL MAGAZINE FOR GEOMATICS
WWW.GIM-INTERNATIONAL.COM

geomares PUBLISHING

ISSUE 3 • VOLUME 31 • MARCH 2017

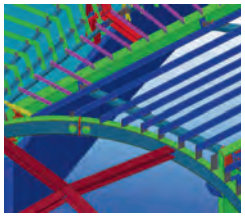
A New Model for Surveyors

BIM: Important Opportunities and Challenges for Surveyors

BIM: THE NEW GIS FOR THE INDUSTRY

PAVING THE WAY FOR SELF-DRIVING CARS

CRANE CAMERA SITE SURVEYING



Building information modelling (BIM) is a hot topic in architecture, engineering and construction. BIM supports a more intelligent approach to planning, construction and the use of buildings. The geomatics industry is well positioned to take the lead in the management of the geospatial data that plays a crucial role in BIM. This issue has a strong focus on BIM and the surveying field. (Image source: Autodesk / Network Rail and Jacobs)

ADVERTISERS INDEX

GIM INTERNATIONAL

PUBLISHING DIRECTOR Durk Haarsma
FINANCIAL DIRECTOR Meine van der Bijl
SENIOR EDITOR Dr Ir. Mathias Lemmens
CONTRIBUTING EDITORS Dr Ir. Christiaan Lemmen, Dr Rohan Bennett, Martin Kodde MSc, Huibert-Jan Lekkerkerk, Frédérique Coumans, Ir. Sabine de Milliano
CONTENT MANAGER Wim van Wegen
COPY-EDITOR Lynn Radford, Englishproof.nl
KEY ACCOUNT MANAGER Sybout Wijma
ACCOUNT MANAGER Sharon Robson, Myrthe van der Schuit
MARKETING ASSISTANT Trea Fledderus
CIRCULATION MANAGER Adrian Holland
DESIGN ZeeDesign, Witmarsum, www.zeedesign.nl

REGIONAL CORRESPONDENTS
Ulrich Boes (Bulgaria), Prof. Dr Alper Çabuk (Turkey), Papa Oumar Dieye (Niger), Dr Olajide Kufoniyi (Nigeria), Dr Dmitry Kurtener (Russia), Dr Jonathan Li (Canada), Dr Carlos Lopez (Uruguay), Dr B. Babu Madhavan (Japan), Dr Wilber Ottichilo (Kenya), Dr Carl Reed (USA), Dr Aniruddha Roy (India), Prof. Dr Heinz Rüther (South Africa), Dr Tania Maria Sausen (Brazil)

GIM INTERNATIONAL
GIM International, the global magazine for geomatics, is published each month by Geomares Publishing. The magazine and related e-newsletter provide topical overviews and accurately presents the latest news in geomatics, all around the world. *GIM International* is orientated towards a professional and managerial readership, those leading decision making, and has a worldwide circulation.

PAID SUBSCRIPTIONS
GIM International is available monthly on a subscription basis. The annual subscription rate for *GIM International* is €120 with. Subscription can commence at any time, by arrangement via our website or by contacting Abonnementenland, a Dutch subscription administration company. Subscriptions are automatically renewed upon expiry, unless Abonnementenland receives written notification of cancellation at least 60 days before expiry date. Prices and conditions may be subject to change. For multi-year subscription rates or information on current paid subscriptions, contact Abonnementenland, Postbus 20, 1910 AA Uitgeest, Netherlands
+31 (0)251-257926
(09.00-17.00 hrs, UTC +1)
paidsubscription@geomares.nl.

ADVERTISEMENTS
Information about advertising and deadlines are available in the Media Planner. For more information please contact our key account manager: sybout.wijma@geomares.nl.

EDITORIAL CONTRIBUTIONS
All material submitted to Geomares Publishing and relating to *GIM International* will be treated as unconditionally assigned for publication under copyright subject to the editor's unrestricted right to edit and offer editorial comment. Geomares Publishing assumes no responsibility for unsolicited material or for the accuracy of information thus received. Geomares Publishing assumes, in addition, no obligation to return material if not explicitly requested. Contributions must be sent for the attention of the editorial manager: wim.van.wegen@geomares.nl.

geomares PUBLISHING

Geomares Publishing
P.O. Box 112, 8530 AC Lemmer,
The Netherlands
T: +31 (0) 514-56 18 54
F: +31 (0) 514-56 38 98
gim-international@geomares.nl
www.gim-international.com

Engine for Truth

The truth seems to be a victim of the turmoil in today's world. I feel a burning need to explain what we do in our profession, including in magazines like *GIM International*, in order to make it clear that journalism revolves around truth in the form of facts. Certain politicians are blaming the media for disseminating 'fake news' or running reports that omit the facts. Meanwhile, politicians themselves are increasingly not telling the truth or, to put it politely, being 'economical' with it, often for their own electoral gain. This creates a circle of blame, causing citizens to no longer trust anybody – neither the politicians that have been chosen to represent them nor the newspapers and the TV news bulletins. The result: societies where trust is being eroded and fear spreads. As a journalist myself, and therefore belonging to one of the two parties in the blame game that has in fact been going on for years but has reached new heights in Europe and the United States over the past few months, I strongly feel that we should look at ourselves and check whether we are obeying the set of rules that our profession imposes on itself. At the same time, looking at our work at *GIM International*, I believe we report in a fair way; we base our articles and news stories on facts, the number one rule for good journalism. I can't speak for politicians, because I am not one. I can only hope that they also take a look at themselves in the mirror and decide to use facts as the underlying basis for all their messages to the electorate. In the geospatial industry, which is so focused on gathering, processing and analysing geodata, I am sure we all agree that there's no escaping the truth, even if we would want to. The facts are the foundation of what we do; measurements enable positioning with millimetre accuracy, and there's no bargaining with xyz. And, in fact, that's exactly what's needed these days: no bargaining with the facts. Now that I've got that off my chest, it's good to see that the non-negotiable geodata is changing more and more fields of application, with construction being one of them. This issue of *GIM International*, with a special focus on building information modelling (BIM), includes an article on crane camera site monitoring as an alternative to UAVs for 3D mapping, written by Sabrina Cardot on page 31. The article states that BIM was already used by 48 percent of the construction industry in 2015, and that that figure has since grown tremendously. This further strengthens the basis on which buildings are constructed; they rest, as it were, on the truth. That optimistic growth shows that the truth is not a victim everywhere. In fact, it is actually gaining ground in many places outside of politics and the media – with geodata as its engine.

▲ *Durk Haarsma, publishing director*

Tomorrow's Technology

The United Nations' Sustainable Development Goals (SDGs) are considered an important compass for our professional sector. To create a better world by 2030, the geospatial sector can play an excellent role in providing the information and technology for managing, monitoring and planning global activities in the most optimal and sustainable way. Almost a dozen of the 17 goals can be related to our profession.

Of course, I am preaching to the converted. And, to be honest, I think that even the World Hairdressing Federation could make a case for a good haircut and the right colour of your hair being essential in achieving the SDGs. But therein also lies the power of the SDGs. They allow everybody to get involved and to make a valuable contribution.

I truly believe that geospatialists and geo-specialists can make a difference. Our profession matters – but not with the state of play as I experience it today. With only 13 years still to go, our present practice, technology and knowledge is impressive, but not enough. The intelligence that geospatial information adds to our society and management systems still needs another push, another leap. In transportation, in creating smart cities and in taking climate change measures, for example, we need more geospatial intelligence than we have right now.

▲ *Kees de Zeeuw.*

In the administration of land, too, more progress is necessary than we are making today – much more progress. If we truly want to register land rights for all by 2030, we are talking about billions of parcels that must be registered in areas where circumstances are still poor and where it is difficult to work. Tomorrow's technology is needed to ignite and accelerate the registration of land rights. This must be expressed in solutions we haven't thought of yet, at prices and costs that are way below the current levels.

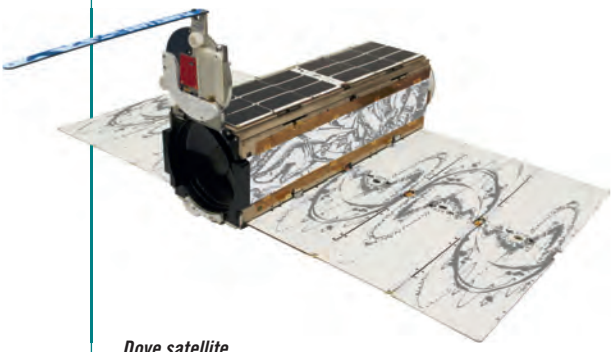
Let me give you an example of what I've learned in Suriname (South America) recently. The country is large but has a low population density, with the majority of people living in the capital city, Paramaribo. The forested area is difficult to access but is of high value in terms of 'people, profit and planet'. Although the development of the cadastral system is being taken up professionally and ambitiously in Suriname, the present pace of work will not result in land rights for all and sustainable management of the land by 2030. Yes, satellite images are available that can accelerate the process of mapping and land management. But unfortunately the costs of these images – both purchase and handling – are still too high for them to be a real option for use by local governments in speeding things up. The same holds true for IT systems, mobile services and measurement devices.

By continuing geospatial development and innovation, we have to create better options, resulting in solutions that can create the speed, considerably reduce the cost and are of a quality that fits with the SDGs. So now, finish reading this magazine and then get back to work. Keep in mind that we need your contribution of tomorrow to achieve our global goals by 2030!

Planet Launches Record-breaking 88 Satellites

Planet successfully has launched 88 Dove satellites, creating the largest satellite constellation ever to reach orbit. With these satellites in orbit, Planet will reach its Mission 1: the ability to image all of Earth's landmass every day. In 2011 Planet set itself the audacious mission of imaging the entire Earth land area every day. The company was convinced that, armed with such data, humanity would be able to have a significant positive impact on many of the world's greatest challenges. Planet calculated that it would take between 100 and 150 satellites to achieve this, and started building them. Following the launch, which took place on 14 February, Planet now operates 144 satellites in orbit.

▸ **http://bit.ly/2IRRgzI**



Dove satellite.

ILMF and ASPRS Annual Meeting to Take Place Together in 2018

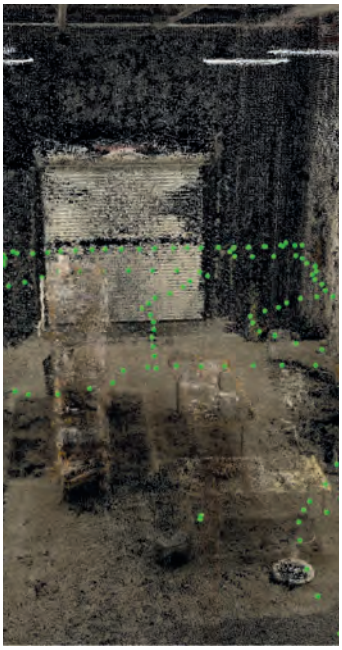
Diversified Communications, organiser of International LiDAR Mapping Forum (ILMF), and the American Society for Photogrammetry & Remote Sensing (ASPRS) have announced that their annual geospatial events will take place together in Denver, USA, in 2018. The combined event will feature a single exhibit hall and inclusive social activities, giving attendees access to more geospatial solutions and networking than would have been possible had the events continued separately. The events will maintain parallel technical programmes, including ILMF product reviews and ASPRS workshops, awards and committee meetings. Attendees will be able to purchase a conference pass that allows entry to programmes of their choice, or they may choose a universal pass that allows entry to all programmes.

▸ **http://bit.ly/2kwqegH**

Indoor Mapping with Terrestrial Photogrammetry

Swiss engineering and geomatics consulting firm Mosini Caviezel SA has been testing terrestrial photogrammetry for indoor mapping as a new method for establishing property plans. The company is evaluating the optimal indoor mapping workflow, and testing different positions and methods for data capture. The project consisted of several phases and took place in an office building of Mosini Caviezel SA, Switzerland: a rural house that includes five rooms and a large hallway. The main objectives were to create an indoor plan in 2D, evaluate the application of terrestrial photogrammetry for establishing a PPE plan (*Propriété Par Étages* / 'property by floors' or condominium ownership of an apartment) and devise an optimal, low-cost and sustainable protocol allowing surveying and architecture companies to document property indoors.

▸ **http://bit.ly/2lUdQ7c**



Terrestrial photogrammetry for indoor mapping.

A GOLDEN OPPORTUNITY FOR THE GEOSPATIAL INFORMATION COMMUNITY

The SDGs Indicator Framework

As anyone cognisant of the UN's work will have noticed, since 25 September 2015 every policymaker involved with international development has been excited by the 2030 Agenda for Sustainable Development – a 15-year road map which would even constitute, in my humble opinion, a kind of bill of development rights. This column looks at the 2030 Agenda through the geospatial information lens, highlighting the opportunities to raise awareness and understanding of the fact that geospatial information is fundamental to supporting sustainable development.

By way of background, it is worth noting that, unlike the Millennium Development Goals (MDGs, from 2000-2015), which were limited in terms of scope (eight goals) and coverage (dedicated to developing countries) and were devised by a small UN team, the 2030 Agenda (from 2016-2030) is the result of global consultation, covers all development challenges (17 goals, 169 targets, 230 indicators) and involves all stakeholders: public and private sectors as well as civil society. More significantly, the 2030 Agenda builds on the progress made under the MDGs, taking into account the lessons learned from their implementation and including the shortfalls – the chief one of which is the 'data gap'.

The recognition of data's importance, as outlined in the SDSN report titled 'Data for Development', has put it at the centre of the implementation and monitoring of the Sustainable Development Goals (SDGs). The geospatial community is well aware that GIS is a data-centric system and geospatial data constitutes its most costly component, accounting for up to 70 percent of the total cost. It is incumbent on the geospatial community to capitalise on its established experience with data and make the case that geospatial data/Earth observations constitute a large part of big data, hence putting geospatial information at the core of the data revolution.

The 17 Sustainable Development Goals were set by politicians, but the means of measuring and monitoring their achievements, reflected by the SDGs Indicator Framework which encompasses some 230 indicators, were defined by statisticians. The SDGs Indicator Framework is a one-time opportunity for the geospatial community to catch up and be involved at the implementation level, cooperating with statisticians and other stakeholders. As stated in the Terms of Reference of the UN Working Group on Geospatial Information of the Inter-Agency and Expert Group on SDG Indicators, geospatial specialists should particularly contribute to the data disaggregation of the indicators where the geographic dimension (location, urban/rural, region, etc.) is required, and not leave it to others to define geography through their own lenses.

The SDGs call for cooperation and partnership; the 17th goal stresses the importance of partnerships between the various groups, as well between nations and UN agencies. They constitute a golden opportunity for the geospatial community to connect with policymakers on the benefits of using and understanding data geospatially and building geospatial infrastructures, and to 'educate' project managers who are mainly economists or development specialists with limited geospatial background. ◂

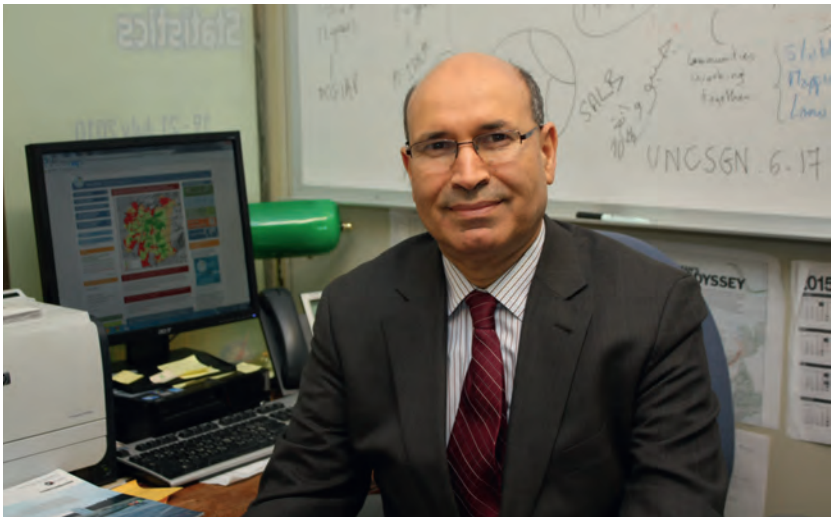
FURTHER READING

- SDSN report on 'Data for Development: A Needs Assessment for SDG Monitoring and Statistical Capacity Development', 17 April 2015 (http://unsdsn.org/wp-content/uploads/2015/04/Data-for-Development-Full-Report.pdf)
- The Terms of Reference of the UN Working Group on Geospatial Information of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (https://unstats.un.org/sdgs/files/Working-Group-ToR--GeoSpatial.pdf – II/4)

AMOR LAARIBI

Mr Amor Laaribi has over 30 years of experience working in the field of geospatial information for decision-making and development. He joined the United Nations Statistics Division Office in February 2000 to define and plan the priorities of the UN in the geospatial information area and to promote its use with census mapping in developing countries. He contributed to the foundation of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) and led the work of the UN Expert Group on the Integration of Statistical and Geospatial Information in support of the 2030 Agenda.

✉ amorlaaribi7@gmail.com



▲ *Amor Laaribi.*

Precision 3D Topo 2017 Lidar and Drone Survey Tool

Carlson Software's Precision 3D Topo 2017 is designed for use by surveyors, civil engineers and contractors. It allows users to import survey data, points, polylines, surfaces, point clouds, traditional Lidar data, aerial drone survey data and more from a wide variety of programs and entities to create usable 3D surfaces. According to Nathan Crews, lead developer of Precision 3D P3D Topo, the solution enables much faster design and analysis in the 3D environment than the many-step processes of the CAD world. Its 3D design tools save time and reduce the chance of errors, making it an obvious tool to improve the business bottom line.

▸ **http://bit.ly/2lUmjra**

Precision 3D Topo 2017.

YellowScan Launches Real-time In-flight Lidar Station

YellowScan has announced the launch of the YellowScan LiveStation, developed to enable surveyors to monitor in real time the validity and quality of the data being collected so they can ensure that the survey is going smoothly. The solution features live 3D point cloud visualisation (including zooming, translation, rotation), live transect and trajectory visualisation, speed, altitude and IMU & GNSS controls, and mission replay. The new solution renders a real-time, three-dimensional representation of the point cloud during flight, with ability to zoom, translate or rotate. Simultaneously, the user interface presents an immediate summary of the system's status. The transect view allows the operator to check in real time whether the Lidar is able to penetrate a forest's canopy and sample the ground. Missions can later be replayed for analysing flight conditions and data.

▸ **http://bit.ly/2kwxRDN**

New Positioning Capabilities with NovAtel OEM7 Upgrade

NovAtel has announced the OEM7 7.200 version firmware, with a new positioning functionality including the Interference Toolkit (ITK). The ITK allows users to detect and mitigate intentional interference such as the adversarial jamming of GNSS signals as well as unintentional interference from external sources. The new RTK ASSIST corrections service assures continued high-accuracy positioning when signals from an RTK network are unavailable or disrupted. With the ITK, NovAtel's OEM7 customers can now auto-detect and report in-band radio frequency (RF) interference so that any interference adversely affecting their receiver's positioning performance can be quickly nullified.

▸ **http://bit.ly/2lqhmbK**

ISPRS Launches Jack Dangermond Award

As a token of appreciation for outstanding ISPRS scientists and their exceptional achievements, individual awards are presented during ISPRS Congresses. Many of these awards are donated by ISPRS Members. As ISPRS would also like to award best papers published in the *ISPRS Journal of Geo-Information* (IJGI), an agreement has been made with Esri, one of the strongest commercial leaders in GIS, and MDPI, publisher of IJGI, to create a new award: the Jack Dangermond Award. The award consists of a grand prize of USD10,000 and will be given to the most outstanding paper published exclusively in the *ISPRS Journal of Geo-Information* during the four years preceding each congress.

Petr Seidl, Lena Halounová and Jack Dangermond.

▸ **http://bit.ly/2lRW0tz**

5 Questions to... Jimmy Pewtress (Kullasoft)

Mobile apps have been identified as one of the new disruptors in the geomatics industry. To what extent do you agree?

I wouldn't say that mobile apps are disruptive to the extent that say Uber or Airbnb have revolutionised their respective industries. I think it will be a while before anybody who wants to can simply set themselves up as a surveyor armed with just a smartphone! I do agree, though, that there's scope for large-scale disruption of the traditional working processes of the geomatics industry when it comes to things like data capture and transfer in the field, providing easy access to information, interacting with equipment and so on. Despite the rise of powerful technologies such as laser scanning and photogrammetry, I still come across surveyors and engineers who record site data in handwritten notes or using arbitrary solutions they've devised themselves. These all take time to decipher and process back at the office and it's areas like this where I know I can make a difference and add value.

Kullasoft creates mobile apps designed for surveyors. How do these apps help the surveyor?

The apps are really only half the story. At the heart of what we do is the Kulla web platform. This is a cloud-based system that stores the data collected by the apps in a central location, then allows access to that information by whoever needs it via a web browser. Mobile apps help surveyors out on site by providing a simple, standardised method of recording the work that they're doing, and a quick and easy way of exporting that information to a place where their colleagues can access it immediately. Back at base, having the survey data saved in a structured format means that we can create interfaces within the web portal that allow users to view and edit that information however they wish, create documentation from it if required and refer back to it in future. So it's more of an end-to-end system, with the apps acting as a data capture mechanism.

Which renowned survey companies are already using the app?

Plowman Craven are using our PGM Manager app to record data of all the control points they install, and then automatically create witness diagrams to supply to Network Rail as part of the required deliverables (see also blog post and case study: http://bit.ly/2k3HIVP). We have witness diagram templates built into the web portal for the Environment Agency, Network Rail and hopefully soon Historic England as well. We can easily reproduce bespoke templates for any in-house designs, so any survey companies that have to produce documented station descriptions can save themselves time and money.

Do you foresee other surveying tasks that can be carried out with apps?

Yes, lots! Things like health and safety logs, risk assessments, time sheets, shift reports, manhole cards for United Utilities, lone worker check-ins, the list goes on. When it comes to the more technical aspects of geospatial work such as laser scanning, in-depth knowledge of the subject matter is required. The complexity and scale is such that a team of developers would be needed to build the products, plus the big players like Leica and Trimble develop their own software to complement their products. I'm a software developer first and foremost – my background isn't really in surveying – so there's going to be limits on what I can achieve. However, Kullasoft is positioned to provide solutions to all the time-consuming processes that have to be done alongside the main surveying tasks, giving people more time to concentrate on the job at hand.

Can we expect more apps from Kullasoft in the future?

Certainly! Now that the main platform is in place, we can quickly and easily add as many apps as we like, which can all upload their data to the same location. All we need to do is add the web interfaces so people can interact with the data and there's another useful tool for people to use. The longer-term vision is to build up a suite of apps that surveyors can pick or choose from, depending on their needs, in order to build up a diverse customer base.

Jimmy Pewtress is the founder of Kullasoft, a software development company specialising in mobile apps for the geospatial industry.

More information
For an extended version of this interview visit www.gim-international.com.

Rwanda Pioneers UAV Mapping

Participants of the Rwanda UAV mapping training course.

After Rwanda previously made waves in the news for allegedly being the first country to approve drone-based deliveries, people started paying attention. The country, with its rolling hills and one of the fastest-growing economies in Central Africa, has already established regulations regarding drones and has become a vanguard of sorts for the region. To support this development, in 2016 the University of Twente organised a course in Rwanda on the latest drone mapping techniques. There is a huge market in Africa at the moment, according to Francesco Nex, assistant professor at the ITC Faculty, University of Twente. The country is growing very fast, with a shortage of surveying and maps available. Nex recently taught photogrammetry for an applied drone mapping training course at INES-Ruhengeri Institute in Rwanda, along with his colleagues Rohan Bennett and Anton Vrieling. The Netherlands annually sponsors such continued education events for former students of Dutch institutes, and in 2016 the University of Twente organised a course in Rwanda on the latest drone mapping techniques.

http://bit.ly/2Iq5aYv

New Leica Sensor Brings Efficiency to Airborne Lidar Mapping

Leica SPL100.

Leica Geosystems has announced the release of the Leica SPL100 as part of the RealTerrain reality capture solution. It enables airborne professionals to more efficiently collect and process Lidar data of large areas, day or night and in leaf-on or leaf-off conditions. Combining the SPL100 single photon Lidar (SPL) and imaging sensor with Leica HxMap, the scalable post-processing workflow software, RealTerrain enables the efficient collection and rapid processing of large-area Lidar datasets. The SPL100 is able to collect six million points per second with 100 output beams, and HxMap provides a complete single-interface post-processing platform to create industry-standard Lidar and image data products. The efficiency gained by SPL100 acquisition and HxMap data processing enables larger and more frequent Lidar data acquisition for applications such as dense vegetation mapping and change detection.

http://bit.ly/2IdzraE

Siemens and Bentley Systems Strengthen Strategic Alliance

Building on the strategic alliance between Siemens and Bentley Systems that was made public in November 2016, Siemens' Energy Management Division and Bentley Systems have announced an agreement to jointly develop solutions to accelerate digitalisation of planning, design and operations for power utilities and industrial power customers. Bentley Systems is a global leader in software solutions for advancing the design, construction and operations of infrastructure. The first of the new offerings will integrate Bentley Systems' utility design and geographic information system (GIS) capabilities with Siemens' Power System Simulation (PSS) suite, with specific solutions for power transmission, power distribution and industrial facilities. Combining these two platforms provides customers with Bentley's expertise in 3D infrastructure asset modelling and GIS together with Siemens' knowledge and renowned experience in energy system planning and simulation.

http://bit.ly/2jYRkwP

Bentley's Bhupinder Singh.

INTERVIEW WITH MOHSEN KALANTARI

BIM: The New GIS for the Industry

As anyone who frequently visits trade shows and conferences in the geospatial industry or reads relevant geomatics literature already knows, building information modelling (BIM) is a hot topic. But just how special is BIM? And which new opportunities does the technology bring? In this interview, Mohsen Kalantari, an expert from the University of Melbourne, Australia, and chair of the International Association of Geodesy's BIM-GIS working group, shares his thoughts.

BIM is a buzzword these days in the geomatics industry. Are you happy with all the attention it is receiving?

There is certainly an increasing awareness about BIM in the geomatics industry. This awareness is particularly evident in the parts of the industry that deal with laser scanning of the built environment. While there are firms and individuals in our industry who are involved in preparing and managing BIM data, the majority of what we do with BIM is about providing the base data for its creation. Most of our involvement is about preparing an accurate and representative point cloud of built environments for architecture, engineering, infrastructure, petrochemical industries and others. We often leave the rest to the client as to how they transform point clouds into building information models. But it's not enough to only focus on what we have traditionally been experts in – i.e. spatial data collection and processing. With the increasing amount of BIM data about the built environment and the need to keep the data current, the geomatics industry is well positioned to take the lead in the management of this data.

BIM is changing the way surveyors work. Can you paint a picture of how the future will look?

Well, I'm not entirely sure about this – unless the surveying industry looks at the business opportunities arising from BIM more holistically. If we grab these opportunities then yes, we will need to change how we work. At the moment, unfortunately, the companies and individuals that are specialised in land surveying disregard BIM. The firms that are involved with multistorey buildings, major infrastructures, heritage buildings and similar areas may well be active in collecting data for BIM and preparing BIM data for their clients. But there are many areas, such as land administration and cadastres, where I haven't seen any practical applications. More importantly, I haven't seen much of a trend towards positioning ourselves as leading the industry in managing and maintaining BIM data – and this is where the new opportunity lies. Unlike the spatial data, which is owned and managed by public-sector mapping agencies, the data about buildings is often the property of the building owners. These owners are mainly private-sector companies or individuals who don't have the capacity to manage and maintain the data about the buildings.

'BIM versus GIS' is an often-heard discussion. Or should it be 'BIM plus GIS'?

For sure it should be BIM plus GIS as they are complementary. I've been involved in a project led by the Open Geospatial Consortium (OGC) called 'Future City Pilot' where we examined the potential of BIM and GIS integration in urban planning. It's evident that bringing BIM and GIS together will benefit many application domains such as architecture, urban planning, disaster

management, infrastructure engineering, facilities management, decision-making, construction, etc. However, there are many challenges in integrating BIM and GIS. I'm involved in organising an event on the integration of BIM and GIS in October in Melbourne. In this event, we will be focusing on teasing out the technical, legal and institutional challenges involved in bringing BIM and GIS together.

What are the latest developments when it comes to BIM technology?

BIM technologies are rapidly evolving, there's no doubt about it. Particularly tools for creating BIM content and collaboration using BIM in the architecture, engineering and construction (AEC) industry are becoming more accessible and functional. I guess we're in the era of technology integration. From a technological perspective, BIM is no longer special. What is significant is how BIM is integrated with other technologies such as point clouds, virtual (VR), augmented (AR) or mixed realities, GIS and others. I'm involved in research projects on BIM and virtual reality integration where we try to examine how this integration can help emergency responders in a virtual training environment. Another research project is looking at whether BIM and VR integration can ultimately replace show homes that construction companies build for marketing purposes. We've just finalised research on extending IFC (*the BIM standard, Ed.*) for land administration applications.

How do traditional surveying methods (total stations, laser scanning) go together with BIM?

From a spatial data perspective, one of the critical values of BIM is its capability to represent buildings at a finer level of detail. While the exteriors of buildings and infrastructure may have a lot of details, BIM is more helpful in representing building interiors. Total stations may not have much flexibility in building interiors in comparison to laser scanning. As I mentioned before, laser scanning has been our industry's connecting point to BIM. This will continue, for sure, but I hope it evolves into bigger opportunities such as BIM management.

Adoption of BIM is mandated in the UK construction sector. How are things developing in other parts of the world?

Well, there is also a similar regulation in place in the USA and Singapore. Mandating BIM very much depends on the readiness of the AEC industry in a given country. I'm aware that there is resistance in Australia's AEC industry against mandating BIM. The reality is that BIM may be ready technology-wise, but there's still a need for capacity building. The majority of the AEC workforce are not technically competent in BIM but the industry has realised the importance and potential of BIM. That's why there's a demand from the industry to include BIM in university teaching. Since last year, for example, we've been offering a building information modelling subject in which we provide a broad range of BIM knowledge and technology including spatial data and structural, architectural and mechanical energy aspects of BIM. I guess it's just a matter of time before BIM in one form or another will be indispensable in AEC and building management.

FROM A SPATIAL DATA PERSPECTIVE, ONE OF THE CRITICAL VALUES OF BIM IS ITS CAPABILITY TO REPRESENT BUILDINGS AT A FINER LEVEL OF DETAIL

How do you foresee the future of BIM and surveying?

It depends on the surveying industry, whether we see it as a significant opportunity and embrace it. From speaking to my colleagues in the industry, I know that some are still taking it very lightly and others are already embracing it. I personally believe BIM is the next GIS for our industry. For example, GIS is now vastly used in asset management. If we get to grips with BIM it will open up new opportunities such as building and facilities management, which are both huge industries in term of annual revenue.

What are your favourite projects carried out with BIM that give a good example of the seemingly endless possibilities of this technology?

I'm not going to lie here – I haven't seen any project that showcases BIM's potential. But what we have seen is the use of BIM in documentation and project management before and during construction. The actual value of BIM is during the infrastructure or building life cycle. I guess we need to sit and watch. The successful BIM projects are those that will be meaningfully used during the building life cycle and perhaps in demolition.

Last question: does BIM make the geomatics sector more appealing?

As an industry, we need to stay relevant to the societal issues. There's a growing number of multistorey/high-rise buildings and major infrastructures. These developments are already generating socio-economic issues. BIM can be helpful in addressing these issues, and that's why a BIM-enabled industry will grow. ◀

MOHSEN KALANTARI

Dr Mohsen Kalantari is a senior lecturer in geomatics and associate director at the Centre for SDI and Land Administration in the Department of Infrastructure Engineering at the University of Melbourne, Australia. He teaches BIM, land administration systems and spatial analysis. He is the author of several publications in scientific, professional and public media outlets and he is currently involved in several research projects. Dr Kalantari chairs the International Association of Geodesy's BIM-GIS working group, co-chairs the OGC's Land Administration DWG and is affiliated with the FIG 3D-Cadastre working group. He also advises land administration and mapping agencies in Australia and Asia.

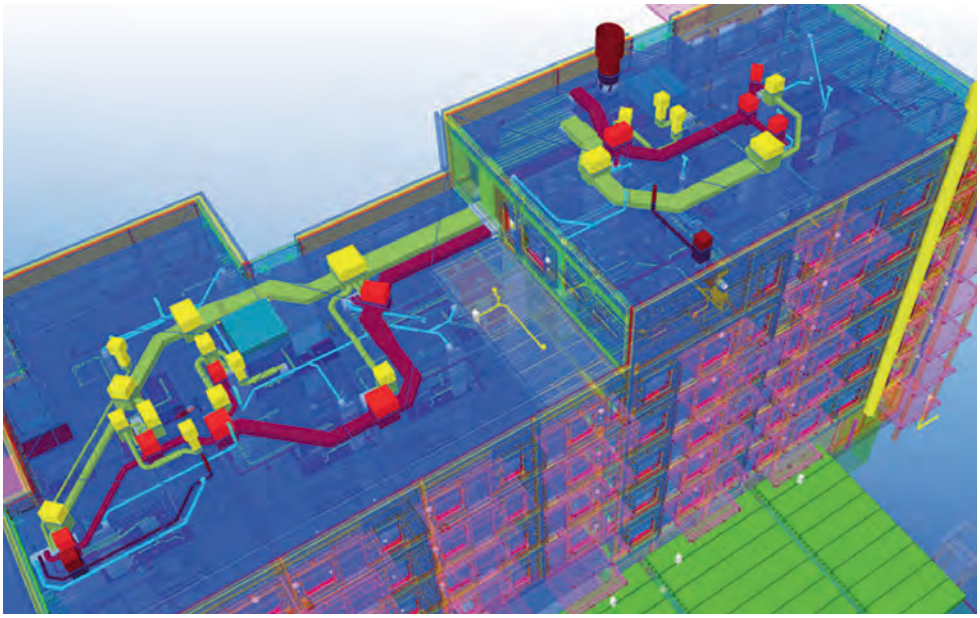
BIM: IMPORTANT OPPORTUNITIES AND CHALLENGES FOR SURVEYORS

A New **Model for Surveyors**

Building information modelling (BIM) is one of the most intriguing opportunities for surveyors to come along in years. This model-based approach combines technologies and processes to support the efficient creation and use of information for building construction and operations. Because of its strong ties to spatial information, BIM offers a familiar landscape and rich possibilities for surveyors and other geospatial professionals.

The opportunities stem from the growing acceptance of BIM within the surveyor's traditional client base of engineers, architects and property owners. By gaining an understanding of the key concepts of BIM and of how their skills and tools can contribute to BIM-based approaches to construction, surveyors can position themselves to effectively serve these clients' needs. The perception and use of BIM varies with the needs of each project's stakeholders. While spatial information is a key component of many BIM processes, it is only a portion of the information that project stakeholders need to be able to move from a design model to physical construction and operation. Additional data on a structure's individual components – including descriptions, specifications, sourcing, installation, maintenance and asset management – is used by multiple disciplines. In addition, BIM often includes project management and the 4D and 5D processes that bring scheduling and costing components into project modelling.

For surveyors working on BIM-based projects, flexibility is an essential characteristic. A surveyor is not expected to be an expert on all aspects of a BIM-based project, and nor is the architect, structural engineer or plumbing contractor. However, it is certainly important for the surveyor to understand the role of spatial information in the myriad BIM processes. In addition, the surveyor must know how to apply his or her skills to ensure accurate, efficient utilisation of spatial data. Surveyors and other geospatial professionals would do well to become highly skilled in BIM concepts and technologies that rely on spatial information. By doing so, they can provide valuable services throughout a project's



▲ *A 3D model of a planned building. BIM processes combine design data from multiple sources to develop integrated models and plans.*

▲ *A laser scanner captures data at a bridge. 3D scanning provides detailed, timely data on conditions and progress for BIM projects such as civil infrastructure.*

development, construction and operation stages.

IT IS IMPORTANT TO UNDERSTAND THE ROLE OF SPATIAL INFORMATION IN THE MYRIAD BIM PROCESSES

AUTOMATION IN CONSTRUCTION

The basic concepts behind the benefits that BIM brings to the surveyor's clients have been in place for years. BIM begins with a digital approach to a project's processes. Automation and digital technology have demonstrated their value in a variety of industries for decades. Computer-aided design and manufacturing (CAD/CAM) has transformed industrial processes and produced cost-effective increases in productivity, capacity and quality. In many businesses, automation is essential to remain profitable and competitive. The automation trend will continue and will push automated processes and equipment into new applications and arenas, including some already familiar to surveyors.

But even in the face of documented benefits, some industries remain slow to adopt new technologies – and the construction industry is one of them, according to a 2015 report by McKinsey & Company. Automated machine guidance is gaining acceptance in construction projects that involve significant earthwork, but those tasks represent a relatively small portion of the overall construction market. A much larger segment, building construction, is filled with opportunities for improved efficiency and productivity. Within the building industry, architects, engineers and project owners use BIM to improve quality and reduce costs throughout a project's life cycle. Because surveyors can participate in multiple BIM processes, they stand to benefit as the use of BIM takes hold.

Geospatial information is already essential during the planning and design phases. But more – and larger – opportunities for surveyors can be realised when BIM is carried into the subsequent phases of a building project, including construction, inspection, financial control, project management and beyond. A 2014 analysis by McGraw-Hill found that contractors report the return on investment (ROI) for BIM ranges from 10 to 25 percent. The ROI increases as BIM is used in more stages of a project and as the contractor's experience and engagement with the technology increases. The report noted that BIM can be especially valuable in the later phases such as building operations and life cycle management. Surveyors can play a key part in these later phases through collection and management of as-built and inspection data. Project owners rely on as-built information in BIM databases when formulating decisions on upgrades and modifications over the life of the building.

BIM is also moving beyond the arena of traditional building construction. Projects such as civil infrastructure, utilities, power

MIXED REALITY: READY FOR PRIME TIME

Mixed reality (sometimes referred to as 'augmented' or 'modified' reality) combines digital models with the real environment to produce a view of the physical world overlaid with 'virtual' information. The techniques of mixed reality allow users to experience new or modified conditions in relation to an existing physical setting. This differs from virtual reality commonly found in gaming, where nothing is real and users are isolated from their physical surroundings. Instead, mixed reality enables the user to control the amount of digital content that is overlaid onto the physical world.

The growth of mixed reality stems from advances in both hardware and software to simplify a very sophisticated technology. One example is the Microsoft HoloLens, a wearable device that can map its environment and then add digital content. That makes things simple for the user – there is no need to somehow locate and orient the device in a location; it does that for itself. Other devices, such as the Google Tango tablet, provide similar capabilities.

On the software side much of mixed reality has roots in gaming, which opened the door for virtual reality at the consumer level. Gaming provides a powerful, hardware-agnostic platform for software development. This approach enables developers to port applications to multiple devices, which is an important advantage in today's world of rapidly changing hardware capabilities.

Mixed reality is finding a home in BIM. For example, Trimble's SketchUp Viewer software enables users to export and visualise models on HoloLens. A user can look at a model at a smaller scale, so one could 'set' a model on a table top like a little hologram and rotate it around for different views. Alternatively, it is possible to display the model at a 1:1 scale and move around inside it to experience the relation of the model to the physical environment.

Industry experts expect that the 1:1 scale will be where people start to see the most value in mixed reality. In one case, a designer took a client on-site and used mixed reality to show the client a proposed modification to a building. Almost immediately, the client moved from the "Wow, this is amazing technology" reaction to analysing the scene and suggesting changes to the design. Although the client had seen 2D and 3D depictions of the project on a computer screen, the mixed reality enabled him to spot the necessary changes. The team could then implement the revisions before construction began and avoid costly rework later in the project.

The large and complex 3D models common to BIM can tax the capability of handheld or wearable technologies. Developers are again tapping gaming technologies to leverage algorithms that optimise visualisation of large-scale models. While the technologies continue to evolve, modified reality has already proven its ability as a common and valuable tool for surveyors, architects, engineers and their clients.

▲ *A point cloud reveals bulges in a concrete shaft. Designers can extract precise dimensions to adapt to the discrepancies.*

▲ *A field controller with layout data for building construction. Data and instructions can be sent directly from a BIM server to on-site devices.*

stations and industrial facilities all benefit from BIM's ability to provide strong integration of information and workflows together with streamlined interaction among owners, contractors and consultants. The key advantages include: increased collaboration among owners and designers; reduced errors and omissions; the use of virtual construction and constructability analysis to reduce rework; and detailed as-built information for use in operations and asset management.

THE PRESENCE OF GEOSPATIAL INFORMATION IN BIM HELPS TO STREAMLINE THE COLLABORATIVE PROCESSES OF FEASIBILITY ANALYSIS, PLANNING AND PERMITTING

GEOSPATIAL INFORMATION FOR BIM

The awareness of BIM is accelerating in certain sectors within the architecture, engineering and construction (AEC) markets. Some stakeholders in the construction arena have also recognised the potential of BIM to produce rapid improvements. Disciplines including general contractors, fabricators and mechanical, electrical and plumbing (MEP) subcontractors were among the early adopters and have been followed by design professionals such as architects and engineers.

Geospatial data from ground and aerial sources is one of the first and most important layers in a construction project model. The presence of geospatial information in BIM helps to streamline the collaborative processes of feasibility analysis, planning and permitting. Accurate geospatial information also helps to prevent surprises during the main construction work. As BIM takes hold, surveyors are learning new skills and creating innovative approaches to meet the expanding needs of their clients.

While many of the solutions that surveyors use for a BIM-based project are familiar and something they commonly utilise, newer geospatial technologies are garnering more attention. This is due in part to BIM's strong capabilities for 3D modelling and visualisation. Aerial and terrestrial photogrammetry and Lidar can provide fast, non-intrusive measurement with rapid processing and delivery of results. Photorealistic 3D models of existing conditions can be merged with design data to support visualisation and design work. Traditional ground surveys remain vital components of any building project. Data from global navigation satellite systems (GNSSs) and total stations can be integrated with Lidar and photos to provide georeferencing and increased detail and precision for use by design and ownership teams.

A key part of sharing information during a BIM project is to ensure that all components and stakeholders are working in a common reference frame. Although important during initial planning, georeferenced positions are less critical to building construction contractors. Instead of ties to geodetic data, project coordinates are often related to building corners or grid lines. The surveyor can provide a valuable service by managing the horizontal and vertical datum transformations between the various site and building design models to establish a single, consistent 3D reference frame.

Tasks involving spatial information and positioning are abundant during construction of a BIM project. Surveyors can provide expertise and tools for layout, utility connections, quality control, volume measurements and as-built inspections. For example, surveyors might use GNSSs or total stations to confirm the correct location of concrete forms prior to pours. After a pour, a surveyor can use a laser scanner to quickly check floors and walls for flatness, plumb and bulges.

▲ *A contractor uses a robotic layout station to mark construction points. A key part of BIM solutions, specialised tools can eliminate paper drawings and enable tradespersons to work directly from design models.*

A recent project at a large water treatment plant near Washington DC, USA, illustrates how scanning can be combined with BIM during construction. Project surveyors used a scanner to confirm dimensions and fit of large pipes and structural components prior to installation. By combining point clouds with design models, the surveyors exposed a number of discrepancies between the design and physical conditions. The issues could be resolved before problems arose; components could be modified during fabrication to ensure accurate fit when installed. The technique prevented extensive – and very costly – rework.

Many other measuring tasks, such as layout for a building's MEP systems, are commonly performed by subcontractors and tradespersons. New tools developed specifically for these tasks can take data directly from the BIM database and guide the tradespersons through the positioning and layout processes. The tools provide accurate measurements while interacting with the workers using simple, familiar terms and workflows. Surveyors support this work by creating and maintaining the coordinate framework and extending it to include interior horizontal and vertical control points.

EMERGING TECHNOLOGIES AND PLATFORMS

One of the most valuable characteristics of BIM is its capacity for close collaboration among stakeholders. Cloud-based services support sharing and interaction by a wide variety of disciplines that use dozens of different file formats and work processes. Systems can combine models from multiple sources such as structural design, utility services, MEP and more into an integrated model for visualisation, analysis, construction planning and project management. Accurate spatial information is essential and surveyors can develop and maintain key data throughout the project.

Effective collaboration relies on efficient information exchange. File management, applications software and visualisation tools can all reside on a central server. By using cloud services, remote workers can access site data and develop changes or instructions with the confidence that the information will be immediately available to other team members. Additionally, cloud-based services provide strong version management and can automatically push design updates and work orders to the necessary people and locations.

BIM tools for visualisation enable users to see 2D and 3D images of the project during all phases including design models, construction progress and existing conditions for life cycle upgrades and facility management. Recent advances in technologies for mixed reality can support complex models to allow stakeholders to see and move around in the building model. Models can be experienced as stand-alone models or overlaid into existing structures to show users how designed features will interact with existing conditions.

Surveyors should think of BIM as a niche opportunity, albeit a very big niche. Because of their expertise with spatial information, surveyors and other geospatial professionals are well positioned to become trusted participants in BIM-based construction projects. They can leverage their skills in 3D data management, modelling and visualisation to support the design, build and operate processes that lie at the core of BIM. By developing and maintaining connections with stakeholders throughout the project, the surveyor sets the stage for long-term, profitable relationships. ◀

ABOUT THE AUTHOR

Ron Bisio joined Trimble in 1996 and held several marketing, sales and general management positions prior to taking over worldwide responsibility for Trimble's Geospatial Division as vice president. He holds a master of business administration from the University of Denver, a master of regional planning from the University of Massachusetts, and an undergraduate degree in geographic information systems & cartography from Salem State University in Salem, Massachusetts, USA.

A NEW FIELD DATA COLLECTION GIS TOOL FOR SMART CONSERVATION

Digital Transformation in New Zealand

In January 2016, staff from New Zealand's Department of Conservation (DOC) were supplied with tablets and smartphones equipped with Survey123 for ArcGIS, a form-centric mobile data collection application. The Hokitika township biodiversity monitoring field team used this mobile app as well as their current paper-based capture methods to evaluate the potential of digital data collection technologies in their workflows. This undertaking showed that not only can Survey123 improve efficiency and reduce field data capture operational costs, but it can also make captured data available easily and instantly for visualisation and analysis.

Like many other government departments, the New Zealand DOC is going through a digital transformation, replacing paper-based workflows with end-to-end business processes in which information flows instantly across staff teams, departments and – when appropriate – the public. Modern enterprise geographic information system (GIS) technology allows everyone in an organisation to create, access and share information anywhere, anytime and from any device, making their work more efficient and meaningful.

At the New Zealand DOC, wildlife surveys are typically conducted using paper booklets. "The paper-based methodology that we use at the moment is functional, but it requires a massive downstream team to digitise that information. It's sometimes even necessary to go back to the field team to confirm the data because it's unreadable due to smudging or rain," says Benno Kappers, DOC natural heritage information project leader. "Real-time mobile data collection can significantly reduce downstream efforts."

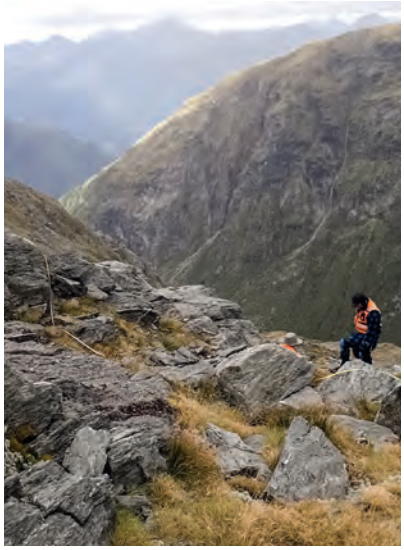
SMARTPHONES INSTEAD OF PAPER

A pilot programme was initiated to expose the New Zealand DOC staff to using mobile devices for in-field data capture as well as to compare the end-to-end system and organisational processes of both the electronic and traditional paper-based collection methods. Field crews were provided with Android smartphones and tablets. The software on these devices was Esri's Survey123 for ArcGIS, a data gathering mobile app that speeds up the collection process using simple forms. The programme's team visited three remote locations on New Zealand's South Island to survey possum crossings along fixed transects (paths).

EFFICIENCY IN THE FIELD

Using a simple spreadsheet and the mobile app's desktop companion tool,

▲ *Figure 1, Vegetation monitoring using standard methods.*



▲ *Figure 2, Field staff surveying transects.*

Figure 3, Mobile survey hardware provided for the pilot programme.

Figure 4, The Survey123 for ArcGIS app.

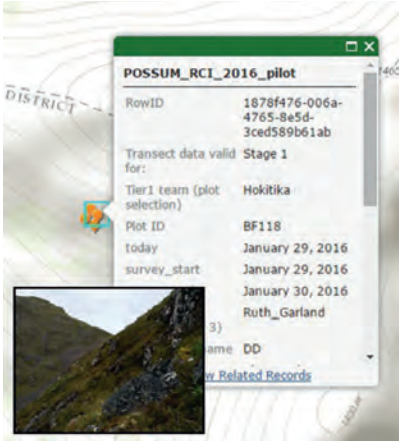


Figure 5, Data visualised in ArcGIS Online

Survey123 Connect for ArcGIS, customised forms were created and published in the ArcGIS platform. These forms were then downloaded to the mobile devices to facilitate the collection of information in the field.

Survey123 provided a simple, intuitive interface for users to input field data, which enabled staff to concentrate on making observations rather than on the process of recording them, which was one of the issues with paper-based data collection. Validation rules and expressions configured in the forms reduced the number of user-input errors.

DOWNSTREAM GAINS

Capturing data via traditional paper-based methods involves not just recording field data but also scanning and uploading it to the server, as well as physical logistics such as inventorying and shipping completed booklets. Much of the work in these processes was greatly simplified – if not eliminated – with app-based data collection.

Collecting data through forms on smartphones provided New Zealand DOC with greater control of field-user input. "People became far more concise about what they needed to say," explains Kappers. "That is helpful not only from an efficiency perspective but also from a data management one." Through the use of forms, the data captured was better structured than with paper submissions, and error-prone digitisation processes were eliminated as well.

REAL-TIME ACCESS TO INFORMATION

Getting feedback on paper-recorded data can take several months. After inputting information into Survey123, captured data was directly transferred back to the ArcGIS platform, where other members of the organisation could access the data in tables, maps and other types of information products. This real-time integration of field-collected data into an enterprise GIS platform made the storage, quality assurance, analysis and viewing of information more efficient and less costly.

RESULTS

Not only did the new software make the processes that staff undertook more efficient and less costly, it even rendered some processes unnecessary. Many tasks – including printing field booklets for every recorded plot, scanning the pages and uploading the scans to the server; packing, sending and tracking field booklets to the server in Christchurch; and issuing, digitising and performing quality assurance on booklets – have all been made obsolete due to the capabilities of Survey123 for ArcGIS. Additionally, in the pilot programme, these capabilities showed a reduction of 336 staff hours per monitoring method, per season.

SHARING WITH CITIZENS AND STAKEHOLDERS

For the New Zealand DOC, digital data collection with smartphones has been proven to make processes more efficient, in particular in downstream procedures but also in preparation work. In addition, departments can now provide almost-instant feedback on the data that staff supply, and once this data is integrated into online maps it can be shared with numerous citizen groups and stakeholders in the community with an interest in wildlife conservation, natural resource protection and stewardship of the planet. "These measurements that we undertake follow strict national protocols and could all be followed by community groups as well," comments Kappers. "If Survey123 allows us to share these forms with private community groups, the same information management which enables us to start comparing measurements of New Zealand's public land can also be applied to private land parcels. And that is a really valuable contribution to make."

FURTHER IMPROVEMENTS

New features and fixes are added to Survey123 for ArcGIS through monthly upgrades to the product. High-priority items in the road map include adding the ability for field users to capture areas and linear features as well as location data. Additionally, improvements are being made to workflow editing capabilities, including the ability to update existing database records. These two new features will become available in the first half of 2017 across all supported platforms.

ISMAEL CHIVITE

Ismael Chivite works as a senior product manager at Esri. With over 20 years of GIS experience, Chivite is passionate about building ArcGIS products that help organisations use geography to improve the way they work.

ichivite@esri.com

BY **WIM VAN WEGEN**, CONTENT MANAGER, GIM INTERNATIONAL

Premium **Precision Engineering** in Northern Germany

The annual Oldenburger 3D-Tage event, which I described as a *Geheimtipp* a couple of years ago, is held in the northern German city of Oldenburg and is now in its 16th year. At the 2017 edition, the spotlight was once again on a wide range of topics related to optical 3D measuring techniques, photogrammetry and laser scanning.

The Oldenburger 3D-Tage event, which always takes place at the Jade University of Applied Sciences, provides an excellent update on what's hot and what's not in the world of 3D data capture and visualisation. In addition to being able to display their surveying and geomatics systems in the small exhibition area, manufacturers are also allocated time slots to present details of their latest technological developments and product updates. For example, Topcon presented an overview of its mobile mapping technology, comprising GNSS survey, hybrid positioning and photogrammetry. By combining these measurement tools including software packages, the company offers surveyors a complete workflow solution.

MAPPING INNOVATIONS

The sessions at the two-day Oldenburger 3D-Tage event included lots of projects from students and researchers, most of whom are working at German universities. The general standard of contributions – often consisting of a 15 to 20-minute presentation – was high, providing some interesting new insights into the possibilities in the geospatial field and where the sector is heading. In one example, Dorit Borrmann and her colleagues have made significant progress over the last couple of years on 3D scan acquisition with their intelligent robot, named Irma3D, for mapping applications and in particular for surveying remote sites or dangerous areas.

The topics of virtual reality and augmented reality, with browsers, smartphones and tablets as online platforms, received considerable attention. Some presentations also covered the use of 'mixed reality': the simultaneous localisation and mapping (SLAM) of the environment and the merging the real and virtual worlds to produce new environments and visualisations. Thanks to these mapping technologies, the geomatics industry is becoming even more tech-savvy.

The attendees were also given a glimpse of the future. Topcon has recently started a collaboration with DAQRI, a leading player in enterprise augmented reality, to develop wearable technology designed to change the way construction and survey professionals interface with the job site. Leica Geosystems and Trimble – represented by distributor AllTerra – offer similar state-of-the-art solutions.

UNMANNED AERIAL SYSTEMS

One subject that has been touched upon before is that of suitable cameras for surveying and mapping with unmanned aerial systems (UASs). Ansgar Greiwe delivered a presentation on this topic, focusing on cameras for half-yearly flights with a high accuracy of 3cm and an area ranging from eight to 36 hectares. In photogrammetry, image quality is one of the key factors influencing the level of accuracy that can be achieved, especially in processes such as structure from motion (SfM). The camera systems available for UASs are based on various sensor concepts that have differing effects on the image quality. The impact of the image quality on the surveying accuracy in various scenarios with both Bayer-Pattern and Foveon sensors was examined.

Simon Mondry showed how a DJI Phantom can be used for surveying applications, combined with a Z+F laser scanner, a Trimble total station and a GNSS receiver from Leica Geosystems. Affordable consumer drones were compared against professional UASs. However, as a very relevant presentation of Heinz-Jürgen Przybilla showed, there are still parties seeking a solution based on metric cameras mounted on a UAS. IGN (France) and DLR (Germany) are currently working on the development of a metric UAS camera.

APPLICATION FIELDS

Many aspects of the surveying industry were discussed over the course of the event. The wide range of application fields covered included a virtual presentation of Cologne Cathedral, the development of a concept for automated 3D digitalisation of cultural heritage, the geometric precision of the Creaform HandySCAN 700 handheld 3D laser scanner and as-built documentation for building information modelling (BIM), to name but a few. After two days in the pleasant city of Oldenburg, the participants returned home filled with new information and inspiration. Many other conferences and trade shows still lie ahead, but Oldenburg has certainly got the year off to a good start. As the saying goes: 'Well begun is half done'! ◀

▲ *The general standard of the presentations at the Oldenburger 3D-Tage was high.*

How **Industry 4.0 and BIM** are Shaping the Future of the Construction Environment

The construction industry is on the cusp of a new industrial age. The fourth industrial revolution, or 'Industry 4.0', will see construction coming in line with more digitally developed industries, which will revolutionise not only how physical structures are designed, built and maintained, but also how they are subsequently used.

What it means in reality is open to interpretation and the ability to future-gaze. Some anticipate it will mean the use of smart materials and technologies to make our buildings intelligent. Others envisage that it will come to mean autonomous machinery carrying out aspects of production, with minimal human input. But what is commonly agreed is that it represents the use of technology to fundamentally improve the way we design and construct the world around us.

Better availability of relevant information, rapid issue resolution and collaborative working in the design, construction and operation of projects are among the key ways in which digitalisation is improving efficiency and resource use. As a result, engineering and construction companies plan to invest five percent of annual revenue in digital operations solutions per annum over the next five years[1].

At a global level, one practice that is helping to define what industry improvements are possible in the here and now through available digital tools and practices is building information modelling (BIM).

LEAVING BEHIND THE PAST

It is not disloyal to say that the construction industry has some challenges to overcome. For centuries the industry has been associated with delays and unforeseen costs, and the precedent for this has led to these failings being accepted as inevitabilities. Industry 4.0 represents an opportunity to evolve and set a new precedent for what is possible, not what has gone before. BIM is the first step in this evolution by attempting to create a central repository to collate digital information about a project or asset.

Even the most precision-based aspects of the industry have been reliant on analogue techniques and processes that come with too much room for costly mistakes. A good example is the tape measure, a tool still used on every construction project around the world but one that relies solely on the ability of the user to interpret and document the results. But this kind of analogue data does not facilitate a collaborative ecosystem needed for today's construction projects.

THE VALUE OF DIGITAL DATA

A key component of Industry 4.0 is digital data. With increased access to accurate, real-life data throughout all stages of an asset's lifecycle – from design through to construction and maintenance – time and cost efficiencies can be found and errors reduced. The benefits of digital data are already being seen to a degree through initial adoption of BIM. Yet, often, the creation of digital assets to represent the built environment is not based on the real-world data and therefore BIM is not being used to its full potential.

Geospatial experts play an important role within BIM because they can map and position complex, digital data in the real world defining how, when and where a project can be constructed. Conversely they also have the ability to inform the creation of the 'digital twin': a digitised version of the physical asset based on what exists in the real world. With comprehensive geospatial knowledge of the intended site, alongside the stream of digital data captured on-site, errors and delays do not need to be inevitable.

TRUST & COLLABORATION

The availability of digital data, whilst significant, is only a small step in bridging the gap between the analogue ways of working of the past and the construction industry's digital future. Industry 4.0 is underpinned by cross-industry trust and collaboration. Geospatial engineers, surveyors, designers and contractors will need to come together, freely exchange information and collaboratively solve issues as they occur, to maximise the benefit of free-flowing information. For instance, regular ongoing digital data capture and validation procedures of on-site conditions allow project teams to identify discrepancies between design intent and the actual construction. Any disparity can be captured and fed back into the project's digital environment to allow designers and contractors to assess and make informed, real-time decisions on remedial action, thus preventing costly mistakes from occurring.

Surveys, including one by the BIM Task Group in the UK, indicate that awareness of BIM is becoming widespread. However, comprehension of how it should be implemented remains inconsistent; BIM's roots in software still lead some to believe its only relevance is as a 3D modelling tool. This often means BIM's true potential – to guide all parties from initial planning stages through construction to building usage and maintenance – is not fully realised.

A common understanding of how the potential of BIM can be maximised and a joint effort to implement it will have a dramatic impact in bringing forward Industry 4.0. In practice this means all parties involved in a project – from design, planning, construction and maintenance – are working from and feeding into the same BIM data environment rather than working with segregated models or collecting data that is used in isolation. This requires an unprecedented level of collaboration and trust.

A VISION FOR THE FUTURE

If Industry 4.0 is to be achieved, companies will not only need to ensure staff have the right expertise and culture but also a clear ambition and vision for what success looks like. A good example of this is the UK's BIM Alliance. The British body made up of industry representatives advises how BIM – and, more widely, digital construction practices – can be utilised across sectors. To champion the end goal of BIM rather than its technical components, Anne Kemp, chair of the BIM Alliance, pragmatically defines BIM as 'Better Information Management'.

Similar advisory bodies in other markets, promoting how digitisation will enrich the sector and providing practical advice on how to work collaboratively with new technologies, could help drive Industry 4.0 forward. And by promoting the Industry 4.0 ideology we can all move our industry into the future and reap the benefits. ◂

ABOUT THE AUTHOR

Mark King is EMEA BIM solutions manager for Leica Geosystems. Mark joined Leica Geosystems in 2014 and is focused on Leica's BIM Field Trip solutions that link the office and construction site through 3D data.

FURTHER READING

For more information about unlocking the value of BIM, please see Leica Geosystems' whitepaper: http://leica-geosystems.com/en-gb/about-us/local-content/emea/en-gb/bimwhitepaper

[1] http://read.pwcnl/i/689382-industry-4-0-engineering-and-construction-key-findings

THE IMPRESSIVE CONTRIBUTION OF GEOMATICS TO AUTONOMOUS DRIVING

Paving the Way for Self-driving Cars

Since Karl Benz was granted a patent for his first internal combustion engine in 1879, the automotive industry has changed substantially. Or has it? The main principle remains the same: cars still have four wheels, a petrol- or diesel-powered engine – electric cars are still underrepresented and so far there are just a few hydrogen cars publicly available in select markets – and they still need to be driven by a human being. However, a major change is just around the corner: self-driving vehicles. And they won't get far without geomatics technologies.

Not only car manufacturers such as Ford, Volvo, Tesla (Figure 1) and Mercedes-Benz (Figure 2), but also the likes of Google and Uber have been testing autonomous vehicles over the past few years. Volvo recently announced it is looking for drivers who are interested in participating in its self-driving cars trial, reportedly the largest conducted by the automobile industry so far. Operating the car should be as easy as using a smartphone, the Swedish carmaker states. Great strides have been made in the development of the next-generation car, but what is the technology behind it? This article zooms in on the key role geomatics plays in autonomous driving.

GNSS

Self-driving cars can navigate on their own, which already implies that geomatics is involved. Global navigation satellite system (GNSS) technology provides the accuracy that a vehicle requires to be self-driving. A high-precision and reliable localisation solution is fundamental. Just imagine, for example, what could happen if poor localisation positions the car on the wrong side of the road. Therefore, the availability of accurate and reliable GNSS technology is a major challenge to the advancement of autonomous driving. Only the most sophisticated GNSS receivers are suitable for use in self-driving cars. Those receivers rely on multiple frequencies and use multiple constellations. GNSS positioning is combined with an inertial navigation system (INS), creating a powerful system that compensates for the inherent weaknesses that occur when just one system is used. Additionally, anti-jam technology is used to provide the required positioning and sensor integration.

One of the companies known among geomatics professionals focusing on autonomous cars is NovAtel. The Canada-based GNSS specialist states that its technology is capable of providing decimetre-level accuracy to ensure a vehicle stays in its lane and/or at a safe distance from other vehicles. NovAtel aims to develop solutions that make driverless cars a common sight on our roads, providing the autonomous driving positioning reference. The Canadians therefore have established a special engineering team – the Safety Critical Systems Group – dedicated to developing functionally safe GNSS positioning technology for fully autonomous applications.

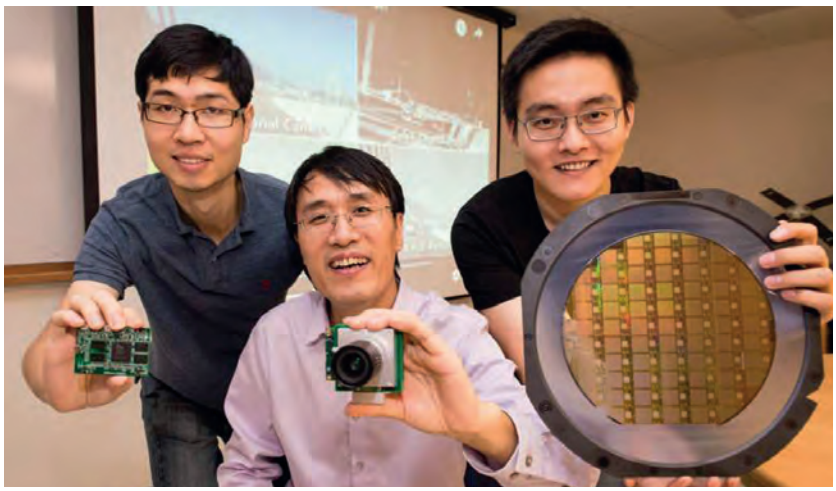
▲ *Figure 1, Tesla Autopilot drives itself safely in a variety of conditions. (Courtesy: Tesla)*

OPTICAL CAMERAS

Optical cameras are part of a suite of sensors that work with an on-board computer to map the local environment in real time. The camera sees objects right in front of it. These include pedestrians and other motorists, but also wild animals crossing. It is clear that autonomous driving demands safe interpretation of the camera images in order to make them fully suitable for decision-making. Nanyang Technological University in

Singapore (NTU Singapore, Figure 3) recently announced it has developed an ultrafast high-contrast camera to help self-driving cars see better in extreme conditions such as bad weather. Whereas typical optical cameras can face difficulties when blinded by bright light or at night, this new smart camera is able to record all moving objects in real-time. Several camera technologies are being applied in the self-driving car industry, each with their own advocates. For example, Tesla uses cameras as a primary sensor and has equipped its cars with eight monocular cameras. Stereo cameras, on the other hand, give the car depth of field that can be compared to human vision. Stereo cameras also offer the advantage of being cheap to produce while providing high-quality measurements in real time. However, some claim that fisheye cameras are an even better alternative, as these are capable of covering a wider field of view as well as of detecting obstacles in the very near vicinity of the car that are often not seen by a binocular stereo camera set-up ([1] Christian Häne et al).

▲ *Figure 2, Mercedes-Benz is one of the pioneers when it comes to autonomous driving. (Courtesy: Daimler AG)*



▲ *Figure 3, The NTU Singapore research team that developed the ultrafast camera. (Courtesy: NTU Singapore)*

RADAR

On-board radar technology increases the safety of passengers, a fundamental issue in autonomous driving. Radar sensors are mounted on the car's front and rear bumpers, giving the car awareness of what is in front of and behind it. The car will maintain a safe distance (two seconds) from the car ahead. When equipped with radar technology, the car automatically speeds up or slows down depending on the behaviour of other vehicles. In fact, radar observes the (changing) distances between the car and other vehicles. The software interprets the data and sends a signal that the car needs to accelerate or decelerate.

The latest development in the field of radar technology is vehicle-to-everything (V2X) radar. This combines vehicle-to-vehicle communication and vehicle-to-infrastructure technology, while operating on a single antenna. Radar has a big advantage compared to other technologies: it can cope with weather conditions such as fog, snow and heavy rain. V2X is able to instantly detect vehicle speeds, thanks to Doppler measurements, and obtains 360-degree sensing from a single antenna. These capabilities make V2X radar an important step in developing new sensors for autonomous vehicles.

LIDAR

In the automotive industry, Lidar is usually applied as a spinning cylinder mounted on the vehicle's roof. Laser pulses bounce off the surrounding objects, the time of flight is measured and, thanks to real-time processing of the Lidar data from the 360-degree sensors, the car 'knows' exactly how far it is away from other objects. As Lidar functions as the eye of driverless cars, it is no surprise that most self-driving car solutions use Lidar as the main sensor. Lidar is essential for emergency braking, pedestrian detection and collision avoidance.

In August 2016 Velodyne LiDAR, a global leader in Lidar technology, announced that it had received a combined USD150 million investment from co-investors Ford and China's leading search engine company, Baidu. The investment will allow Velodyne to rapidly expand the design and production of high-performance, cost-effective automotive Lidar sensors (Figure 4). This step paves the way for mass adoption in autonomous vehicles and so-called Advanced Driver Assistance System (ADAS) applications and will thus accelerate the critical, transformative benefits they provide. Lidar technology has been recognised by global automotive companies as a critical enabler in the development of fully autonomous vehicles. Meanwhile, in December 2016, Magna – a leading manufacturer of auto parts – and Innovize revealed that they are partnering to deliver Lidar remote sensing solutions for the implementation of autonomous driving features and full autonomy in future vehicles. These are just two examples of the automotive industry investing in Lidar, and several well-known carmakers have also shifted their focus onto Lidar. Most self-driving concept cars rely on radar and Lidar to cross-validate what they are seeing and to predict motion.

▲ *Figure 4, Car-mounted Velodyne LiDAR technology.*

▲ *Figure 5, Self-driving Uber Volvo XC90 in San Francisco. (Courtesy: Uber)*

In 2016 Princeton Lightwave, a leading manufacturer of photon Lidar (also known as Geiger-mode Lidar or single photon Lidar/SPL) formed the Automotive LiDAR Business Unit. In contrary to conventional Lidar systems, photon Lidar creates an array of points from a single pulse fired by the system; one pulse is divided into dozens or hundreds of sub-pulses. The technology is widely used in Earth observation studies and is capable of sensing beyond 200 metres, which is a significantly longer range than other Lidar systems. Single photon Lidar is especially suitable for self-driving cars when it comes to navigation, as they require very high-fidelity mapping of geometric road design. Because the car is aware of its environment – e.g. the roadbed, curves, slopes, etc. – it is able to calculate safe speeds, lane changes and so on. The unit at Princeton Lightwave is set to commercialise the company's photon Lidar activities for the autonomous car industry. Most self-driving cars rely on Lidar, but Tesla is an exception. So far, the owner of the company, the eccentric billionaire Elon Musk, is sticking to conventional radar combined with ultrasonic sensors. Musk has repeatedly dismissed the need for Lidar, stating that it makes no sense in the context of driverless cars. However, in view of the indisputable fact that the cost of Lidar technology will fall, it is not entirely unlikely that Teslas will also be equipped with Lidar sooner or later.

ARTIFICIAL INTELLIGENCE

Ford is not only focusing heavily on Lidar technology. In February 2017, the firm declared it will be investing USD1 billion over the next five years in Argo AI, an artificial intelligence company – interestingly enough founded by former Google and Uber leaders. The idea behind this massive investment is that Argo AI's robotics experience and artificial intelligence software is essential to further advance driverless cars. The key objective of this cooperation is a new software platform for Ford's fully autonomous vehicle due to be launched in 2021.

Artificial intelligence is a fundamental tool to overcome the biggest on-road challenge for self-driving cars, namely how to cope with the randomness of traffic flow and how to react to other drivers. Traffic is ever-changing and there are no patterns of behaviour; every single situation differs from a previous one. Artificial intelligence, which is all about is the combination of deep learning and sensor fusion, will not enable cars to predict traffic situations. However, it is possible to create a complete, three-dimensional live map of the environment surrounding the car, thus helping the vehicle to make better decisions more quickly. By sharing their experiences and analysis with other vehicles, self-driving cars can outperform humans. Thanks to artificial intelligence algorithms, they can improve their ability to react to situations on the road without having to first experience those situations themselves.

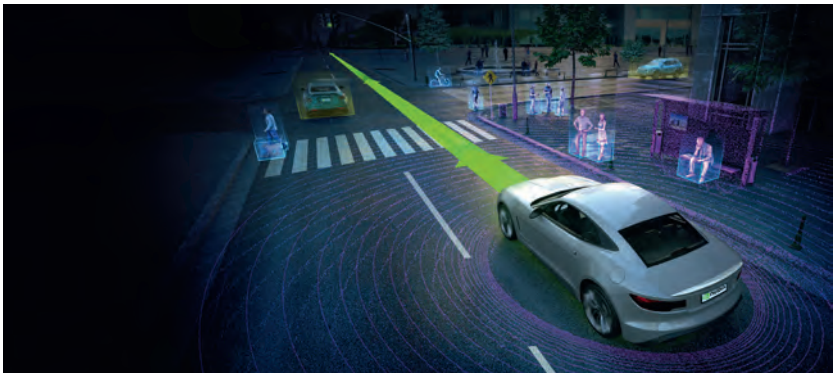
3D MAPS

The advancement of autonomous vehicles is a driving force behind the collection of point clouds around the world. Maps for self-driving cars need to provide more information at a higher fidelity and accuracy, comprising features such as lane markings and roadside barriers. High-definition (HD) map datasets deliver high-precision intelligence on road features, e.g. painted lines, signs, 3D building

FURTHER READING

- [1] Christian Häne, Torsten Sattler, Marc Pollefeys: Obstacle Detection for Self-Driving Cars Using Only Monocular Cameras and Wheel Odometry
- Driving towards the Autonomous Vehicle: European GNSS Agency (www.gsc-europa.eu)
- Mathias Lemmens: Photon Lidar, a Promising Advance in Mapping Applications; GIM International
- Steve Crowe: How AI is Making Self-Driving Cars Smarter; Robotics Trends

John Ristevski: Building a Global 3D Routing Map, *GIM International*



▲ *Figure 6, NVIDIA Drive PX 2 utilises deep learning to enable object detection and classification, map localisation and path planning. (Courtesy: NVIDIA)*

models, signals, stop signs and parking spaces. So-called self-healing mapping systems provide a state-of-the-art solution for autonomous cars. They solve the problem of out-of-date navigation data since they give cars the intelligence to update their own maps. Autonomous vehicles will be able to acquire and process data and convert it into useful information while on the road. In addition, the cars will be connected with the cloud in order make the right decisions about where they are going, including choosing the optimal route.

A mapping system for self-driving cars, designed to help carmakers, map companies and start-ups to rapidly create HD maps and keep them updated, is being offered by companies such as HERE, NVIDIA (Figure 6) and Sanborn. An interesting project is underway in Japan, where a consortium of car manufacturers is taking part in the Dynamic Map Planning initiative, initially set up by Mitsubishi Electric. Nine carmakers are teaming up with the mapmakers from Zenrin. The association will create a digital chart of the nation's key expressways by driving specially equipped vehicles over them. Japan aims to have autonomous cars on its roads on a considerable scale by the 2020 Tokyo Summer Olympics.

CONCLUSION

A driverless vehicle needs to be able to understand in real time what is happening around it, precisely locate itself on an HD map, and plan a safe path forward. The world's most advanced self-driving car platforms combine deep learning, sensor fusion and surround vision for an optimal driving experience. GNSS, ranging and 3D mapping systems (in particular Lidar), and artificial intelligence are making this possible. Therefore, they are all fundamental factors in the future success of the autonomous car as a game changer in transportation, as Lidar has already proven to be in the world of autonomous vehicles. What perhaps counts against Lidar is its price tag, especially compared with technologies such as cameras, GPS-like data or radar, but thanks to technical innovations this obstacle is gradually being eroded. As a report by Market Research Future indicates, the global autonomous vehicles market is expected to reach a value of USD65.3 billion by 2027. Hence, the best advice to the geomatics sector is: fasten your seatbelt and enjoy the ride!

ACKNOWLEDGEMENT

Thanks to Sabine de Milliano for reviewing the article and her valuable suggestions for improvements. ◀

BIOGRAPHY OF THE AUTHOR

Wim van Wegen is content manager of *GIM International*. In his role, he is responsible for the print and online publications of one of the world's leading geomatics trade media brands. He is also a contributor of columns and feature articles, and often interviews renowned experts in the geospatial industry. Van Wegen has a bachelor degree in European studies from the NHL University of Applied Sciences in Leeuwarden, The Netherlands.

✉ wim.van.wegen@geomares.nl

AN ALTERNATIVE TO UAVS FOR 3D MAPPING AND BIM VERIFICATION

Crane Camera Site Surveying

The construction industry is fully embracing the concept of BIM, as it provides an efficient way to manage complex projects. A prerequisite for BIM to be used successfully, however, is that the very detailed schedule and build sequences defined by BIM are strictly adhered to. Regular and accurate site surveys are crucial to achieve this. Although UAVs are suitable for collecting such site data, they have various limitations. A crane-based camera mapping system offers an alternative and enables the automated capturing of on-site data, both at minimal cost and without interfering with the site. This article explains how a crane camera solution enables project managers to resolve some of the most complex and lingering challenges in construction.

In the past few years, building information modelling (BIM) has gained considerable ground in construction. More and more companies worldwide are adopting BIM technologies to optimise project management, helping them to better synchronise all aspects of the construction process: planning, designing, building, operation and maintenance. In 2010, the UK-based National Building Specification (NBS) reported that less than 15 percent of the construction industry was engaged with the building information modelling approach. In 2015, that number reached 48 percent, and 2016 saw tremendous growth as governments engaged in BIM, creating new policies to encourage and support BIM adoption. However, there still are many challenges to address in the industry today. Companies like Liebherr, the world's largest manufacturer of tower cranes, recognise the need to adopt intelligent and collaborative systems to improve project management efficiency. Being able to visualise and monitor the progress of construction sites is one of the key challenges highlighted by construction professionals. The lack of communication and feedback in the industry shows there is a strong necessity for continuous site surveying and tracking technologies.

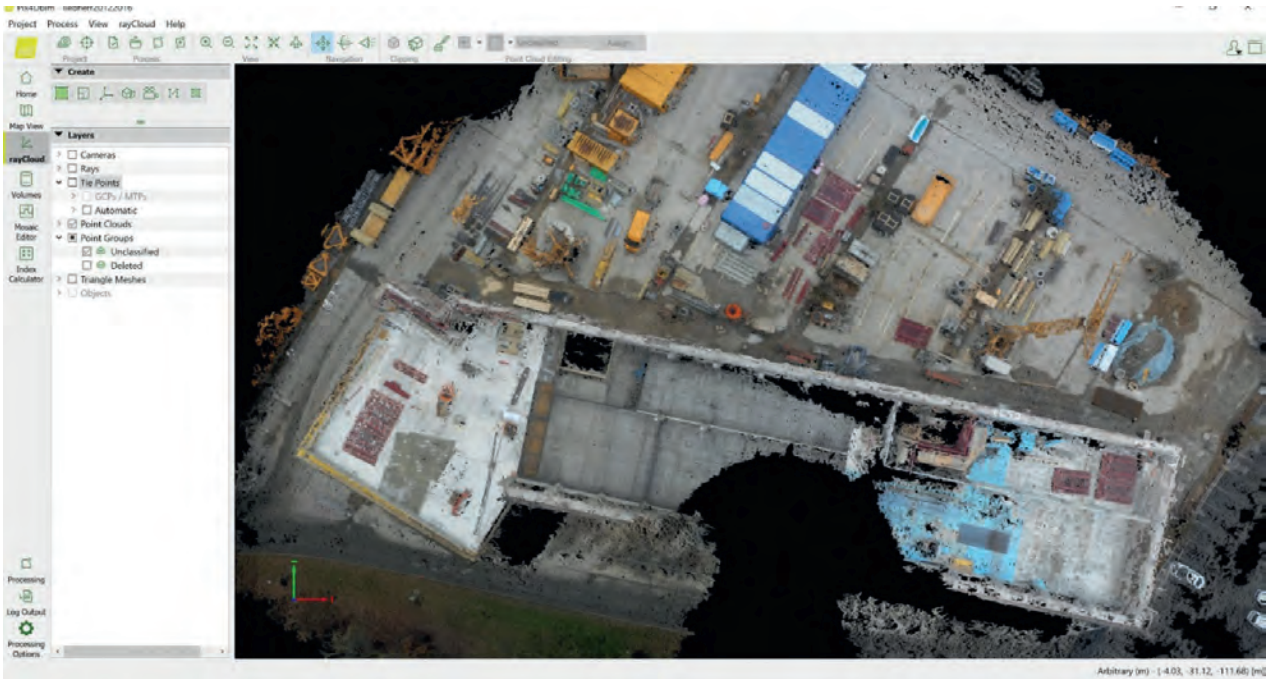
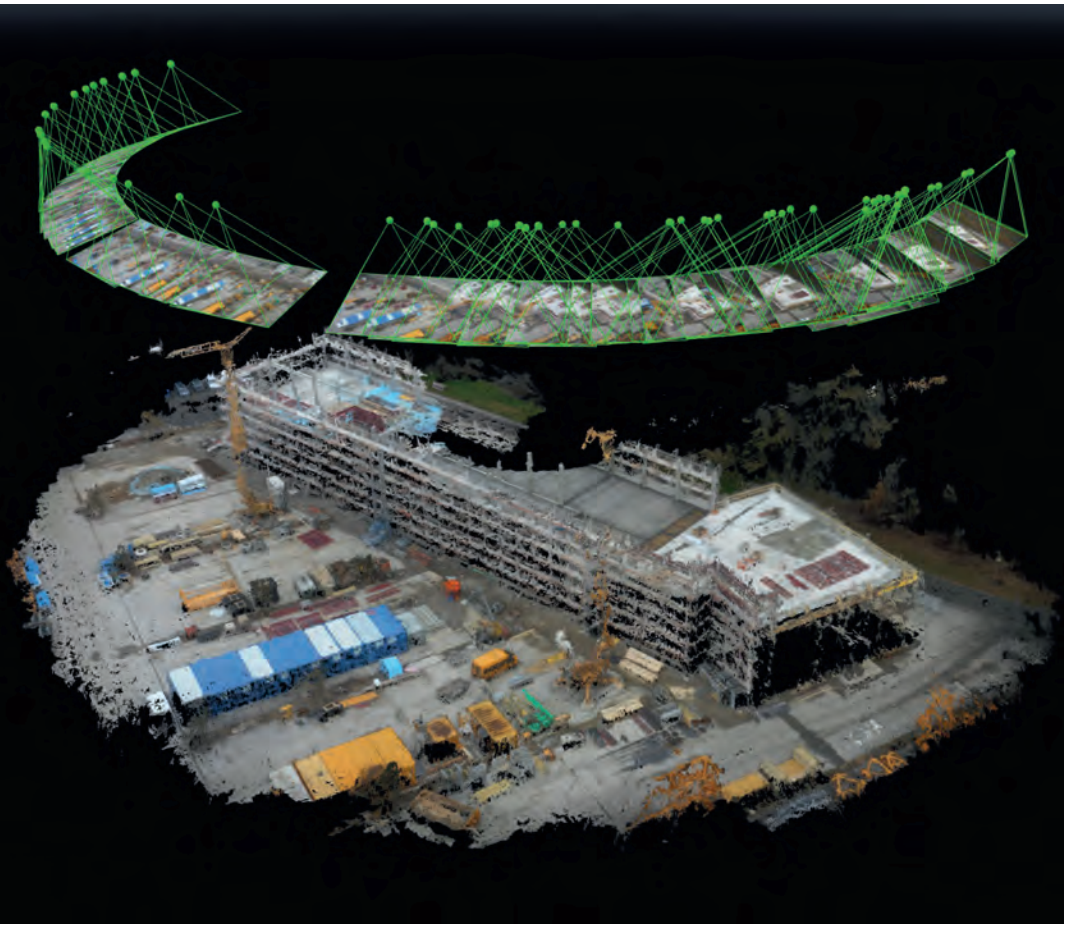


Figure 1, 3D point cloud of the site, exported to the Pix4D desktop software.



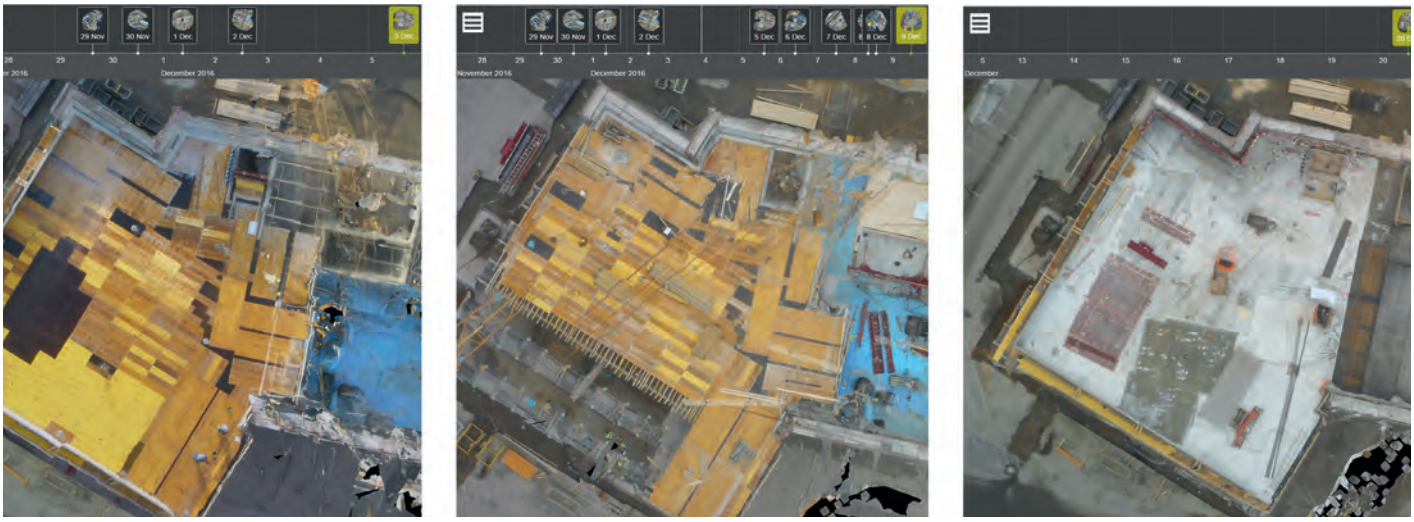
▲ *Figure 2, 3D point cloud of the site with camera positions.*

UAV MAPPING

The introduction of unmanned aerial vehicle (UAV) mapping has revolutionised aspects of site monitoring in construction, with more and more construction companies embracing the use of UAVs as part of their smart building process. Orthomosaic maps, point clouds and digital surface models can be produced from UAV-based sensors for complete aerial site surveys and inspections. Data collected with UAVs is typically available shortly after the flight and can usually be processed within just a couple of hours. Although their use in construction is increasing, UAVs have their limitations as well. Piloting UAVs over construction sites in cities, urban districts, airport zones or critical areas can sometimes be a real challenge due to flight permissions, weather conditions, legal restrictions and job site obstructions. Alternative solutions are therefore required to complement UAV-based surveying systems.

A NEW SITE MONITORING SOLUTION

A camera mounted on a crane is an excellent alternative to UAV mapping and traditional techniques such as terrestrial laser scanning. Cranes are already present on construction sites and no flight permission is required. In places where UAV flights are sometimes too difficult or even impossible, a crane camera is ideal as a long-term alternative, or it can work alongside and complement UAV imagery. UAV-software developer Pix4D has teamed up with Liebherr in creating a new site monitoring solution. Combining Pix4D's expertise in site mapping and Liebherr's experience with cranes, a crane-based automated solution with BIM integration has been developed. The new solution consists of an advanced camera system installed on tower cranes which is connected to the Pix4D cloud-based software. Mounted on and powered by the crane, the camera system is fixed at the end or along the jib. The optimal location depends on the site configuration, but a position over the centre of the building site usually provides the best results. The system is equipped with movement sensors and firmware, and takes images automatically when the crane begins to operate. When enough data has been collected to provide a complete aerial overview of the site, it is



▲ *Figure 3, Site progress of one part of the new Liebherr administration building, viewed as 2D orthographic images in the Pix4D cloud-based platform. A timeline feature makes it possible to compare different stages in the construction process.*

automatically transferred to the Pix4D Cloud via a Wi-Fi or 3G/4G connection, where it is processed.

DAILY MAPPING SURVEYS

The Pix4D Cloud turns the images into 2D and 3D map intelligence: orthophotos, 3D point clouds, 3D mesh models and digital surface models. The crane camera solution produces similar surveying results as UAVs, but the system operates without human intervention. It automatically delivers daily updates of the as-built status, which are available in the cloud to be analysed and shared with anyone who needs to review the current site status. Additionally, results can be exported to BIM software for further analysis. It is a major advantage to receive automatic reports rather than having to wait for feedback from the field. With continuous mapping during construction works, it is easier to monitor a site and spot errors or omissions early. An estimated 15 percent of a typical construction site's cost is caused by human mistakes, so by having an automated solution to verify the as-built status and align the schedule, a significant reduction in cost and project duration can be achieved.

FIRST RESULTS

The first crane-based camera solution has been deployed on the construction site of Liebherr's new administration building in Biberach an der Riss (Germany), the headquarters for the Tower Crane Division. Installed in November 2016, the solution has been running since then, fulfilling its promises: monitoring the site daily, offering a complete aerial overview of the job site, documenting progress and facilitating communication among all stakeholders. Liebherr team members can access the Pix4D Cloud to visualise the site day by day.

TOWARDS FULLY AUTOMATED MONITORING

Given the complexity of construction sites and the large volumes of data involved, there is a strong demand for fully automated solutions. With an automated workflow that operates without human intervention and that provides deliverables that are compatible with BIM software, the crane-based camera system already marks a major step in the right direction. The next step is to combine the crane-based data with ground-based handheld cameras and develop integrated solutions to automatically produce 3D point clouds of the construction site as seen from multiple angles. These developments will not only challenge traditional forms of surveying such as laser scanning, but they will also bring the industry one step closer to real-time, fully automated, accurate and continuous monitoring of the entire construction site. ◂

ABOUT THE AUTHOR

Sabrina Cardot is a construction industry marketing specialist at Pix4D. Founded in 2011 as a spin-off of EPFL in Switzerland after more than ten years of leading scientific research, Pix4D has become the main provider and industry standard for professional UAV photogrammetry software.

✉ sabrina.cardot@pix4d.com

SOUTH
Target your success

POLAR

X5/X6

- 8GB SD storage
  (Android y/Windows Mobile optional)
- Laser centering
- 4.3 inch 480×800 screen
- NFC and fingerprint identification optional
- 4 hours quick charge

GALAXY G6

- Linux Operating System
- WIFI hotspot & connection
- Radio router
- Rinex storage support
- Complete NTRIP Caster
- 8GB SD storage

www.southinstrument.com

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

CHONGQING SURVEY INSTITUTE REALISED WHAT MANY STILL DREAM OF

3D GIS in China

Since 1998, the Chongqing Survey Institute (CSI) has been managing the 3D geoinformation database, including terrain, buildings, underground pipelines, geology and underground buildings of the megapolis of 30 million people. For the commercial market, CSI's 3D Mobile group focuses on combining the indoor and outdoor environment with e-commerce systems. Meanwhile, its BIM and GIS Integration group concentrates on three fields: geological survey, construction sector and municipal administration.

Chongqing is a city of unique topographical and landscape features. It is built on mountains and partially surrounded by the Yangtze and Jialing rivers, making mapping the city a big challenge for the Chongqing Survey Institute (CSI). Capturing the terrain in three dimensions is, due to the topographic features, an immediate plus. By integrating ground and underground 3D geoinformation, the 3D database of Chongqing is widely used in the fields of urban planning, utility management, construction simulation, emergency response, etc. CSI has been honoured as an advanced city survey unit in China several times. There are tens of millions of objects in the database, which currently covers spatial objects of 82,000km^2, including both above-ground and underground structures, roads, terrain and (underground) pipe networks. Chongqing is changing at an annual rate of approximately 5 percent, mainly because of the development of new urban areas. There are about 30 employees responsible for the maintenance of the 3D geodatabase. "For pipeline data this is automated with rule-based workflows, but other 3D data still requires manual modelling," explains Ms Mei Xue, vice chief engineer of CSI and also in charge of the Geo-Information department. "According to the local regulations, when a building or a civil project is completed, the 3D model needs to be input into the database. So far we've been updating the database on a monthly basis."

HOW CAN SO MUCH INFORMATION BE INTEGRATED SUCCESSFULLY INTO CONTEMPORARY SPATIAL PLANNING?

NOT ONLY FOR VISUALISATION

The Chongqing 3D models are highly informative models; one can take coordinates from the 3D objects, other attributes and hyperlinks for further information, etc. Therefore the 3D models with different levels of detail – from topographic sources to civil & infrastructure engineering and architecture, engineering & construction (AEC) – are not only for visualisation purposes, but are also widely used in environmental simulation and decision-making. They facilitate many changes. For instance, the rule-based 3D engine provides real-time adjustment, 3D simulation and assessment for the planning and design schemes. These are new but very effective technological tools for the workflow planners, according to Ms Xue: "The 3D engine can also be applied in 'intensive' city management when connected with information about enterprises, population and real estate."

▲ *Mei Xue: "Thanks to our high-performance database, we can provide new kinds of 3D survey and design services on the commercial market."*

▲ *Mapping Chongqing in three dimensions is, due to the topographic features, an immediate plus.*

▲ *Software has been developed to integrate BIM models with 3D GIS. Here an example of a civil application.*

CSI maintains a leading position at national level in the aspects of key 3D city simulation and 3D modelling technologies, mass multi-source data integration, and so on. A total of 66 software programs with independent copyright have been developed and 29 national patents were acquired which brought notable economic profit and social benefit. "With the rapid development of 3D geodata acquisition techniques, the biggest challenge is no longer the timely generation of urban data. Rather, it is in relation to how so much information can be exploited and integrated successfully into contemporary spatial planning and management. And we have to solve the redundancy and inconsistency issues when modelling data from different sources," Mei Xue adds.

The promising 3D technology makes ever-more demands on the capabilities of the institute's staff. They are focused on the cultivation of cross-functional skills and teams in software engineering, surveying and mapping, geology and law. Furthermore, there is a growing need for engineers who are keen to become experts in big data modelling and data mining. The role of a surveyor is changing, of course. "With the modernisation of surveying and mapping technology and equipment, many surveyors now need to work indoors as well – some of them are in charge of research & development tasks." There are 914 surveyors at the institute, 587 of whom work outdoors.

USER BENEFITS

Elsewhere, most 3D tools have to be used with 2D GIS and then visualised in a 3D environment (draping attributes over surfaces, so in effect 2.5D). That is not the case in Chongqing. The special topography of Chongqing makes it very difficult to demonstrate the complex topographic and landscape characteristics through 2.5D maps. Therefore, Ms Xue and her team use the concept of micro-topography to conduct 3D modelling based on the comprehensive utilisation of procedure modelling, building information modelling (BIM), Max modelling and oblique imagery modelling. "We've also developed our own software platform for the integration, management, dissemination and application of data. This platform supports the 3D analysis on matters such as landforms

and sunlight. However, professional analysis software is still needed in terms of the complex environmental simulation analysis – noise, atmosphere, dewatering, etc."
The establishment of the 3D database requires vast investment in data collection, update and maintenance management. However, the vice chief engineer does not give any numbers, not even on the plus side (describing them only as "very remarkable benefits"). When asked about the applications of 3D GIS which deliver the greatest user benefits in Chongqing, she answers: "I'd say the 3D civil design application and the 3D urban planning review application. These two applications are widely used by both the public and private sector in Chongqing. In the planning and design field alone, the 3D database has created enormous economic benefits. For example, thanks to our high-performance and very up-to-date database, we can provide new kinds of 3D survey and design services with greatly improved competitiveness on the commercial market."

THERE IS A GROWING NEED FOR ENGINEERS WHO ARE EXPERTS IN BIG DATA MODELLING AND DATA MINING

E-COMMERCE

For the commercial market, the institute's 3D Mobile group focuses on combining the indoor and outdoor environment with e-commerce systems. Citizens can view the restaurants and shops, search the racks of clothes in real time, view the price tags and use their mobile devices to make purchases. The 3D environment of the shops is captured by the Chongqing Survey Institute, and the retailers themselves can update the information about their merchandise on the platform.
The institute has set up an internet-based operation platform and – equally importantly – has established good cooperative relationships with the local commercial enterprises who also sell via e-services. That required new marketing expertise. The main technological challenge for CSI in combining the indoor and outdoor environment with e-commerce systems is the real-time image mosaic and fusion technique. Due to the frequently changing indoor environment – and in particular the displayed goods – the store owners need a convenient and efficient way to automatically match and correct the real-time images of their brick-and-mortar shops and update commodity information after the indoor photos are uploaded.

BIM

Nowadays integrating 3D data with different semantics, especially BIM and GIS, is one of the biggest challenges in the 3D domain. CSI's BIM and GIS Integration group is addressing the integration issue in both the architecture and civil fields. The team has also developed software to integrate and simulate the BIM models of buildings, roads, bridges and parcels in the 3D GIS environment. According to CityGML's level of detail (LOD) concept, most of the 3D models are at LOD2-3, while a small number of core areas reach LOD4 due to the integration with BIM data. The accuracy of data is consistent with the 1:500 topographic maps. Mei Xue: "In my opinion, what matters most in the integration with BIM data is the semantic divergence and difference rather than the accuracy of data. Interoperability is the keyword of GIS-BIM integration for which cross-functional knowledge, experience and communication are crucial." At present, a team of 20 has been set up to conduct technical research into the integration of BIM and GIS, primarily comprising three fields: geological survey, construction and municipal administration. With the professional BIM technical engineers and software research & development employees in each sector, CSI has completed several pilot projects in all three fields. "The economic value of these pilots, however, is yet to be examined through market projects," states Ms Xue, indicating one of her plans for 2017. Another plan is to provide spatial data for the construction of smart cities. "This year we hope that more BIM models can be integrated in the 3D database for the pilot applications of smart city. Another important goal is to provide BIM engineers with better GIS tools. In the field of civil design, the designed roads and pipelines need to be integrated into the geographical environment. But today's BIM software is not very well suited to cope with the high volume of 3D geodata about the area in which the new constructions are planned. We will provide a cloud-based 3D platform to our BIM engineers. By uploading the proposals to the cloud, they can simulate the proposals in a 3D geospatial environment and assess the environmental impact." ◀

▲ *CSI's 3D Mobile group combines the indoor and outdoor environment with e-commerce systems.*

CSI

Established in 1950, the Chongqing Survey Institute (CSI) is one of the oldest urban surveying institutes in China. The institute is part of the Chongqing Municipal Planning Bureau. The amount of public funding each year depends on specific programmes. Most of them are basic survey programmes, e.g. to produce and update 1:5,000 DLG (digital line graph), DEM (digital elevation model) and DOM (digital orthophoto model) data. By far the largest part of the institute's income comes from commercial activities, such as geology surveys, GIS software development, civil programme design and engineering surveys. CSI employs over 1,000 multi-disciplinary staff, including six women in high management positions (out of 67). The average age of the employees is 35.
Chongqing is a mega-city – or sub-province – in southwest China and one of four municipalities directly controlled by the central government (as are Beijing and Shanghai). Chongqing is a rapidly urbanising area of more than 82,000km^2 and it has a population of nearly 31 million people.

Keynote Speakers at FIG Working Week 2017

During the FIG Working Week a series of exciting motivational speeches will set the tone for the event. The Working Week will be held in beautiful Helsinki, the capital of Finland, from 29 May–2 June 2017. The overall theme of the Working Week is 'Surveying the world of tomorrow – From digitalisation to augmented reality'. After digitalised data is available and in use, a next step is to combine information in order to collect the data intelligently and to take further steps towards the intelligent use of digital information.

Keynote speaker at the Opening Ceremony will be Mr Ed Parsons, geospatial technologist at Google with responsibility for evangelising Google's mission to organise the world's information using geography.

During the first plenary session, 'Living of Tomorrow – In a Digitalised World', Mr Arvo Kokkonen, director general of the Finnish National Land Survey, will challenge the audience with his keynote speech on 'Does the Surveying Sector Change Quickly Enough?'. Then Mr Greg Bentley, CEO and president of Bentley Systems, will present a fascinating overview of 3D city initiatives. Mr Oumar Sylla, Land and GLTN Unit leader of UN Habitat, will subsequently shares his vision on the development of cities after Habitat III and the surveyors' role.

The second series of keynotes is themed 'Professional behaviour – In a Digitalised World'. Ms Heidi Kuusiniemi, director of navigation and positioning at the Finnish Geospatial Research Institute, will give her visionary presentation on future trends in pervasive positioning. Prof Dr Yola Georgiadou, professor of geoinformation for governance from ITC, University of Twente, will highlight 'Geo-ethics: Past, Present, Future'. Renowned Dr Jolyne Sanjak, chief program officer at Landesa, will speak about innovative and more affordable technology and how to democratise data gathering.

The third and final series is about 'The Contribution of Our Profession – In a Digitalised World'. Prof Markku Poutanen, director of geodesy and geodynamics at the Finnish Geospatial Research Institute, will start with a presentation on the essence of the future of geodetic reference frames. Then Dr Janet Edeme, policy officer at Africa Union, will introduce the LSBi initiative. Prof Juha Hyyppä, director of remote sensing and photogrammetry at the Finnish Geospatial Research Institute will subsequently look ahead in 'What about the future? How does the future look for surveyors in this technological era?'.

More information
www.fig.net

Spotlight on GSDI Member: Delft University of Technology Explores Business Models for Open Data

Governments worldwide are adopting open data policies. This presents a challenge for agencies required to generate revenue to cover a substantial part of their operating costs – so-called self-funding agencies. With revenue being lost due to open data, there is a real risk that data update frequency and quality could suffer.

One of GSDI's members [1], the Knowledge Centre Open Data at Delft University of Technology in The Netherlands (TU Delft) [2], has done case-study research on the financial effects of open data policies on the business models of self-funding agencies. While there is no one-size-fits-all model solution, their recent work suggests that taking on new roles in the information value chain is a promising approach for self-funding agencies. Before open data, organisations primarily were 'aggregators' of (raw) data; now they are moving towards an 'enabler' role by developing tools and/or platforms to facilitate users and ensure effective use of the data. Some organisations offer expert knowledge as a fee-based, value-added service.

The case studies demonstrated that, in addition to adapting the organisation's role, there must be a guaranteed main source of revenue, whether it be financing through the government budget or access to legal instruments for levying charges. In all the open data cases, revenue generated by fee-based services was relatively low compared to the main source of funding. The cases also demonstrated that providing open data does not necessarily lead to losses in revenue in the long term. Where organisations have implemented open data in addition to fee-based services, there have been no negative effects on the fee-based services. In a number of cases, revenue from fee-based services has even increased. In addition, the research indicated that open data has led to internal efficiency gains.

More research is needed to confirm the initial findings, but it is encouraging that organisations have been able to navigate and cope with a dynamic economic and political landscape. We commend TUDelft's effort and look forward to further findings. See: Welle Donker, F., van Loenen, B. (2016). Sustainable Business Models for Public Sector Open Data Providers, *eJournal of eDemocracy and Open Government*, JeDEM 8(1): 28-61, http://www.jedem.org/index.php/jedem/article/view/390.

More information
[1] gsdiassociation.org
[2] opendata.bk.tudelft.nl

Commission 4: 'Positioning & Applications'

IAG Commission 4 is dedicated to the various aspects dealing with positioning and applications. The main topics are terrestrial and satellite-based positioning systems development, including sensor and information fusion, navigation and guidance of platforms, interferometric laser and radar applications, applications of geodetic positioning using three-dimensional geodetic networks (passive and active networks), including monitoring of ground and structural deformation, applications of geodesy to engineering, and atmospheric investigations using space geodetic techniques.
These topics and applications deal with signals of various types, collected by different sensors or instruments, that are used for positioning at different levels of accuracy. These signals can be used separately, but are being increasingly integrated into multi-sensor technologies. Commission 4 is therefore interested in the development and application of single- and multi-signal/sensor positioning dealing with, but not restricted to, systems for navigation and guidance, transportation, personal mobility, industrial and indoor positioning applications. Of particular interest is the use of low-cost sensors, including GNSS systems and smartphone navigation sensors. Furthermore the applications are broad, including geospatial mapping and engineering – ranging from construction work, geotechnical and structural health monitoring and mining, to natural phenomena such as landslides and ground subsidence – as well as geodetic applications based primarily on high-precision, multi-constellation GNSS techniques. Commission 4 is also concerned with the use of geodetic tools of all kinds for atmospheric remote sensing – comprising atmospheric monitoring (e.g. troposphere and ionosphere), space weather studies as well as GNSS reflectometry. From the geodetic point of view the atmosphere is nowadays not only seen as a source of signal disturbance, which has to be corrected for, but also as a medium of interest, since almost all geodetic measurement techniques provide valuable information about parameters of the atmosphere.

Commission 4 is composed of four sub-commissions: SC4.1 dealing with emerging positioning technologies and GNSS augmentation; SC4.2 dealing with geospatial mapping and geodetic engineering; SC4.3 dealing with atmosphere remote sensing; and SC4.4 dealing with multi-constellation GNSS. The president of Commission 4 is Marcelo Santos and the vice-president is Allison Kealy.

More information
http://iag-comm4.gge.unb.ca/

Participants of the IAG Commission 4 Symposium, Wroclaw, Poland, 4-7 September 2016.

The Fringe (Not the Comb-over) in DC

As is customary in the days before each ICA International Cartographic Conference (ICC), a number of pre-conference workshops have been arranged. These 'fringe' events provide a taster for the main conference, and allow for detailed consideration of particular issues relating to cartography. They also give significant opportunities for the working commissions of ICA to join forces in addressing topics of common interest, as well as reaching out to other local groups.

The portfolio of workshops organised for the event in Washington DC, USA, can be accessed through http://icc2017.org/preconference-workshops/. The workshops are being held either in the main conference centre (the impressive Marriott Wardman Park Hotel), the nearby George Washington University, or in the Library of Congress.

The Commission on Generalisation and Multiple Representation, for its 20th workshop (1-2 July), will explore new challenges and solutions in the domain of automated generalisation for on-demand mapping, and the changing context of map use. It will also liaise, on the second day, with the Symposium on Location-based Social Media Data and Tracking Data. This symposium (also presented from 1-2 July) is organised by the Commission on Geospatial Analysis and Modelling, jointly with the Commission on Location-Based Services, and the Commission on Visual Analytics. This event addresses the growing availability and use of location-based social media data and tracking data which have created unprecedented opportunities for researchers from various disciplines. At the same time, these developments also challenge researchers with new theoretical, technical, ethical and social questions.

The Commission on Map Production and Geoinformation Management will collaborate with the GIS Management Institute, an integral part of the wide-ranging URISA organisation, in promoting a one-day workshop (1 July) on 'Supporting sustainable development with geoinformation management and modern maps: things you hardly consider'. This has the intention to enhance knowledge in considering supply chain perspectives for modern map production, using GIS-capable mature models for improving management performances in geoinformation management, and technological aspects for establishing decentralised service-oriented mapping architectures.

Also on 1 July, the Commission on Cartographic Heritage into the Digital is running 'Mapping tools for non-mapping experts: incorporating geospatial visualisation tools in libraries', highlighting how librarians can easily incorporate user-friendly geospatial visualisation tools such as Carto, leaflet.js, etc. into a variety of library-based projects. The Commissions on Planetary Cartography, Cartography for Children, and Maps & Graphics for Blind & Partially Sighted People met together at a pre-conference workshop in 2015 before the last ICC in Rio de Janeiro, Brazil. In Washington, they will gather again to discuss recent developments in GIS-based production of planetary geologic maps, international contributions to planetary mapping, the need for planetary maps in education and public outreach, the possibilities of planetary maps in atlases, a contest for designing Exploration Zone maps for future human surface operations on Mars, and planetary maps designed for young adults. There are more events of this type, which will be presented in next month's ICA column.

More information
www.icaci.org

Invitation to Participate in the ISPRS 2020 Congress

We are inviting you to attend the XXIV ISPRS Congress (http://www.isprs2020-nice.com), which will take place in the gorgeous city of Nice, on the Mediterranean coast, from 28 June to 4 July 2020.

Nice, the cosmopolitan and multicultural capital of the French Riviera, is one of the best places in the world to host an unforgettable ISPRS Congress. Indeed, Nice is an outstanding location between sea and mountains, close to the Italian border, where culture and heritage meet with the cutting-edge technology of Sophia Antipolis, the French Silicon Valley. The Acropolis congress centre is in the heart of the city, just four minutes' walk from the old town of Nice, 10 minutes' walk from the beaches and 15 minutes by tramway from the airport.

We are putting together a very rich scientific programme that will enable you stay up to date about the state of the art in science and technology, to meet and exchange knowledge with a large number of scientists, and also to cross-pollinate ideas with scientists coming from related fields. Indeed, this congress will gather together leading specialists, experts and researchers in the fields of

photogrammetry, remote sensing and spatial information sciences coming from universities, research foundations, mapping and spatial agencies, public organisations and private companies. A space agency forum and a cadastral agency forum will also address policy issues in geoinformation. Furthermore, the ISPRS student consortium will organise a summer school with the help of the French engineering schools and universities involved in the congress organisation.

The ISPRS 2020 Congress will hold a strong industrial exhibition with private and public companies. That will give you the unique opportunity to get updated in the advances of new geospatial technologies and solutions (satellite systems, Lidar, hyperspectral, mobile mapping, UAVs, big data processing, geodata warehouses, geovisualisation, geoservices, VGI technologies, spatial data infrastructures, etc.) and to learn about the latest technologies.

The ISPRS 2020 Congress will be hosted by SFPT (the French society of photogrammetry and remote sensing), and is being organised with the support of the major French public institutions dealing with photogrammetry, remote sensing and spatial information sciences: IGN, CNES, IRSTEA, INRIA, IRD, CNRS/INSU, and several others that will be joining us soon.

More information
www.isprs.org

2017

APRIL

GIS-FORUM
Moscow, Russia
from 19-21 April
For more information:
www.gisforum.ru/en

GISTAM 2017
Porto, Portugal
from 27-28 April
For more information:
www.gistam.org/?y=2017

MAY

XPONENTIAL 2017
Dallas, USA
from 8-11 May
For more information:
www.xponential.org/xponential2017

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

FIG WORKING WEEK 2017
Helsinki, Finland
from 29 May - 2 June
For more information:
www.fig.net/fig2017

JUNE

HEXAGON LIVE
Las Vegas, USA
from 13-16 June
For more information:
hxgnlive.com/2017

JULY

INTERNATIONAL CARTOGRAPHIC CONFERENCE
Washington, USA
from 2-7 July
For more information:
icc2017.org

ESRI USER CONFERENCE
San Diego, USA
from 10-14 July
For more information:
www.esri.com/events/user-conference

SEPTEMBER

UAV-G 2017
Bonn, Germany
from 4-7 September
For more information:
uavg17.ipb.uni-bonn.de

ISPRS GEOSPATIAL WEEK
Wuhan, China
from 18-22 September
For more information:
zhuanti.3snews.net/2016/ISPRS

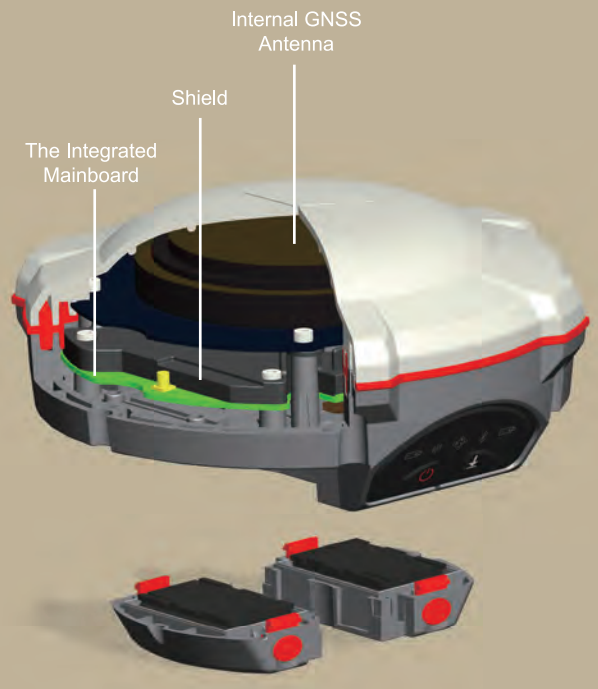
INTERGEO
Berlin, Germany
from 26-28 September
for more information:
www.intergeo.de

CALENDAR NOTICES

Please send notices at least 3 months before the event date to: Trea Fledderus, marketing assistant, email: trea.fledderus@geomares.nl

For extended information on the shows mentioned on this page, see our website: www.gim-international.com.

GNSS RECEIVER
T300



3G Tx & Rx — BUILT IN 3G / TX & RX
SUPER LIGHT
ULTRA SMALL
COMPATIBLE WITH OTHER BRANDS GNSS RTK
LOW POWER CONSUMPTION
BUILT IN MEMORY CARD SLOT

THE NEXT LEVEL RTK

GNSS RECEIVER
M300 Pro

FULL CONSTELLATION
IP67
LINUX OS
WEB SERVER
USER FRIENDLY INTERFACE
LARGE CAPACITY MEMORY

THE NEXT GENERATION CORS RECEIVER

SinoGNSS®
By ComNav Technology Ltd.

www.comnavtech.com
ComNav Technology Ltd.

Register Today!

Are you a surveyor, GIS expert, architect or cartographer? Then Trimble Express is made for you!

Trimble Express will be happening throughout Europe in 2017. Wherever you are, you will find the right location to discover the best in Trimble solutions.

Come join us. We will be featuring our newest products, live demonstrations, innovative technologies and more.

Find out more:
Trimble.com/TrimbleExpress2017

Get your Pass for 2017

TRANSFORMING THE WAY THE WORLD WORKS

Trimble 2017 express