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The September 2016 issue of *GIM International* is focused on spatial and urban planning. This theme is reflected by several articles (e.g. 'Web-based 3D in Urban Planning') and columns (e.g. Vanessa Watson comments on urban planning in an African context) that connect the geomatics profession with the spatial planning field.

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BPA WORLDWIDE BUSINESS

Urban Transformation

More than half of the world's population are currently living in urban areas and this percentage will only increase further in the years to come. Most of the biggest metropolitan areas or 'megacities' are located in the developing world – Africa and Asia – and the vast majority of population growth over the next 25 years is expected to occur in cities. Pressure on these vast urban sprawls is immense, not least because they are often located in disaster-prone areas and lacking infrastructure in many ways. Way too often, citizens migrating from rural areas to cities in search of new opportunities end up getting caught in the poverty trap. This complex combination of factors requires smart planning. This issue of *GIM International* features an article called 'Urban Development & Services Need Transformation' by our contributing editor Frédérique Coumans (on page 29). In her feature, Coumans reports on the Industry Agenda of the World Economic Forum (WEF), a Switzerland-based non-profit organisation for public-private cooperation, and more specifically on the part of the Industry Agenda that is focusing on information technologies and their role in urban transformation. WEF published a study on the urban transformation in April 2016. Geoinformation is without doubt one of the key factors in decision-making for urban planning. Capturing, processing and analysing geodata, culminating in a geographic information system (GIS) combined with imagery or in a 3D model, has become a main policymaking instrument. In an interview with Tom Cheesewright, self-titled 'applied futurist', founder of Book of the Future and TEDx speaker (on page 12), we touch on the maturing technologies of unmanned aerial vehicles/systems (UAVs/UASs), building information modelling (BIM) and artificial intelligence, 3D printing and off-site construction in relation to urban planning. Cheesewright explains what we in the geomatics industry can expect the future to bring and how we can prepare for it. One of these maturing technologies is of course the deployment of cameras together with UAVs or UASs.

On a completely different note, we were very saddened to hear about the passing of Professor Karl-Friedrich Thöne, geodesist and president of the German Land Surveyors Association (DVW). Professor Thöne died unexpectedly a few days before his 60th birthday. As organiser of the yearly Intergeo, the biggest trade show in our industry, DVW significantly helps to shape the field of geomatics and its future direction. I'm sure everybody who encountered him will agree that Karl-Friedrich Thöne was a knowledgeable, respectful and amicable man, both in his years as DVW president and before then. I met Professor Thöne on numerous occasions all over the world and I can only say that the field of geomatics has lost a grand geodesist. But moreover I'm sure his family and friends will miss him dearly in their daily lives. We extend our deepest sympathies to them at this sad time.

▲ *Durk Haarsma, publishing director*

No State Budget Means No Governance. What To Do?

Each country's economy comprises a part which is referred to as 'informal', and it can sometimes be larger than the formal part. The economic activities in the informal economy are unrecorded, not captured by official accounts and statistics, are invisible for policymaking, do not contribute to tax generation, and leave workers without the normal labour standards and protection. Pundits expected the informal economy to shrink as living standards rose but, today, there is a common understanding that the informal economy is here to stay. I do not welcome this prospect, because informal economies have a negative effect on governance. While I appreciate that, in some countries, citizens might want to hide from their government for good reason, the bottom line is that governments should not miss out on the essential data to formulate evidence-based policies, to generate tax income and to provide decent working conditions. Focusing on the state finances, global statistics show that many states are in a precarious position: government expenditures are financed by remittances, aid and natural resources rents (oil, gas, minerals). The contribution of taxation is very limited; 3 to 5% of GDP is no exception, while expenditure is much higher, say 35%. But remittances may fall, as too may oil prices, and aid is shrinking so relying solely on these sources is risky. A few oil countries have already asked IMF for a bailout. Increasing the tax base appears to be a prerequisite for better governance. This leads us on to the question of how to tackle the problem of the missing information. Which minimum set of data should a country have in place? First of all a civil register is needed, because a government should know about its 'capita'. As governments are well known for developing records of franchised citizens, this appears to be mainstream business. Similarly, a register of legal bodies is essential to complement the one on natural persons. Then comes the matter of taxation: what to focus on. Taxes on income, profits, imports and exports can be collected on a self-declaration basis, with random checks acting as a deterrent. And which reliable tax base fits easily in a database? Land-based property tax, of course. But recording property requires laws to define what 'property' entails and experience has shown that, in countries with pluralistic property arrangements, a synthesis at national level is not easily achieved. Where this is still problematic, one solution is to use possession as the tax base and — for the time being at least — to avoid the property question. Of course, the possessor might be the owner but there is no need for the government to make ownership explicit; it is the possession that counts. Sensitive matters are thus avoided. One dataset is still missing, namely a street address for all so that tax invoices can be delivered. Simply linking an address to a coordinate gives spatial enablement. The fit-for-purpose approach and land administration domain model remain fully applicable, also with possession as a tax base. Thus, with a minimum of four datasets, governments can create their own success. Just a little bit more formalisation is the key.

▲ *Paul van der Molen.*

GIS Technology to Tackle Zika Virus

Florida, the southeasternmost US state, is home to more than 3.6 million women aged 15 to 44 years. With more than 300 Zika virus cases reported in Florida to date, the state has become a top focus in the public health battle to curb the spread of Zika infections in the United States. Gathering and mapping such data - using GIS software from Esri - is part of the US Department of Health & Human Services (HHS) Office of the Assistant Secretary for Preparedness and Response (ASPR) effort to combat this growing health risk domestically and internationally. The health impacts of the Zika virus are greatest on developing foetuses. Drawing on US Census data, Esri is showing experts at the ASPR and other agencies within HHS where best to target information and reach women of child-bearing age and their partners. To plan for the domestic assistance that states may need, ASPR is also using Esri software to monitor the spread of the Zika virus across the United States and in 34 other countries where infections have been found.

GIS software is used to tackle Zika.

▸ http://bit.ly/2aVkGZF

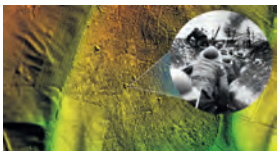
Strong Growth Predicted for Global Scanning and 3D Modelling Market

Strong growth is predicted in the scanning and 3D modelling market, as nearly 4 out of 5 firms expect their business to expand over the next 12 months. This is one of the findings in a new survey of the laser scanning and 3D modelling industry. Sent to over 5,500 firms, the survey illuminates crucial industry data including average project profit margin, scanning/modelling best practices, profit margin degraders, hardware and software market share and more.

▸ http://bit.ly/2aNpDIS

Modelling software.

Bluesky Lidar Reveals WWI Battle of the Somme Secrets



Lidar imagery.

An aerial survey using aircraft mounted lasers has revealed previously undiscovered evidence that might potentially help to dispute accusations of a lack of determination by Welsh soldiers during the first Battle of the Somme in the World War I of 1914-1918. Aerial mapping company Bluesky flew an area of northern France called Mametz Wood, capturing accurate 3D measurements of the terrain and ground cover. Specially commissioned by Bearhug TV, the Bluesky Lidar survey revealed two distinct and previously unrecorded topographies for further investigation and analysis. The Bluesky data allowed the experts to read the landscape from the air, seeing through the trees and vegetation, commented the programme's producer, Louise Bray of Bearhug TV. This revealed a number of clues in a never before seen landscape. It was hoped that these discoveries might give a better understanding of the difficulties faced by the soldiers on the ground.

▸ **http://bit.ly/2bhgOBH**

Augmented Reality Adds Extra Dimension to Intergeo

With Pokémon Go turning the hunt for virtual monsters into a global craze, one could be forgiven for thinking that augmented reality (AR) had only just been invented. However, AR is neither a new nor an unknown technology. At Intergeo 2016, a large number of exhibitors will be showcasing their AR applications for urban planning, utility companies and much more besides. Augmented reality creates huge added value for numerous scenarios by adding text/image-based information levels that are invisible to the human eye. At Intergeo 2016, for example, the Berlin-based Game Science Center (GSC) will be presenting its augmented reality sandbox. Transported back to their childhood, visitors will dig in actual sand and see how contour lines and levels simultaneously adapt to the newly created topography. AR makes this possible. Children and adults alike learn to read maps and understand their geography interactively through play. The AR sandbox is by no means simply an (educational) toy, though. It can be adapted for tasks such as planning the location of wind turbines or measures for protecting against tsunamis.

Fully 3D/AR-enabled mobile GIS Augview.

▸ **http://bit.ly/2aTXXXA**

Trimble Acquires AXIO-NET from Airbus D&S

Trimble has announced the take-over of AXIO-NET GmbH from Airbus Defence and Space. AXIO-NET is a Germany-based provider of global navigation satellite system (GNSS) corrections and professional data services serving the domestic market, the United Kingdom and Benelux. AXIO-NET delivers both real-time and post-processed network Real Time Kinematic (RTK) solutions to a broad range of users including surveyors, GIS professionals and farmers. In addition to traditional correction services, AXIO-NET performs a variety of data-based professional services for the geospatial market, including coordinate transformation services as well as network set-up, configuration and operations consulting.

▸ **http://bit.ly/2aXn2m0**

AXIO-NET crew in action.

14 INSPIRE Themes for Global Sustainable Development Goals

The scope of geospatial data extends far beyond environmental, social and economic analysis, a study by UN-GIMM: Europe has found. Research by the regional committee of experts shows that information about location also plays a key role in implementing policy to help address a wide range of concerns at regional, national and global level. The report, which is the first deliverable of the Working Group on core data, has identified 14 INSPIRE themes that can support the UN's sustainable development goals (SDGs) and meet user needs for authoritative, harmonised and homogeneous framework core data.

▸ **http://bit.ly/2aNrhnv**

The 17 Sustainable Development Goals.

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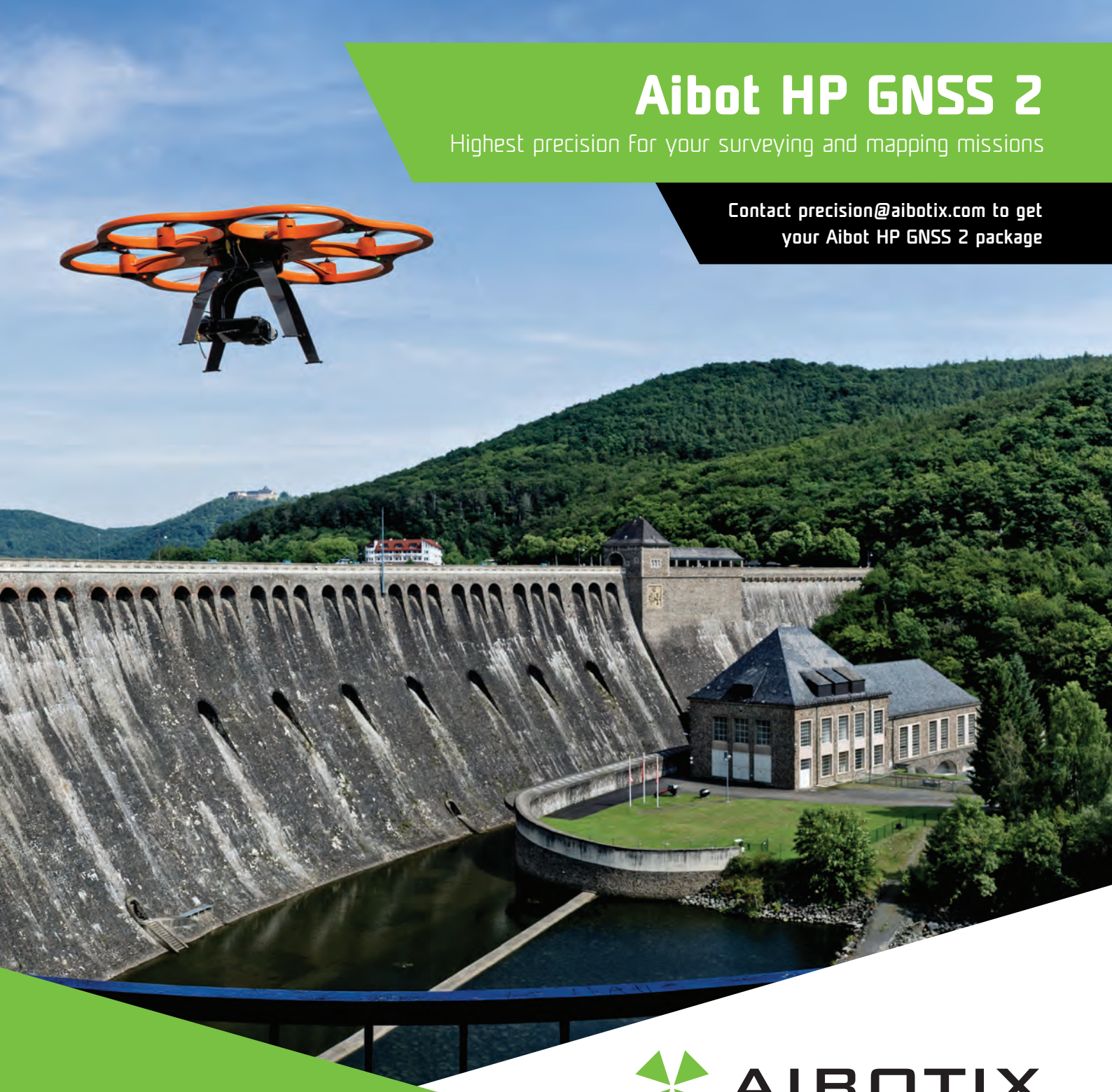

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Urban Planning and the Future of **African Cities**

It is a well-known fact that African cities face a challenging future. With some 65% of urban populations living in slum conditions and 70% in informal work, they are also set to double in size over the next 20 years, as much from natural increase as from in-migration. The already huge backlogs in basic urban infrastructure (especially sanitation and clean water) represent overwhelming challenges to local governments which are underfunded and under-capacitated. Urban planning should be playing a key role in addressing these issues, yet it is being handicapped by a recent wave of interest by the international property development industry in turning valuable urban land into 'fantasy cities'.

Since the 2008 global financial crisis, Dubai-lookalike visions for African cities have increasingly appeared on international property developer websites. Some claim that African cities have become the world's next 'property investment frontier'. Glass-box skyscrapers separated by swathes of green and rapid transit routes have seemingly not lost their allure, while the 'real' world of informal shack-dwellers and street traders is being erased from the map and from the consciousness of politicians and the urban elite.

New urban visions such as the one for Kigali, Rwanda (see Figure), prepared by a US firm of architects, assume that the current largely informal urban population can be 'wished away'. The new satellite cities such as those to surround Nairobi in Kenya, Hope City in Ghana and many others promise a modernised and sanitised living environment for the middle classes, far removed from the squalor and congestion of existing cities. Hope City, designed by an Italian architect who was evidently inspired by African beehives, is a particularly futuristic conception of buildings which contain all the facilities needed for their residents and working populations, seemingly removing the need to go outside at all.

Other cities are creating large land areas through infill to create new urban extensions. Kinshasa in the Democratic Republic of Congo is one of Africa's largest and poorest cities, yet a major land infill of the Congo River will support upmarket retail and residential developments – destroying the livelihoods of many small farmers along the banks of the river in the process. Eko-Atlantic is being created on an artificial island off the coast of Lagos; the island stretches for over 10 kilometres, allowing some 250,000 people to disengage themselves from the congestion and pollution of existing Lagos.

Adding to the selling power of the glitzy graphics, many of these plans also claim to be 'smart' or 'eco' and sustainable cities, thus drawing on fashionable rhetoric to justify designs that are very far from these concepts. Design has become a superficial exercise of cut-and-paste graphics along with copied text to give the impression that there is a concern with more than just profit.

But the real impacts will be felt in increasingly unequal cities in which the poor are consistently marginalised in both a spatial and functional sense – as they are pushed further and further towards the urban peripheries, and as public infrastructural and facility resources are redirected away from meeting basic needs and towards supporting the demands of the new enclaves of the elite. ◀

▲ *Vanessa Watson*

▲ *Kigali, Rwanda.*

GIM INTERNATIONAL INTERVIEWS TOM CHEESEWRIGHT

Geomatics Provides Truth about the Physical World

New digital technologies are changing our industry. Or is it the other way round? Is the future of geomatics a virtual one? Will surveying soon be done in digital realities? *GIM International* talked to renowned futurist Tom Cheesewright to find out what he foresees for the digital era and how disruptive those changes will be.

You often talk about the synchronisation of the two worlds we currently inhabit: the physical world and the digital one. Can you explain this to us?

The boundary between the digital and physical dimensions has been getting thinner for decades now. Eventually it will disappear and there will be no distinction between digital and physical. This is happening in three ways. Firstly, computers are starting to inhabit our world. Instead of discrete boxes of silicon and steel, computers are being embedded into everyday objects around us: walls and floors, clothes and accessories. Before long, the concept of a computer will become redundant; almost everything around us will be capable of some level of computing. Secondly, the way we interact with these machines is changing. Fifty years ago, talking to a computer was like communicating with an ogre in a cave. You had to go to its cold, dark, air-conditioned lair and speak with great deference to this big beast in its own language. Today I can shout at my phone from across the room and half the time it might actually play the song I want! Before long, most of our interactions with machines will be based on words and gestures: intuitive and natural, not forced and artificial. Machines will begin to extrapolate more from our behaviour using their own sensors, reducing the need for us to explicitly tell them what to do. Thirdly, we're beginning to overlay the physical world with a distinct digital reality. Eventually, augmented reality will be a near-permanent experience for many of us. The distinction between what is physical and what is digital is starting to become irrelevant – at least, until you try to walk across a virtual bridge...

Location is the point of synchronisation between these two worlds. How does that work?

For all our successes with technology, nothing we have made yet matches the power of the physical world. As much as our brains might extrapolate from the visual data they are fed, a virtual rollercoaster is nothing like the real thing, and driving a real sports car is still much more thrilling than any computer game. It's a question of bandwidth. In the physical world, all of our senses are engaged. We're overwhelmed with data, whether we're watching a concert or just working with a colleague. That's why all the data shows we are more productive when we're physically co-located; why millennials are so engaged in the experience economy; and why high streets are still popular places to meet, even if the economics of digital delivery mean some classes of product just don't work there any more. So location and physicality remain hugely important to us. And as more of our interactions with the digital world come through physical media and motion, the ability to understand our location becomes increasingly key to synchronising the two worlds.

How will the geospatial industry benefit from the endless possibilities of virtual reality (VR) and augmented reality (AR)?

VR and AR are really two sides of the same coin, it's just about which way reality moves. VR is about recreating reality in a virtual environment, while AR is about making the virtual 'real'. While we can create entirely fictional realities, lots of people will want to virtually experience real places, such as in the sci-fi game Beyond Flesh and Blood, which is set in my home town of Manchester. This expands the existing market for location data beyond the more prosaic mapping applications. But augmented reality offers perhaps the biggest opportunity for the geospatial industry. AR fails – miserably – if it's not bound tightly to the real world. To overlay compelling digital experiences on the physical world, creators need hyper-accurate information, not just about location but also about the visual and other cues that can be used to connect the virtual to the physical.

Talking about VR and AR, one really high-profile hype at the moment is Pokémon Go, which brings together the real and virtual world for a smartphone game. What are your thoughts on this?

Pokémon Go represents a 'holy trinity' of factors: location-based gaming (like geocaching), augmented reality, and a compelling media property that appeals to two distinct but equally enthusiastic age bands. In many ways the experience is very,

▲ *Tom Cheesewright delivered a keynote speech at GEO Business 2016 in London. For more information visit www.geobusinessshow.com.*

very low-fi, but the game mechanics are well crafted. This is very much just the beginning. In a few years' time, looking back at Pokemon Go will be like looking back at the great 8-bit console games from where we are today.

There are lots of buzzwords around nowadays: BIM, AI, 3D printing, robotics. Aren't we forgetting the geospatial data itself?

Artificial intelligence (AI), 3D printing and robotics have many applications that may not rely on geospatial data, or at least not explicitly. Because of this broad, horizontal relevance – not least in consumer applications – they naturally attract more of a buzz. However, where these buzz markets do have applications that intersect with geospatial data, I would agree that they tend to overshadow the fundamental data underpinning the exercise. People dramatically underestimate the complexity and scale of the geospatial data challenge. They tend to think in two-dimensional terms: "It's a map, right? Don't we have maps?". Meanwhile, BIM is 'under-buzzed'. Although there's a hardcore group of people focused on it, the majority of the markets that should be adopting it enthusiastically are instead having to be dragged into the 21st century.

'Smart City' is another term being used a lot. How would you define it?

Right now, most projects are about using technology to make cities cheaper to run. Yes, there are environmental factors, but what's driving investment is the prospect of doing more with less cash, rather than less energy or water; those are side benefits. A true definition of a smart city should incorporate more than just cost. 'The application of technology to improve efficiency, safety and quality of life' might be one way to put it. I would like to see more technologies applied to create moments of joy: interactions with the physical environment that don't just make things cheaper or easier, but that actually make them fun.

Can you give us some inspiring examples of truly smart cities?

Santander in Spain is probably the best and most local example right now. There, technology has been applied to issues like energy use, but also quality-of-life issues like the time it takes to park your car. Dynamically routing people to empty parking spaces across the city, using smart signs – not just another app – is estimated to save eight minutes off the time it takes to park.

Some renowned experts say that the smart city concept is not about gigabits or bandwidth, but rather about participation from locals, such as in infrastructure planning.

Smart cities actually need very little bandwidth, unless you're surveilling your population in high-definition video. Sensors mostly spit out integers. Moving these around and storing them is very inexpensive. The ▶

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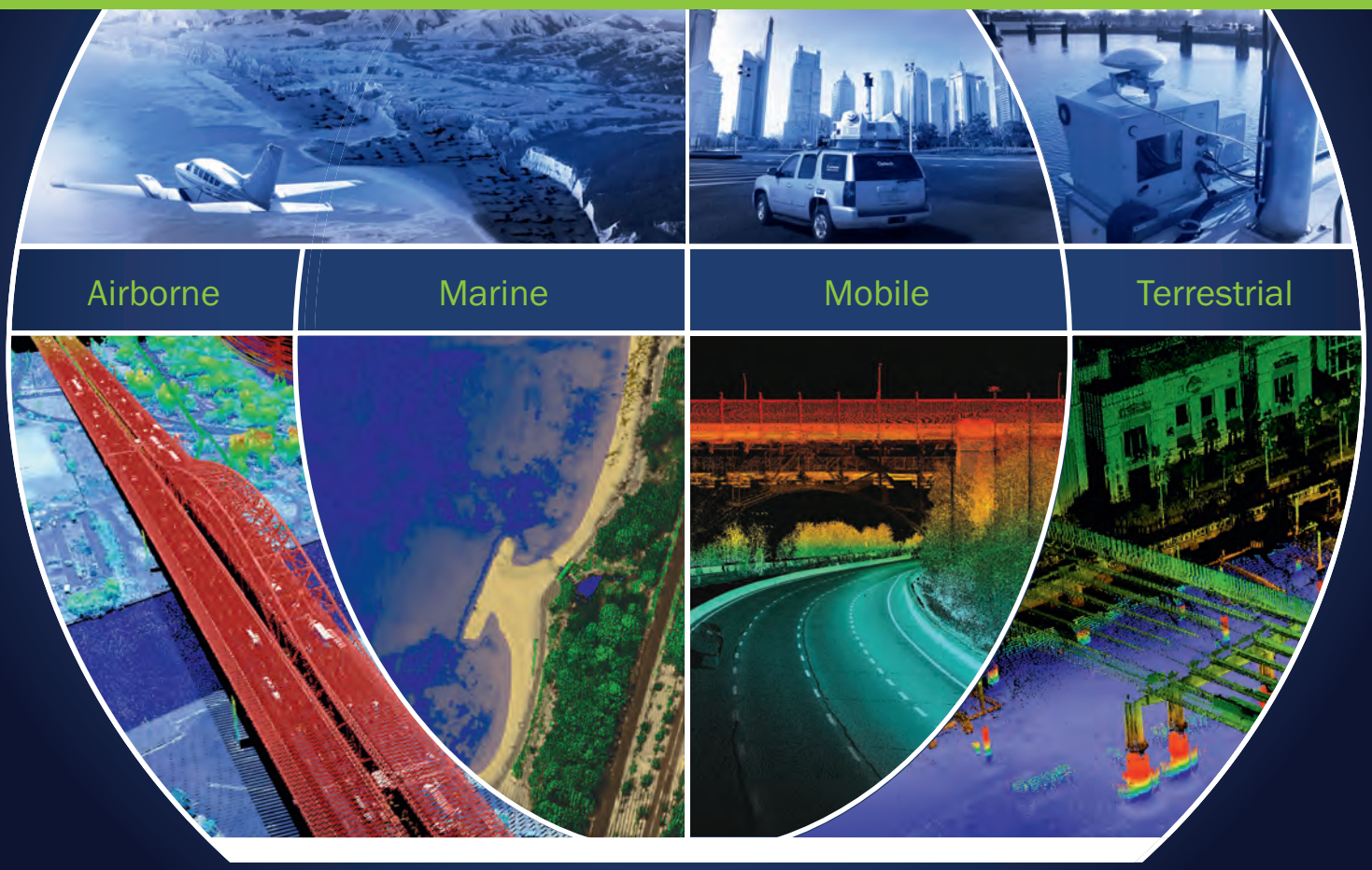

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challenge lies in making sense of this data, and the most effective way to do that right now is to give the information to people. The smartest cities of the future will be ones where the city becomes an open platform on which others can experiment and innovate. This won't be for everyone. Who has the time to get involved in planning decisions? But what you can do is push hyper-relevant information to the people affected by decisions, and ask them questions. You can allow the motivated to make use of large datasets. And you can source extremely powerful guidance from social media conversations. The CPU team at the Manchester School of Architecture are doing pioneering work in this field.

Urban planning is done from the top down. Do you think modern technology is going to change this?

Yes and no. For your average citizen, part of the barrier to engaging in urban planning in the past has been friction, as I know from personal experience recently. Endless committees, hand-drawn diagrams, bureaucratic processes – it's just an ugly experience to engage with. Reduce the friction and you will get more engagement… but still not a lot; not many people want to devote more of their time to this. What technology will transform is the intelligence that can be applied to planning. Planners will be able to leverage more real-world data – both hard and soft – to drive their decision-making, and even model the impacts of their decisions with computer-generated future scenarios.

Future opportunities may be beyond the realms of our current geospatial imagination, but what's in it for the geomatics industry?

I often say that the finance function is the department of truth for any business. They know the reality. Similarly, geomatics is the department of truth for the physical world: the source of hard data about a fast-changing environment – data that can be relied upon for decisions with serious implications, whether it's the construction of a building, the navigation of a self-driving car or the production of a virtual-reality training environment. Truth is a great market to be in!

TOM CHEESEWRIGHT

Tom Cheesewright is the founder of UK-based applied futurism practice Book of the Future and creator of the Futurist's Toolkit, a suite of tools for agile organisations. Clients range from charities and public sector organisations to FTSE100 enterprises and global technology corporations. After graduating in mechatronic engineering, Tom spent 14 years in the tech industry working with global brands such as BT, EE and IBM, and subsequently founded a series of technology-driven companies. Most recently, Tom co-founded venture-backed big data analytics start-up CANDDi (http://canddi.com), of which he remains a shareholder. Through consulting, speaking and media work, Tom helps people to see, share and respond to a coherent vision of tomorrow. He acts as an advisor to a number of technology-driven start-ups and is a frequent presence on TV, radio and in the media.

EXAMPLES AND CRITICAL SUCCESS FACTORS

Web-based 3D in Urban Planning

Urban planning has become more complicated due to today's rate of urbanisation and the rapid expansion of cities. Web-based 3D tools coupled with high-quality 3D city models and digital terrain models offer viable solutions. Although the majority of plans are still produced in 2D, there is a growing trend towards 3D. The author provides examples and discusses some critical success factors.

The majority of plans are still produced in 2D. One hurdle has traditionally been the high acquisition cost for digital terrain models (DTMs) and 3D city models. This is changing quickly as the technology for the capture and automated processing of detailed 3D geodata is rapidly maturing and eroding the cost barrier. The fact that access to 3D geodata no longer requires specialised software and workstations is also supporting the transition to 3D.

BROWSER-BASED CITY PLANNING

Advances in 3D support of WebGL and HTML5 internet-based tools have made it possible to establish workflows which incorporate 3D geodata. These tools support easy interaction with massive DTMs and city models. Meanwhile, high-quality 3D geodata is nowadays the proverbial 'one click away' for anyone with a web browser. Agency9's CityPlanner is an example of an easy-to-use web-based planning tool. It is used to stream 3D city models of unlimited size, and the service scales from a single user – such as an architect or planner – to large organisations. As a cloud service, it makes it easy to get started as users are not dependent on IT departments or hardware investments. This new 3D planning paradigm allows municipalities and other organisations, both governmental and non-governmental ones, to explore the possibilities of 3D geodata.

Figure 1, A giant reality 3D model of Stockholm, produced by Blom/ Terratec, visualised in a web browser.

EASY ACCESS AND USE

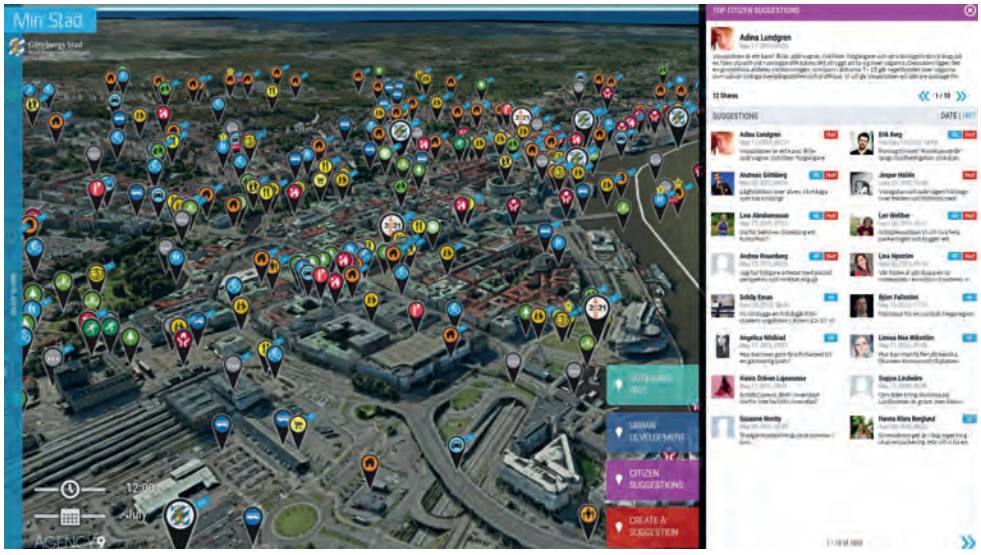
Web-based 3D planning tools such as CityPlanner provide instant access to 3D city models and other geodata in a web browser (Figure 1). This eliminates the need for users to go through lengthy procedures, such as requesting geodata from the GIS Department and scheduling experts to set up and configure workstations. 3D models and data can be accessed and visualised during design sessions at any workplace or in any meeting room, either in the office or externally. Existing 2D geodata, such as zoning, street and utility maps or environmental information, can be draped on the city model. 3D buildings and other objects can be sketched, terrain features modified and existing buildings hidden to simulate demolition, for example. The scene can be visually analysed from different viewpoints by moving the camera to desired positions and angles. Points of interest can be added to share images, attachments, text or other types of information. Real-time sun and shadow analysis provides insight into the

effects on solar-energy collection and sun hours in planned residential areas. Gathering feedback is easy, since visualisations can be shared with anyone, anywhere through a web link. The resulting collaborative workflow reduces lead times and helps to avoid misunderstandings. Planners do not need in-depth CAD skills and they are also less dependent on the expertise of visualisation specialists. Changes can be quickly updated and distributed while provisional sketches can be refined by CAD models made by architects, for example.

PARTICIPATIVE PLANNING

Web-based 3D tools support communicative planning by creating short feedback loops and interaction with stakeholders and citizens (Figure 2). Citizens may be affected by the changes resulting from implementation of the plans. With the right communication they can feel like stakeholders during the planning process, which creates awareness, engagement and involvement. Communication with citizens at an early stage can thus reduce frustration, miscommunication and complaints. Feedback can also provide valuable crowd-sourced information which may be incorporated into further planning. Citizen participation currently takes place at physical meetings, which limits participation. Use of the internet can widen the audience to include families, minorities and others who would not normally attend such meetings.

▲ *Figure 2, Proper planning using web-based tools consists of multiple steps with short feedback loops and interaction with stakeholders and citizens.*



▲ *Figure 3, Gothenburg's MinStad 3D portal engages tens of thousands of people.*

Experience shows that the use of 3D models in communication with citizens not only supports their understanding of the situation and generates inspiring feedback, but also results in users spending more time on studying plans and proposals. As an example, a study carried out by one city revealed that very few stakeholders and citizens visited the public website for urban planning projects, and only 1% of them opened the PDF attachment describing the projects. In contrast, an interactive 3D model was viewed by 30% of the visitors, resulting in a remarkable increase in awareness. A proper strategy, 3D tools which allow for a digital dialogue (see Figure 3) together with high-quality 3D geodata substantially improve public participation.

CITIZENS FEEL LIKE STAKEHOLDERS DURING THE PLANNING PROCESS, WHICH CREATES AWARENESS, ENGAGEMENT AND INVOLVEMENT

CHOICE OF GEODATA

Background data that represents the existing scene is essential for 3D visualisation. City models are traditionally represented by a DTM combined with separate building layers, which may contain simple building geometries, more refined roof structures or even textured facade imagery.

As an alternative to geometry models, photorealistic 3D city models (mesh models) are now growing rapidly for planning purposes. These reality models can be automatically created from satellite or aerial imagery at affordable costs by using tools such as ContextCapture from Bentley, PhotoScan from Agisoft or Streetfactory from Airbus. Aside from budget, the choice of 3D geodata depends on the purpose of the specific visualisation and the planner's own preferences. The choices may relate to the following questions:

- Who is the target group for the visualisation (e.g. citizens, stakeholders, planning experts)?
- What level of detail is required? Aim to avoid confusing the situation with street scenery and distracting colours which are not a part of the plan.
- How accurate does the model need to be?

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Many organisations may invest in both photorealistic and geometric 3D city models to serve different use cases. Furthermore, the availability of national 3D maps, e.g. from national mapping agencies (Figure 4), is driving national use of 3D in planning. Deployment of such models in Norway, Sweden and Denmark, for example, is giving organisations involved in planning instant access to basic 3D data nationwide.

CRITICAL SUCCESS FACTORS

Traditionally, 3D visualisation has been a one-off project created by a consultant, resulting in a video that is distributed online. Such projects are usually expensive to continue. Leading an organisation towards a 3D-based workflow is complex. Obstacles to overcome may include organisational issues and fear of new technology. Therefore, as a first step, organisations are recommended to carefully select a pilot with high visibility to create awareness and demonstrate value. Management commitment is the key long-term success factor, along with defining feasible targets and allocating proper resources. Without the right publicity, even the best projects can fail. Therefore, communication with the public is key and involvement of the Communication Department is essential. A successful project can open the eyes of management and other stakeholders, which helps drive the implementation forward. ◀

▲ *Figure 4, A national 3D model of Norway provided on the web by Norkart.*

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BRINGING DYNAMICS INTO THE 3D MODEL OF A POWER SUBSTATION IN RUSSIA

Serious Gaming for Facility Management

Terrestrial laser scanning has become a standard surveying technique for creating 3D CAD models of industrial objects and for site documentation. However, some facility managers are no longer satisfied with purely static 3D models; they are increasingly demanding animation functionalities to improve maintenance and repair planning and also to guarantee workforce safety. Dynamics can be introduced using game-based tools. The authors demonstrate the potential of serious gaming for supporting facility management at a power substation in Russia.

The service area of Khakasskoye PMES, a regional branch of the Russian electricity distribution company, includes the Republic of Khakassia and the Tyva Republic, with over 3,300km of power transmission lines and 17 power substations. A 220kV power substation built in 1964 was chosen for the pilot project. This substation covers six hectares and services not only the inhabitants of the cities of Abakan and Chernogorsk but also the Chernogorskiy coal mine and other industrial sites. In June 2014, in the space of two man-days, two hectares of the site were scanned from 37 positions using a Leica P20 (Figure 1). The spacing of the points was a few millimetres resulting in an excessive amount of points. Therefore, the point cloud was thinned before being imported into Leica Cyclone for further processing. A major challenge was posed by the strong electric power fields which could have damaged the scanner, so the field crew were forced to follow strict safety rules.

BLENDER 3D

After the creation of a 3D geometric model from the point cloud, the model was textured. To optimise real-time interactive visualisation, the number of polygons was decreased by merging or simplifying 3D meshes resulting in a dataset of 300MB. Such a modestly sized model allows fast and smooth visualisation even on low-end computers. The simplification did not affect the required accuracy; the global accuracy was 2cm and the local accuracy was better than 1cm. The modelling was done using Blender 3D. This free and open-source software enables the creation of 3D models and interaction with the 3D model, as well as the creation of games, movies and artwork. The code, which was first developed in the mid-1990s, has been freely available since 2002. With 500,000-plus users worldwide already, Blender 3D is in continuous further development. It is likely one of the best freely available software tools for developing complex 3D models and for preparing scenes for 3D game engines. Hot keys make Blender3D faster than many comparable tools.

THE UNITY3D GAME ENGINE DOES NOT NEED ANY SUPPORT FROM EXPENSIVE CAD-LIKE SOFTWARE

▲ *Figure 1, Laser scanning of the power substation.*

▲ *Figure 2, 3D models of vehicles and workers; information on scene elements can be displayed.*

Figure 3, Danger zones for workers modelled as semi-transparent red tubes.

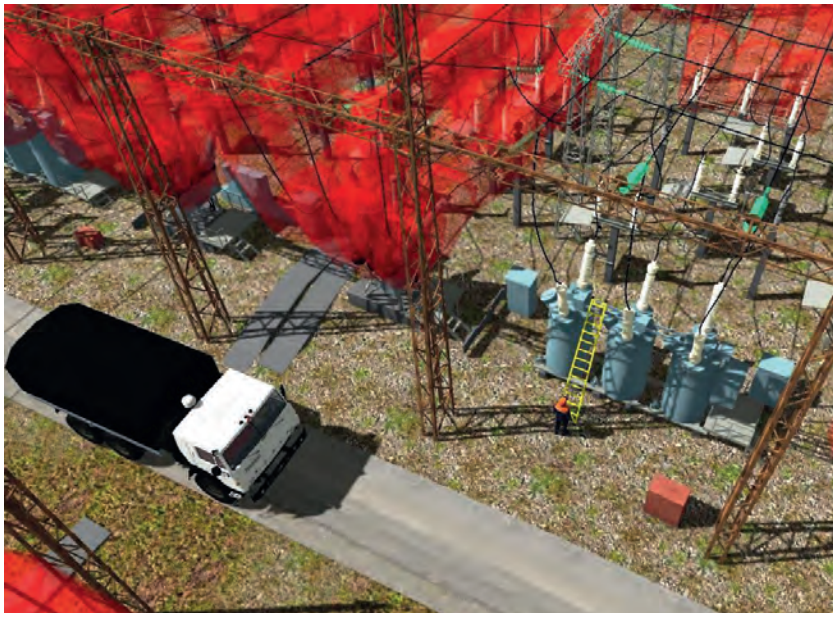

Figure 4, A section of the outdoor switchgear is switched off for repair.

3D models of vehicles and workers were created for animation purposes, allowing users to move them around the site just as in a game (Figure 2). The 3D model of the site was complemented by the incorporation of electrical danger zones according to current standards and regulations. The size of the danger zone depends not only on the type of the conductor voltage, whereby a higher voltage means a larger zone, but also on the type of objects moving through the scene – danger zones for workers are smaller than for vehicles and machines. The various types of danger zones were modelled and visualised in the scene as semi-transparent tubes around the conductors (Figure 3). Blue indicates danger zones for machines and red for workers.

UNITY3D ENGINE

The game-like environment was created using the Unity3D game engine. First developed in 2005, this game engine is primarily used for developing computer games; it is probably one of the most popular tools in the gaming industry with millions of developers worldwide. The basic functionalities are free of charge. The Pro version used in the pilot entails a licence fee. Applications can run for free on any computer, either as a stand-alone or within a browser. The creation of a stand-alone game-like application with a simple graphical user interface (GUI) took about 30 working days including building the graphical interface from scratch and performing many

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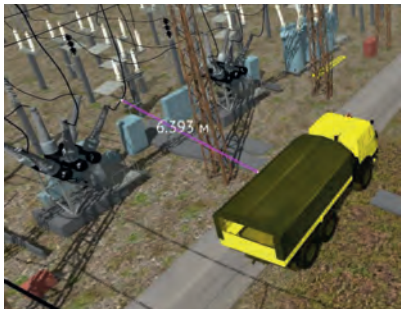
▲ *Figure 5, Animation of a fire emergency during the daytime (top) and at night.*



▲ *Figure 6, Automatic tracking of the shortest distance between a moving vehicle and a high-voltage wire.*

iterative refinements based on customer wishes. The application was implemented on workstations at the power substation, the GUI is simple and intuitive, and field engineers do not need to learn to work with complex CAD systems and graphics editors. These are important advantages of gaming software. The model can be visualised in both mono and stereo; the latter significantly increases the immersion and features task-based training and game-based learning.

USE CASES

Three use cases were tested: (1) site familiarisation; (2) training and game-based learning (GBL); and (3) planning of maintenance and repairs. In the first use case, to get acquainted with the site, a user can walk or fly through the 3D model or rotate and zoom in from a fixed viewpoint. At the click of a button, attributive information about the scene pops up (see Figure 2). Machines and workers can be moved from one position to another. When an object passes through the danger zone, an alert is generated by on-screen flashing, tooltip text and/or alarm sounds. An electrical danger zone can be either visualised or made invisible. The latter enables the user to learn how to move safely through the scene without the benefit of additional information. A 3D avatar was used to show the potential of animation.

The second use case involves learning how to move through the site safely under various circumstances. For example, a section of the substation switchgear can be switched off for repair, which changes the configuration of danger zones (Figure 4). When a fire emergency occurs, the engineer has to perform actions according to service instructions. The time of day can be set (Figure 5) and extra conditions for the action may also be set, such as that it should be completed within a pre-specified time span for example.

THE SHORTEST DISTANCE TO A HIGH-VOLTAGE WIRE CAN BE TRACKED WHILE THE VEHICLE MOVES THROUGH THE SCENE

The third use case relates to planning of maintenance and repairs. Distances between objects can be measured in the model and, by moving machines and workers, the user can create the desired configuration. (Figure 6). 2D schemes can be created using orthoprojections (Figure 7).

▲ *Figure 7, Orthographic projection of a part of the 3D model for planning repairs.*

CONCLUDING REMARKS

The facility managers involved in the pilot regard the use of this technique in the planning of maintenance and repairs as highly promising. The application can be extended for further training of the personnel and to monitor the site and the locations of employees and vehicles alike in real time. ◀

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IMPROVING GEOMECHANICAL ANALYSIS WITH TERRESTRIAL LASER SCANNERS

Solid as a **Rock?**

People often describe something hard and immovable as 'solid as a rock'. But rock does not always live up to its reputation. Depending on its characteristics and local conditions, sections of rock may slip, slide, crumble or deform, potentially serious consequences. Geologists study the geomechanical properties of rock masses to understand how they may fail. This is traditionally done by measuring the characteristics of the rock mass discontinuity sets by climbing the rock face or by using photogrammetry, but terrestrial laser scanning (TLS) has caught the attention of geologists as being a safer and more effective method. This article illustrates the use of TLS for geomechanical analysis in the Italian Alps.

▲ *Figure 1, South-west ridge of the Matterhorn as seen from the survey point (Carrel Hut visible in the centre).*

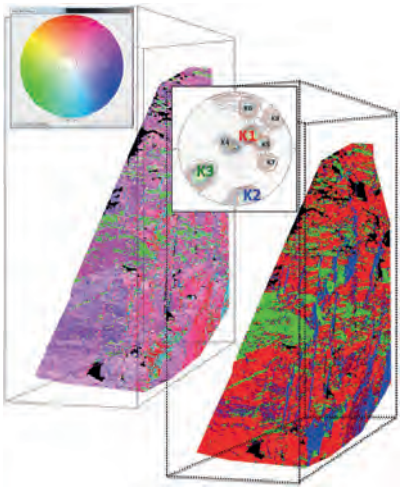
Peaking at over 4,000 metres in height, the Matterhorn is a famous landmark on the border between Switzerland and Italy. Climbers ascending the summit of this Alpine mountain along the conventional Italian route on the south-west ridge usually start at the Carrel Hut, a small building perched on a cliff. Unfortunately, melting permafrost has weakened the rock mass of the cliff, causing regular rock falls which occasionally even lead to closure of the route. This hazardous situation prompted the Fondazione Montagna Sicura (Safe Mountain Foundation, FMS) to ask the Turin University spin-off IMAGEO to analyse the nearby rock and determine the danger to the route and the hut. This activity was initiated within the framework of the PERMAdataROC Interreg III project in the summer of 2008. Surveying the Matterhorn is now done on a regular basis. Initially it was one of IMAGEO's early chances to test TLS for this application, but the Alps remain an interesting research location for further improvement of the technology today.

BENEFITS OF TLS

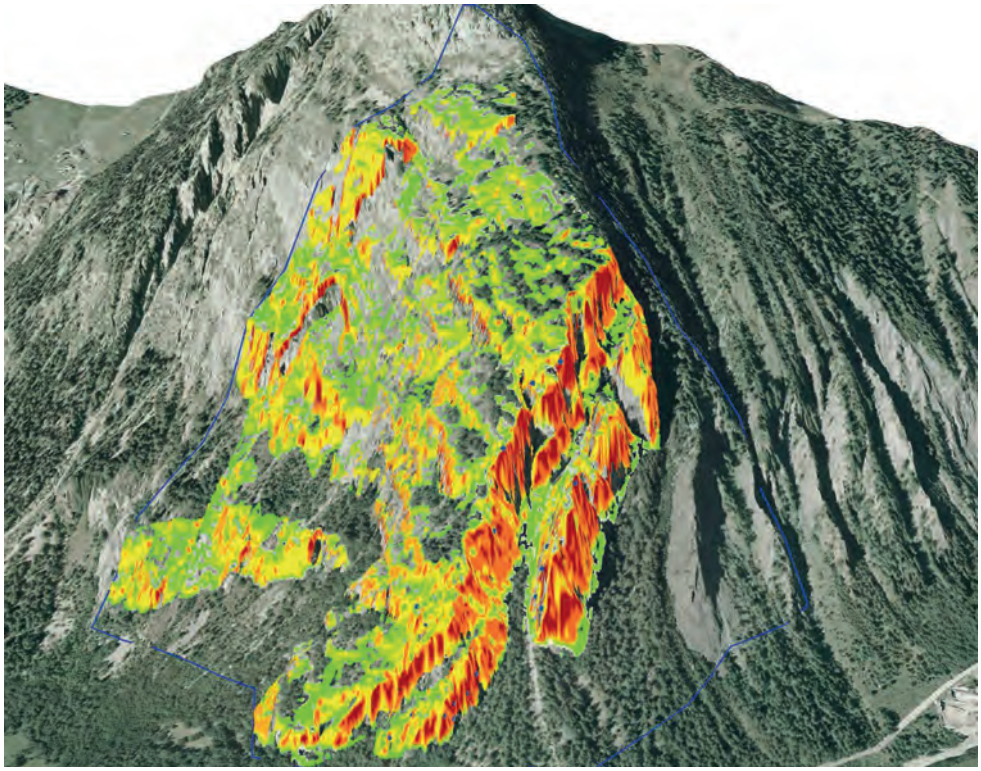
Compared to an on-site survey, the main benefit of using TLS is its range. Instead of having to climb around unstable rocks, researchers examining the unstable part of the Matterhorn around the Carrel Hut can set up the laser scanner (the Optech ILRIS TLS in this case) 400 metres away on the crest of the considerably safer and more accessible Testa del Leone. The TLS also proves superior to traditional photogrammetry thanks to the inherently 3D nature of its laser point cloud. The first step of rock mass geomechanical characterisation is to measure the geometric discontinuity parameters (dip and dip direction) in 3D, and a TLS can quickly cover the entire region of interest with millions of 3D laser points. Conversely, to derive 3D data from photogrammetry, one needs to shoot the mountain area from multiple angles and merge the image sets using triangulation software. This technique can be useful, but is much less accurate than TLS data and requires operators to set up reference points on the rock face in order to scale the 3D model, as photogrammetry is inherently dimensionless. In this particular case the only possible vantage point is the Testa del Leone, thereby precluding the use of terrestrial photogrammetry. Recent experiments have been carried out with cameras mounted on unmanned aerial vehicles (UAVs) to overcome these issues, but they cannot fully replace TLS surveys because UAVs generally have far shorter ranges and cannot easily operate in the windy and high-altitude conditions of the Alps. In favourable conditions, however, both methods can be combined successfully to improve the overall coverage since a UAV can capture rock ledges that a ground-based TLS may miss.

DIP AND DIP DIRECTION

As always, surveying is only half the effort. With the raw 3D data available, geometric features of rock mass discontinuities need to be extracted to identify the mountain's



▲ *Figure 2, Slope orientation analysis (left) and orientation of the main discontinuity sets (right) on the Matterhorn.*



▲ *Figure 3, Automatically generated slope mass rating (SMR) map of a slope near Courmayeur in the north-western part of the Alps (red indicates areas that are less stable).*

weak spots. The first items of interest are the dip and the dip direction, as they show the location of potentially unstable rock volumes and their possible sliding mechanisms. Terranum Coltop3D is used to determine the local orientation of the slope for each point based on the surrounding points. Rocscience Dips is used to project the data onto a 2D stereonet. Statistical analysis of the data subsequently helps to group the measurements and obtain the orientation of the main discontinuity sets.

ROCK FRACTURES

In addition to the dip and dip direction, it is also important to understand the distribution of fractures in the rock mass because the combination of discontinuity sets creates removable blocks of different sizes and shapes. More fractures generally make for weaker rock, but geologists need to consider several other variables including their spacing, length and intersection. For the Matterhorn survey, each of these variables was measured manually in the past in a tedious and time-consuming task. This task has now been automated thanks to third-party software and custom algorithms. The first step is to turn the point cloud into a mesh using JRC 3D Reconstructor and then use a custom semi-automatic tool to detect the main fracture traces. These traces are then turned into polylines and exported as a GIS format before grouping them into discontinuity sets based on their orientation. Unfortunately, there is little off-the-shelf software available to map the frequency, spacing and intensity (P21) of fractures, as well as the elementary rock volume (Vb) and volumetric joint count (JV). Therefore, Esri's ArcPy and GDAL (a set of open-source spatial libraries) have been used to develop custom algorithms to perform the required task. Finally, all the information about the dip and fractures are combined into a slope mass rating (SMR) map, an index commonly used for rock mass classification.

IMPROVING AUTOMATION

The data delivered so far has been of great use to FMS in supporting remedial work and as a monitoring solution. Based on this success, five to seven TLS surveys per year are now done in the Alps alone. Each survey helps to further improve the efficiency in the automation of data processing and analysis using the various software tools. TLS and the associated software tools are now also used in applications other than mountains, such as mapping rock slope stability along roads and railways. For example, an underground test survey has been performed for a mine operator to prove that TLS was suitable for surveying the tunnel faces.

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Dr Andrea Tamburini is a geologist with a PhD in geomatics. He has led several projects regarding landslide and glacier hazard assessment and monitoring. From 1987 to 2007, Tamburini worked with various ENEL Group research companies (ISMES, CESI). Since 2007 he has been president and CEO of IMAGEO Srl, a spin-off company of Turin University. His main expertise regards the use of geomatics for the study and characterisation of unstable slopes at both local and regional scale, as well as the geomechanical characterisation of rock cliffs, open-pit mine slopes and tunnel faces.

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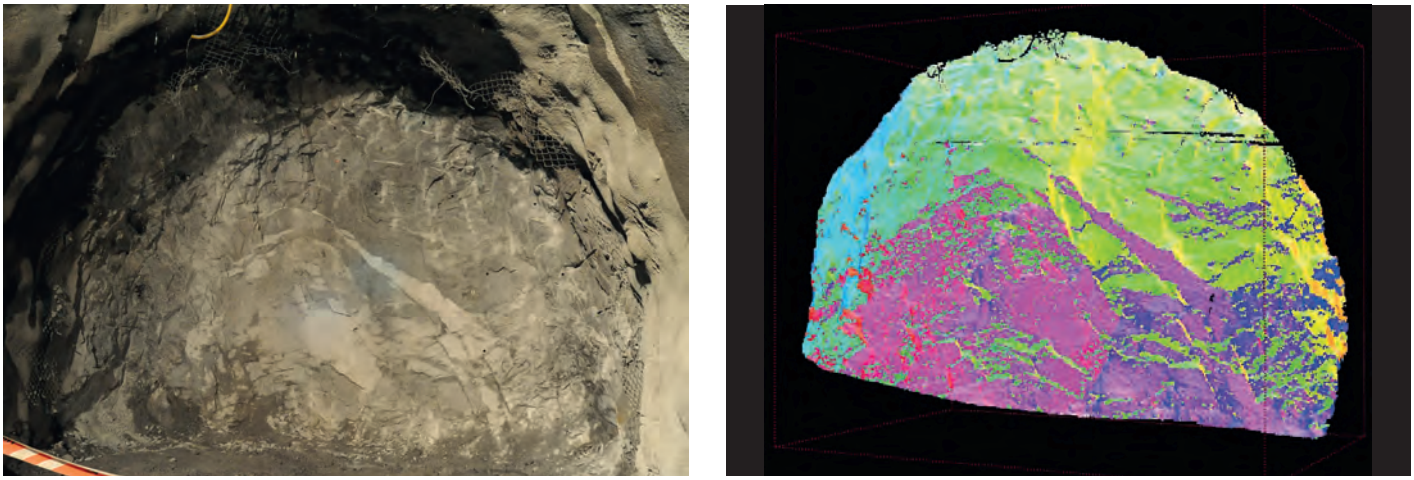

▲ *Figure 4, Tunnel face (left) and automatically generated map of its joint orientation (right).*

Surveying speed was of major concern here, as mining activities had to stop temporarily during the survey. The time required to map the rock faces was reduced by mounting the ILRIS TLS on a pickup truck to drive from tunnel to tunnel; it was possible to scan each tunnel face in just seven minutes. As the data was also post-processed on site after the survey using the automated tools, just two to three hours were required to produce the final data, which the mine owners agreed was just as accurate as their conventional photogrammetric methods.

EFFECTIVE NEW APPROACH

The results of the Matterhorn project and the underground mine tests have proven that TLS is an effective new approach for analysing the stability of rock mass in several contexts, both with static and kinematic surveying. This helps in planning more detailed investigations, designing protection works and defining the most appropriate strategy to monitor slope deformation in the future. ◀

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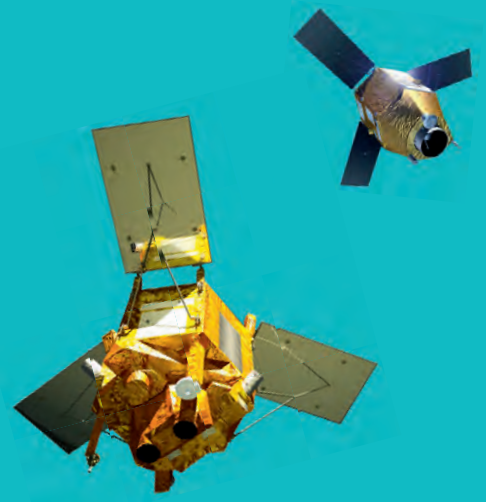

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BY **FRÉDÉRIQUE COUMANS**, CONTRIBUTING EDITOR

A WORLD ECONOMIC FORUM INITIATIVE

Urban **Development and Services** in Need of Transformation

The future of urban development and urban services is high on the Industry Agenda of the World Economic Forum (WEF), which has developed a strategic vision for the rising number of very large cities with their accumulation of problems and challenges. The World Economic Forum's report considers many possible solutions in equal measure, but at *GIM International* we are most interested in the information technology driving urban transformation.

▲ *The World Economic Forum's most renowned activity is the annual gathering of international political leaders, industrialists, intellectuals and members of royalty in Davos, Switzerland. Photo: WEF*

▲ *Front cover of the report.*

People continue to migrate to cities for better economic and social opportunities. Cities, currently home to 55 percent of the global population, account for 70 percent of global gross domestic product (GDP), but they also account for widening inequality gaps. In absolute terms, the world's slum population has risen from 650 million in 1990 to nearly one billion today. In Africa, which has the highest rate of urbanisation globally, 62 percent of people live in slum conditions. Other key urbanisation-related issues around the world include urban planning (in Asia), migration and social segregation (in Europe), social inclusion (in North America), mobility (in South America), safety and security (in the Middle East and North Africa) and water (in Sub-Saharan Africa).

Increasing climate variability and extreme weather events are expected to severely affect urban areas. The percentage of the world's population living in cities is expected to increase from 55 percent to 66 percent by 2050, a rise of 2.5 billion people, with about 90 percent of that increase concentrated in Asia and Africa. By 2030, 41 urban agglomerations are projected to have populations of at least ten million each. Globally, some 60 percent of the area predicted to be urban by 2030 is yet to be built. City administrations will not be able to keep pace with the increasing demands and will need support from the private sector in the transformation process, including in terms of design, implementation, operation, maintenance and – last but certainly not least – financing.

WEF undertook a study and published the accompanying report in April 2016, titled 'Inspiring Future Cities & Urban Services'. The steering committee for this project consisted of 22 board members of mainly very large private companies from all over the world. The advisory board (and other contributors) was composed of 31 representatives from renowned not-for profit organisations. The project was managed by PwC.

SITUATIONAL AWARENESS

Information technology (IT) has consistently been one of the drivers of transformation and is likewise driving the emergence of the new urban services. According to the report, city administrators are increasingly looking at ten types of technologies to identify solutions to their urban challenges (see figure). The technologies imply different types of urban services; examples are given throughout the report. Sensor-related technologies for improving situational awareness are important and they often have a geospatial connection.

1. *The Internet of Things*. Deployed sensors (hooked up to the internet) and advanced computing are making the physical assets of an organisation that maintains infrastructure or a network more intelligent; responses can be based on the ambient conditions. For example, thanks to sensors built into the network, a water company could save millions of litres of water and substantial amounts of money per year by reducing the time required to detect and resolve network events.
2. *Mobile-based sensing*. Mobile applications are being developed in many cities that allow, for example, residents to report public issues directly from their smartphones into the city's work-order management system. Those issues go immediately to the right person in City Hall to fix the problem.
3. *Location & condition sensing*. A growing number of applications have been deployed that gather information on disasters from sources such as surveillance cameras, water-level gauges, rain gauges and seismometers, and process the data at a command centre. If analysis suggests that evacuation is required, multiple emergency agencies are informed, using various communication channels to save people's lives. 'Simpler' services can also be valuable. Street Bump, for instance, helps residents of Boston, USA, to improve their neighbourhood streets. Volunteers use the mobile app to collect road condition data while they drive. Boston aggregates the data across users to provide the city with real-time information for fixing short-term problems and planning long-term investments.

DATA FOR IMPROVING DECISION-MAKING

The second cluster of information technologies concentrates on decision improvement.

4. *Big data*. Cities can use big data – from business transactions, video streams and sensor data to social media feeds such as tweets – to manage their transport systems on a day-to-day basis, for example. The big data solution operates in real time on tens of thousands of video streams to detect a range of information, including number plates, vehicle demographic analysis and intelligent scene analysis for many moving vehicles. All of this can be integrated with multiple, disparate physical security, building and traffic-management control and monitoring functions. Government organisations can thus make instant conceptual and contextual associations between disparate pieces of data and are able to respond in the most efficient way possible.
5. *Data analytics*. Utilities, to name just one sector, have begun applying differential rates based on in-depth consumer analysis, users' consumption patterns and network efficiency levels. The consumption data also allows users to monitor rates and save money by shifting use away from times when utility rates are high. Consumption analytics are supporting the distributor to determine the right user charges for normalising peak loads.
6. *Open data*. Urban regions can create opportunities to attract transnational

TECHNOLOGY IS NOT A SILVER-BULLET SOLUTION TO URBAN PROBLEMS

companies and local businesses interested in urban technology. In Dublin, Republic of Ireland, for instance, Dublinked is managed by a partnership of four city councils in Dublin's region, a university and a major technology provider which has recently opened a 'smart city R&D centre' creating 200 jobs in the city.

SECTOR-SPECIFIC IT

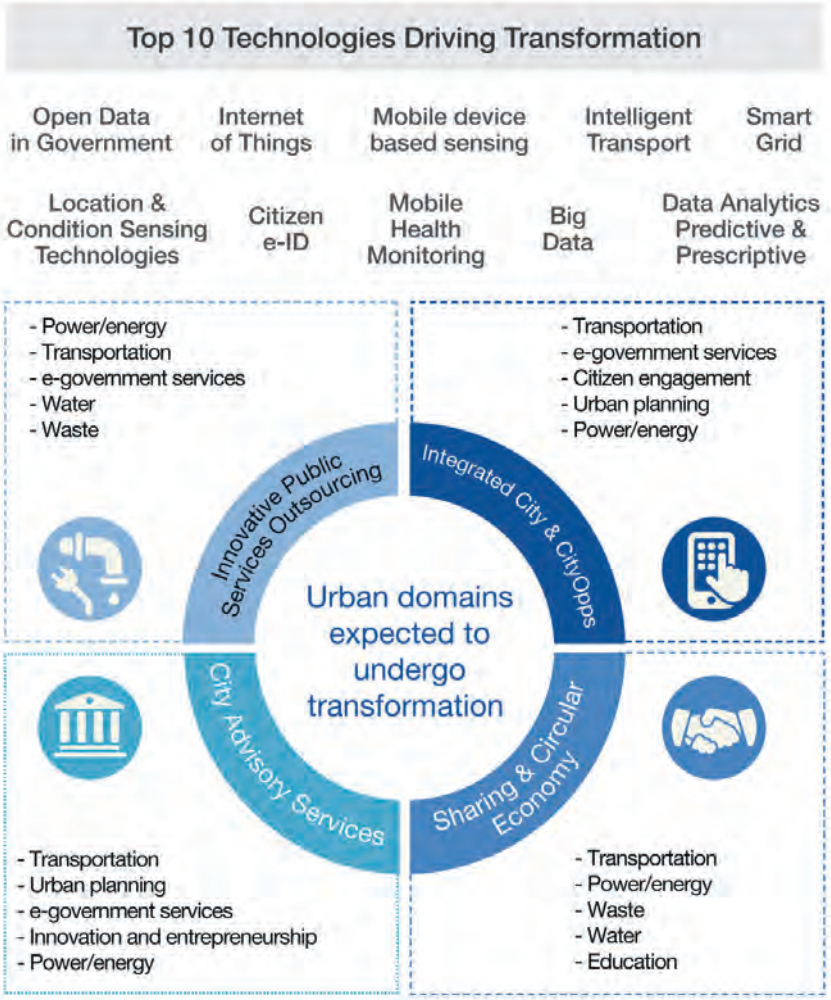
The remaining four information technologies mentioned for solving key urban challenges are sector-specific:

7. *Intelligent transport*. Intelligent transportation systems include stand-alone applications such as traffic management systems, information and warning systems installed in individual vehicles, and cooperative applications involving vehicle-to-infrastructure and vehicle-to-vehicle communications. Another promising solution to the congestion problem is an electronic road pricing system, which charges motorists based on their road usage during peak hours. This prompts motorists to change their mode of transport, travel route and time of travel.

8. *Smart grid*. In many countries, urban communities are being provided with a fibre-optic smart-grid energy network. Beyond energy security, the overall impacts are a reduction in energy consumption and cost-saving benefits from reduced usage and demand-sensitive pricing. Large industries can also sign up to 'time-of-use' tariffs that will save those businesses millions collectively a year.

9. *Citizen e-ID*. Maximum data sharing between administrations and agencies is an important goal. A facilitator is a shared IT platform that enables once-only data collection. In Belgium, for instance, citizens log on to some Flemish e-government services using electronic ID cards that automatically transfer data to the relevant government registry.

10. *Mobile health monitoring*. To offset the shortage of healthcare facilities for inhabitants of mega cities, 3G-enabled wireless monitoring devices can be used to measure and monitor the health of sick and elderly people or people in an area with health hazards.



TEN-STEP ACTION PLAN

The World Economic Forum's philosophy is an optimistic one. Although the pace of urbanisation brings numerous challenges, WEF also sees it as presenting an opportunity to re-define the social, economic and environmental fabric of our cities, as well as re-think the private sector's role in urban investment and service delivery. The World Economic Forum is the world's leading promoter of public-private partnerships (PPPs).

However, technology is not a silver-bullet solution to urban problems. To holistically address such problems, cities need to transform planning, governance and regulatory aspects, while further strengthening the use of technology. The action plan proposed by WEF contains tens steps that city managers need to consider when aiming to change the way urban services are delivered. The first step is 'Identify DNA', i.e. the city's key characteristics. That uniqueness needs to be strengthened through innovative use of urban services. The next steps are 'Identify Challenges', 'Develop a Shared Vision', 'Identify and Prioritise Goals' and 'Develop Programmes'. In the subsequent step, cities that are embracing technology-enabled urban services are also advised to 'Revisit Regulations' concerning data sharing, privacy and the sharing economy. 'Develop Capacity' is the next step; besides the development of management and technical capabilities, champions for the initiative need to be identified. Then, 'Financing and Funding' must of course be tackled and 'Quick Wins' need to be targeted in order to build the city's brand and attract best people, solutions and capital. Agile way to implement programmes should be encouraged at this stage. The last step is inevitably to 'Manage Benefits and Monitor'.

WORLD ECONOMIC FORUM

The World Economic Forum is the international, not-for-profit organisation for public-private cooperation, helping leaders of society to improve the state of the world. Its most renowned activity is the annual gathering of the world's political leaders, top industrialists, intellectuals and members of royalty in Davos, Switzerland.

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IMPROVING TENURE SECURITY OF SMALLHOLDERS IN GHANA

Affordable **Land Certificates**

61% of land owners in Ghana do not have legal title, and that percentage is even higher in rural areas. This is because remote farmland is difficult to access for licensed land surveyors, the cost of obtaining a land certificate is exorbitantly high for many smallholders and property registration involves many steps. The authors describe a pilot project in Ghana to provide farmers with land certificates at a fair price.

Tenure insecurity arises when people do not have clear and long-term rights to the land they cultivate and/or their rights are not protected when infringed. Although all people should enjoy equal rights according to formal legislation, women often lose their land when their husband dies or leaves them. A good marriage and good relationships with male relatives are crucial for women to maintain their rights to land.

DEMAND FOR TENURE SECURITY

The authors' research in Ghana and Indonesia revealed that most farmers without a land certificate are interested in obtaining one, as they believe it would strengthen their tenure. A certificate would also increase the farmer's willingness to invest in the land by ensuring he would reap the future benefits. Furthermore, it would reduce their fear of leasing their land to a caretaker as the certificate would enable the farmer to tackle infringing claims. Additionally, a certificate would keep the land within the family after the farmer's death.

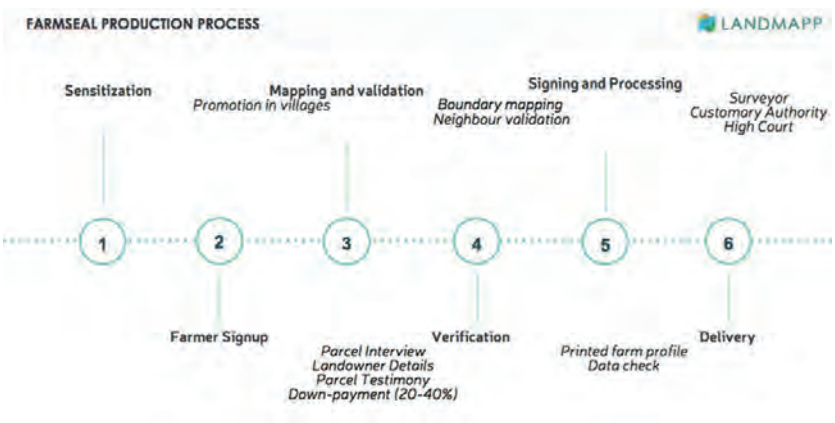
LEGAL SYSTEM

Land ownership in Ghana is related either to private/customary land parcels or public/state land parcels. The latter are vested in the president, held in trust by the government on behalf of the Ghanaian people; these account for around 20% of the territory. Customary land parcels, covering around 80% of the territory, are vested in chiefs, stools, clans and families. Chiefs are traditionally recognised as the political heads of communities and their authority is symbolised either by their stool (in the south) or by their skin (in the north). Customary chiefs are entitled to allocate land to their constituents. In certain parts of Ghana, such as the Volta or Central regions, land is vested in clans and families – the first settlers who are therefore allodial owners. Here, a chief's tasks are limited to traditional political administration and they are less concerned with the allocation of land.

INCREASING PRESSURE ON LAND IS ERODING CUSTOMARY TENURE SECURITY

AMBIGUITY

Indigenous people are part of a stool, skin or clan and thus have access to land, while migrants can be granted use rights. Increasing pressure on land – especially farmland – coupled with migration and the decline of the legitimacy of traditional institutions is eroding customary tenure security. To underpin their claims during boundary disputes, farmers need documentation proving their ownership. This is also the case when applying for a loan with land as collateral. Furthermore, tenure security based on the statutory system alone is inappropriate as customary authorities still influence people-to-land relationships. In most developing countries, legal pluralism has resulted in the state granting greater legal recognition to customary systems. Hence,



▲ *Figure 1, Flow diagram of developing a FarmSeal document.*

▲ *Figure 2, Location of the four pilot areas in the southern part of Ghana (background: Google Maps).*

▲ *Figure 3, Local staff interviewing a farmer.*

▲ *Figure 4, A mapper collecting boundary data in the field.*

Ghana statutory and customary laws govern land, which often results in ambiguity and conflict.

FURTHER READING

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PILOT

Landmapp is a start-up which provides affordable customary land documents, called FarmSeal documents, to cocoa farmers in Ghana. In 2015 a pilot project was conducted to fine-tune the process of developing FarmSeal documents (see Figure 1). The pilot, which was carried out together with two farmer organisations – Kuapa Kokoo and ABOCFA – documented 300 parcels in Kukuom, Bibiani, Poano and Suhum (Figure 2), with between 60 and 80 farmers in each of the four localities.

DATA COLLECTION

A member of the local field staff, called the 'interviewer', collects data about the farmer and his family as well as the farm itself via a questionnaire running on an Android tablet (Figure 3). The farmer is asked to provide various information including a photo for identification purposes, marital status, telephone number, spouse's details, number of children and number and quality of cocoa trees and the average yield. After the interview, another member of the local staff, called the 'mapper', collects parcel polygons by walking around the boundary along with the farmer and a neighbour who acts as a witness (Figure 4). The recorded boundary is verified with the owners of the neighbouring parcels in order to avoid subsequent disputes. Emlid Reach RTK and Bad Elf GNSS Surveyor tools enable high-accuracy data to be obtained about the boundary location. Usually, the mapper is a technical person while the interviewer needs social skills and patience to obtain the correct answers from the farmer. Both interviewers and mappers receive training in the methodology and the use of the technology (Figure 5).

PREPARING THE DOCUMENT

The data collected during the interview and the boundary mapping process is input to produce the FarmSeal document. It is essential to maintain good relationships with customary chiefs and to involve them in the development and legalisation of the document. The legal status of the document depends on the chief's original signature on a hard-copy version. However, chiefs may be reluctant to sign since they are effectively signing away their power to reallocate the land at a later stage. One incentive for signing is a small fee as compensation for the time spent, but the reliable data they receive about their constituents is far more important, since their own data about the people living in their jurisdiction is currently inaccurate and results in missed tax revenues. This incentive particularly helps to ensure the chiefs' cooperation. By negotiating the fees for signing multiple documents, a lower price per farmer can be agreed. This enables a land document to be offered to farmers at an affordable price while also requiring less effort on the part of each farmer than in an individual approach.

FARM-RELATED DATA IS COLLECTED VIA A QUESTIONNAIRE RUNNING ON AN ANDROID TABLET

INCREASING LEGAL VALIDITY

The customary chiefs have full authority over usufructuary rights of lands, which is not full title but de facto resembles it closely, as they can determine the shape and form of land rights documentation including the

right to use, cultivate, develop, lease and transfer land. The signature of the customary chief gives the document legal validity so that a farmer can uphold his claim in court.

Land Valuation Board and Land Commission Secretariat. The Administrator of Stool Lands is part of the Lands Commission and this is where the customary system connects to

EUR5 and EUR25 per document for his services. Finally, the farmer receives a signed copy and another copy is stored in the Landmapp office in Accra for safekeeping. ◀

A LICENSED LAND SURVEYOR CHECKS THE DOCUMENT FOR TECHNICAL VALIDITY AND COMPETING CLAIMS

To further augment the authoritativeness of the FarmSeal document, it is drawn up according to the standards of the Lands Commission. Established in 2008, the Lands Commission is a merger of the former Survey Department, Land Title Registry, the government bureaucracy. To make the document even more authoritative, a licensed land surveyor checks the document for technical validity and competing claims and signs the document on behalf of Landmapp. He receives between

▶ *Figure 5, Training of a group of mappers to use the technology in the field.*

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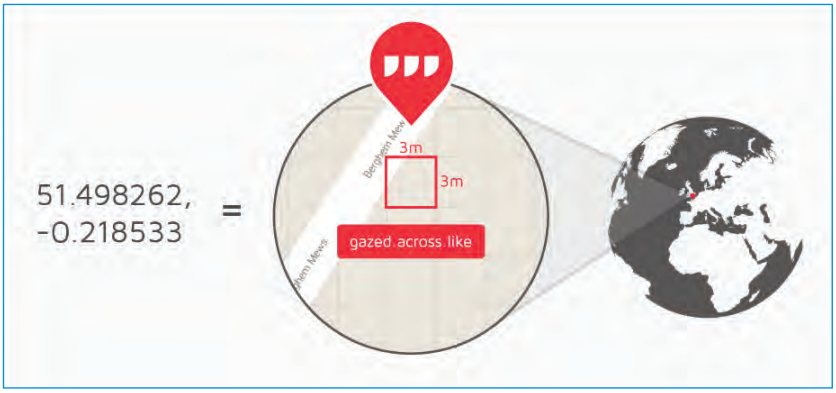
From Bitcoins to Bitsquares

An article in *The Economist* in October 2015 stated that land registries across much of the world are "badly kept, mismanaged and/or corrupt". This causes insecurity and injustice. It also means that it can be difficult for citizens to use their property as collateral for a mortgage, which hampers economic development. Building good and reliable land administration systems, however, can be a complicated and expensive activity. Now, a secure mechanism called blockchain, originally developed to handle and store transactions in the bitcoin digital currency, offers a chance for land administration by providing trust by definition.

Especially in developing countries, which do not have a well-functioning land registry, people can be wrongly evicted from their homes. The problem here is that properties are not registered properly and/or the fact that, once a property has been registered, it can easily be mutated or even deleted. Often the trusted third party, overseeing the land registry, can in fact not be trusted. Building good and reliable land administration systems, however, can be a complicated and expensive activity.

DISTRIBUTED LEDGER

In 2008 a person or group publishing under the pseudonym Satoshi Nakamoto published a paper called 'Bitcoin: A Peer-to-Peer Electronic Cash System'. The paper introduces bitcoin, a so-called cryptocurrency, which uses advanced cryptographic algorithms to efficiently facilitate safe and fast transactions between users without the intervention of a trusted third party such as a bank. In a conventional system, banks oversee these transactions: the transfer of value. Banks prevent double spending of money and money being transferred to the wrong person. With bitcoin, the banks are absent and replaced by an intelligent system, called the blockchain. The blockchain is a secure mechanism to handle and store bitcoin transactions. Once a transaction has taken place, cryptographical links mean that it cannot be altered or erased from existence. In other words, a transaction is irreversible. An additional advantage is that not only the transaction itself, but also the history of transactions is safely captured, making the data immutable and hence providing trust by



▲ *Figure 1, A unique three-word address facilitates quick, easy and unambiguous communication. (Courtesy: what3words.com)*

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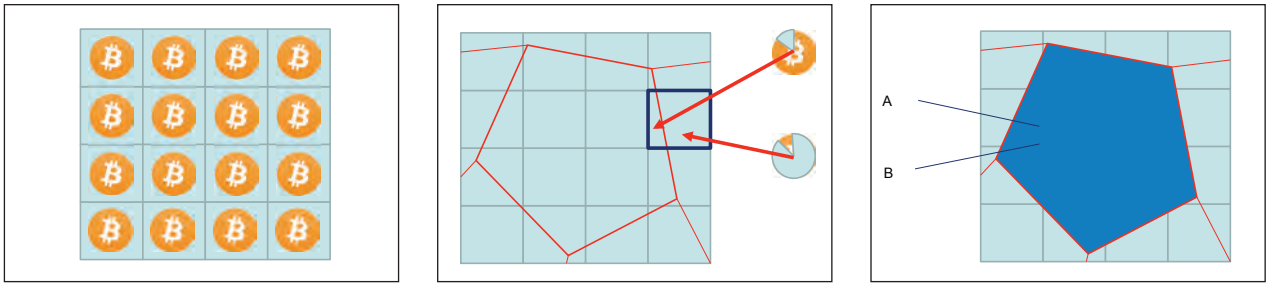

▲ *Figure 2, Problems in overlapping conventional parcel representations can be overcome.*

definition. Blockchain is also known as the 'distributed ledger'; it is the database that provides proof of who owns what at any given time, and it is publicly available.

BITSQUARE CONCEPT

By taking a conceptual step in thinking, it is possible to move from bitcoins being transferred with blockchain technology to bitsquares being transferred by blockchain technology; squares of land replace coins as the units of transaction. Each square has a unique ID and the rights holders are now in a blockchain environment. Transactions on the land market can be followed visibly and openly in the blockchain. It is possible to identify illegal transactions for those areas where a land market does not exist – in case of customary tenure or in case of protected nature areas, for example. All this can be published in a completely transparent way to the world.

WHAT3WORDS

what3words is such a system: a grid that divides the world into 57 trillion 3m by 3m squares of land, each with its own unique three-word address. The related geocoder turns geographic coordinates into these three-word addresses and vice versa. The use of words means that even non-technical people can accurately find any location and communicate it more quickly, more easily and with less ambiguity than any other system based on street addresses, postcodes, latitude and longitude coordinates or mobile short links (see Figure 1). There may of course be some georeferencing problems in overlapping conventional parcel representations (see Figure 2) but these can be overcome with the right attention – and then the revolution can start! ◀

HYPE OR SUBSTANCE?

BLOCKCHAIN

Blockchain for Land Administration

Over the past year, the international property rights sector has been abuzz with the potential for blockchain technology to fundamentally transform the approach to land administration. Even Peruvian economist and expert on property rights Hernando de Soto himself became part of this discussion in June 2015 while on Richard Branson's private island, brainstorming as to how blockchain might be applicable to the land sector. However, the initial frenzy has waned as the implementation of blockchain has demonstrated that the technology is not simply a wholesale 'fix' of the land sector, but rather should be applied realistically and piloted at a reasonable scale.

The initial excitement was ignited in part by an announcement in May 2015 that the government of Honduras would build a land title registry using blockchain technology. However, the proposed land registry project in Honduras has since stalled as the key actors have made a few startling realisations: property rights are in fact quite complicated, government moves slowly and technologically is not a cure-all panacea.

Now that it is no longer perceived as a grandiose and singular solution, we have begun to see how aspects of blockchain, applied in conjunction with proven approaches and technologies in the land sector, might make

sense in particular situations. Organisations like Prosoft Alliance, Ukraine, have integrated with blockchain platforms (in this instance, Factom) to provide authentication and timestamping of transactions as a component of their land information systems. The International Bitcoin Real Estate Association has developed from a LinkedIn group into an actual association that held its first conference in May 2016. Perhaps most interestingly, the Republic of Georgia's National Agency of Public Registry has announced a partnership to design and pilot a blockchain titling process with US firm BitFury. It is worth noting that Hernando de Soto is advising on this project.

A potential implementation of blockchain in Georgia presents an exciting opportunity as it could be a better fit for this technology. The technically advanced Georgian registry and cadastre enjoys almost complete coverage, and the country currently ranks third in the world for ease of registering property according to the World Bank's 'Doing Business' report. In this case, the incremental improvement in transparency and security of transactions as a result of blockchain might well be justified. That is not necessarily so in other less advanced countries, where the primary obstacles lie in documenting rights in the first instance, resolving and demarcating boundaries, and establishing the necessary policies and laws for an effective modern land administration infrastructure.

Although progress is being made in understanding how and when to apply blockchain, it is important to remember that blockchain is still a nascent technology. We need look no further than the Ethereum crash of 17 June 2016, which – after possibly a hack or more likely an error in the code – allowed about USD60 million worth of the Ethereum digital currency to be diverted to an unintended recipient. The very basis of the blockchain is that it is a decentralised registry and thus there is no way to 'roll back' transactions or contracts after they are recorded. There is no single registrar that can fix an error. Therefore, at the moment, it is still unclear what can be done about the USD60 million that disappeared from the rightful owners. The consequences of a similar situation in a land registry are unthinkable.

In many countries it is important to recognise that land administration is fundamentally a governance issue which, compounded by a lack of data and transparency, results in insecure land rights – not due to systems that are not secure, but because of a lack of recording and equitable recognition of rights in the first place. ◀

Frank Pichel is chief programme officer at Cadasta Foundation in the USA. He is a land administration specialist with experience in designing, managing and implementing land-related projects with a technology focus around the globe. Cadasta Foundation provides an open platform that enables property rights to be documented and administered by the individuals and communities that own them, in concert with government land agencies where possible. Visit www.cadasta.org for more information.

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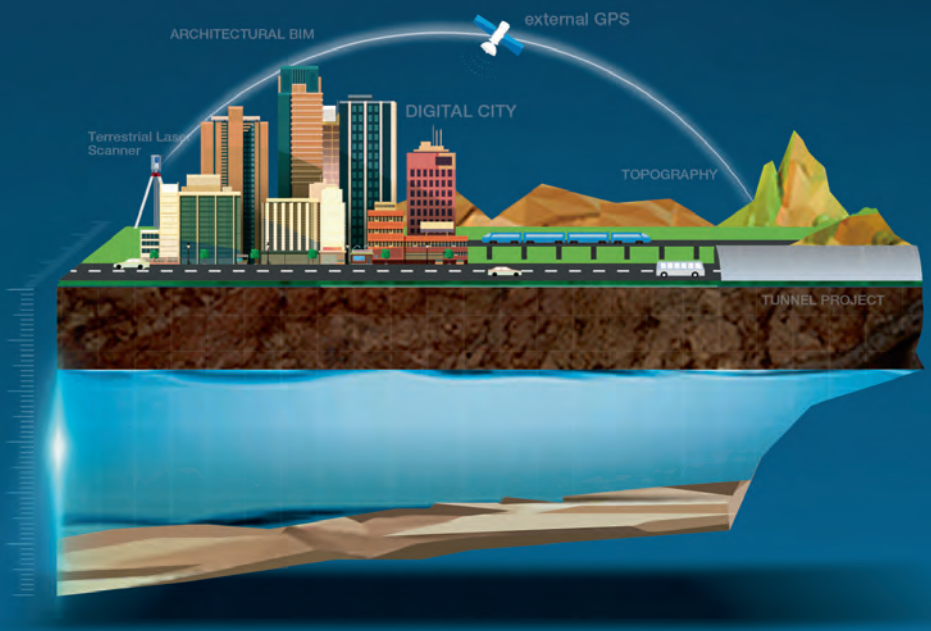

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Pioneering Spatial Planning in the 1930s

I was born at the bottom of the sea. Want to fact-check this? Just compare a pre-1940s map of The Netherlands to a more contemporary one. The old map shows an inlet of the North Sea, the Zuiderzee. The new one reveals large parts of the Zuiderzee having been turned into land, actually no longer part of the North Sea. In 1932, a 32km-long dam (the Afsluitdijk) was completed, separating the former Zuiderzee and the North Sea. This part of the sea was turned into a lake, the IJsselmeer (also known as Lake IJssel or Lake Yssel in English).

The idea behind the construction of the Afsluitdijk was to defend areas against flooding, caused by the force of the open sea. The dam is part of the Zuiderzee Works, a man-made system of dams and dikes, land reclamation and water drainage works. But it was not only about protecting the Dutch against the threats of the sea; creating new agricultural land was another driving force behind this masterpiece. A third goal was to improve water management by creating a freshwater lake.

Polder is a Dutch word and this is no coincidence. There is an English saying "God created the world but the Dutch created Holland." In 1930, the Wieringermeer was the first polder of the Zuiderzee Works that was drained, even before the construction of the Afsluitdijk was completed. The Noordoostpolder (North-East Polder) followed in 1942 and then in 1957 Eastern Flevoland and in 1968 Southern Flevoland. I was born in Emmeloord, the administrative centre of the Noordoostpolder, and grew up near a small village named Bant.

The story of the Noordoostpolder is also the story of my family. In 1941, while the pumping stations were still draining, my grandfather came to the Noordoostpolder as one of the early pioneers. The workers (called polder pioneers) were housed in wooden barracks. Cultivation began from the edges of the polder, and involved a lot of hard manual labour: digging ditches and trenches, fertilising, sowing and harvesting. This heavy work went on for weeks. The food was often limited during the war and 8 or 12 men were put up in a single room. However, the atmosphere was good in the camps, they were partners in misfortune.

My grandfather was a polder pioneer with only one objective: his dream was to start his own farm. Pieces of new land were allocated, with priority being given to the early pioneers who had been in the polder from the start. In the spring of 1952, the good news finally came that my grandfather was eligible for a farm. About thirty years later my father took over the farm, which was eventually turned into a holiday park. I was raised at the same place where my pioneering grandfather had once settled.

I am very much aware of the cultural and historical value the Noordoostpolder has. Dutch spatial planning has a worldwide reputation, as it is synonymous with quality of design. The reclamation of land from the sea makes the Noordoostpolder and the other polders special areas in their own right, but the fact that it formed a real-life testing area for Christaller's Central Place Theory adds extra value to it. Christaller's theory – regarding the scope and mutual distance of settlements – played a major role in the spatial planning of the Noordoostpolder. I recently had the opportunity to view the area from above; a sightseeing flight in a Cessna showed the breathtaking summer landscape of this part of The Netherlands. I now could see with my own eyes that the mission of the spatial planners was a very successful one.

Greetings from the bottom of the sea!

▲ *Polder pioneers taking a break.*

▲ *The village of Bant and surroundings seen from above.*

HXGN LIVE 2016

Integrating into **Complete Solutions**

The Anaheim Convention Center near Los Angeles, USA, was the venue for Hexagon's latest annual user conference: HxGN Live. Over the course of a full week in June 2016, visitors from all over the world came together to learn about the latest developments within the parent company of well-known brands such as Leica and Intergraph.

◀ *Hexagon's CEO Ola Rollén during his keynote speech.*

For several years now, the theme of the HxGN Live conference has been 'Great stories start here'. This year it was the turn of Hexagon's CEO Ola Rollén to tell a story in his keynote address: a story that contained 'data' and 'narrative', which are the two essential ingredients of a good story according to Rollén. They are, coincidentally, also the two ingredients needed to change perception and make informed decisions. Rollén stated that data should not be viewed in isolation, but analysed such that it can lead to a feedback loop for continuous improvement. He illustrated this in a keynote full of movie references, which was quite apt at a conference located so close to Disneyland and Hollywood. The Hexagon CEO outlined how the company's products can work in unison to deliver data and narrative with a feedback loop in the domains of manufacturing, construction and safety. In one example, for instance, anomalies measured at the end of a car production line may be used to alter the design for upcoming production batches.

BIM

In a good fit with the message of the keynote, Hexagon announced a new solution for building information modelling (BIM). BIM is the new paradigm for information sharing and 3D design in the construction industry. Unlike a lot of other software in the BIM realm, Hexagon's Smart Build product does not focus on 3D design or engineering, but rather on 4D planning of the construction operations from a web-based 3D environment. It is based on the existing software platform in use for industrial plants. The product will help contractors to monitor progress by assigning work packages to staff who can sign off after a piece of work is completed. The feedback loop in this product is visible through the integration of Leica survey equipment for validation and quality control of completed building elements such as concrete slabs.

AUGMENTED REALITY AND ROBOTS

The Process, Power & Marine division provided a peek into the future with the Smart Helmet from Daqri, which includes various sensors such as an infrared camera and IMU. It is also equipped with an augmented reality visor, like Microsoft's Holo Lens. 3D models from engineering software could be rendered on this helmet, which would open up huge potential in various applications. Throughout the conference, various survey equipment and software was on display showcasing incremental improvements in well-known categories of hardware and software. Particularly eye-catching was the launch of a little robotic surveillance guard by the company Gamma 2 Robotics. The robot, named RAMSEE, integrates a range of sensors and a friendly digital face. It uses artificial intelligence to autonomously survey and guard indoor environments. The robot can react to unexpected behaviour using

▲ *Surveillance robot RAMSEE.*

▲ *Overview of the exhibition hall.*

sound, speech and light. RAMSEE was introduced at Hexagon's conference within the framework of a partnership aimed at integrating robot technology in the company's safety & infrastructure products. The Pegasus Mobile Mapping solution by Leica, in which an all-terrain remote-controlled vehicle was equipped with the Pegasus 2 system, illustrated another application of robot technology. The presentation about this combination showed many potential uses including border protection and scanning of hazardous areas.

SUBSURFACE

The same mobile mapping technology was also on display as part of the Pegasus Stream. This enormous, and admittedly somewhat impractical, construction combines the Pegasus 2 laser scanner with the Ground Penetrating Radar Array from IDS, a company recently bought by Leica. The combination of both technologies enables full 3D mapping of both the surface and subsurface to be performed at the same time. With the combined system, this could be achieved with a single drive, although speed constraints apply due to the maximum measurement frequency of the radar.

SINGLE-PHOTON LIDAR

Earlier this year Hexagon announced the acquisition of SigmaSpace as provider of single-photon Lidar, which is a rapidly emerging technology for airborne applications. Whereas traditional Lidar systems emit a pulse of laser light and wait for the pulse to be reflected, single-photon Lidar requires just one returning photon for a range measurement. This makes it possible to fly higher and perform more efficient Lidar surveys. Various presentations during the trade show evaluated the use of this technology, such as in forestry applications for instance. Additionally, Hexagon announced that it would rely on single-photon Lidar technology for building an elevation model as part of its content programme.

CONCLUSION

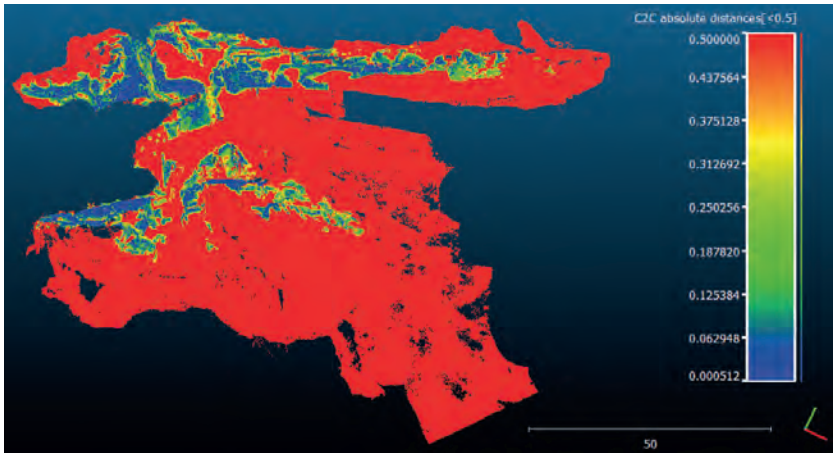
As a showcase of technology from the Hexagon group and a gathering of geomatics engineers from around the world, HxGN Live 2016 showed how survey, GIS, analytics and artificial intelligence are rapidly integrating into complete solutions. While the realisation of the vision of automated decision-making and feedback loops may still be some years off, the first steps are visible in the technology available today. Innovation will be fast-paced, and so too will the competition. Interesting times lie ahead for the geomatics industry. ◀

▲ *A visitor trying out the Smart Helmet with augmented reality.*

SMP3D

High-quality Modelling of 3D Point Clouds

SPM3D is a young company, headquartered in Kiev, Ukraine, providing a wide range of solutions for advanced processing of laser scanning and photogrammetry data. The company brings together young scientists from within Ukraine and Germany. It is aimed at satisfying the high-quality data processing needs of European customers.



▲ *Analysis of difference between laser scanning and photogrammetric point clouds.*

SPM3D was founded as a private company in October 2015 by Thomas Luhmann, Denys Gorkovchuk and Julia Kravchenko. Its international team of scientists come from both Ukraine and Germany. Participation in international programmes and implementation of educational projects have resulted in a fruitful cooperation in the business and the formation of a joint start-up company.

More information
www.spm3d.com

Every month *GIM International* invites a company to introduce itself in these pages. The resulting article, entitled Company's View, is subject to the usual copy editing procedures, but the publisher takes no responsibility for the content and the views expressed are not necessarily those of the magazine.

Despite the political instability in Ukraine, the founders decided to headquarter the company in Kiev due to the following aspects:

- constant rise in the number of IT professionals on the job market: according to the publication *IT Outsourcing News* this number will increase up to 200,000 by 2020
- wide range of technical capabilities offered by Ukrainian specialists: export turnover of Ukraine's software development industry reached USD2.5 billion in 2015
- slow but sustainable harmonisation of Ukrainian national quality standards with European: a guarantee of high-quality products on the technology services market
- lower salaries compared to most European countries: in terms of wages, Ukraine is currently ranked 170th out of 210 countries.

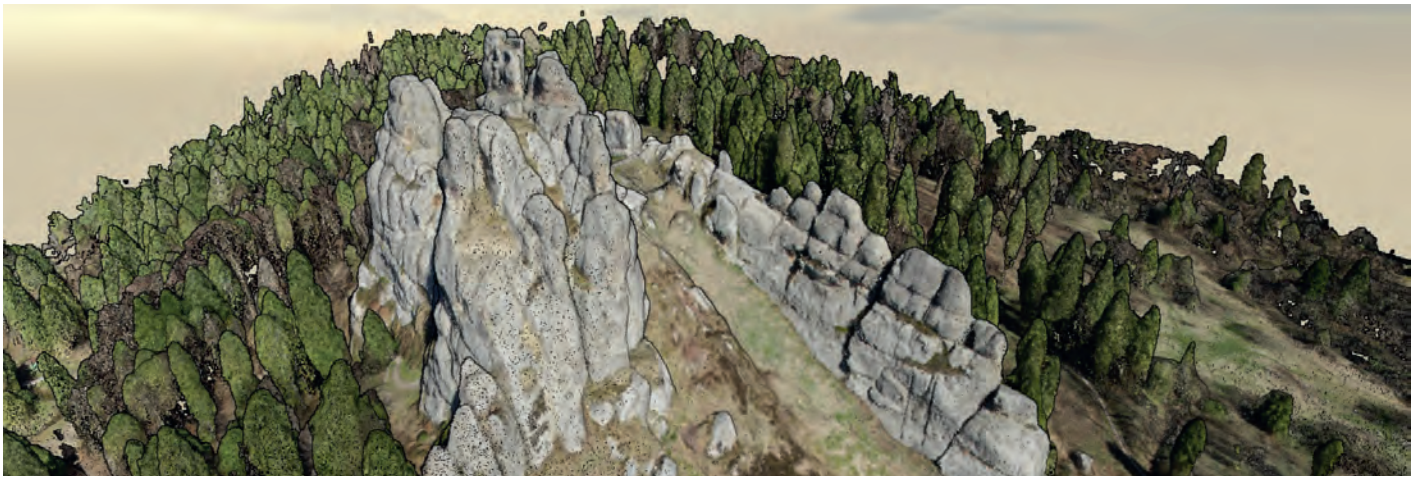
In recent years laser scanning has increased its fields of application, spanning geological, archaeological and architectural surveys, for example, and encompassing real-time monitoring and rapid prototyping. Every year laser scanners become faster, lighter, more precise and more intelligent. However, processing the scan data is still the most complicated and time-consuming aspect of the scanning task.

The main aim of creating the private company SPM3D is to meet the growing demand of customers in terms of technological solutions for processing point clouds from laser scanning and photogrammetric data. The company is based on the advanced technical and educational skills of its specialists. SPM3D conducts projects in the field of laser scanning that include the entire cycle of data processing:

- Initial point-cloud processing: registration, cleaning, optimising, exporting
- Design: CAD drawings, mesh generation, solid modelling
- Analysis: deformations, curvature, comparison with reference models.

EXPERIENCE

The specialists at SPM3D have been working with laser scanning and photogrammetry for over three years and the portfolio now includes more than 60 projects in various fields – architecture, construction, mapping, surveying, urban planning, mining, power engineering and the oil and gas industry. The company has considerable experience in modelling of cultural heritage objects. It has participated in scanning of The Holy Dormition Kiev-Pechersk Lavra for calculating the areas of ancient drawings. A model of the Cathedral of the Transfiguration of the Saviour (Kiev, Ukraine) was made for designing the interior frescos. A combination of photogrammetry and laser scanning was



▲ *Modelling of Tustan Rocks historical complex, Lviv region, Ukraine.*

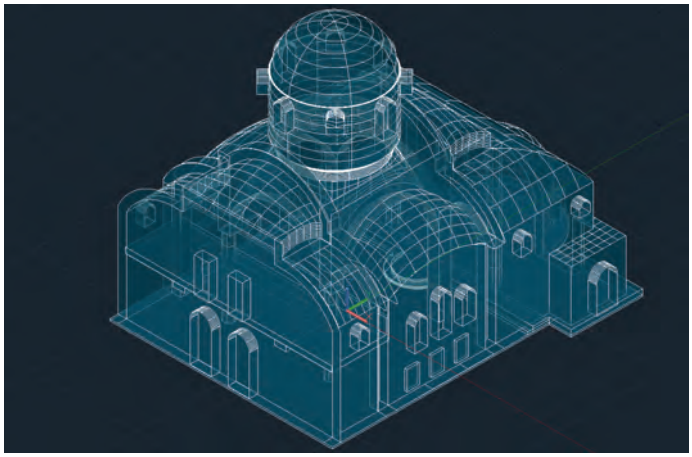
applied to model the Tustan Rocks historical complex in Lviv Region, Ukraine. Preservation of cultural and historical heritage required a 3D representation of rocks, but it was impossible to scan the whole rock complex. The object has very steep slopes and is surrounded by a lot of trees which prevent placement of the scanner. Therefore, only some parts of the rocks were scanned; everything else was captured by digital cameras. Different point clouds were acquired from laser scanning and photogrammetry, analysed for deviations and combined into one single model. The generated model was used by archaeologists to analyse the level of decay and to make a 3D reconstruction of an ancient castle which existed on the rocks in the 14th century, using the grooves in the stones.

INTERNATIONAL AND GLOBAL SCOPE

Ukraine's formation of foreign economic relations in the field of technological innovation and laser scanning is a good example of the transformation process in the country's economy and has extremely important significance for the integration of Ukraine into the European market. SPM3D, founded by scientists, demonstrates the potential of Ukrainian experts and offers new solutions and approaches for modelling of complex real-world objects to solve the problems of interdisciplinary applications. Since its foundation, SPM3D has already established successful business connections with a number of German surveying offices.

VIEW OF THE FUTURE

The company focuses on the continuous development and improvement of the skills and competence of its specialists. SPM3D strives to realise projects which bring together education and technologies, science and business. Knowledge transfer from research academic centres to practical applications and thus to end users is a promising way to attract investment into high-tech industries such as laser scanning and photogrammetry. In this regard, the company has established stable relationships with universities both in Kiev and in Oldenburg, Germany, and it employs MSc students, PhD students and young scientists. SPM3D is committed to providing an exciting and innovative work environment for specialists in Ukraine by encouraging and promoting the advancement of its employees. The company's future activities will concentrate on enhancing the business to a wider range of international customers across Europe in the fields of architecture, building information modelling, mobile mapping and cultural heritage. ◀



▲ *Reconstruction of the ancient castle on the rocks.*

◀ *3D model of the interior surfaces of the Cathedral of the Transfiguration of the Saviour.*

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FIG Working Week 2017

The focus of the FIG Working Week 2017 (29 May to 2 June 2017, Helsinki, Finland) will be 'Surveying the world of tomorrow – From digitalisation to augmented reality'. We have been witnessing the first beginning of a development leading towards services which not only describe the visible world around us but also simultaneously bring up other information connected to our place of interest. One step is to become digitalised and to use the digital information; the next step is to combine information and be able to collect the data intelligently and to take further steps into the intelligent use of digital information. The theme is chosen to highlight the opportunities and open a view into a future where the information we produce is put to more efficient use.
FIG Working Week 2017 is the main event for all ten FIG technical commissions.

REQUEST FOR PROPOSALS

Proposals for papers are requested in all topics: professional standards & practice; professional education; spatial information management; hydrography; positioning & measurement; engineering surveys; cadastre & land management; spatial planning and development; valuation & management of real estate and construction economics & management.

DEADLINES

Deadline for authors to submit for peer-reviewed papers is 1 October 2016. Deadline to submit for non-peer reviewed abstracts is 15 November 2016.
fig.net/fig2017

OTHER FIG EVENTS IN 2016:

COMMISSION 7 ANNUAL MEETING

The yearly Commission 7 meeting will be held from 24-28 October in Coimbra, Portugal, in connection with the Geoconference on 'Cadastre 4.0 - Transparency-Participation-Collaboration'.
figc7.ordemengenheiros.pt/pt/

COMMISSION 3 ANNUAL MEETING

Commission 3 Annual Meeting and Workshop 'From Volume to Quality: Bridging the Gap for Spatial Data Infrastructure' will be held jointly with EGoS GA and Geomat 2016 'Spatial Information Management for Sustainable Development' – International Symposium. The annual meeting and workshop will be held in collaboration with Romanian Surveyors Association from 3-6 November 2016.
com3fig.wix.com/fig-commission3-2016

SYMPOSIUM ON LAND CONSOLIDATION

This event will be held from 9 to 11 November 2016 in Apeldoorn, The Netherlands. The symposium is organised in close cooperation with FIG Commissions 7 and 8, the UN Food and Agricultural Organisation FAO; Landnet and the Netherlands' Cadastre, Land Registry and Mapping Agency – Kadaster. The event is supported by the World Bank and the Global Land Tool Network. We face great challenges in terms of food security for a growing world population and the need for sustainable development. This symposium will address the role of land consolidation and land readjustment in relation to these challenges. It will give participants the opportunity to discuss strategies for sustainable development and to design resilient landscapes that meet the needs of society. The symposium will focus on four themes: a) land administration, land consolidation & readjustment, b) good governance, c) sustainable development and d) financial arrangements.
lcsymposium.nl

5TH FIG AFRICA REGIONAL NETWORK WORKSHOP

The ARN Workshop 2016 will focus on: Ensuring Good Land Governance Practices in the Land Profession and What you can do about it… and will be held from 16 to 18 November 2016 in Abidjan, Ivory Coast.

More information
www.fig.net

Spatial Data Infrastructure (SDI): Evolving Metaphors and Terms

The term 'SDI' has no unanimous definition. The SDI concept emerged during the dawning of the internet, and the 'information superhighway' metaphor inspired the depicting of the SDI concept using the word 'infrastructure'. This conveyed the physical and organisational structures needed to support activities that could benefit from spatial data and technologies. However, to the detriment of the concept, the word 'infrastructure' suggests something 'big' that government constructs, requiring strategic planning, thorough analysis and dedicated funding. Meanwhile, though, the primary concern is having a 'data foundation' that enables a host of services and enterprises upon which society relies. There is no prescription per se as to how spatial data infrastructure gets developed – rather only the objective that reliable, accessible and actionable data be available to support societal needs.

Still today, the concept of SDI is confused with how SDI is implemented, by whom and with which methods. Some associate the term SDI with outdated governance structures and practices from 30 years ago, as if SDI revolves only around 'authoritative data' and is 'top-down, built by government'. The reality is that SDI implementation has been evolving since its origins in the late 1980s. Current implementation efforts, at national and local levels, across thematic communities and involving multiple data creators, have embraced new data generation and dissemination techniques, have greater focus on data use and uptake via web applications, and reveal a growing emphasis on user-centred design.

While new approaches and terms have arisen dealing with aspects of data collection, delivery and management – such as volunteered geographic information (VGI), location-based services (LBS), geospatial sensor web, the Internet of Things (IoT), environmental observatories and repositories, linked data and smart cities – the term SDI uniquely addresses the full 'information ecosystem'. SDI goes beyond data, standards and tools; it also encompasses the complicated array of policy, institutional relationships, legal concerns and financial arrangements that facilitate the availability of, access to and use of spatial data.

Past, present and future SDI developments will all be explored at the 15th Global Spatial Data Infrastructure Conference (http://gsdi15.org.tw), being held in Taipei, Taiwan, from 29 November to 2 December 2016. Hosted by the Taiwan Association of Disaster Prevention Industry (TADPI), with strong support from Ministry of the Interior, GSDI 15 will bring together colleagues from around the world who are dedicated to geospatial collaboration and interoperability, ultimately to ensure that a ubiquitous data foundation is a reality.

More information
www.gsdi.org

Report: 18th International Geodynamics and Earth Tides Symposium

The 18th International Geodynamics and Earth Tides Symposium was held from 5-9 June 2016 in Trieste, Italy. It welcomed researchers working on the observation of tidal effects on gravity, tilt and strain, Earth rotation parameters and Earth's deformation. The successful symposium attracted 105 participants from 31 countries who presented 66 oral presentations and 40 posters. The contributions were grouped into the following sessions:

1. Tides and non-tidal loading
2. Geodynamics and the earthquake cycle
3. Variations in Earth rotation
4. Tides in space geodetic observations
5. Volcano geodesy
6. Natural and anthropogenic subsurface fluid effects
7. Instrument and software developments

Nine invited lectures allowed insight into specific themes: 1) the principal outcomes of 18 years superconducting gravity in Medicina (Italy) by H. Wziontek; 2) the lunisolar stress tensor and the triggering of earthquakes, the correction of observed free oscillation spectra due to local heterogeneities obtainable from tidal observations by W. Zürn; 3) a review of the results of 40 years of long-base laser strainmeter observations in California by D. Agnew; 4) the geodetic observation of slow-slip events or giant silent earthquakes at subduction zones by K. Heki; 5) the role of Earth tides in global plate tectonics by C. Doglioni; 6) an overview of local to global geodetic monitoring of natural hazards and global change by H. Schuh; 7) the separation of surface loading from time-dependent tectonic deformation in GNSS observations by J. Freymueller; 8) a review of new developments of terrestrial and space-based gravimetric instrumentation in China by Houze Xu; and 9) the influence of external forces on the triggering of quakes by P. Varga. During the symposium, the Paul Melchior Medal 2016 was awarded to Trevor Baker. The medal is given to an outstanding scientist who has made a high impact on the Earth tidal community through significant science or technology contributions to tidal research.

The participants were invited to visit the Grotta Gigante, a giant cave close to Trieste in the classical karst that houses the long-base Marussi horizontal pendulums and also to visit the mouths of the Timavo river, a powerful fast-flowing body of water that emerges from the foot of the karst after flowing for 40km several hundred metres below the surface.

The Local Organizing Committee wishes to thank the University of Trieste and the sponsors of the symposium, namely the Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), the Dipartimento di Fisica E. Caianiello, University of Salerno, the Department of Mathematics and Geosciences of the University of Trieste, Leica Geosystems S.P.A., the IAG, the European Geosciences Union, M. Fermeglia – the Rector of the University of Trieste and M.C. Pedicchio – the president of OGS, Institute of Oceanography and Applied Geophysics for hosting and supporting this event.

Link to the meeting homepage: http://g-et2016.units.it/

Participants at the event.

More information
www.iag-aig.org

Where the Cartographers Are ...

One of the new groups elected at the ICA General Assembly last year is the Commission on Location Based Services (LBS). LBS became an active research field in the early 2000s. Since that time, there have been many changes in the field, such as the increasing demands in expanding LBS from outdoor to indoor, from location-aware to context-aware, and from navigation systems and mobile guides to more diverse applications (e.g. healthcare, transportation, gaming). The appearance of new interface technologies (e.g. digital glasses, smartwatches, augmented reality devices) and the increasing smartness of our environments and cities (e.g. with different kinds of sensors) also affect LBS. At the same time, we have seen more and more LBS entering the general public's daily life, greatly influencing how people interact with each other and their behaviours in different environments. LBS also brings many opportunities (for example in city administration and urban planning, big data) and challenges (for example, privacy, legal and ethical issues, the 'side effects' of technology) to our planet and to society. These changes open up a lot of basic and applied research questions to the LBS research community.

To motivate LBS research further and stimulate collective efforts, the Commission has started an initiative to develop a cross-cutting research agenda for the field, aiming to identify key research questions and challenges that are essential for LBS development in the next five to ten years. Input is sought from all. For details of how to contribute to this exercise see the Commission website: lbs.icaci.org/research-agenda/

This research agenda is one of many topics to be discussed at the 13th International Conference on Location Based Services (LBS 2016), which will take place in Vienna, Austria, from 14-16 November 2016. This meeting is organised by the Commission and TU Wien. Returning to the 'birthplace' of LBS conferences, it will build on the worldwide success of previous conferences in this series. It will offer a common ground for colleagues from various disciplines and fields of practice to interact and exchange knowledge, experience, plans and ideas about how LBS can and could be improved and how it will influence both science and society. For more information, please refer to the conference website: lbsconference.org/ Cartography can contribute to, and benefit from, development in LBS. An interdisciplinary approach to the field typifies both the LBS conferences and the work of the Commission. Regardless of your location, you are encouraged to join the work of the Commission.

More information
www.icaci.org

▲ *The famous Giant Ferris Wheel, Vienna.*

XXIII ISPRS Congress Is Already History

Since 2012, several of these monthly ISPRS contributions in *GIM International* have focused on the XXIII ISPRS Congress. The end of the Congress, held from 12-19 July in Prague, Czech Republic, brought with it a sense of relief that the four-year preparation period had been successful and that the participants were satisfied and enjoyed the gathering.

The authors presented a total of 897 papers in 186 oral sessions and 922 interactive papers reviewed by 663 reviewers who selected them from 1,994 submissions. The reviewing process comprised 3,750 reviews which were processed within six weeks. All papers are available at http://www.isprs.org/publications/Default.aspx.

ISPRS recognised the achievements of key people in the form of various awards throughout the Congress programme (find more details at www.isprs.org).

The General Assembly held during the Congress voted three times. In the first election, members of the General Assembly elected new Technical Commission presidents for new ISPRS Commissions (see the ISPRS website for the names of the presidents and their vice-presidents). The second election decided on the 2020 ISPRS Congress venue (Nice, France) and congress director (Nicolas Paparoditis). The third election determined the new ISPRS Council members: president (Germany), secretary general (Czech Republic), 1st vice president (China), 2nd vice president (USA) and treasurer (Canada).

In addition to the sessions, the Congress comprised many events: Summer School (which this year was held before the Congress), Welcome and Exhibitor Reception, Gala Dinner, Youth Forum, a scientific event of the ISPRS Student Consortium, Soccer Match as a continuation of Melbourne and several new events including a Fun Run and Ice-Breaking party for young scientists and their friends, plus many others.

The whole programme was documented by the Congress Daily – published by the *GIM International* team – and Congress TV, both of which were available to all participants every morning digitally by email.

While we may forget many days in our lives, we will always be able to remember the Congress days thanks to the many photos and videos available via the Congress website and/or reactions on the Congress Facebook page.

More information
www.isprs.org

FUTURE EVENTS

AGENDA

SEPTEMBER

THE COMMERCIAL UAV SHOW ASIA
Singapore
from 1 -2 September
For more information:
W: http://bit.ly/1BRnBZz

INTERDRONE
Las Vegas, Nevada, USA
from 7-9 September
For more information:
W: http://www.interdrone.com/

GEOBIA 2016
Enschede, The Netherlands
from 14-16 September
For more information:
W: https://www.geobia2016.com/

2ND VIRTUAL GEOSCIENCE CONFERENCE
Bergen, Norway
from 22-23 September
For more information:
W: http://virtualoutcrop.com/vgc2016

OCTOBER

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

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

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

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

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

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

NOVEMBER

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

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

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

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

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.

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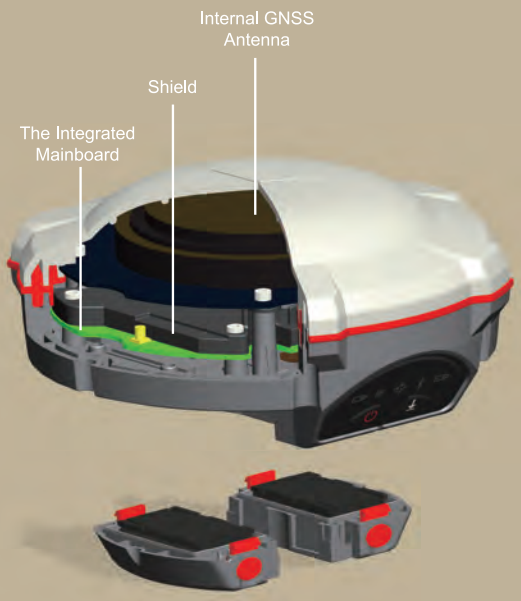

THE NEXT LEVEL RTK

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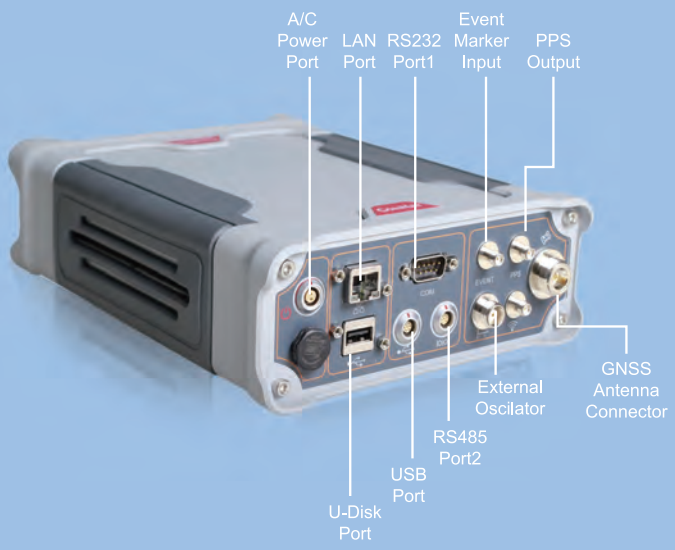

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Hamburg, Germany
ComNav Booth Number: Hall A1 D1.018

www.comnavtech.com