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Beneficial Mix

The 'cloud' is often viewed as a purely technological advance in information technology. However, it is much more than that; it is actually changing the laws of economics and business for many companies, both those that provide software, and those that buy software and IT services because they need them for their daily activities – and some companies may be affected at both ends of the spectrum. The benefit of cloud technology is in the mix. Cloud computing consists of applications, software and data stored on a (virtual) server that can be accessed by web clients which in turn can be installed on almost every conceivable computer-based device. This concept now makes software programs such as cloud-based Geographical Information Systems (GIS) or photogrammetry and remote-sensing imagery services available to so many more users – perhaps better described as 'subscribers' – than before, when they were hosted on conventional servers and brought to customers via 'old-fashioned' IT infrastructures. The cloud is significantly broadening the scope and widening the audience for many manufacturers in the geospatial sector. As costs continue to decline, it also makes it much easier for them to provide support through the web, to release new versions simultaneously around the world, and to reduce implementation costs that are not transferable to clients. This can only be good for their profit & loss accounts. At the other end of the spectrum, it is now much simpler and cheaper for users – be they private individuals or small companies – to subscribe to GIS-based, imagery or other geospatial services which previously would have been harder to access and perhaps prohibitively expensive. For such new users, cloud-based geoinformation may result in a stronger basis for decision-making, and ultimately lead to better business policies and strategies. It is worth pointing out that not all these new users are necessarily in sectors where one would traditionally expect them to rely on geoinformation for their business processes. On the contrary, geoinformation in the cloud might represent a new option for certain types of companies which would previously not even have considered using geoinformation to support their commercial activities and improve their decision-making. The technological benefits of the cloud, in terms of accessing and analysing geoinformation and being able to apply the findings to their commercial situation, could easily help to improve the profit & loss accounts of such smaller companies as well. When the cloud is involved, doing business becomes easier and is based on a firmer foundation. Now, after the first few years in which entrepreneurs took a wait-and-see approach to what the future might hold, cloud-based services are skyrocketing. I really do hope that this advantageous mix of factors will benefit the geomatics industry in the years ahead, both by increasing margins to a healthy level and by encouraging entrepreneurs who are prepared to think out of the box to incorporate the use of geoinformation in their businesses in new and innovative ways.

Photography: Arie Bruinsma

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No 2353

The cover shows the robot Irma3D (Intelligent Robot for Mapping Applications in 3D) in front of the town hall in Bremen, Germany. The robot is scanning the scene with its RIEGL VZ-400 laser scanner to acquire a set of thermal images. The availability of a complete 3D point cloud of buildings enhanced with thermal information enables architects to analyse the heat insulation and identify necessary modifications (http://youtu.be/TPoCebERysc).

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Decision Time for Land Professionals

Land professionals are currently being confronted with a considerable number of possible and potentially radical changes across their professional landscape. These are being triggered in many cases by disruptive technologies (e.g. UAVs, crowdsourcing and low cost Low Earth Orbit (LEO) satellites) and are resulting in paradigm shifts in how land professionals should deliver their services. For example, the adoption of 'spatially-fit-for-purpose' and the 'continuum-of-continuums' concepts will fundamentally change how land professionals record land rights, and proposals to use crowdsourcing of land rights by para-surveyors or citizens are challenging the fundamental role of many land professionals.

ROBIN McLAREN
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These disruptions are challenging the status quo, and are perceived as a particular threat to the current gatekeepers of the status quo, namely national mapping and cadastral agencies, the surveying and legal professions and those land and property investors taking advantage of the current chaos in inefficient or incomplete land administration solutions.

These new concepts pose particular challenges to land professionals in a very conservative land sector and have consequently exposed significant tensions. The progressive branch of the profession sees these radical changes as innovative and exciting opportunities for positive and essential change: if the profession is to seriously contribute to providing solutions to the 21st century's challenges then these opportunities need investigation. Meanwhile, those in a more conventionalist branch, currently holding more influence with regards to change, are not persuaded that a radical change programme is necessary. This conflict was highly evident at the recent FIG Working Week in Abuja, Nigeria, where young African land professionals highlighted their frustration during the sessions debating the future of the profession. Herein lies the challenge for FIG: to engage all its members and provide strong leadership on a comprehensive journey of change. If this is not successful then other professions will simply fill the vacuum.

The pressure on land professionals to change and provide more appropriate and efficient services is growing from within global political circles. Land was prominently on the agenda for the recent G8 and G20 meetings, and land indicators are planned within the replacement of the Millennium Development Goals (see the UN report 'A New Global Partnership: Eradicate Poverty and Transform Economies through Sustainable Development'). The profession is being seriously challenged to solve land issues faster – there is no hiding. It seems that land professionals are at a very significant juncture.

STREETMAPPER COLLECTS 3D DATA FOR RAILWAY PROJECT ++ FIRST EVER INDIGENOUS MAPPING DAY ++ CONTROVERSIAL 400-YEAR-OLD AUSTRALIAN MAP EXHIBITED ++ MEIXNER SIGN
NDIC GLACIER WITH UAV ++ SCANNING SCOTTISH OLD ROMAN WALL IN 3D ++ LATEST RELEASE OF ARCGIS DELIVERS TRANSFORMATIONAL CAPABILITIES ++ TI ASAHI AND ZOLLER + FR˜HL

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2. Old Roman Antonine Wall in Scotland 3D Scanned
   - http://tw.gs/R7V6aw
3. Controversial 400-year-old Australian Map Exhibited
   - http://tw.gs/R7V6bz
4. Highly Accurate Railway Mapping Project with TopoDrone UAV
   - http://tw.gs/R7V6d2
5. Cartography as a Tool for Supporting Geospatial Decisions
   - http://tw.gs/R7V6e3

First Ever Indigenous Mapping Day

In partnership with the National Congress of American Indians (NCAI), and in honour of the United Nations' International Day of the World's Indigenous Peoples, Google Map Maker, Google Earth Outreach and the Google American Indian Network organised Google's first ever Indigenous Mapping Day on 9 August 2013.

http://tw.gs/Qbv101

Street Trike in the Arctic.

University of Southampton Maps Icelandic Glacier with UAV

Alex Clayton and Tom Bishop of the University of Southampton, UK, conducted flights over the Skaftafellsjökull glacier in Iceland just one week after completing training with a QuestUAV. Despite poor visibility and very little experience with their new UAV, they succeeded in capturing imagery for a high-resolution DEM of the area which was later processed in Agisoft Photoscan.

http://tw.gs/Qbv1AY

Alex Clayton, one of the two UAV pilots.
(Image courtesy: University of Southampton)

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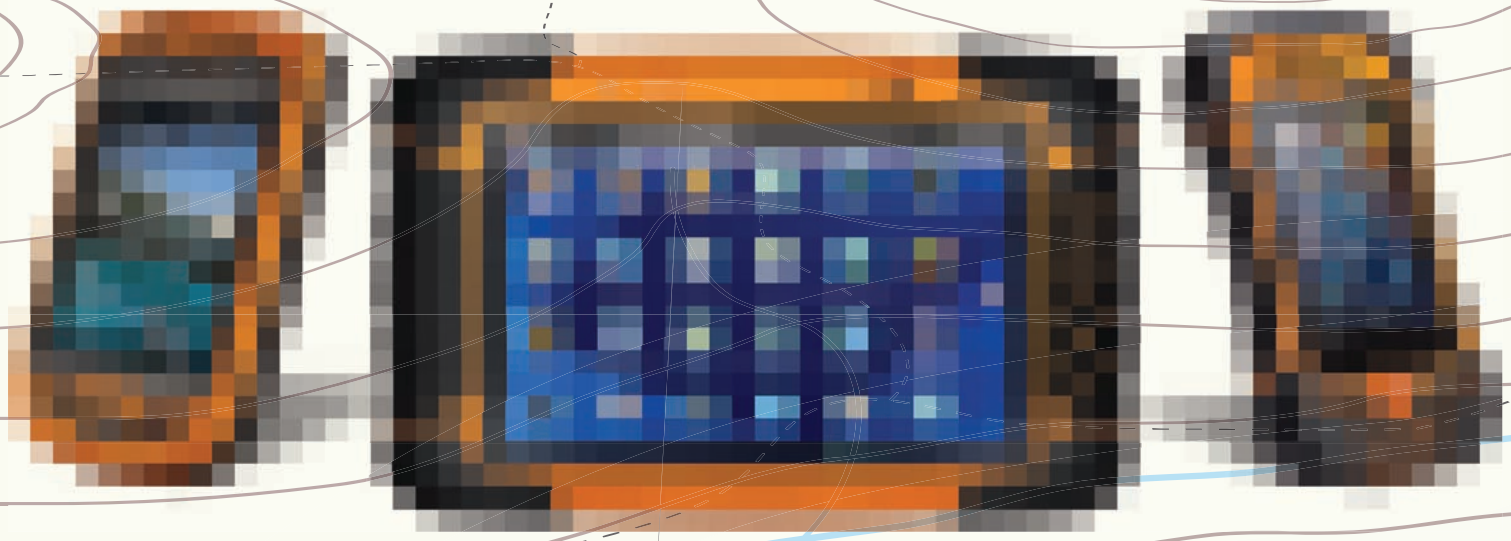

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Controversial 400-year-old Australian Map Exhibited

A controversial map that casts doubt on when Europeans really discovered Australia will be displayed 'down under' for the first time at an exclusive exhibition of the nation's earliest chartings. Novae Guineae Forma and Situs – a 1593 map that depicts a giant, unnamed land mass believed by some experts to be Australia – pre-dates the earliest confirmed map of the continent by more than a decade.

http://tw.gs/Qbv1Av

Novae Guineae Forma and Situs.

Meixner Signs Geoverse Agreement with Euclideon

Meixner Imaging, Austria, and Euclideon, Australia, have announced the signing of an agreement that appoints Meixner as the premium distributor for Geoverse software in the EMEA region. The agreement was signed by Harald Meixner, CEO of Meixner, and David Merson, chairman at Euclideon. Euclideon developed the Geoverse software to allow viewing of large point cloud datasets. Euclideon's technology is able to handle unlimited amounts of Lidar data on entry-level computers. The data can be loaded instantaneously and manipulated in ways previously unimaginable.

http://tw.gs/Qbv5aW

Scanning Scottish Old Roman Wall in 3D

The Romans were known for their engineering feats, skill and innovation and now the Antonine Wall, built in 142 AD, is to be scanned using the very latest in modern technology as part of the groundbreaking Scottish Ten project. An expert team is to scan the site as part of the project which will digitally document Scotland's five World Heritage Sites and five international heritage sites.

http://tw.gs/Qbv1Bx

Scanning the chambered tomb of Maeshowe, another historical site in Scotland. (Courtesy: The Scottish Ten)

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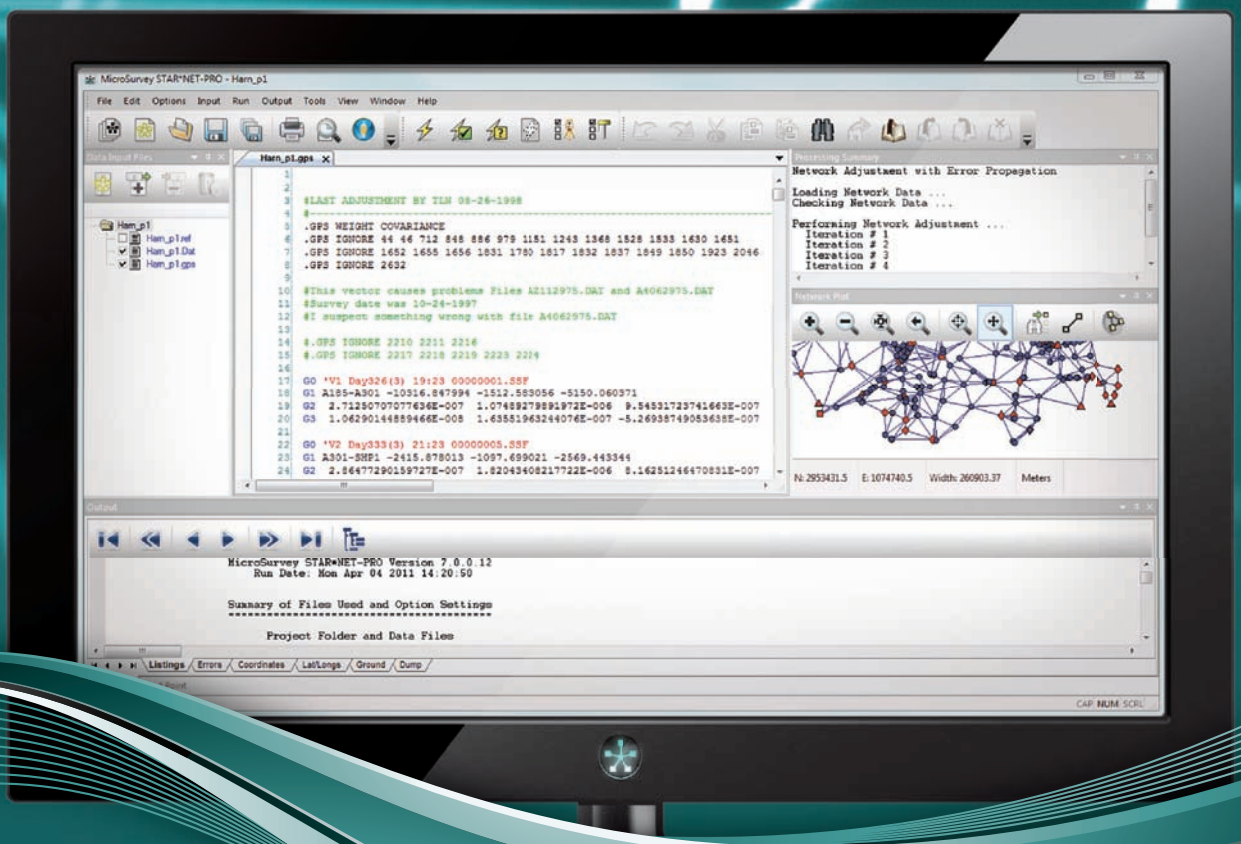

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TI Asahi and Zoller + Fröhlich Sign 3D Scanner Agreement

TI Asahi and Zoller + Fröhlich have signed an OEM agreement for exclusive worldwide distribution of 3D scanners by TI Asahi. Under the agreement, Zoller + Fröhlich will OEM-supply Pentax-branded high-precision 3D and 2D scanners to the Japanese company. TI Asahi will distribute the scanners through its global sales channels together with software for specific applications which will enable 3D scanners to be incorporated in various solution-oriented systems, serving the needs of a variety of industries which require highly accurate scanned data in 2D and 3D. ◂

▸ **http://tw.gs/Qbv2ay**

Pentax S3180-V 3D scanner.

Latest Release of ArcGIS Delivers Transformational Capabilities

Esri has released the new version of ArcGIS, marking an important new step in the history of the Esri platform. With ArcGIS 10.2, Esri has taken advantage of the significant changes in IT that magnify the power and accessibility of GIS. The new release improves real-time data access and integration with existing infrastructure. ArcGIS 10.2 also allows people to more easily deploy web GIS – the key component for implementing GIS as a platform. Web GIS helps users to organise their work and simplifies geographic information discovery, access, sharing and collaboration. ◂

▸ **http://tw.gs/Qbv1Dy**

Latest Surphaser HSX100 Laser Scanner Announced

Basis Software, USA, announced the release of the 'IR' version of the HSX100, its latest hemispherical laser scanner, at the 2013 Coordinate Metrology Systems Conference (CSMC). The 100HSX-IR incorporates the many advances of the HSX100 platform with characteristics that are specifically tailored for intermediate-range (1-35m), high-accuracy scanning. ◂

▸ **http://tw.gs/Qbv2bX**

Surphaser HSX100.

INTERNATIONAL CONGRESS: CALL FOR PAPERS ++ PROFESSIONAL UAV IMAGES FROM SM ++

ASPRS LIDAR DIVISION LAUNCHES FIRST LAS DOMAIN PROFILE ++ LATEST RELEASE OF A

Venue Maps to Improve Indoor Positioning for Location-based Apps

More precise positioning opens up opportunities for indoor location-based consumer experiences.

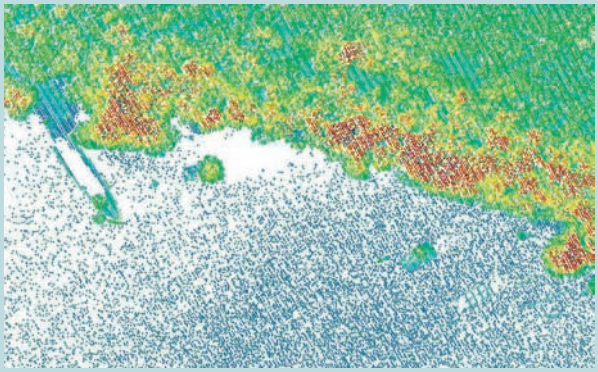
HERE, a Nokia business, is making its indoor Venue Maps available to Qualcomm Atheros. Leveraging indoor map data from HERE that is tightly coupled to the core indoor positioning engine will help Qualcomm IZat location technologies deliver more precise positioning (within 3 to 5 metres) to mobile devices inside buildings. Improving the overall indoor location experience for consumers, this combination is expected to accelerate the development and use of compelling location-based experiences as well as promotions in shopping malls, transportation hubs and entertainment venues around the globe.

http://tw.gs/Qbv2cX

3D Mapping Technology to Locate Sunken Vessels

A team of shipwreck hunters have turned to advanced 3D mapping technology to locate sunken vessels along the South Australian coastline without getting their feet wet. The team members are aiming to uncover these long-forgotten hulks by using GIS technology from Esri Australia to create digital 3D reconstructions of the ocean floor.

http://tw.gs/Qbv2d3



Sunbeam and other hulks in Lidar.

Professional UAV Images from Smartphone Camera

Lehmann Aviation (France) has launched the LA300, an automatic drone for professional, still aerial images (41MP) and video for most accurate mapping and surveying. Designed for professional applications, including georeferenced orthomosaics and digital elevation models (DEM), the LA300 achieves professional imaging using the Nokia 1020 smartphone camera.

http://tw.gs/Qbv2fa

The Lehmann Aviation LA300 UAV.

Geospatial Information Leaders Discuss Future of Digital Mapping

Nearly 300 senior leaders in the field of geospatial information gathered in Cambridge, UK, recently to discuss the future global direction of digital mapping. From 21 to 26 July 2013, Cambridge was the host city of not one but two international events that attracted leading geospatial experts from over 100 countries to discuss a variety of major issues which impact nations, communities and people across the globe.

http://tw.gs/Qbv2e5

FIG International Congress: Call for Papers

The organisers of the XXV FIG International Congress 2014 which will be held at the Kuala Lumpur Convention Centre in Kuala Lumpur, Malaysia, from 16 to 21 June 2014, have issued a call for papers. The overall theme of the congress is 'Engaging the Challenges – Enhancing the Relevance'. The call for papers applies to both peer-reviewed and non-peer-reviewed papers. The deadline for peer-reviewed papers is 1 November 2013 and for non-peer reviewed papers is 1 December 2013.

http://tw.gs/Qbv2f4

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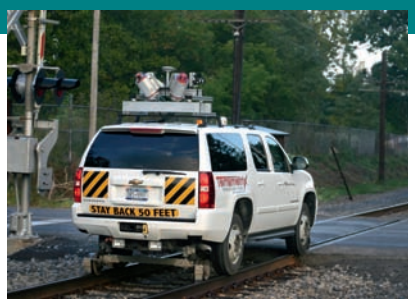

StreetMapper operating as a rail mapper.

StreetMapper Collects 3D Data for Railway Project

Mobile mapping system StreetMapper has been used to collect design-grade 3D data for a rail improvement project in New York, USA. Supplied by 3D Laser Mapping, StreetMapper uses a series of vehicle-mounted laser scanners to collect data at speed and with minimal risk to survey personnel. Selected by engineering firm CHA and operated by service provider Terrametrix, the StreetMapper system was chosen as a rapid and more cost-effective alternative to a conventional track survey.

http://tw.gs/Qbv1hz

ASPRS Lidar Division Launches First LAS Domain Profile

Thanks to a recent initiative of the ASPRS Lidar Division, different segments of the Lidar mapping community now have the ability to customise the LAS file format to meet their application-specific needs. The new mechanism that makes this possible is the LAS Domain Profile, which is a derivative of the base LAS v1.4 specification that adds (but does not remove or alter existing) point classes and attributes.

http://tw.gs/Qbv20y

Paying to Support Good Governance

'What are the characteristics of users who are willing to pay for geoinformation (GI) produced in Rwanda?' That is the central question raised in the article by Felicia Akinyemi (see page 29). 'Here we go again,' might be your initial response. 'To charge or not charge?' has been the subject of debate for several decades. Charging or paying are two sides of the same coin – charging from the producer's side, paying from the user's side. Firstly, nothing is ever for free. 'Free' only means that someone other than the one who benefits from the goods or services will end up paying the bill. And yet the question 'To pay or not to pay?' is a fair one, especially since 2008 when the evil side of our monetary system emerged, forcing nations to double or even triple their sovereign debt and to debase their currencies.

In most countries, GI is produced by national mapping agencies, cadastres and other institutions. One of the effects of charging without differentiating between types of user is that other governmental agencies and researchers also become confronted with a charge – with the result that 'Our organisation can't afford this'. So an odd situation may arise: budgetary constraints may mean that a government official may have no access to data that has been created or collected by a fellow civil servant. The official will hence be required to do his job without key resources or by using inferior alternatives. This is a waste of taxpayers' money and does not support good governance. Therefore, this type of users should be exempt from any charges. Those who are willing to pay are those who aim to profit from products and services built upon GI. The hard work done by civil servants, fuelled by taxpayers' money, should not be solely harvested by commercial firms. That is undeniably true and is plain common sense. But that is not the only reason why a charge should be made for GI. The face of the Earth is changing day and night, both due to human impact and forces of nature. To retain its value, GI needs to be updated regularly. Governments faced with huge, spiralling public debt are not fond of maintenance, as illustrated by the condition of many roads, bridges, dikes and suchlike in many countries around the world. And the same holds true for the GI infrastructure. Some may utter: 'I've already paid for public-sector information through taxation, so why must I pay a second time?' That may sound fair and reasonable, but it's not, since national treasuries are rapidly running out of ways and means. Under the pressure of austerity programmes, they will pinch budgets wherever they can, including for updating GI datasets. The value of GI will erode with the passing of time and impair good governance. The question is not 'To pay or not to pay?' but rather who should pay, who gets exemption, and what is a fair price?

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SURPHASER HSX100 LASER SCANNER ANNOUNCED ++ VENUE MAPS TO IMPROVE INDOOR POSITIONING FOR LOCATION-BASED APPS ++ 3D MAPPING TECH UNKEN VESSELS ++ GEOSPATIAL INFORMATION LEADERS DISCUSS FUTURE OF DIGITAL MAPPING ++ FIG INTERNATIONAL CONGRESS: CALL FOR PAPERS ++ PROFI S FROM

GIM INTERNATIONAL INTERVIEWS JOHANNES RIEGL

Innovating Laser Scanning Technology

The RIEGL laser scanner company has been innovating laser scanning technology for the past 30 years. Nowadays, the company's equipment can be found in the most remote and challenging locations around the world, and even in space. Dr Johannes Riegl offers a look behind the scenes at RIEGL and explains how the various laser scanning technologies have evolved over the years. Looking ahead, UAVs will increasingly be equipped with both laser scanning and cameras. Furthermore, emerging markets are already key to the RIEGL company's business growth and Dr Riegl expects that they will play an even greater role in the future.

You're founder and CEO of the company, which is named after you. Can you tell our readers about the company's origins and why you started it?

I had been working since 1970 at the Technical University of Vienna, Austria, on the (self-defined) topic of measuring short distances using optical pulsed radar technology. I was keen to continue that technical/scientific-based work focused on industrial and commercial use and applications, so I founded the RIEGL company as a spin-off.

What is your basic product development philosophy and business model?

From the beginning, it was – and still is – our aim to not only meet, but also exceed our customers' expectations with regards to reliability and longevity, the highest possible technical performance, and the usefulness of our products. We accomplish all of these things while also retaining a compact size and weight of our equipment and offering it for an affordable price.

We have a very long heritage of introducing unrivalled, market-changing Lidar solutions. For instance, some 10 years ago we were the very first firm worldwide to introduce waveform technology in commercial laser scanning. This technology offers incredible value and performance and has enabled RIEGL to approach new performance levels, and allowed our customers to address new applications and markets. At the same time, we have improved the pulsed-radar measurement precision to levels that everybody – including ourselves – would have considered impossible not too long ago.

Which major developments do you foresee in Lidar technology, both airborne and terrestrial, in the next five years?

I expect the bar to be raised even higher in the years ahead with regard to even higher sampling rates and longer ranges, at even smaller sizes and weights – in airborne, static and also mobile laser scanning. Moreover, I believe we will see the widespread use of multiple-wavelength topographic and bathymetric airborne sensors, installed in all types of manned aircraft as well as in UAVs.

We always endeavour to be at the forefront in further pushing back the limits. For instance, we just recently introduced a new class in airborne laser scanning, our LMS-Q1560 airborne mapping system. This fully integrated system can be operated at a maximum pulse repetition rate of 800kHz while operating at high altitudes in demanding projects. We are able with our own proprietary software RiMTA to resolve range ambiguities automatically and thus handle up to 10 pulses in the air simultaneously. This gives users great advantages in their flight planning and in using their sensors more efficiently than any other systems on the market.

Today's UAVs are mainly equipped with small, lightweight digital cameras. How do you see the future of UAVs and laser scanning?

I am convinced that in the near future UAVs will be simultaneously equipped with airborne laser scanners and cameras for increased overall performance. Both the market demand for and the availability of UAV sensor platforms are evolving at an impressive pace right now. We're fully aware of that, and of course consider these specific new challenges in our decision-making and product planning. One good example of a powerful, high-end UAV scanner system has resulted from the partnership between RIEGL and the Austrian high-tech firm Schiebel.

Do you see a role for Lidar, both airborne and terrestrial, in establishing or improving cadastres in developing countries?

Definitely, as the demand for accurate cadastres is common in developing countries. Every country needs to have this vital information. A cadastre is a set of legal boundaries that may or may not be physically visible. Since Lidar perfectly maps the physically present signs, it will have – and in fact is already having – an impact on the improvement of cadastres in many countries, such as in Eastern Europe for instance. To give another example, our latest airborne products like the VQ-820-G hydrographic scanner are perfectly suited for national mapping initiatives. They enable professionals to identify such details both above and below the surface. As you ▸

Johannes Riegl

Dr Johannes Riegl holds a degree in engineering and a PhD in communications engineering from the Vienna University of Technology in Austria. From 1970 to 1972, he worked on his thesis on optical short distance measurement. Johannes Riegl is the CEO and managing director of RIEGL Laser Measurement Systems GmbH which he founded in 1978. He has also worked as a lecturer at the Institute of Communications and Radio-Frequency Engineering at the Vienna University of Technology, focused on the topics of radar technology and optoelectronics.

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More than 250 guests attended RIEGL LIDAR 2013.

can imagine, rivers, lakes and oceans play a key role in defining boundaries, so properly mapping these in their entirety is important. We're already participating in the establishment of boundaries through the provision of such advanced systems.

In addition to hardware, you also produce proprietary software. Do you see open software as a competitor or as an ally?
Open source software is a great aid to exchanging and sharing, and helps to technology to become adopted. It exists as a resource for those interested in experimenting in a safe, non-risk environment to develop their skills, share with the wider community and enable the whole profession to build on their work. We actively participate in the open source community by providing tools and time to help improve the level of expertise, technology and capabilities of open source. And while we give to the open source community, we use it for commercial endeavours as well. We find the open source community to be symbiotic and synergetic.

In what manner do you co-operate with universities?
Both myself and several of my high-ranking colleagues have a background as university professors. Based on this, we enjoy very good co-operation within several academic research projects, and regularly also regularly act as sponsors. Furthermore, it's crucial for us to have close co-operation with universities as a way of recruiting excellently educated employees.

What are your experiences with respect to the interest in Lidar technology in China and India?
China is a very promising market for our products, and is already on its way to becoming one of our main export countries. We are very glad to have strong partners in China to promote and distribute our product line. Our products are well accepted and appreciated and we maintain excellent contacts with universities and authorities. To support the further growth we expect in the coming years, we're planning to enhance our direct activities and our presence in the country. On the other hand, sales in India have been relatively slow, despite the fact that it is such a huge and rapidly developing country benefiting from ongoing infrastructure improvements and so on. However, we will definitely see further growth in India with Lidar as well, and we are gladly prepared to take up that challenge.

Are you already experiencing severe competition from emerging markets such as China and India?
Quite the opposite – our products are highly sought-after in China. And plagiarism has not been a real problem for us up to now – the performance of our products is by far unrivalled.

In your view, what will be the emerging areas for Lidar technology in the coming decade?
Our products are applicable for an extremely wide field of applications including high-altitude aerial mapping, civil engineering, monitoring, mining, city modelling and so many more. Our customers regularly surprise us with new applications using our sensors. A few years ago, for instance, who would have expected a UAV to fly shoreline mapping missions using a bathymetric laser scanner? Yet now it has become reality. We can expect a lot more, exciting applications for Lidar to surface within the next decade, since the boundaries of this technology have yet to be explored. It is an exciting time for a company such as ours.

In 2012 the RIEGL user conference was held in Orlando, USA, and with Vienna 2013 it seems to have become an annual event. What's the reason behind this conference?
The RIEGL user conference is a great opportunity to touch base with our worldwide customers, partners and friends. We welcomed more than 250 guests from all around the world to the last edition. Our visitors were offered a dense conference programme, networking opportunities, a tour of our facilities, and more. For instance, we used the occasion to introduce a new class of airborne laser scanning in the shape of our LMS-Q1560 fully integrated airborne mapping system, whereas we normally introduce new products during the Intergeo event in Germany. We also re-introduced our well-proven VMX-450 mobile laser scanning system, now optimised for the demanding tasks in railway applications.

Will you be organising another user conference? And if so, where?
After our inaugural user conference last year for airborne and mobile scanning and this year's international RIEGL LIDAR 2013 user conference in Vienna for all business segments, we plan on holding our next edition in 2015. However, we've not yet decided where the next conference will be held. ◂

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No 2426

WEB-BASED SPATIAL DEVELOPMENT INDEXES IN THE CZECH REPUBLIC

Urban Dynamics

Determining changes in the built-up area over time can be done in many ways. In the Czech Republic, only the large cities can afford to monitor such changes using advanced and expensive datasets such as aerial imagery and tools like GIS. Statistical and cadastral data is available countrywide which also allows small municipalities with limited means to monitor urban dynamics. The authors have developed three approaches of increasing complexity with associated cost levels. The resulting spatial development indexes of all municipalities are published on the web on a regular basis.

One of the many challenges today's cities are facing is spatial expansion combined with shrinking population density. That means that there are fewer taxpayers per square kilometre of built-up area, which impedes proper management of settlements. To monitor and control urban expansion, central and local planners need regular data on the growth rate, size and location of built-up areas. The way of calculating these parameters depends on available data sources, their temporal resolution and the type of users. The three approaches presented here have been developed for the Ministry of Regional Development which monitors urban dynamics for spatial planning purposes. Each of the three approaches has a different degree of complexity, beginning with basic followed by advanced and then sophisticated.

BASIC

The basic approach has been designed for all 6,251 municipalities, of which just under 10% are cities. Small villages, which are governed by a mayor supported by an assistant, do not have a spatial planning office. Therefore this

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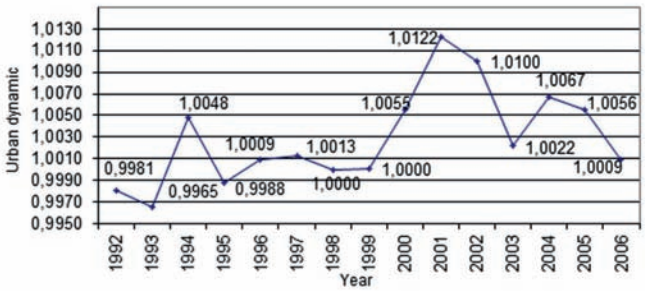
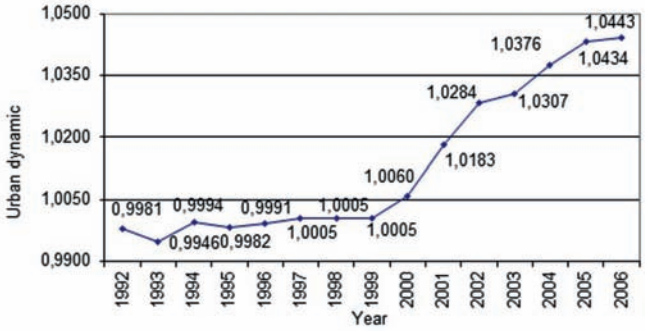


▲ *Figure 1, Annual urban growth in Vsetín between 1992 and 2006.*



▲ *Figure 2. Urban growth between 1992 and 2006 with respect to a reference year in Hradec Králové.*

▲ *Figure 3, 2006 land use map of Hradec Králové; red: urbanised, green: non-urbanised.*

approach is centred on cadastral data, which is available online and free of charge to municipalities. Together with statistical data and data on building permits, contracts and so on, the cadastral dataset provides sufficient information to calculate indicators of urban dynamics on a yearly basis. The land use types distinguished by the cadastre are grouped into two main categories: urbanised and non-urbanised (Table 1). The regrouping is done annually.

Arable area	Non-urbanised
Hop fields	Non-urbanised
Vineyards	Non-urbanised
Gardens	Urbanised
Orchards	Non-urbanised
Meadows	Non-urbanised
Agricultural area	Non-urbanised
Forest area	Non-urbanised
Water	Non-urbanised
Developed area	Urbanised
Other urbanised area	Urbanised

▲ *Table 1, Regrouping of cadastral land use types into urbanised and non-urbanised.*

Since the statistical office provides figures by the end of every year, indicators of urban dynamics can be computed on an annual basis. The key indicator is annual growth of built-up area expressed as a percentage with respect to the previous year. For example, the city of Vsetín showed an annual growth in built-up area of 1.2% in 2001 which is the largest expansion over a period of 15 years (Figure 1). Since then, the trend has been decreasing. The second indicator calculates the growth with respect to a reference year (Figure 2). A useful reference is the year of approval of the municipality's master plan as this helps planners to evaluate its impact on spatial dynamics. Another useful reference is the year of the Population and Houses Census which has been carried out every 10 years since 1868; the statistics provide information on expansion of built-up areas and thus urban dynamics over 10-year periods. Especially for the authorities in small municipalities, simplicity is essential. Therefore it is important that the calculations can be performed automatically and the results are presented in a user-friendly way.

Since municipalities have online access to the cadastral data, the calculations can be done online but there is no real need for frequent evaluation. The results are – among other data – also input to determine the impact of land use changes on the sustainable development of the settlement, which is a mandatory activity in accordance with the Building Act.

ADVANCED

The advanced approach uses municipalities' master plans and other documents available in cities' spatial planning offices. The geodata is available in vector data format in accordance with legislation. Those municipalities that have converted CAD drawings into digital geodata are able to evaluate urban dynamics in a GIS environment. Particularly large cities use GIS. Essential data concerns land use and ideally this should be the current use. All use types of parcels on the master plan have to be aggregated in either urbanised or non-urbanised.

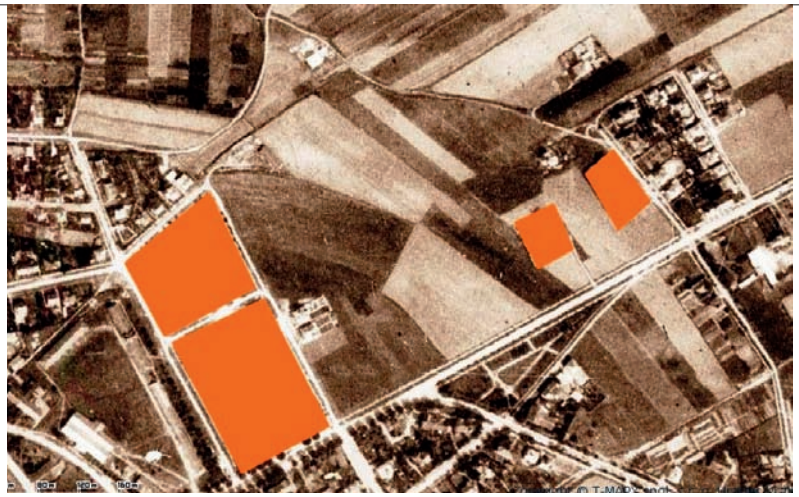


Figure 4, Urbanised area in the municipality of Hradec Králové in 1937; orange polygons indicate urbanised areas.

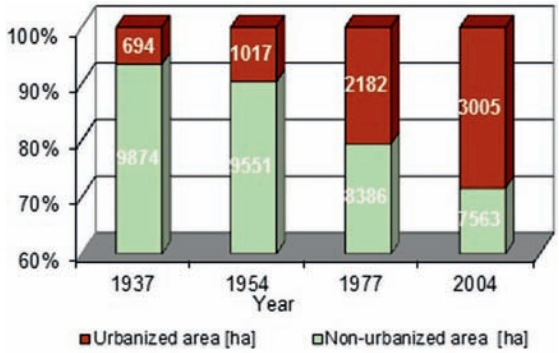


Figure 5, Portion of urbanised and non-urbanised area of Hradec Králové in 1937, 1954, 1977 and 2004.

Figure 6, Maps of the south-west part of Hradec Králové showing the evolution of residential areas; left: 1937, middle: 1957, and 1977.

Urbanised is subdivided into fixed (continuation of the present land use) and areas which need redevelopment. The latter should include brownfield sites; these are areas where the former land use, often industrial, has been abandoned while revival is pending. Non-urbanised is subdivided into fixed areas, areas due to be urbanised, and areas to be changed to another non-urbanised use. The situation immediately after approval of the master plan may act as a starting point for computing urban dynamics over the years. The calculation is similar to the one used for the basic approach. Final results can be presented alphanumerically or as graphs and maps (Figure 3). This approach distinguishes urbanised from non-urbanised areas more reliably than the basic approach and allows evaluation of the impact of changes in the master plan. It suffices to determine the indicators every four years as the changes in land use are gradual. Furthermore, calculations over the space of several years results in larger numbers, which are more impressive to politicians. For example, an annual change rate of 0.7% sounds modest while a 3.5% change rate over five years is likely to attract more attention.

SOPHISTICATED

The sophisticated approach uses digital aerial images from the military which has been capturing the entire territory of the country every decade since the 1930s at a scale of 1:5,000. This imagery enables analysis of urban dynamics over a time span of almost 80 years. The boundaries of urbanised areas are digitised as shown in Figure 4 and – as they are georeferenced – can be combined with other GIS data. The temporal resolution of 10 years allows computation of municipalities' urbanisation rates over time (Figure 5) and the spatial evolution of built-up areas to be mapped (Figure 6).

CONCLUDING REMARKS

The three approaches have been certified by the Czech Ministry of Regional Development and can be used as a tool for the biannual evaluation of sustainable development of settlements. Gradually, small municipalities will replace their CAD data with geodata which supports an upgrade of their approach from basic to advanced or even sophisticated.

FURTHER READING

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Maštálka, M. (2009) Územně promítnutelné indikátory udržitelného rozvoje. (Indicators of Spatial Sustainable Development), PhD thesis with English summary, Brno University of Technology

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AUTOMATED CALCULATION OF WIND POTENTIAL FOR SMALL WIND TURBINES

Site Suitability and Efficiency

Renewable energies are affecting the energy markets of today and tomorrow, and wind energy represents significant potential for further expansion. While the construction of large wind turbines is very widespread, small wind turbines are a less-common topic of discussion. Thanks to their versatility, small wind turbines can be installed at almost every site where the appropriate wind speed is present. However, it is currently often difficult to identify such sites due to a lack of available wind speed data. Within the WIND-AREA research project, a method has been developed of modelling wind currents in order to highlight suitable sites for small wind turbines.

The wind speed at a potential site is influenced by the structure and the land cover of the Earth's surface. Topographic structures and obstacles (e.g. houses) lower the wind speed. Valleys or street canyons can act as accelerating channels of higher wind speeds due to the 'Venturi effect'; this is the name given to situations in which higher wind speeds result from the same amount of air being pressed

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Anne Fuchs (MEng) obtained a bachelor's and master's degree in Geoinformation and Public Works at the University of Applied Sciences in Frankfurt/Main, Germany. Since graduating in 2012, she has been a research assistant on the research into renewable energies in land management there. Her main task is the WIND-AREA research project.

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Andreas Wicht (MEng) obtained a bachelor's and master's degree in Geoinformation and Public Works at the University of Applied Sciences in Frankfurt/Main, Germany. Since graduating in 2012, he became a research assistant on the research into renewable energies in land management there until February 2013, when he moved to the laboratory of photogrammetry and remote sensing.

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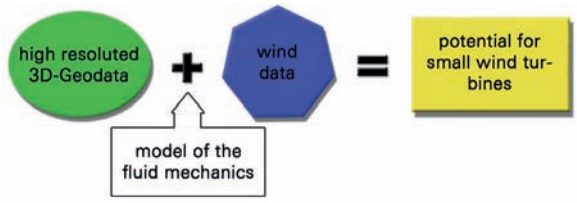

◀ *Figure 1, Horizontal small wind turbines. (Courtesy: erikdegraaf/ Fotolia.com)*

▲ *Figure 2, Methodology for deriving wind potential maps.*

through narrow areas in the same amount of time as on a plain area. Different land covers such as grass or vegetation have different effects on the wind speed. The impact of such effects becomes less significant, the higher the observed air layer is above ground. Conversely, the lower air layers in which small wind turbines are installed can display extremely varying wind speeds.
High wind speeds are essential for small wind turbines to run efficiently because a site's potential energy output increases exponentially by the power of three in relation to the wind speed. In other words, a two times higher wind speed results in an eight times higher energy harvest. Determining the wind speed can be costly, which lowers the potential profitability of sites. Thus in order to find sites with high wind speeds suitable for small wind turbines, it was desirable to develop a method which models the wind currents in low air layers.

METHODOLOGY

The methodology is based on combining high-resolution laser-scanning data with wind data aided by tools of fluid mechanics. A methodology for deriving wind potential maps for large wind turbines has already been developed. This method was assessed for potential use in analysing the situation for small wind turbines and optimised for the wind current simulation in low air layers.
Classic wind potential maps assign roughness values to different land covers. However, such experimentally determined values are insufficient for the simulation of wind currents in low air layers. Therefore, WIND-AREA provides a methodology which takes detailed account of the interference of wind currents by built-up areas, surface structure and surface roughness. Hence, in contrast to the classic methods used to analyse site potential, WIND-AREA uses high-resolution 3D geodata. Preliminary simulation results in different resolutions (Figure 3) has confirmed the necessity of using high-resolution geodata.
The final map represents the difference of the wind rasters in 1m and 3m resolution. It shows that the highest differences (brown and dark green) are within the areas of building edges which are represented less accurately at lower resolutions.

FLOW MODELS

To simulate the wind currents, the high-resolution 3D geodata has to be combined with the wind data. Statistical or numerical flow models are available for this. Statistical flow models use linear equations, which include the parameters of height, slope and exposition for the wind current calculation. In complex areas, such as mountains, such calculation models fall short. However, numerical flow models are able to simulate wind currents more accurately. Particularly, Computational Fluid Dynamics (CFD) models produce a more accurate result by using the equations of motion (Navier-Stokes equations) to calculate the currents in an iterative process. A disadvantage of CFD models is the high usage of computation resources. However, since precise calculation of wind currents is necessary and such models provide good accuracy in lower air layers and on complex terrain, the use of CFD models is recommended when analysing the potential for small wind turbines.

SIMULATING WIND CURRENTS

In the process of wind current calculation, high-resolution 3D geodata is combined with regional wind data using a flow model. It is very important to take any obstacles into account, and that is achieved by using a high-resolution digital surface model (DSM). Other influences on the wind currents by other types of land cover are taken into account by assigning roughness values.
Based on this surface model of the test area, the wind fields for 12 sectors (0°, 30°, 60°, ... 330°) are calculated by the iterative process of the CFD model. Wind fields show how the wind current acts within the ▶

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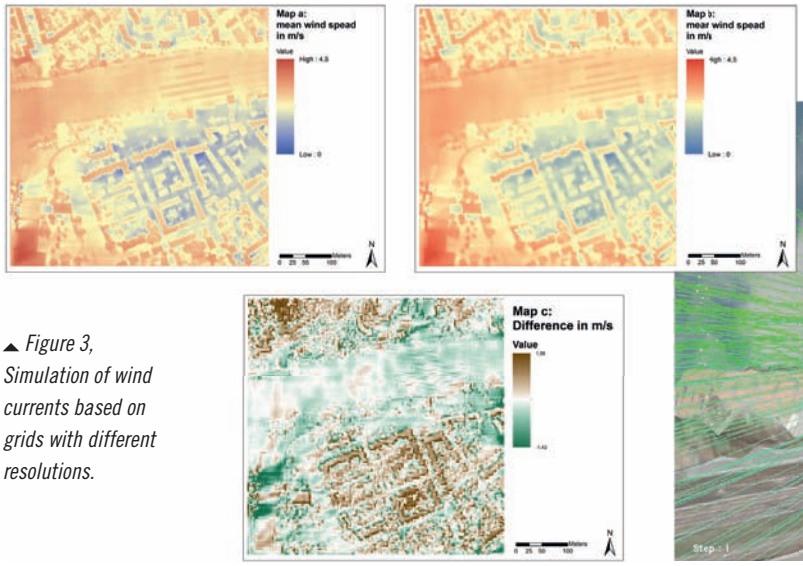
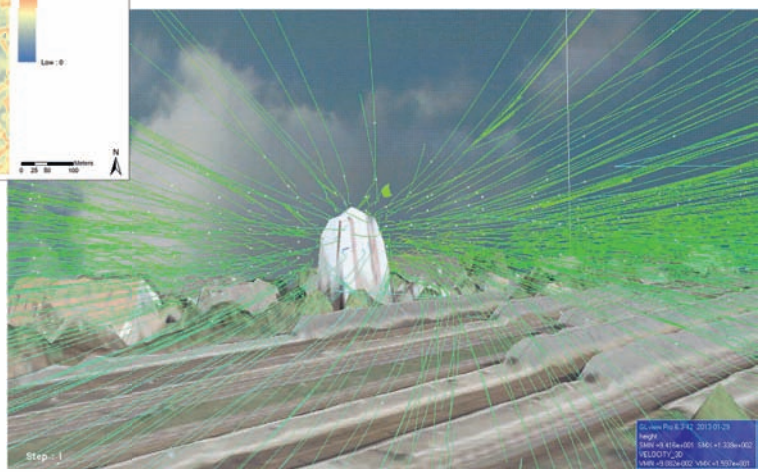


▲ *Figure 3, Simulation of wind currents based on grids with different resolutions.*

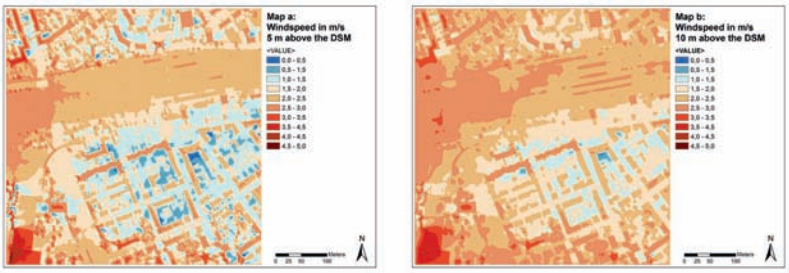


▲ *Figure 4, Simulated flow around a building, wind direction 30°.*

model depending on the direction of influx. By intersecting the different wind fields with the regional wind data on the wind speeds and direction, the average wind speed per raster cell can be derived for different air layers. Using the DSM as the basis for the wind current calculation enables flows around buildings or turbulences to be derived precisely (Figure 4), thus allowing potential areas within urbanised areas and complex terrain to be identified. In those areas, high wind speeds are possible due to the Venturi effect resulting from channels formed between buildings or other structures.

WIND-AREA RESULTS

The result of WIND-AREA is wind potential maps of larger study areas, generated fully automatically based on existing data. These maps show the average annual wind speeds in air layers at different heights (Figure 5), and they can be used to identify good to very good sites for small wind turbines in urban and rural areas. It is possible to make reliable predictions of the profitability of those sites. WIND-AREA results can help citizens and municipalities to plan the location of small wind turbines. The wind potential maps are expected to lead to an increase in small wind turbines in Germany. Small wind turbines can be used to generate decentralised electrical energy to supply single buildings or urban areas. The generation of electrical energy by small wind turbines can complement the electrical energy provided by solar panels and lead – together with biogas, geothermic and water energy – to autarkic energy supplies for cities or municipalities. The combination of geodata with thematic geodata as seen in WIND-AREA as well as other research projects including ERNEUERBAR KOMM! (holistic potential analysis for renewable energies) and SUN-AREA (solar roof cadastre) helps to promote the expansion of renewable energies. ◀



◀ *Figure 5, Wind potential maps for small wind turbines.*

AUTOMATION IN 3D MOBILE LASER SCANNING

Towards Optimal 3D Point Clouds

Motivated by the increasing need for rapid characterisation of environments in 3D, the authors have designed a robot system that automates the work of an operator of terrestrial laser scanners. The built system makes it possible to work without markers or targets, saving surveyors more than 75% of the time spent in the field. Another impulse for developing the platform was the demand for a remote inspection tool. The robot is capable of surveying remote sites or danger areas, such as plants, underground mines, tunnels, caves or channels. The availability of the robotic platform further enables the study of mobile laser scanning systems. Now, the system is ready to do the work. This article details firstly the mobile robot and secondly the software solution. The software consists of automatic, high-precision registration programmes for terrestrial scans, i.e. bundle adjustment, and extension to mobile mapping, which requires precise calibration and trajectory optimisation. The algorithms do not rely on features at any point.

The Intelligent Robot for Mapping Applications in 3D (Irma3D) is a robotic mobile laser scanning system for automating terrestrial laser scanning and miniaturising mobile mapping. Scientific issues like automatic registration and calibration in a mobile laser scanning scenario have been explored. Irma3D is a small, lightweight, battery-powered, three-wheeled vehicle (Figures 2 and 4).

Andreas Nüchter is professor of computer science at the University of Würzburg, Germany. Until June 2013, he was an assistant professor at Jacobs University Bremen, where the robot Irma3D was initially developed. Prof Nüchter holds a PhD degree from the University of Bonn, Germany, and is a senior member of the robotics and automation community.

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Jan Elseberg is a PhD student in Prof Nüchter's group. He is working on SLAM algorithms, automatic calibration and mobile mapping applications. As a computer scientist, he is also involved with efficient data structures and implementations. He holds a master's degree from the University of Osnabrück, Germany.

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Dorit Borrmann is a PhD student in Prof Nüchter's group. The robot Irma3D was developed under her supervision. She is interested in the combinations between photogrammetric and laser scanning methods. She holds a master's degree from the University of Osnabrück, Germany.

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▲ *Figure 1, Results of the semi-rigid SLAM on a dataset acquired with a constantly spinning RIEGL VZ-400.*

With a width of 52cm and an overall length of 65cm it is small enough to pass through narrow doorways. The three-wheeled design allows for a high manoeuvrability such that it can rotate on the spot. These properties make Irma3D ideally suited for indoor environments. However, the high-powered electrical two-active-wheel differential drive with a top speed of about 2.2m/s combined with the passive castor also make it capable of operating in moderately challenging outdoor environments. The robot is controlled remotely, either via a WLAN connection or through a gamepad. Irma3D can also be used in a fully autonomous mode. Once activated, Irma3D will attempt to explore its surroundings within preset limits and create a 3D map of the environment.

As a laser scanner platform, it can be used as a mobile laser scanner, i.e. to acquire range measurements while moving through the environment. Alternatively, the robot can remain still when a 3D point cloud is acquired. This type of static laser scanning is called 'stop-and-go scanning'. It is possible to create 3D models of the environment as detailed for mobile laser scanning. However, since the laser scanner is not operating while the robot is moving, more time is required in this mode to create equally large point clouds. This dual use of Irma3D is made possible by the 3D terrestrial laser rangefinder that it is equipped with. Without a 3D scanner that is able to freely rotate, Irma3D could not acquire 3D range images of its environment.

The robot Irma3D is a combination of several sensors, a mobile platform and a portable laptop for processing data and controlling the robot itself. The chassis of the robot is a modified VolksBot RT3 which has two front wheels. Each is actuated by an individual 150W motor. The motors are powerful enough to move the robot at a total maximum velocity of 2.2m/s. The third wheel is at the back of the chassis. It is swivel-mounted and thus completely passive as it follows the directions of the front wheels. The platform is powered by four lead batteries, 12V 7.2Ah. The chassis has a variable laptop mount that can fit any reasonably sized laptop. Currently Irma3D operates on a Samsung Q45 Samsung 12.1" laptop with the Intel Core 2 Duo CPU T7250. The laptop mount has been situated such that the laptop will rest above the control elements of the chassis (Figure 4). The physical dimensions of the VolksBot RT3 platform are 58cm × 52cm × 32cm with a weight of about 22kg. Most of this weight is from the lead batteries, each contributing about 2.5kg. By equipping the robot with a laser scanner and a camera, the height and weight increase accordingly.

For navigation and obstacle avoidance, the robot is equipped with a SICK LMS100. This 2D laser scanner is mounted at the front of the chassis and is facing forward, acquiring 2D range scans at a rate of 50Hz. To support a human operator controlling the robot remotely, two small webcams of type QuickCam Pro 9000 by Logitech are also attached to the front of the chassis. The motors of the VolksBot are equipped with encoders to measure wheel rotations. This information is used to provide pose estimates of the robot via odometry. The pose estimates are improved using data from the IMU xSens MTi that is also attached to the robotic platform. The IMU is susceptible to magnetic interference and must be positioned away from strong magnetic fields to reduce erroneous sensor readings. Since the motors as well as the laser scanners generate magnetic fields, the IMU is fixed to the rear and bottom of the chassis.

The central sensor of Irma3D is the RIEGL VZ-400 3D laser scanner. The scanner is mounted on top of the VolksBot chassis. Attached to the top of the scanner is a Canon 1000D DSLR camera. After a 3D scan has been conducted, the camera is used to acquire colour information for the point cloud. A similar process is done using the thermal camera optris imager PI, which is also mounted on top of the scanner to acquire information about the thermal properties of structures in the point

cloud. The RIEGL VZ-400 is able to freely rotate around its vertical axis to acquire 3D scans even when the robot is not in motion. It also returns so-called calibrated relative reflectance values as a correction for the influence of the distance to the surface.

HIGH-PRECISION REGISTRATION

The basis of the software development is the well-known iterative closest point (ICP) algorithm. Given two 3D point clouds and a rough initial pose estimate, e.g. by the robot's odometry, ICP iteratively revises the pose estimation (translation and rotation with 6 degrees of freedom) of the second scan. To do so, the algorithm selects the closest points between the two raw scans and minimises an error function. Current research in the context of ICP algorithms is mainly focusing on fast variants of ICP algorithms.

Pairwise ICP improves the scan pose estimates, but registration errors mount up when adding more scans. Simultaneous Localistion And Mapping (SLAM) algorithms use loop closings to minimise the extent of such errors. The recently presented globally consistent scan matching algorithm, which is a bundle adjustment solution for 3D scans, extends the ICP algorithm. The input is *n* point clouds and its output is improved pose estimates for all scans. In an ICP-like fashion, the algorithm iteratively calculates the closest points between all scan pairs as specified in the SLAM graph. Using these point pairs, an improved pose based on least square error minimisation is calculated. Figure 3 shows a scene in Horn, Austria, where the scans have been registered with ICP and its globally consistent extension. Notably, this algorithm does not require any feature extraction.

AUTOMATIC CALIBRATION

To acquire high-quality range measurement data with a mobile laser scanning system, the position and orientation of every individual sensor must be known. Algorithmic calibration methods of these systems are currently being developed, i.e. algorithms to establish the parameters that best describe sensor displacements based on the sensor data itself. In this process, parameters roughly measured with external instruments are fine-tuned automatically.

SLAM algorithms use loop closings to minimise the extent of registration errors

The state of the art in mobile mapping is: (1) For all sensors, determine the position and orientation on the vehicle (calibration), (2) Data acquisition, (3) Extract the trajectory of the vehicle from the sensor data (Kalman-Filter, etc.) (4) 'Unwind' the laser measurements with the trajectory to create a 3D point cloud. Unwinding means to compute the 3D point cloud based on the scanner's range measurement, the current rotation

Figure 2, Irma 3D performing a scanning job in Ostia Antica, Italy (summer 2012).

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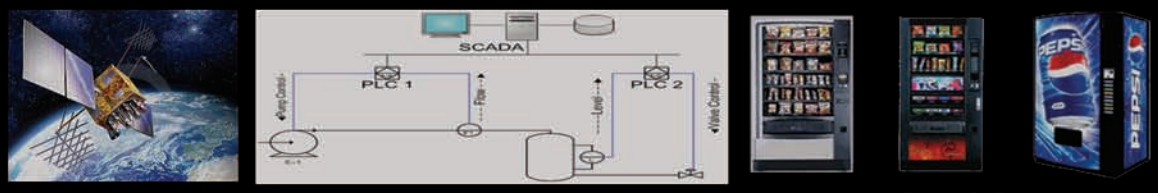

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Hardware dimensions of the smallest version: 44 x 22 x 7mm
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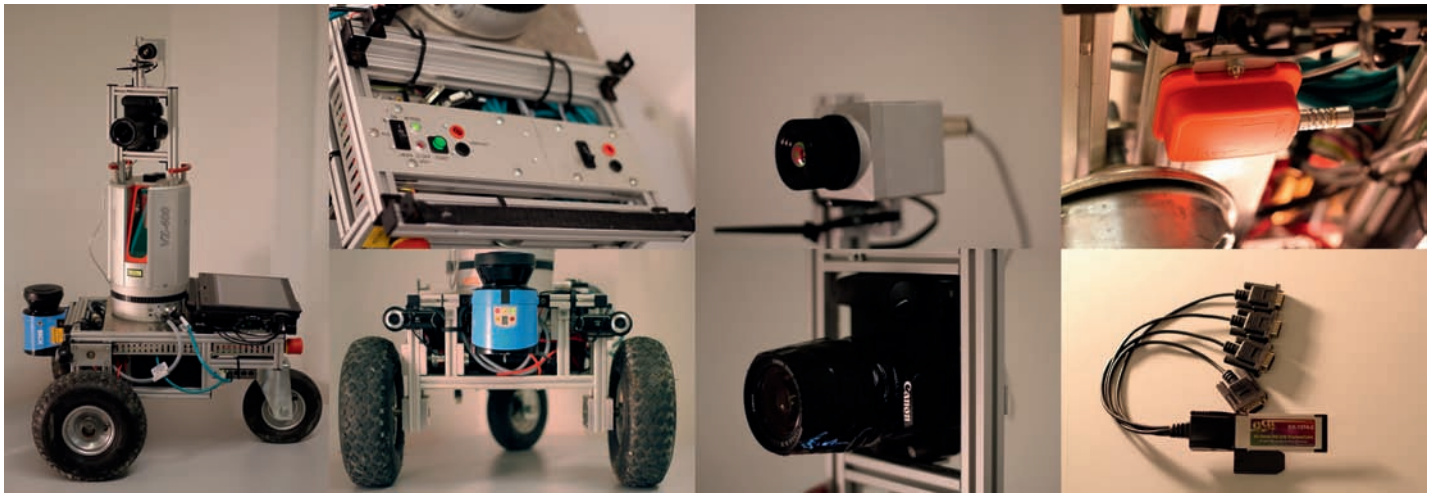
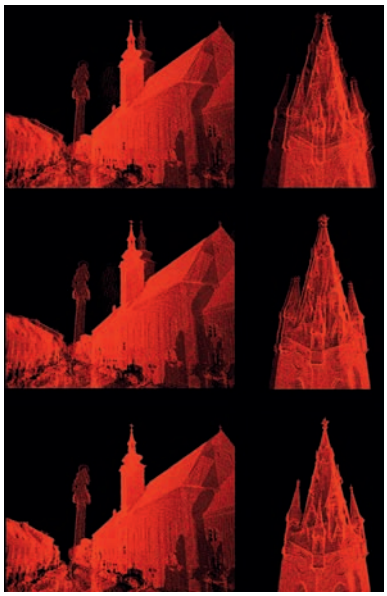
TraceME applications: Personal tracking with SOS. Object protection and tracking. Logistics. M2M. Security and Surveillance. Remote control and Diagnostics. ODB-II version available. Vehicle immobilisation. Rentals tracking. Alternative and cheaper solution for SCADA. Alzheimer-, eldery-, patients- and people tracking. Remote control of Vending- and other machines in the field. Animal tracking. Backup Power Generators. OEM version is possible.



▲ *Figure 4, The Irma3D.*

of the scanning mirror, the trajectory and the calibration information.

The automatic calibration method follows these four steps, but the 'unwind' step is treated as a function. An error measure has been designed whereby the quality of the resulting point cloud is determined based on the 3D points. The used entropy is calculated from closest point correspondences very similar to the previously mentioned registration methods. It is possible to optimise for the position and pose of every sensor, i.e. performing automatic bore sight alignment, and for timing inaccuracies. Aside from sensor misalignment, a second source of errors are timing-related issues. On a mobile platform, all subsystems need to be synchronised to a common time frame. This can be achieved with pure hardware via triggering or with mixes of hardware and software like pulse per second (PPS) or the network time protocol. As the robot Irma3D is not equipped with a GPS clock or any central trigger mechanism, every sensor uses its own timer and the synchronisation is improved by the calibration procedure.



▶ *Figure 3, Top: Registration of 3D point clouds by incrementally applying ICP results in a noticeable error. Middle and bottom: By applying the globally consistent scan matching, these errors are removed and the intrinsic accuracy is improved.*

SEMI-RIGID SLAM

Besides calibration, an even more significant source of errors is the incorrect positioning of the vehicle. Solving this problem requires approaches other than classical, rigid SLAM algorithms. An area that may provide a solution is the area of non-rigid registration. This approach optimises the point cloud using full 6D poses and is not restricted to a single scanner rotation. Instead, scan quality is improved globally in all 6 degrees of freedom for the entire trajectory. In an ICP-like fashion, this semi-rigid SLAM solution computes the closest point pairs and includes a timing threshold to prevent matching of consecutive scan slices. This way, a rotating scanner is not necessary for the algorithm to improve scan quality. This can be demonstrated on state-of-the-art mobile laser scanners.

Figure 1 shows results on a mobile mapping dataset acquired by RIEGL Laser Measurement Systems GmbH. A constantly spinning RIEGL VZ-400 laser scanner was mounted on a car roof rack. The only input was GPS data and the scans from the spinning laser. The top part depicts an overview and the system set-up. The middle part presents the initial 3D point cloud by unwinding the scans using the GPS trajectory. The bottom part shows the optimised point cloud.

FUTURE PLANS

To complete the acquired 3D point clouds, the plan is to equip a small unmanned aerial with a laser scanner and add scan points from a bird's-eye perspective. Furthermore, the interpretation of the acquired data, i.e. semantic scene perception and understanding, is of interest. ◀

MORE INFORMATION

Several programs for processing terrestrial laser scans are available under GNU public license within the '3DTK – The 3D Toolkit' project at sourceforge (http://threedtk.de).

For a comparison between a state-of-the-art mobile mapping solution with an Optech scanner and the semi-rigid SLAM: http://youtu.be/L28C2YmUPWA. For more videos and animations of the robot: www.youtube.com/user/AutomationAtJacobs.

For further information about the scanners: www.riegl.com and www.youtube.com/user/RIEGLLMS.

ACCESS TO GEOGRAPHIC DATA FROM A USER PERSPECTIVE

To Pay or Not to Pay

User access to geographic data has never been a straightforward process, not because the problem is technologically intractable but rather due to the matter of having appropriate funding models in place. Since the proponents of both free access and paid access pricing models put forward equally viable arguments, policymakers are left undecided about which funding model to choose. Going beyond whether users should pay for geographic data produced by government establishments, this assessment of Rwanda contributes to the age-long debate by examining the willingness of users themselves to pay. The results show that a user's willingness to pay for geographic data is not determined hedonically. Instead, the most influencing factor is the organisation's particular area of focus; willingness varies depending on whether the activities are commercial, humanitarian or educational in outlook or mandated legally such as is the case for government institutions.

Free access and paid access are both common models used for geographic data access and sharing. The free access model advocates free-of-charge access to geographic data for all users, specifically public-sector information (PSI). The argument is that since PSI is funded using taxpayers' money, why should they pay twice? The paid access model focuses on making profit from selling data, with the goal being to generate income. The producer aims to not only recover the cost of collection, maintenance and dissemination of data but also to make a profit. Proponents of this model argue that cost recovery and profit-making will support further data development and maintenance by the data producer. Since the proponents of both these pricing models put forward equally viable arguments, policymakers are left undecided about which funding model to choose. Despite decades of ongoing research on the subject, no 'one size fits all' pricing solution has been developed to date.

In the economic context, the theory of hedonic pricing posits that people's willingness to pay for a product (or service) reflects their valuation of bundles of hedonic characteristics of the product rather than a single one-dimensional generic product. That is, a product possesses a myriad of attributes that combine to form bundles of utility-affecting attributes that the consumer values. In economic terms, 'hedonics' refers to the utility or satisfaction one derives through the consumption of products and services. However, there may be other factors in addition to hedonics alone that affect a user's willingness to pay for geographic data. Therefore, the author assessed how willing users are to pay for access to geographic data in Rwanda.

Felicia Akinyemi is a certified GIS professional with a keen interest in facilitating the establishment of spatial data infrastructures in developing country contexts. Her research interest lies in the application of geographic information technologies (GIT) to development-related issues. She is currently an associate professor of geoinformation management and dean of the Faculty of Architecture and Environmental Design at the Kigali Institute of Science and Technology in Rwanda.

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CONDITIONS OF ACCESS

Firstly, the condition of access to public sector geographic data in Rwanda was examined. This highlighted the issue of payment for accessing data from the producers' perspective (Figure 1).

Figure 1 shows a breakdown of the access conditions to geographic data in general. 49% of datasets are given free-of-charge to all categories of users when an official request is made to the producer's office. Although some organisations differentiate between geographic data users when granting access, only 14% of organisations differentiate between user groups. These organisations will make data freely available to government, academic and research users only, whereas private users such as consulting firms and telecommunication firms are made to pay for datasets. 9% will charge for data downloaded from their websites, whereas another 9% will charge for data whether requested from the office or via the website.

USERS' WILLINGNESS TO PAY FOR DATA

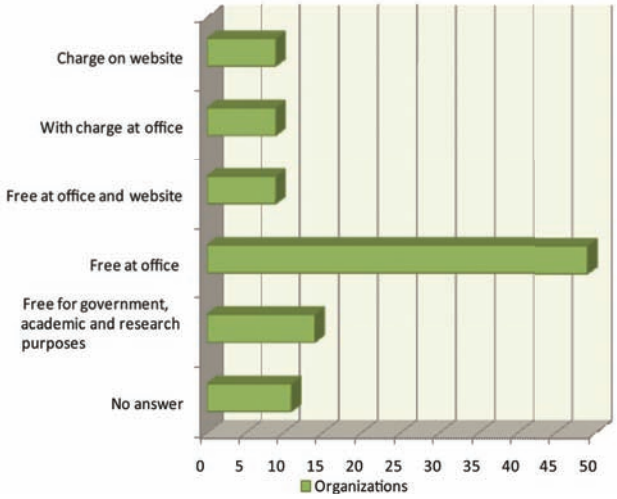
Users' willingness to pay for geographic data in Rwanda was examined by sending a questionnaire to public-sector organisations, academic and research institutions, private sector companies and NGOs. This amounted to 34 organisations in total, since the Rwandan geographic industry is still in its infancy and there are relatively few organisations producing and/or using geographic data. A 90% response rate from the surveyed organisations was achieved (70% were public sector organisations focusing on diverse issues, 15% were engineering/consulting companies, 12% were engaged in academics/research and 3% were non-governmental organisations with a focus on natural resource conservation).

The results reveal that 51% of the organisations assessed are not ready to pay to use geographic data produced by others, particularly PSI, even when the data is a necessity for fulfilling their activities. In comparison, 34% are willing to pay, 9% are neutral (yes and no) on the issue of payment, and the remaining 6% gave no response (Figure 2).

By cross-tabulating the responses received to the question 'Are you willing to pay for data?' with the relevant organisation's status, a definite pattern emerges. Based on the perspectives of geographic data users, this produces the 'Yes' group, the 'No' group and the 'Neutral' group (Figure 3).

Organisations in the 'No' group are not prepared to pay for geographic data; they are government/public-sector institutions (public-sector users on the far right-hand side). The reasoning is that other public institutions also need data they produce. This group favours free, unrestricted geographic data access. Moreover, they assume their activities are of national interest since they are mandated by law, so therefore they should obtain data for free.

Organisations in the 'Yes' group are willing to pay for geographic data; they are mostly private organisations (private-sector users such as private consulting organisations). They would rather pay for the data than go out into the field to collect data themselves, providing that the data quality is assured and it meets their requirements. Clearly, the opinions of the public-sector users and the private users of geographic data are at the two extremes of the scale ('No': not willing to or cannot pay; 'Yes': willing to and can pay). The perspectives of these two groups of users correspond to free access and paid access to geographic data, respectively. It is equally important to capture the users in the 'Neutral' ('no and yes') group who fall in between the two extremes. Examples of such users are academics/research institutions and grassroots organisations such as non-governmental organisations (NGOs). This neutral group leans towards not paying, but when access to the data is absolutely essential to doing their work and there is no other way to obtain it without paying, then they will consider paying.



▲ *Figure 1, Geographic data access conditions.*

CONCLUSION

How willing are users to pay for access to geographic data? The results of this survey contribute to the ongoing debate regarding the issue of finding the proper funding models for accessing geographic data. The main challenge is how to strike a healthy balance between the two extremes of making data freely accessible to all users without discrimination, and the use of paid options for geographic data access. These two sides of the coin are equally valid to finding common ground for further interchange of ideas on the subject (to charge or not to charge, and to pay or not to pay).

Willingness to pay for geographic data may depend on more than hedonics alone

Although the debate on free access and cost recovery is important, ▸

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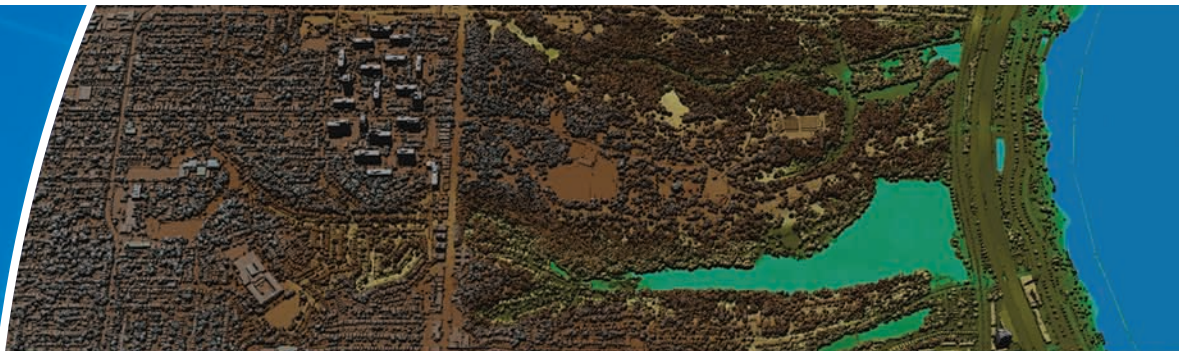
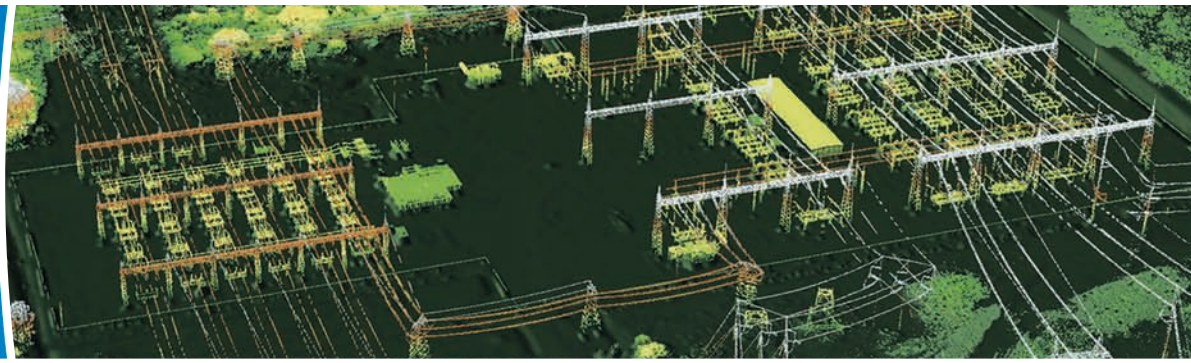


CORRIDOR MAPPING



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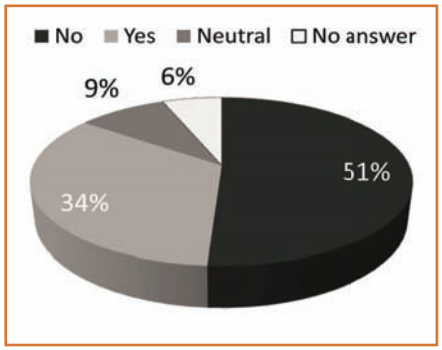


Figure 2, Users' willingness to pay for geographic data.

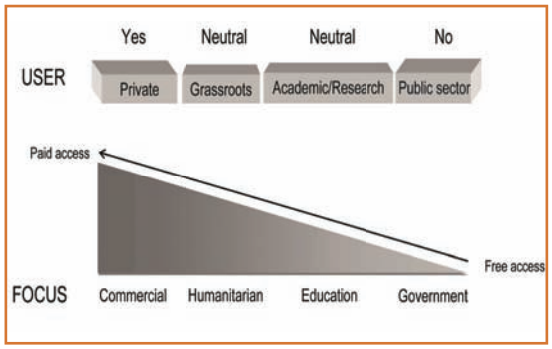


Figure 3, Users' perspectives and the implications for payment for geographic data.

it must be recognised that the arguments used in the debate are sometimes too generalised in nature since they fail to take into account the fact that different situations might call for different measures. One difference which is often disregarded is the purpose for which the data is used. For example, geographic data can be used by public bodies for performing their public tasks, by the private sector for creating commercial products, or by citizens for participating in their national democracy or holding their government accountable.

The question of users' willingness to pay for accessing geographic data takes the debate to another level by examining the subject from the users' perspectives. Contrary to what is often suggested, this research shows that private-sector users in Rwanda are generally willing to pay for geographic data, while other users in Rwanda are less willing to do so.

Based on the results of this survey on users' willingness to pay, it is advisable to differentiate between different use purposes: users should have free access to PSI in Rwanda for non-commercial use purposes, whereas a charge should be made for private-sector use. Such a policy respects the willingness of certain categories of users to pay, and is likely to maximise data use and to represent a sustainable business model for the data provider. Future policy debates on access to public sector information in Rwanda should take this information into account.

ACKNOWLEDGEMENT

Financial support to conduct this research was provided by the Global Spatial Data Infrastructure Association's small grant award (2009/2010).

PHASE ONE

Fully Integrated Aerial Photogrammetry Solutions

iXA camera.

Phase One is headquartered in Copenhagen, Denmark, with offices in New York, London, Cologne, Tokyo, Hong Kong, Shanghai, Sydney and Tel Aviv. As a division of Phase One A/S, Phase One Industrial is dedicated to research, development and manufacture of camera systems for aerial photogrammetry as well as integrated software solutions.

Phase One is an employee-owned company that has been providing photographic components to OEM customers and integrators in the aerial market since its foundation in Denmark in 1993. It established Phase One Industrial in 2011 to research, develop and manufacture specialised camera systems built specifically for industrial applications. Phase One also provides hardware and imaging software solutions for capturing, adjusting, organising, editing and processing images quickly and efficiently.

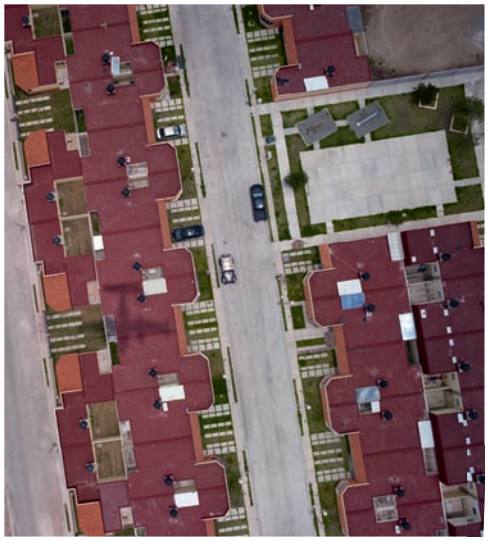
Every month *GIM International* invites a company to introduce itself in these pages. The resulting article, entitled Company's View, is subject to the usual copy editing procedures, but the publisher takes no responsibility for the content and the views expressed are not necessarily those of the magazine.

Phase One is one of the world's leaders in open-platform, high-end medium-format camera systems for professional photographers and advanced amateurs. Phase One also developed Capture One raw converter and workflow software, as well as the Phase One SDK, that provides a set of tools which enables users to build custom applications for image capturing and processing of high-end images produced by iXA and iXR cameras.

Phase One's experience in medium-format digital technology forms the basis for the Phase One Industrial products. The Phase One Industrial's mission is a commitment to the development of aerial and industrial camera platforms and to provide close support to its customers. The Phase One Industrial team benefits from the many successful aerial implementations that Phase One has already provided to well-known partners in the photogrammetric industry.

GLOBAL VILLAGE

As the world increasingly becomes the proverbial global village and as many countries' infrastructure needs to develop quickly, the Phase One iXA aerial camera system has found wide success in the photogrammetric market, both among end users and OEM integrators around the world. Specifically, the iXA is gaining traction as a major component in nadir and oblique camera set-ups, Lidar solutions and in the UAV market. Available with up to 80 megapixels, achromatic models or NIR vision, the iXA is suitable for existing or new systems whether they are single or multiple camera configurations. Because of its



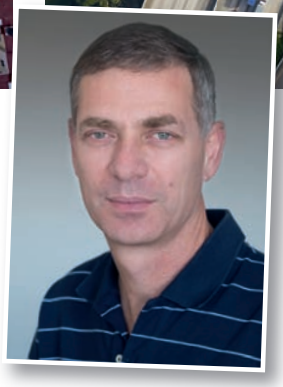
◀◀ *iXA aerial camera, 1/4000 sec; f/5.6; ISO 200 Schneider-Kreuznach LS 55mm f/2.8*

◀ *iXA aerial camera, 1/2000 sec; f/4.0; ISO 100 Schneider-Kreuznach LS 80mm f/2.8*

low weight (1.75kg) and power consumption (max. 20W), it can be integrated into a variety of aircraft including light, single-engine models. Dov Kalinski, general manager of Phase One Industrial, explained that the company uses cutting-edge technology in its aerial cameras and software in order to assist industrial customers with solutions that advance the work they do. The iXA cameras are built from the ground up as aerial cameras, since the company is focused on enabling photogrammetric professionals to capture high-quality images at lower operational costs. He believes that the Phase One iXA camera will become the future standard for all medium-format airborne cameras.

LENS TECHNOLOGY

A sophisticated camera system requires a broad range of lenses to provide options for a variety of shooting conditions. The iXA system employs a wide choice of Schneider-Kreuznach lenses, including 28mm, 55mm, 80mm, 110mm, 150mm and 240mm versions. The lenses are equipped with leaf shutters that work in combination with the camera's focal plane shutter. By using a specially designed secure lens holder, Phase One iXA can optimise the stability of the calibration data and enable quick changing of lenses without a recalibration.



▲*Dov Kalinski, general manager of Phase One Industrial.*

In the last 12 months, resellers in major markets have started promoting, selling and supporting customers working with Phase One Industrial products through the company's worldwide network. Having local experts to talk with about technical issues, in their own language, is a distinct advantage for users, especially when on-the-spot support is given whenever needed.

HIGH-RESOLUTION SOLUTIONS

Today's industry needs information much faster and at a higher quality than previously. With the possibilities available through the internet, satellite communication and other new data-transfer solutions, information has moved to a more sophisticated level than ever before, with demands for higher-resolution images at reasonable prices.
In addition, changing regulations are enabling the use of UAVs in areas and roles that previously were only dreamed of. Over the next three to five years, the expectations are that new policies will allow the use of UAVs for up to 80% of all possible missions, thus greatly increasing the importance of high-resolution solutions for the UAV market. Moving beyond today's limitations, the advent of a small, rugged and light 80MP medium-format iXA camera is becoming an integral part of UAV use as payloads increase and demand for images continues to grow in sectors such as open mining, railways and utilities. The lower operational costs and specific applications make UAVs equipped with medium-format aerial cameras the natural choice for areas where manned flights are either too expensive, too dangerous or impractical.

THE FUTURE

Phase One Industrial continues to work with experts and engineers in the aerial market to develop solutions for the exacting needs of aerial photogrammetry. With a dedicated worldwide staff of engineers, programmers and highly skilled technicians, Phase One is constantly examining ways to streamline the entire capture and processing workflow so that users can benefit from changes in technology. As in the past, Phase One will strive to remain at the cutting edge and introduce new and innovative advances to its aerial photography system. ◀

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Reflecting on the Third Session of UN-GGIM

The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) provides a forum for co-ordination and dialogue between Member States and relevant international organisations – of which FIG is one – on issues related to geospatial information management. It aims to promote and develop common policies, methods and codes of practice globally and to enhance the interoperability of geospatial data and services. The terms of reference call upon Member States to designate experts with specific knowledge drawn from the interrelated fields of surveying, geography, cartography and mapping, remote sensing, land/sea and geographic information systems and environmental protection.

The UN-GGIM Secretariat and Ordnance Survey of the UK collaborated and hosted the third session in Cambridge, UK, in July 2013. The event was held in conjunction with the Cambridge Conference, the international meeting of chief executives from national mapping organisations around the world.

The final report on 'Future trends in geospatial information management: the five to ten year vision' was endorsed. The Committee agreed that the document is a 'living document' and will need to be regularly revisited, reviewed and revised.
A report on the global geodetic reference frame called for the further improvement of national infrastructures and contributions to strengthen regional and global geodetic reference frames. The Committee agreed on the submission of a resolution to be prepared for the 2013-14 Session of the UN General Assembly to seek support and commitment at the highest level to sustain the global geodetic reference frame.

UN-GGIM/ORDNANCE SURVEY

Participants at United Nations Committee of Experts on GGIM.

The Committee also considered the trends in national institutional arrangements in geospatial information management, developing a global map for sustainable development, legal and policy frameworks including critical issues related to authoritative data, and establishing and implementing standards for the global geospatial information community. The importance of adopting and implementing geospatial information standards within national legal and policy framework was emphasised.

In the discussion on linking geospatial information to statistics and other data (e.g. social, economic and environmental data) FIG is heartened as the topic of spatially enabling societies has been a key issue for many years. Spatially enabled societies recognise that activities and events have a geographical and temporal context, and make decisions and organise their affairs through the effective and efficient use of spatial data, information and services.

The committee considered a report that was prepared in collaboration with the International Hydrographic Organization (IHO) and FIG on critical issues relating to the integration of land and marine geospatial information. FIG had earlier provided a background paper that was prepared with FIG Commissions 4 and 5. During the ensuing deliberations, FIG urged the Committee members and their respective governments to avail resources to address key technical challenges within their jurisdiction. The Committee was also asked to consider forming a working party of experts from within to identify, share and promote good policies, standards, infrastructures and practices that already exist in some jurisdictions.

FIG is supportive of a consultative process and urged the Committee to work towards an internationally agreed Statement of Shared Principles on Geospatial Information Management.

CheeHai Teo
FIG president

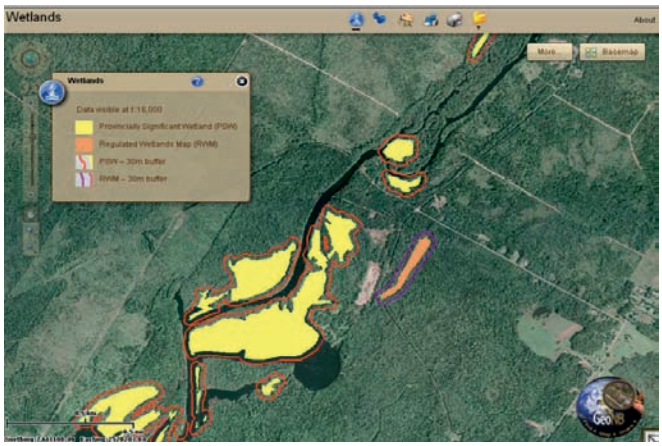
MORE INFORMATION
www.fig.net

SDI in New Brunswick: A Long Tradition

Forest management, mapping, land registration and property assessment are all provincial government responsibilities in the Province of New Brunswick on Canada's east coast. Early attention was paid to more intensive modelling and management the province's forest resources, and provincial government foresters became pioneering users of Esri's ArcInfo software in 1983. Province-wide topographic and property mapping using the Caris GIS software was completed by the mid-1980s, and full conversion of that mapping to digital form soon followed.

New Brunswick was also an early pioneer in the technology and politics of online access, distribution and sharing of that information. Taking lessons learned by colleagues in Australia and by funding the LANDNET cooperative research programme, the province was the first in Canada to consolidate its mapping, land registry and property assessment functions in one organisation in 1990. Originally called the New Brunswick Geographic Information Corporation, it was later renamed Service New Brunswick (SNB) and ultimately became responsible for a wide range of online registration and permitting services offered by the province.

In September 1996, New Brunswick became one of the first jurisdictions in North America to offer complete, integrated web-based access to province-wide property mapping and attribute data. Its Real Property Information Internet Service underpinned the corporation's real property line of business and operated initially on a cost-recovery basis. This first site attracted primarily lawyers, assessors, surveyors and property managers interested in property transactions, as well as early digital map users interested in one-time downloads of digital topographic data. Usage grew quickly, but also peaked early due to the limited user base of professionals and GIS 'power users'.



Wetlands mapping in the GeoNB Portal (2013).

Fast forward to 2013: that user base has grown, and SNB still takes a lead role in maintaining the province's land information infrastructure. Its GeoNB [1] portal is an ArcGIS-based gateway providing free online access to the province's data, aerial photos and maps. Through GeoNB, the public can download more than 30 datasets, a dozen apps supporting programme such as wetland conservation and flood damage reduction, and more than 30 map services that they can integrate into their own web apps. Since the portal was launched in 2009, public usage of provincial data has significantly increased. The number of weekly visits to the site increased from 5,000 in 2010 to more than 10,000 in 2012 – impressive for a province with a population of just over 750,000.

As a result of this recent success, SNB was recognised with a Special Achievement in GIS (SAG) award at the Esri International User Conference in July 2013. Even with this recognition, SNB staff are not resting on their laurels. Custodianship arrangements for framework datasets are being refined and negotiated, and a programme of province-wide Lidar data collection is being planned.

Dr David Coleman is president of the GSDI Association, a professor of geomatics engineering and dean of the Faculty of Engineering at the University of New Brunswick in Canada.

MORE INFORMATION
1. http://snb.ca/geonb
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Since the predecessor of the IAG, the 'Mitteleuropäische Gradmessung', was established back in 1862, IAG is celebrating its 150th anniversary in 2012. Celebrations will climax in September 2013 at the IAG Scientific Assembly in Potsdam, Germany. This location is particularly significant since the first ever meeting, in April 1862, was organised by General Baeyer, as representative of the Kingdom of Prussia, in Berlin. The participants were several geodesists from the Kingdom of Saxony and the Austrian-Hungarian Empire.

GNSS Precise Point Positioning Workshop: Reaching Full Potential

From 12 to 14 June 2013, York University, Natural Resources Canada (NRCan), the International Association of Geodesy (IAG) and the International GNSS Service (IGS) hosted a two-and-a-half-day technical meeting entitled 'GNSS Precise Point Positioning: Reaching Full Potential' in Ottawa, Canada. The workshop was sponsored by York University, NRCan and the Natural Sciences and Engineering Research Council of Canada.

Participants at the PPP workshop.

The purpose of the workshop was to bring together leading academic, government and industry investigators from across the globe to present the latest research findings and developments in GNSS PPP, to discuss issues related to advancing PPP technology, and to contemplate the potential of PPP as a future positioning technique for high-accuracy satellite positioning, navigation and timing. The workshop attracted approximately 100 participants from 20 countries, representing over 50 different academic, government and industrial organisations. Attendees included data product producers, solution providers, technology users and other interested parties.

The workshop featured six oral sessions with 25 presentations, one poster session with 10 posters, and five moderated discussion sessions which enabled structured, ordered group debate across the spectrum of PPP issues.

Some conclusions from the presentations and discussions included:

- GPS PPP, both post-processed and real-time, for static and kinematic modes have reached maturation.
- Key challenges are: modelling equipment biases for various signals from different constellations, improving solution parameterisation, regional augmentation, and validating PPP ambiguity-resolved solutions.
- Resolving undifferenced ambiguities is dependent primarily on determining equipment biases and ionospheric refraction.
- Simulation showed that triple-frequency PPP-AR is possible with a few minutes of data.
- The lines between undifferenced PPP-AR and state space representation RTK are blurring further.
- While PPP is slightly noisier than static baseline relative positioning at an epoch, the two techniques are now equivalent over time.
- Real-time PPP solutions can be used as input to various value-added down-stream products, such as tsunami prediction modelling.
- A growing number of public and private products are being developed for PPP, from precise orbits and clocks for GNSS satellites to satellite equipment delays.
- A better understanding of satellite and receiver equipment biases is needed through definition and calibration activities, as well as standards for communicating such information.
- Initial convergence has been reduced from tens of minutes to close to 10 minutes. Initial BeiDou and Galileo processing indicates further gains in performance through reduced outliers, reduced initial convergence, and improved positioning accuracy.
- There are mutually supportive roles for governments, academia and industry in PPP development: developing clear standards and guidelines, training personnel, and fostering R&D activities.
- If next-generation hardware costs are reduced significantly and PPP solution convergence can be reduced to tens of seconds, even better performance and a wider user base, possibly for mass-market applications, can be expected in the future.

Feedback from workshop attendees was very positive, both in terms of the structure of the event and its contents. The consensus was that the workshop was very useful and that another such event should be organised within the next few years to again take the pulse of PPP research and development, and consider the future impact of the technology.

Sunil Bisnath and Suelynn Choy

MORE INFORMATION
www.iag-aig.org
www.yorku.ca/pppworkshop2013

The New Mapping Paradigm

The ICA Commission on Map Production and GeoBusiness (chair Philippe de Mayer, Belgium, vice chair Markus Jobst, Austria) has been recently addressing its Terms of Reference related to contemporary business practices in production and the impact of new communications and service-oriented production environments. Map production, as a human activity, has changed radically since the turn of this century. It was previously characterised by large agencies (both commercial and governmental), using standard flowlines of production and distributing hard-copy products to specific market sectors. Today, small businesses can compete effectively in the marketplace, map products are flexible in terms of their appearance and format and can be created much more quickly, and applications of mapping can be extended by adding value to such products in a large number of ways.

One of the most important innovations in recent years has been the development of the concept of Service Oriented Architectures (SOA), which help to model and establish new flowlines. The convergence of intelligent GIS, maturing spatial data infrastructures and the handling of big data has led to a need to consider the marketplace for, and effectiveness of, map products. In particular, web technologies have had an enormous impact on the distribution, production, embedding and user acceptance of cartographic products and data.

A highlight has been the recent publication of the book *Service Oriented Mapping 2012*, which is the record of proceedings of a major symposium (SOMAP 2012) in Vienna, Austria, in November 2012. This volume [1] is an essential examination of the latest developments in service-oriented mapping issues and challenges. The contents are derived from the 50 presentations delivered at the symposium and consider the wider implications of service-oriented architectures for the established mapping agencies, infrastructure providers, software developers and individual cartographers. The first introductory section highlights the importance of standards, and the possibilities of SOA in augmented reality and mobile mapping. The next, on 'The Diversity of Service Oriented Map Production', explains the main principles of SOA, which require clearing houses and geospatial process-management methods. Use cases are then described, including applications such as creating a European topographic reference dataset, PHP and KML for thematic map production, examples of service-oriented maps, e.g. crime mapping, experiences in using open-source geospatial technologies for peri-urban development analysis, integration of map services for the living environment, and the current state of implementation of the European Union's INSPIRE geoportal. Advanced perspectives include 'good design', effectiveness of web-delivered mapping products for location-aware visualisation, intelligent GIS, the standardised collection and processing of environmental data, accessing of large archives of Earth observations and spatiotemporal visualisation and simulation. These are followed by a section on 'Geobusiness Considerations and Perspectives' covering some non-technological

Chair Philippe de Maeyer and vice chair Markus Jobst at the SOMAP 2012 symposium.

issues such as licensing, procurement and audits. Finally, the scientific presentations of the symposium are extended with a 'Cookbook on Webmapping and Geo Web Services'.

The themes of, and examples given in, this book demonstrate evocative improvements and changes based on the paradigm of SOA in the domain of cartography and geoinformation management for the coming years.

MORE INFORMATION
1. http://somap.cartography.at
www.icaci.org

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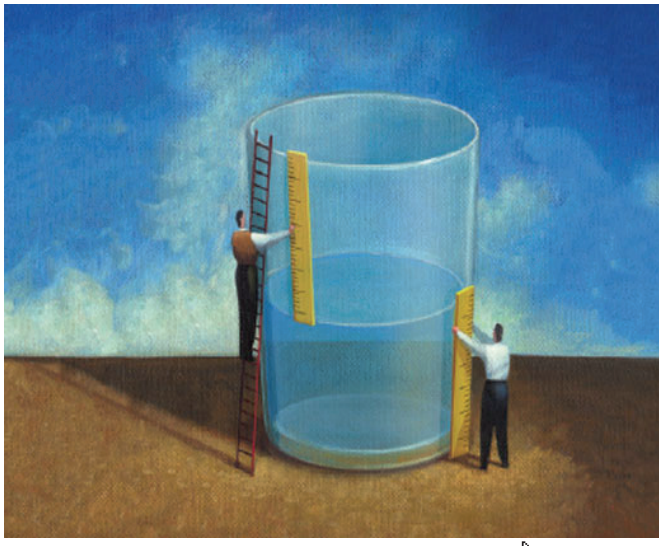
ISPRS HEADQUARTERS
see address of secretary general

Membership Benefits

Originally founded as the International Society for Photogrammetry (ISP) in 1910, the ISPRS, as it became known in 1980, has served its membership base for over a century. Currently catering for 91 Ordinary, 11 Associate, 14 Regional and 68 Sustaining Members from across the globe, the demands of its members are diverse, often complex, and constantly changing. ISPRS is therefore evolving to meet what the Council deems are the requirements of a 21st-century international society.



Half-full or half-empty: how does your ISPRS glass measure up? [3].

As a member of the International Council for Science (ICSU), ISPRS has a mission to strengthen its international science for the benefit of society. ISPRS represents professionals worldwide who are associated with research, applications and commercial development of equipment and software systems in its fields of interest: photogrammetry, remote sensing and spatial information sciences. Amongst other activities, the Society achieves this by:

- Conducting and promoting high-quality research and development in photogrammetry, remote sensing, spatial information systems, related vision sciences, and their applications. The Society's Working Groups in each of its eight Commissions focus on the co-ordination of scientific endeavours. ISPRS is investigating ways to help use the financial resources at its disposal to pump prime scientific initiatives, and has also recently written to the European Union in support of two major research proposals.
- Co-ordinating regular forums for the dissemination of information on new developments in its fields of interest. One of the mainstays of the Society for generations has been its Symposia and Congress series, and the Society's scientific meeting structure is currently undergoing a rigorous review, with a new style of meeting being trialled in Antalya, Turkey, in November 2013 [1].
- Regularly publishing reports of activities and results of research, new developments and applications. Whilst the *ISPRS Journal of Photogrammetry and Remote Sensing* continues to flourish and demonstrated a 2012 impact factor of 3.313, with the rise of open-access publication the Society has recently introduced the *ISPRS International Journal of Geo-Information*.
- Promoting and facilitating education and training programmes in its fields of interest. One of a wide range of outreach and engagement activities, the 2014 ISPRS Student Consortium Summer School will be held in Addis Ababa, Ethiopia.

The ISPRS is a vital and expanding organisation which interacts with other international societies and provides its members with a conduit to international scientific policymaking at the highest level. Specific member benefits are listed on the ISPRS website [2]. However, more can always be done. The Council therefore invites feedback from its members on what specific or generic benefits the Society can provide to ensure that they always regard their ISPRS glass as at least half-full. ◂

MORE INFORMATION
1. www.isprs2013-ssg.org
2. www.isprs.org/members/benefits.aspx
3. http://fatenglishman.com/wp-content/uploads/2012/09/glass-half-full-560.jpg
www.isprs.org

Future events

SEPTEMBER

UAV-g 2013
Rostock, Germany
from **04-06 September**
For more information:
E: info@uav-g.org
W: www.uav-g.org

54th Photogrammetry Week
Stuttgart, Germany
from **09-13 September**
For more information:
E: dieter.fritsch@ifp.uni-stuttgart.de
W: www.ifp.uni-stuttgart.de/phowo/index.en.html

XV International ISM Congress 2013
Aachen, Germany
from **16-20 September**
For more information:
E: sponsoring@ism-germany-2013.de
W: http://ism-germany-2013.de/index_en.htm

Geo-Empower Middle East Summit
Dubai, UAE
from **16-18 September**
For more information:
E: info@fleminggulf.com
W: www.fleminggulf.com/conferenceview/Geo-Empower-Middle-East-Summit/450

Geomatics Atlantic 2013
Saint John, New Brunswick, Canada
from **23-25 September**
For more information:
W: www.geoatlantic.org

13th Int'l Scientific and Technical Conf: From Imagery to map: Digital photogrammetric technologies
Fontainebleau, France
from **23-26 September**
For more information:
E: awada@racurs.ru
W: www.racurs.ru

OCTOBER

International UAV Innovation Grand Prix
Beijing, China
on **01 October**
For more information:
E: uavgp2013@163.com
W: www.uavgp.com.cn

6th International Conference "Earth from Space — the Most Effective Solutions"
Moscow, Russia
from **01-03 October**
For more information:
E: nadezhda@scanex.ru
W: www.conference.scanex.ru/index.php/en.html

Intergeo 2013
Essen, Germany
from **08-10 October**
For more information:
E: dwenzel@hinte-messe.de
W: www.intergeo.de

GeoForm+ 2013
Moscow, Russia
from **15-17 October**
For more information:
W: www.geoexpo.ru

MapTek - Users Conference 2013
Brisbane, Queensland, Australia
from **21-23 October**
For more information:
W: www.maptek.com/users2013

Latin American Remote Sensing Week (LARS 2013)
Santiago, Chile
from **23-25 October**
For more information:
E: viviana.barrientos@saf.cl
W: www.lars.cl

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