

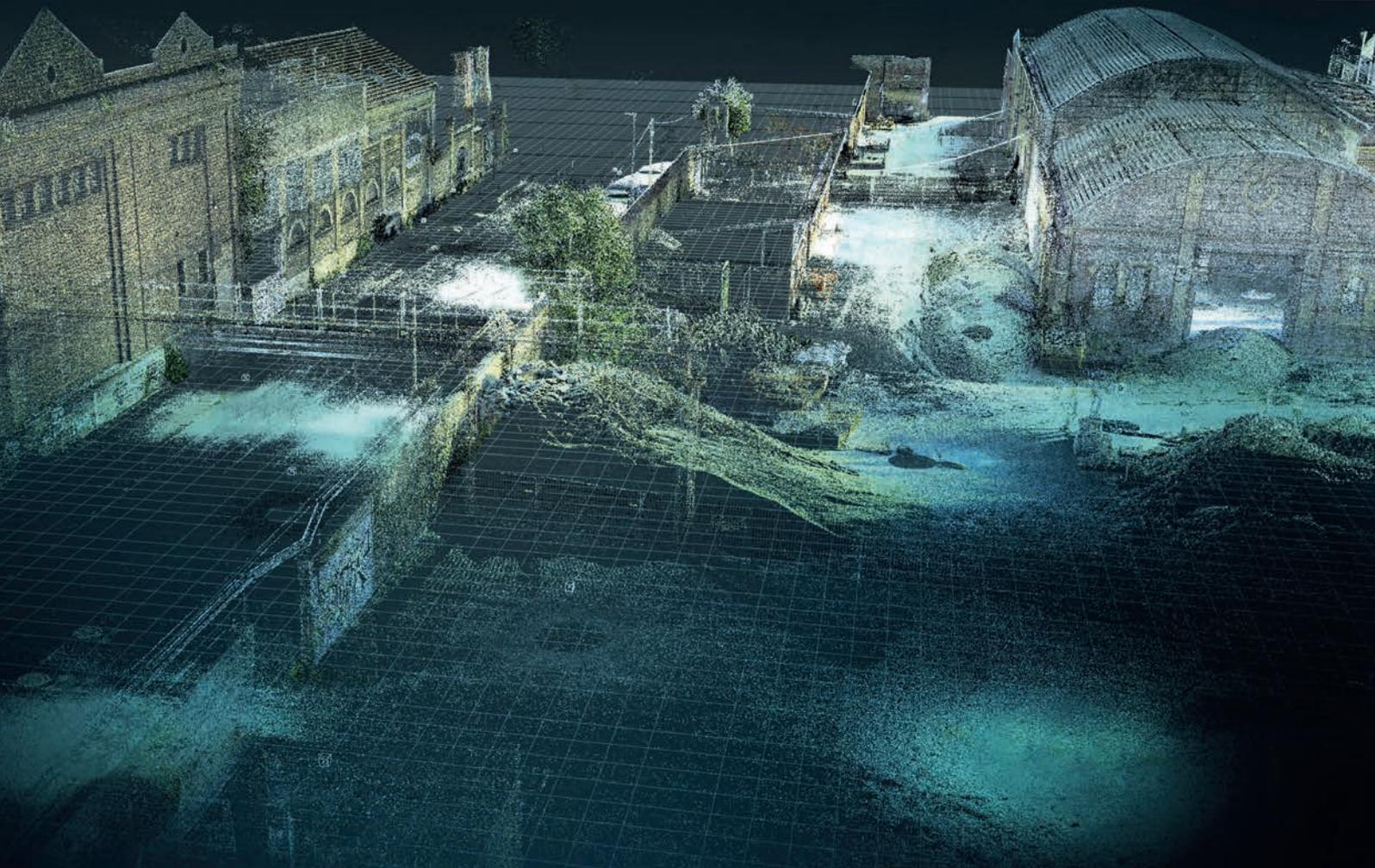
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ISSUE 1

BUSINESS GUIDE 2022



REPORT: ANNUAL GEOSPATIAL INDUSTRY SURVEY

DIGITALIZATION IN THE CONSTRUCTION SECTOR

Q&A: LEADING EXPERTS SHARE THEIR THOUGHTS

COMPANY PROFILES: THE PIONEERS OF TODAY

The logo for e-survey, featuring a stylized 'e' with a crosshair inside a circle, followed by the word 'survey' in a sans-serif font.

E500

Tilt-featured RTK Receiver



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1.35
1.40
1.45
1.50

E500 is a light-weight tilt-featured product by eSurvey GNSS. The durable IP67 design makes it possible to work in various environments. Multi constellation and frequency tracking always gives a fixed solution for your job. Thanks for the small-size design, E500 is suitable for different applications such as car and machine control.

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E300 Pro is a new generation product by eSurvey GNSS. The durable IP67 design makes it possible to work in various of environments. Multi constellation and frequency tracking always give a fixed solution for your job. Thanks for the small-size design, E300 Pro is suitable for different applications such as car and machine control.



E800 is a high-performance product by eSurvey GNSS. The durable IP67 design makes it possible to work in various of environments. Multi constellation and frequency tracking always give a fixed solution for your job. The colorful touch screen is convenient for quick configurations.



NET20 PLUS

NET20 Plus is designed for continuous operation and a wide range of monitoring scenarios, especially for high-precision CORS reference stations. It owns low energy consumption and high communication capacities and it is designed to withstand all harsh environments.



E500

E500 is a light-weight tilt-featured product by eSurvey GNSS. The durable IP67 design makes it possible to work in various environments. Multi constellation and frequency tracking always give a fixed solution for your job. Thanks for the small-size design, E500 is suitable for different applications such as car and machine control.



E200

E200 is a rover receiver by eSurvey GNSS. The durable IP67 design makes it possible to work in various of environments. Multi constellation and frequency tracking always give a fixed solution for your job. The Global 4G Network and RX radio make it suitable as a rover station.



E3 & E3L

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P. 8 Seizing Opportunities in the Golden Era of Geospatial

How is the geospatial industry evolving in today's turbulent times? The climate crisis, the COVID-19 pandemic shifting geopolitical balances – societal challenges are having a major impact on the global economy as a whole as well as on many individual countries and industries. This year's edition of the annual *GIM International* industry survey reveals a number of striking trend shifts. This report interprets the findings and provides interesting insights for geospatial businesses who are looking for opportunities for future growth.



P. 14 Q&A: Leading Experts Share Their Thoughts

GIM International invited various leading experts with different professional backgrounds to share their thoughts on the present and future of the geospatial industry. They provide their views on the key market trends, technology drivers and challenges, and the impacts of COVID-19 and climate change on their organizations and the sector in general.



P. 22 Digitalization in the Construction Industry

Besides the surveying hardware & software and the intricacies of BIM and data exchange, this article explores broader aspects of digitalization in the construction industry. How are they affecting the geospatial sector? What are the opportunities and threats? What about the human factors? And how is the geospatial data actually used in practice?



P. 28 Exploring the State of Mobile Mapping

What is the current state of acceptance of mobile mapping, and what are its most common applications? A worldwide survey, commissioned by NavVis and supported by *GIM International* plus three other publications, was recently conducted to find out. Here, we highlight some of the key findings and share the reactions from a number of suppliers of mobile mapping products.



P. 32 Hydrography: Growth Prospects on the Horizon

Besides asking *GIM International* readers about their views on the current and future state of the geospatial industry, we also conducted a survey among the readers of our sister publication, *Hydro International*. The responses from hydrography professionals around the world generated a wave of interesting insights. Here, we have selected the most relevant findings for geospatial professionals. The full report is available on the *Hydro International* website.



P. 5 Editorial

P. 7, 33 Editor's Picks

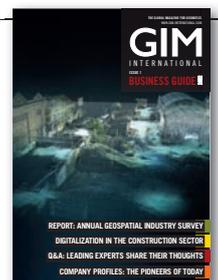
P. 21 Perspectives

P. 34 Company Profiles

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COVER STORY

In this era of digital twins, creating high-precision 3D maps and models from aerial images is an important aspect of the survey profession. Innovative software solutions allow the acquired data to be processed in real time, while AI enables the detection and classification of objects and generation of enhanced digital terrain models. (Image courtesy: Capturing Reality)



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Why it's wise to have a Plan B (even in times of optimism)

We were delighted to receive an overwhelming response to our annual survey on the state of the geospatial business, with over a thousand *GIM International* readers participating this year. Wim van Wegen has summarized the outcomes for you on page 8 of this edition, but I would like to highlight a few of the key findings here – especially in comparison to last year. Whereas in January 2021 we were still in the grip of the COVID-19 pandemic, in general (fingers crossed!) it now looks as if the world is slowly emerging from the situation that has dominated much of life for the past two years. The current mood among our readers can be described as cautiously optimistic. Travel restrictions due to the pandemic are still disrupting 'business as usual', according to almost half of the respondents. The other two main business obstacles are employee absence and national lockdowns. Less than 1 in 10 of respondents say that the cancellation of trade shows has had a negative impact on business. Meanwhile, many companies seem to be willing to invest in new hardware, with new UAVs and GNSS receivers topping the list. Manufacturers of mobile and portable mapping systems could also see a surge in sales, since over 30% of our respondents say that they want to invest in such solutions. In terms of software investment plans, point cloud processing software appears to be the winner, with more than 40% of the respondents expressing an interest in it.

Demand for data, ongoing digitalization, technological advancements, economic investment from governments due to COVID-19 and also the end of the pandemic are all named as major contributors to growth. A staggering 75% of all of our respondents – 10% more than last year – describe the business outlook as 'better' or even 'much better' than in the past couple of years. In view of such a huge year-on-year increase, perhaps 'cautious' isn't the right word after all; 'hardcore' optimism about

the future seems more appropriate! And that appeals to my own nature, as I tend to be somebody who sees the glass as half full rather than half empty. In business, however, I believe it's always wise to build in a bit of caution because you never know what will happen. It's also much easier to be optimistic when you have a Plan B. The series of '5 Questions to...' scattered throughout this publication might inspire you with some ideas for your own Plan B: perhaps you should diversify, climb aboard the sustainability train, explore AI and machine learning, cut costs without hurting your core business, or recruit and retain the smartest surveyors around! And actually implementing Plan B in your strategy will drive growth even more than you expected.

At the end of the survey, many respondents took the opportunity to thank the *GIM International* team for producing the magazine and keeping surveying professionals up to date on the developments in the field. Others gave us some useful suggestions for topics that we should cover and technologies we should write about. So now it's my turn to thank all of you – not only for taking part in the survey, but also for continuing to share your feedback and engage with us (and each other) as part of the geospatial community of *GIM International* and beyond!



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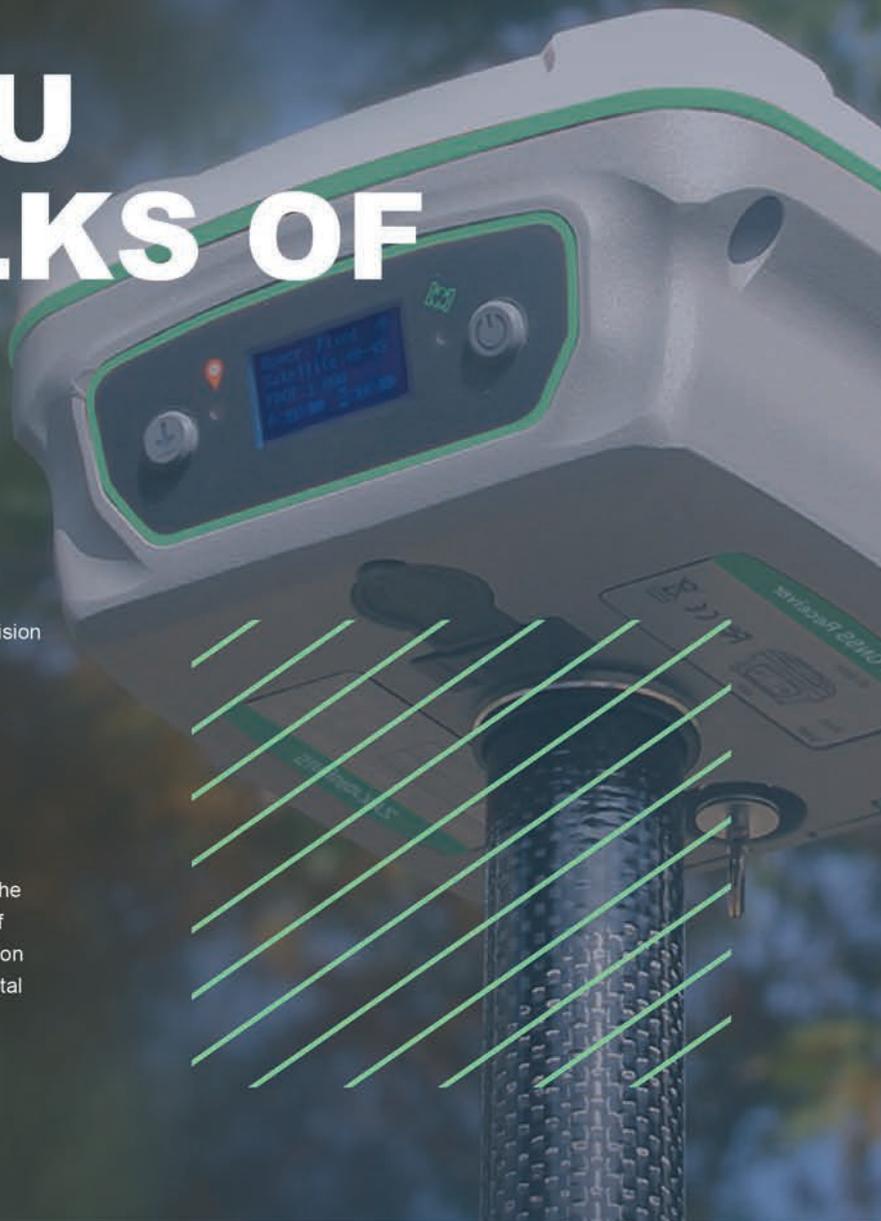
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WHY ARE WE SINGULAR?

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Effective Solutions to Attract New Geospatial Talent

It's common knowledge that the geospatial industry desperately needs new talent, but how can young people be encouraged to enter the mapping and surveying profession? This topic has arisen frequently in *GIM International* in recent years. Here, we present a selection of interviews and articles that discuss potential solutions to the challenge of attracting the next generation of geoprofessionals.

► *Intergeo*, the world's largest trade show for the geospatial industry, is attracting an increasing number of students.



HOW CAN WE ATTRACT STUDENTS TO GEOMATICS?

Outside of our community, and arguably even within our wider community, the term 'geomatics' is unfamiliar and ill defined, writes Ian Brown, senior lecturer at Stockholm University. More common in North America than in many parts of Europe, geomatics can be said to refer to the measurement and analysis of the properties of the Earth. Planetary scientists might argue that geomatics could equally refer to the measurement of other planetary surfaces. Some may argue in favour of a more comprehensive definition, while many in the community may reject the term entirely. If we as a community can't adopt a common terminology with common definitions and communicate that effectively, then how can we expect to engage with the public, decision-makers and future students? How can we attract new talent?



► Scan the QR code for the full story

THE GEOMATICS PROFESSION: LOOKING FORWARD TO THE NEXT DECADE

As the years progress towards 2030, many challenges and opportunities may emerge for the profession across a wide spectrum of activities. The democratization of geospatial data and the rapid advancement of technologies to capture this data require a skilled labour force. As a result, for the developers and technologists there are many opportunities. What will be much more of a challenge is attracting new experts. Where will the surveyors, geospatial scientists, and spatial data specialists come from?



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THREE EXPERTS SHARE THEIR THOUGHTS ON ATTRACTING SKILLED PERSONNEL

There is a shortage of geomatics professionals to meet the ever-growing need for geoinformation. What can the geospatial community do to tackle this challenge? *GIM International* asked three renowned experts to share their thoughts on how the surveying industry could fill the labour gap.



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PERHAPS NOBODY KNOWS IT YET, BUT GEOMATICS IS COOL

The geospatial industry faces a major challenge: how to attract a new generation of mapping and surveying professionals. The sector is crying out for talented young individuals who are willing and able to enter the profession. But, as a quick glance at the labour market reveals, they are currently in short supply, so other measures are needed. A good starting point is to increase the industry's interaction with children in primary and secondary schools to help them see the relevance of geomatics.



► Scan the QR code for the full story

THE NEED TO ENTHUSE YOUNGSTERS ABOUT SURVEYING

In view of the challenges our planet is facing – such as the energy transition, for example – and the opportunities presented by digitalization, we urgently need to increase our focus on the next generation. After all, the youngsters of today are the geospatial professionals of tomorrow. It is encouraging to see a number of recent initiatives that are raising children's awareness of how cool surveying can be.



► Scan the QR code for the full story

Seizing Opportunities in the Golden Era of Geospatial

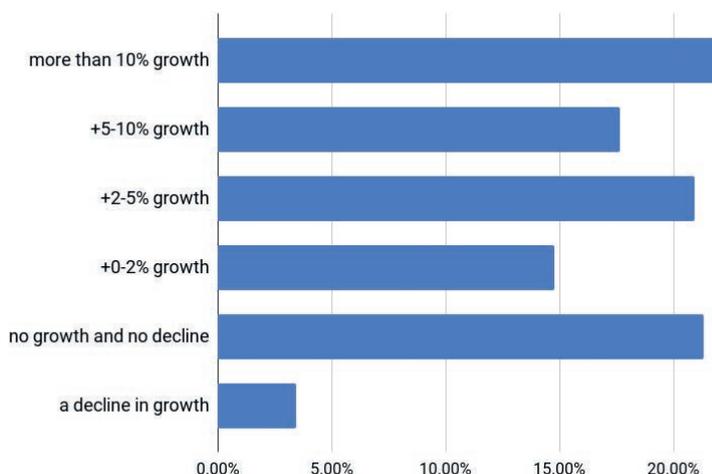
How is the geospatial industry evolving in today's turbulent times? The climate crisis, the COVID-19 pandemic, shifting geopolitical balances – societal challenges are having a major impact on the global economy as a whole as well as on many individual countries and industries. This year's edition of the annual *GIM International* industry survey reveals a number of striking trend shifts. This report interprets the findings and provides interesting insights for geospatial businesses who are looking for opportunities for future growth.

Due to a number of factors, the present – and the future – is still plagued with uncertainty for many of us. When the crystal ball is so clouded and the road ahead appears to be littered with obstacles, how can you develop the optimal strategy for your company? Thankfully, there are some bright spots on the horizon. As COVID-19 gradually fades into the background, many new opportunities are emerging in a number of sectors, and the geospatial industry is at the front of the queue to seize them.

Generating close to a thousand responses from all over the world, this year's *GIM International* industry survey provided us with a wealth of insights and paints a colourful picture of the professional geomatics landscape. Where does the industry see new opportunities? How is the role of the land surveyor evolving? What are the biggest constraints? How do technological advances benefit the sector? What investments are organizations planning? And what gives cause for all the optimism that shines through in the results of our survey?

PROSPECTS FOR THE SURVEYING AND MAPPING MARKET

Let's start our journey through the survey findings with the current mood across the geospatial community. We asked our readers how they view the prospects in the surveying and mapping industry in 2022, compared with the past couple of years. 48.8% of the respondents indicate that they foresee better market circumstances, while 26.3% are even more optimistic and rate the prospects as 'much better'. So what forms the basis for this optimism (Figure 1) about a brighter short-term future? One of the respondents catches the sentiment of many other responses in a nutshell: "Geospatial data has become the core of decision-making in many different engineering and environmental markets". The influence of challenging circumstances such as the COVID-19 pandemic and climate change is also frequently mentioned as driving the awareness of – and also demand for – geomatics throughout the world. Many mapping and surveying professionals expect this increased need for the fast and reliable collection and processing of huge volumes of geospatial information to be permanent, especially at governmental level. The ongoing digital transformation and the associated growth in the use of spatial data is also contributing to the good mood.



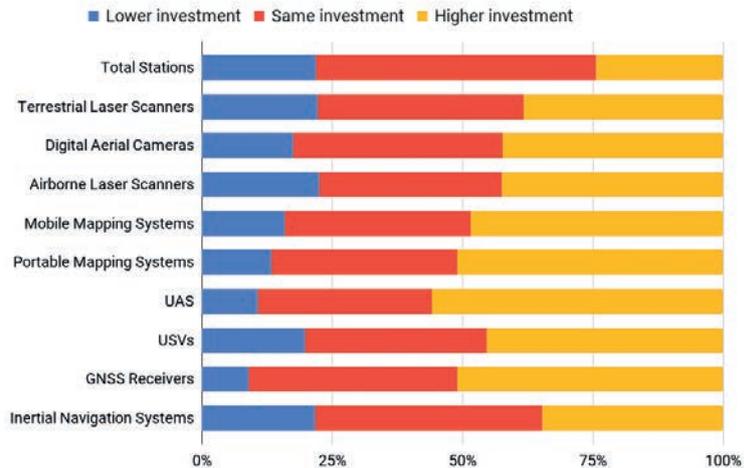
▲ Figure 1: 70% of respondents expect their company to grow over the next three years.

THE INFLUENCE OF COVID-19

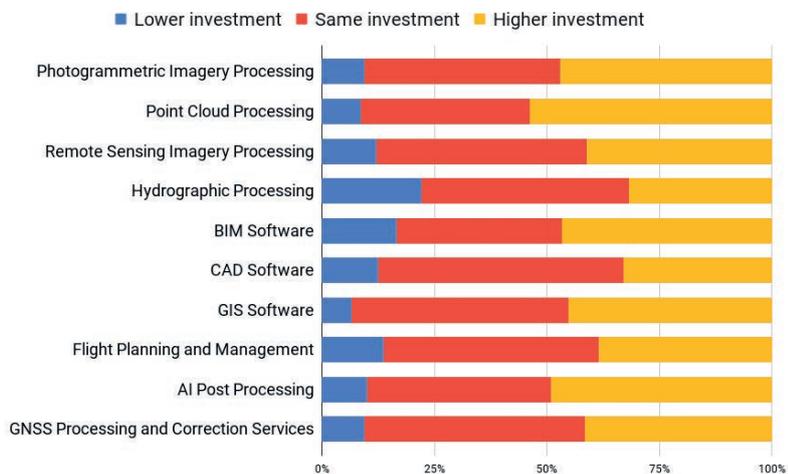
The optimism might have been even greater were it not for the coronavirus-related concerns expressed by various respondents. Travel restrictions (43.1%), national lockdowns (22.8%) and absenteeism due to illness (12.6%) are the top three effects of the pandemic with the biggest business impact. There is light at the end of the tunnel, however. The large majority of the respondents think that COVID-19 restrictions will soon end (and let's hope they are right!), which will automatically improve their business prospects. Additionally, one good thing to have come out of COVID-19 is that many organizations and governments have woken up to the importance of geomatics in supporting the intelligent study of people and land. As a result, as we near the end of the pandemic (or at least get used to living with the virus), all activities that are supported by geospatial data will further increase, which will boost the industry by generating more work and opening up new market segments.

PLANNED INVESTMENTS IN GEOSPATIAL HARDWARE AND SOFTWARE SOLUTIONS

This positive vibe in the mapping and surveying market leads us onto the question of future plans. How does the level of investment planned for 2022 compare with last year? Zooming in on the hardware and software solutions reveals some clear trends. The hardware frontrunners are unmanned aerial systems (56%), GNSS receivers (51%) and portable mapping systems (51%), with mobile mapping systems (48%), airborne laser scanners (42%) and digital aerial cameras (42%) also topping many companies' wish lists (Figure 2). In terms of software (Figure 3), the 'most wanted' solutions are point cloud processing software (54%), artificial



▲ Figure 2: The majority of respondents plan to invest the same amount or more in hardware this year compared to last year.



▲ Figure 3: In 2022, very few companies are expecting to reduce their investment in software compared to last year.

the survey respondents intend to prioritize their organizational investments over the next three years. Across the board, among professionals from all corners of the broad

the rest of the survey. However, this order of priorities gives a good sense of what companies and organizations need most urgently: skilled staff and a sufficient supply of new talent.

MANY ORGANIZATIONS HAVE WOKEN UP TO THE IMPORTANCE OF GEOMATICS IN SUPPORTING THE INTELLIGENT STUDY OF PEOPLE AND LAND

intelligence post-processing software (49%), building information modelling (BIM) software (47%), photogrammetric imagery processing software (47%) and GIS software (46%).

But how should we interpret these results? It is interesting to take a closer look at how

geospatial spectrum, training & competency development, research & development and increasing the size of the workforce achieve higher scores than investing in hardware and software (Figure 4). This does not mean that surveying equipment and solutions have lost relevance; quite the opposite, according to

THE GEOSPATIAL WORKFORCE GAP

Indeed, many of the responses in our survey echoed the following lament: "There is a lot more demand for our services. However, we are limited in taking advantage of the demand by a lack of trained and experienced personnel." This hits the nail on the head. The lack of sufficiently skilled employees coincides with a rising demand for geospatial services as mentioned above, creating a perfect storm. The talent shortage has been in the making for several years, but we have now reached the point that the available workforce is simply too small to support the market demand. This

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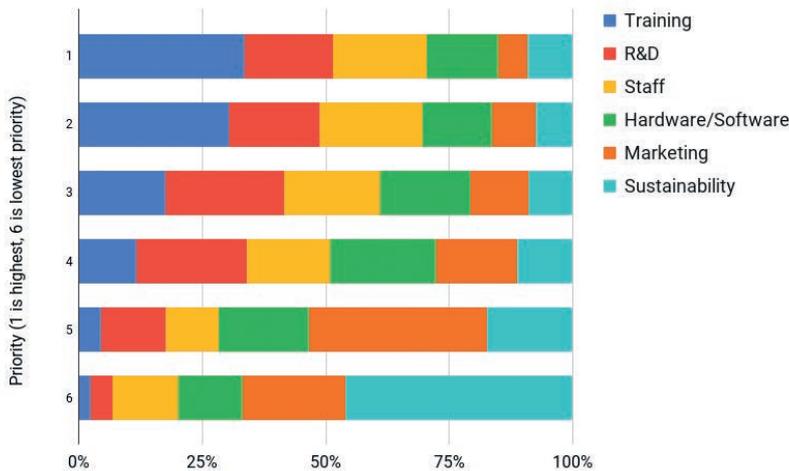
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SIZE OF THE SURVEYING AND MAPPING INDUSTRY

The global surveying and mapping services market is projected to achieve steady growth over the coming years. According to the most recent report by Research and Markets, the size of the global market for surveying and mapping services is expected to reach US\$40.6 billion by 2027, compared with an estimated US\$32 billion in 2020. However, it should be noted that these figures are open to interpretation, since much depends on the precise definition of the market; what kinds of companies and which geospatial-related economic activities have been included in the analysis?



▲ Figure 4: Besides R&D, training and staffing levels are clearly top of mind in the geospatial industry.

poses a threat to the future of the geospatial industry in terms of limiting its capacity to innovate and grow, and making it susceptible to external competition.

The mapping and surveying profession urgently needs to find a way to attract more people who can operate laser scanners, aerial cameras, total stations, GNSS receivers and unmanned aerial vehicles (UAVs or 'drones'), process the resulting data and turn it into valuable information. As most organizations will be fishing in the same pond in their search for new employees, it is crucial to

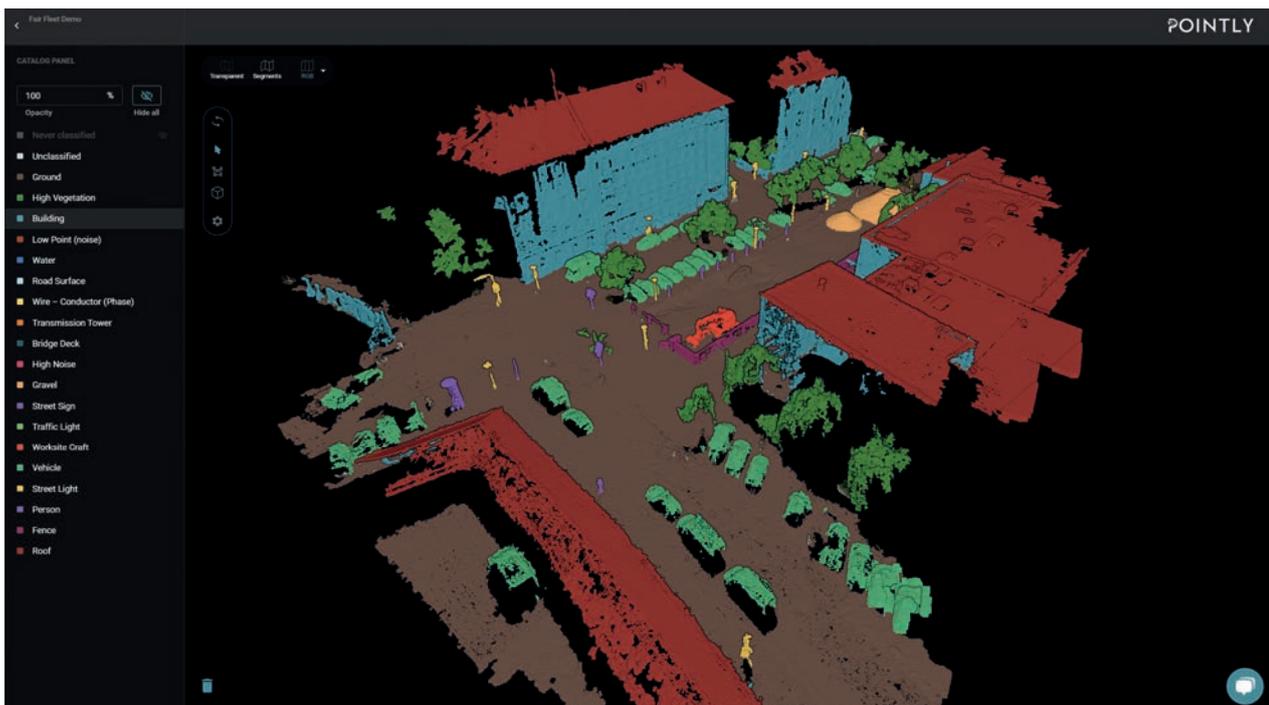
inspire enthusiasm for the geospatial industry among youngsters at an early age. As an added pressure, the number of surveyors is set to shrink even further as many current industry professionals are set to retire in the not-too-distant future – as underlined by the average age of our survey respondents.

Many of the comments from respondents underline the changing nature of the surveying profession. 'Digital natives' are a very welcome addition to the workforce as their tech-savvy knowledge and skills are perfectly aligned with the direction in which the geospatial

industry is heading. However, this is at risk of being held back by another phenomenon, which one respondent summarizes as follows: "There have never been enough surveyors to satisfy the demand and this is being magnified by the poor level of attention paid to mathematics and science at high school level, which is not equipping the young students with the adequate technical background to succeed at university". Needless to say, this differs from one country or region to another, but it probably sounds familiar to many of our readers around the world.

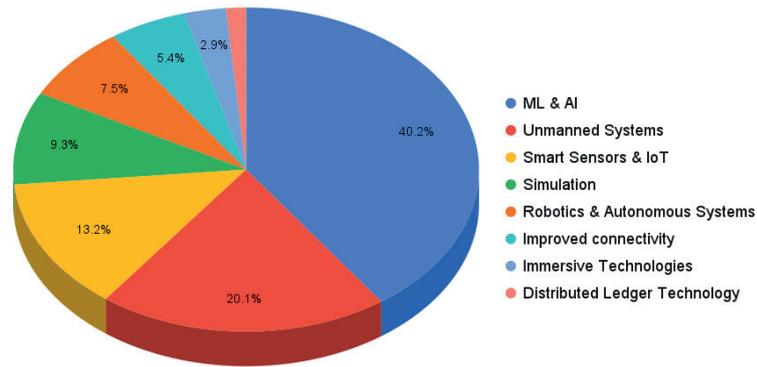
HOW AI IS REVOLUTIONIZING GEOMATICS

Whether they are relatively new on the career ladder or seasoned professionals, all



▲ Innovative AI techniques enable enhanced classification through the segmentation of data points and objects within point clouds, much faster and more precisely than previously possible. (Image courtesy: Pointly)

geospatial specialists are heavily dependent on the very latest technology, techniques and software. To gain more insight into the industry's current digital transformation journey and how it influences the view of the wider world, we asked our readers which technological developments they expect to be the main driver in the coming years. Receiving 40% of the votes, machine learning & artificial intelligence (AI) is widely regarded as a pivotal force (Figure 5), followed by unmanned systems (20.2%) and smart sensors & the Internet of Things (13.2%).



▲ Figure 5: AI is widely regarded as the technology holding the key to the geospatial future.

In the past, AI has often been misused as an umbrella term to the point where it was at risk of becoming an overhyped buzzword. But as the technology has matured and real-life applications have become apparent, the geospatial industry is embracing it and AI is already part of many geospatial solutions. One of the comments from the survey sums it up appropriately: “AI is at the centre of data analytics and, since geomatics deals with spatial data, AI should be seamlessly incorporated in geomatics. In other words: high-end geospatial technology, imagery and artificial intelligence converge and are melting together in geo-AI”. However, another respondent points out that there is a downside to AI becoming such a crucial element, since there is a shortage of graduates with

knowledge of AI and machine learning within the scope of geomatics. This once again highlights the urgency of the labour/talent issue.

SURVEYORS HOLD THE KEY TO MORE EQUALITY

This brings us on to the truly global nature of the geospatial industry. Each of the world's countries and regions has different perspectives and characteristics, such as unique climate conditions, diverse building types and distinct environmental, economic and social priorities. The situation in developing economies calls for different solutions from the geospatial community than in developed countries. This is aptly described

by a respondent from South Africa, who is one of many surveyors active in land rights. “Land rights is an important development area for geomatics, not only in South Africa but also in many other countries across the globe, as development gets held up by various legal hurdles – from housing to renewable energies. This is the case in many countries, especially where legislation is still evolving and changing extensively. Our profession holds the key to progress here.” Another respondent in this year's survey regards the accuracy and availability of geospatial information to be the most important growth area for the geomatics industry: “This sets the improvement of planning and development in motion, which leads to increased security of tenure and protection of people-to-land relationships.”

Against this global backdrop, there is one issue that affects the entire planet: climate change. The geomatics industry offers tools that can help to mitigate, adapt to and perhaps even halt climate change. In particular, the geospatial community can play a key role in the energy transition by helping to develop a roadmap to a carbon-neutral society powered by renewable energy. This places a considerable responsibility on the shoulders of geospatial professionals.

WEALTH OF OPPORTUNITIES WITHIN REACH

Our industry survey has provided a wealth of information that contributes to a deeper understanding of the current – and likely future – state of the geospatial sector. Despite the lingering cloud of uncertainty caused by the persisting coronavirus situation, the mood among the geospatial community is cautiously optimistic. There is an abundance of work for surveyors, but at the same time there are clear concerns in the industry about the urgent need to recruit and train sufficient

3 REASONS WHY AI IS GAINING TRACTION IN GEOMATICS

To a lot of people, artificial intelligence (AI) and machine learning (ML) have previously been slightly intimidating topics. Recently, however, AI has been gaining more traction in the world of geomatics – but why exactly? Here are three reasons:

- 1) The computational power is increasing substantially every year, making it much easier to work with large datasets and AI platforms. Machine learning algorithms in combination with datasets of millions of samples can now be run on most laptops and even through online servers such as the Google Earth engine.
- 2) Open-access (i.e. free of charge) spatial data is becoming available on different scales, making vast amounts of data available for public use. This is making it easier for developers to gain access to the necessary volumes of high-quality data needed to train and test machine learning methods and models.
- 3) Machine learning platforms are easier to use than ever. With online libraries providing all the necessary functionalities along with extensive tutorials, guides and examples freely available, the barrier to entry into the world of machine learning has been lowered. Now, almost anyone can capitalize on this possibility for more efficient and higher quality workflows.

An increasing amount of research is being done into how AI can be combined with geospatial data for improved performance in real-life situations. Multiple studies show that AI holds the potential to automate many of today's manual data processing activities including the production of complex numerical models and pipelines. This will save users time and (when applied correctly) can provide far more accurate results. Hence, for the three reasons outlined above, we can expect to see AI gaining further traction among geomatics professionals and practitioners eager to incorporate it into their future projects.

professionals to handle the ever-growing workload in the very near future. Thanks to the changing nature of the surveyor's role, many geomatics tasks no longer involve fieldwork in all weathers, but can increasingly be performed from the comfort of an office. Likewise, surveying engineers are shifting

towards the role of geospatial data managers, in which the processing and interpretation of geospatial data is at least equally important as capturing it. Meanwhile, although the nature of geomatics solutions required differs from one region to another depending on a variety of local circumstances, the threat of climate

change is one that impacts the whole of planet Earth, and the geospatial community has a key role to play in tackling this challenge. This, along with the energy transition, the digital transformation in the construction sector and the path towards maturity for digital twins for use in construction, smart cities and many other applications, means that a whole range of exciting and profitable new opportunities are within reach for our beautiful profession. ◀



▲ The changing nature of the land surveying profession requires new spatial data management skills. (Photo: Noble Surveys, Australia)

ABOUT THE AUTHOR



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



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GIM International invited various leading experts with different professional backgrounds to share their thoughts on the present and future of the geospatial industry. They provide their views on the key market trends, technology drivers and challenges, and the impacts of COVID-19 and climate change on their organizations and the sector in general.

5 Questions to... Bharat Lohani

Bharat Lohani is a professor of geomatics in India and also co-founder of Geokno.

What has been the impact of COVID-19 on your business?

Our business development operations were affected, as it took some time for both sides to adjust to the transition from physical to online interaction. The closure of government offices led to some delays in paperwork and the release of workorders, while international travel restrictions caused delays in instrument availability. Field surveys became difficult in view of the lockdown and absenteeism among field engineers, and aerial survey projects suffered delays due to COVID-19-related precautions. Other delays and hassle arose from having to move data processing work back and forth from offices to home, and some tasks could not even be performed from home.

What do you regard as the key market trend in the years ahead?

From the perspective of India, the new geospatial data policy is going to open up a large geospatial market and will attract a strong flow of foreign investment into this industry. Our country will witness ambitious projects like a national digital elevation model (DEM), digital twins and greater penetration of geospatial into day-to-day life. Internationally, the trend will be towards more digital twins of cities and other environments. Geospatial market growth will shift from developed countries to developing nations and other countries. The content business will pick up, with companies investing in generating data and solutions and making these available in the online marketplace. I also expect that more retail solutions will start using digital

twins of cities, and that high-definition road mapping for advance driver assistance systems and autonomous vehicles will pick up around the world.

Which technological driver do you expect to be most important in the coming years?

I believe that artificial intelligence will prevail and will play a key role in data processing and application. As drone technology continues to improve, drones will become more effective for large-area surveys at small and large scale. Aerial sensors will improve to provide high-resolution data similar to drones, from higher altitudes and at higher speeds. Meanwhile, 3D sensors like Lidar will find more applications such as smart infrastructure and gadgets, and integration of data generation, GIS and Internet of Things (IoT) will be realized at operational scale.

What do you see as the main challenge in the near future?

Specifically for India, one challenge will be the non-availability of national geospatial standards for data and quality check, which will lead to confusion in project execution and consequent delays in project closure. The lack of trained individuals will also pose a challenge in terms of catering to the high market demand. The high cost of sensors due to monopoly by a few will affect the scaling up of the business. And it remains a challenge to 'initiate the uninitiated client' for geospatial services. For the international industry in general, the shadow of COVID-19 will continue to loom over the market. The use of drones by ill-intentioned persons may lead to severe regulatory restrictions on their use for mapping and other purposes.

The integration of terabytes of data being generated by various sensors including IoT along with edge computing will pose a computation challenge. And with more data and solutions becoming cloud-based, it will be challenging to ensure cyber security.

Due to the climate crisis, companies and organizations urgently need to contribute to a safer and more sustainable world. What is your vision on this?

It is important that business operations should be environmentally sustainable, and there will also be a high demand for sustainable geospatial business solutions. Even though geospatial is not one of the most polluting industries, the trend in other sectors will also affect geospatial. For example, the investments or loans will come with sustainability price tag. The geospatial industry will also have to demonstrate the environmental sustainability of its operations, and environmental audits may become a standard. ◀



Bharat Lohani is a professor of geomatics at IIT Kanpur and also co-founder of Geokno India Pvt.

Ltd. His areas of research and industrial activity are in all domains of Lidar technology. He has been spearheading efforts in India for using Lidar data for problem-solving. Lohani earned his PhD from the University of Reading, UK, in 1999.

5 Questions to... Bisheng Yang

Bisheng Yang is vice-director of LIESMARS at Wuhan University.

What has been the impact of COVID-19 on your business?

COVID-19 has changed the way I work and the way I communicate with researchers around the world. On the one hand the increase in online meetings is a bit exhausting, but on the other the pandemic has prompted me to think even more about the integration of geomatics with other disciplines. After all, the fight against COVID-19 is a hugely important issue for researchers around the world, and as geospatial scholars we should use our knowledge to serve society. For example, COVID-19 has provided a boost for autonomous solutions in logistics, which calls for technologies such as high-precision maps, indoor positioning and object detection. We are experts in these technologies, so we should actively invest and seize opportunities to create new value for the geographic information industry.

What do you regard as the key market trend in the years ahead?

In the past couple of years, the geospatial community has actively participated in the prevention and control of the spread of COVID-19, making full use of modern technologies such as big data, cloud computing and the Internet of Things (IoT) to provide users with automatic monitoring services such as epidemic monitoring analysis, early warnings and traffic monitoring. In the Chinese market, one key commercial trend is the construction of new infrastructure, including 5G, ultra-high-voltage and high-speed intercity railways, charging for electric vehicles, big data centres, artificial intelligence and the Industrial Internet. As an important foundation of this new infrastructure construction, new geospatial techniques – such as new imaging sensors with robots and artificial intelligence (AI) for underground infrastructure inventory, digital twins for smart cities, and ubiquitous positioning and

navigation with low-cost sensors – will receive a boost in the years ahead.

Which technological driver do you expect to be most important in the coming years?

Spatial location/semantic computation is key for location intelligence. It undoubtedly stimulates the development of low-cost, lightweight, energy-saving, small-sized sensors for geospatial information collection, computation and understanding, resulting in AI-based techniques for geospatial digital twins, robot-based intelligent mapping techniques and spatial probe techniques for underground utilities. On the one hand, new techniques should be aimed at greatly improving efficiency and accuracy and reducing the cost and weight of geospatial mapping sensors and software. On the other hand, geospatial techniques must serve more fields and applications, such as energy, transportation and public health, in order to provide intelligent solutions for governments and end-users.

What do you see as the main challenge in the near future?

In my view, there will be several main challenges in the near future. One issue is that COVID-19 will continue to restrict field trips and offline conferences, thus limiting knowledge sharing between the industrial community and the academic community. Secondly, there is a shortage of efficient and intelligent geospatial software or solutions to meet the real-time requirements related to public health in the context of COVID-19; geospatial software or solutions must provide real-time services with fresh geospatial information to the user, requiring new geo-AI theories and methods. The third challenge relates to the shortage of intelligent actions and decisions based on cutting-edge geospatial techniques for new fields. This requires a shift in the geospatial community from Earth surface observation to underground, space and sea exploration.

Due to the climate crisis, companies and organizations urgently need to contribute to a safer and more sustainable world. What is your vision on this?

The low-carbon, 'green' economy has become a global trend. Approximately 30 of the world's countries have currently proposed carbon-neutrality goals, and around a hundred more countries are preparing to propose them. The geospatial community should make its own contribution to a safer and more sustainable world. Geospatial companies and organizations should focus on AI to better understand Earth observation and remote imagery, for geospatial big data analysis, geospatial location intelligence to push the development of geospatial techniques for the achievement of the UN's Sustainable Development Goals, carbon emission and storage, and a green, low-carbon economy. On the other hand, geospatial companies and organizations should put more emphasis on developing efficient solutions to monitor natural disasters (e.g. landslides), the urban microclimate (e.g. heat islands) and key infrastructure risks (e.g. high railways) in order to minimize the loss of life and property. ◀



Dr Bisheng Yang is a professor of geomatics engineering and vice-director of the State Key

Laboratory of Information Engineering in Surveying, Mapping, and Remote Sensing (LIESMARS) at Wuhan University, China. His research expertise includes laser scanning and photogrammetry, point cloud processing and GIS applications. He has received numerous national and international academic awards including the Carl Pulfrich Award (2019).

5 Questions to... Ron Bisio

Ron Bisio is senior vice president of Trimble Geospatial.

What has been the impact of COVID-19 on your business?

From the earliest days of the global pandemic, our customers, distribution partners and employees have demonstrated incredible resilience. Two years in, they continue to operate and stay focused on their role in the global economy, and as a result we've seen an acceleration in the adoption of software and hardware solutions for the digital transformation of construction, transportation and utilities. This comes as governments are putting more funds into infrastructure construction and maintenance. Our customers are incredibly busy capturing physical information and the as-built situation of current infrastructure. This robust market has also magnified the challenges of the slowing pipeline of survey professionals, with more people retiring than joining the profession.

What do you regard as the key market trend in the years ahead?

Digital twins, as the end game of scanning and mobile mapping workflows, will be a central feature of infrastructure improvements across the world, supported by stimulus money pouring into Europe and historic infrastructure investments in the US. Capturing the Earth and converting it into a digital model, or digital twin, is central to improving our roads, bridges, railways and airports. A snapshot of the as-built situation allows survey and mapping professionals to support workflows in construction, transportation and utilities. Our customers, the surveyors in the field, are the ones standing in front of that bridge for which there will be a digital twin so that designers, engineers and planners can work on improving it. The entire time, personnel in the field and office are operating in a fully connected environment, which minimizes downtime caused by information requests and design & stakeout updates. The same thing happens in utilities, with our

customers capturing information about critical infrastructure and feeding it into the workflow and eventually going back out and inspecting and maintaining that information.

Which technological driver do you expect to be most important in the coming years?

Changes in data collection and processing are helping us to broaden our role beyond simply capturing information in the field, and cloud services will enable us to deliver on the digital twin through the software driving our data capabilities. When I joined Trimble in 1996, surveyors used either optical instruments or GNSS. Now, increasingly, surveying companies need experience in other technologies, including scanning, UAVs and augmented reality-enabled visualization. They also need a deeper understanding of the data, and software becomes the data hub where we provide customers what they need, when they need it.

What do you see as the main challenge in the near future?

As more surveyors retire and the next generation brings its digital-native expertise to the workforce, surveying must once again evolve and adapt. This will require increasing awareness of surveying and mapping as careers of choice for tech-minded individuals who want to work on projects making a difference in their communities. The entire surveying ecosystem – businesses, educational institutions, government organizations and trade associations – needs to collaborate to build a stronger pipeline of geospatial professionals. The Trimble Technology Labs at the National College for Advanced Transport & Infrastructure in the UK and Tampere University in Finland are examples of this collaboration. To make the most of the post-pandemic era, we must enhance people's skills and embrace the potential of technology to advance processes across disciplines. But even the most exciting technological advances in automation, artificial intelligence and

augmented reality won't make up for the need for more geospatial professionals to carry the industry forward.

Due to the climate crisis, companies and organizations urgently need to contribute to a safer and more sustainable world. What is your vision on this?

Geospatial technologies are transforming the work of professionals across the globe, including providing sustainability benefits in land and water management and mass data solutions for smart cities. Also, software processes and BIM/GIS integration help streamline complex project communications, leading to a reduction in rework, which means fewer materials and less waste because it was built correctly the first time. And with spatial analysis becoming pervasive across every industry, mapping and GIS are vital in demonstrating the environmental impact of climate change. This includes water management tools, coastal impact, disaster mitigation, public works projects and – in the context of these changing models – endangered species mapping. We've moved from data capture to data intelligence so we can understand and plan better for the future. ◀



Ron Bisio joined Trimble in 1996 and has held several marketing, sales and general management positions prior to taking over worldwide responsibility for Trimble's Geospatial in 2015. He holds a master of business administration from the University of Denver, a master of regional planning from the University of Massachusetts, and an undergraduate degree in geographic information systems & cartography from Salem State University in Salem, Massachusetts, USA.

5 Questions to... Rudolf Staiger

Rudolf Staiger is president of FIG.

What has been the impact of COVID-19 on your business?

The aim of the International Federation of Surveyors (FIG) is to strengthen and to promote the surveying and geospatial profession in a very broad sense. As a non-profit and non-governmental organization, we use different promotion channels and platforms. One very important format is our yearly event, the FIG Working Weeks, and every four years we organize an even bigger event: the FIG Congress. Due to COVID-19, we had to cancel the Working Week 2020 and instead transformed it into a virtual Working Week in 2021, organized by our Dutch colleagues. It was a great success, but almost everybody expressed the wish to meet in person again soon. Thanks to COVID-19, we learned that videoconferences can replace some meetings and are effective when working on a specific task. While this means that in-person meetings can be reduced, they are not completely replaceable. And for the moment, the biggest challenge is the uncertainty with regard to the future events, such as who will be able to travel and the financial risks. We knew that many FIG members were struggling throughout 2020, which is why we reduced the FIG membership fees by 20% as a one-time gesture in 2021.

What do you regard as the key market trend in the years ahead?

The key market trends in the surveying and geospatial industry are scalable cloud-based applications combined with new sensor platforms like drones or mobile scanning devices in an automated or even autonomous operating mode. Digitalization has always been an important topic on our

profession's agenda and this will continue in the future.

Which technological driver do you expect to be most important in the coming years?

The technological drivers are artificial intelligence (AI), Internet of Things (IoT) and distributed and scalable software applications. Real-time wireless communication will also play a more important role in the future.

What do you see as the main challenge in the near future?

We must overcome COVID-19. There are medical, human, social and economic aspects to this, and there are indications that poorer countries and regions are being hit harder than richer parts of the world. In other words, in the future, the wealthier countries should support the poorer parts of our world even more strongly than ever before. Based on the daily news, you could get the impression that the other burning issues like climate change, sea level rise, carbon footprint and fossil fuels have disappeared from our radar screens, so we need to get back to finding future solutions to these issues. The Sustainable Development Goals (SDGs) are also still on the agenda. A FIG Task Force has been

working on how FIG can contribute to the SDGs. Regarding our yearly event, the main challenge in the coming years is to find the optimal post-COVID event format. Most people regard a hybrid format – in which visitors can attend in person or virtually – as the most obvious answer. Unfortunately, hybrid events pose a lot of challenges such as higher production costs accompanied by lower registration fees, the consideration of different time zones and the more complex simultaneous interaction with both the virtual audience and the on-site attendees.

Due to the climate crisis, companies and organizations urgently need to contribute to a safer and more sustainable world. What is your vision on this?

The majority of the global players in the surveying and geospatial industry are high-tech companies with powerful R&D departments. They would love to contribute to a safer and more sustainable world with innovative products. Therefore, incentives are needed which will make extra efforts for sustainable solutions attractive and worthwhile. Once there is a legal and economic framework for sustainable products, the industry in general – and the geospatial sector in particular – will deliver! ◀



Rudolf Staiger has been the president of FIG since 2019. Prior to that, he was vice-president of FIG from 2011 until 2018, and the chair of FIG Commission 5 (Positioning and Measurement) from 2007 to 2011. Staiger currently teaches surveying engineering at the University of Applied Sciences in Bochum, Germany. His areas of special interest are instrumentation and calibration of geodetic sensors, laser scanning and data analysis. He previously spent six years in industry with KERN and Leica Geosystems (both in Switzerland) as a systems engineer, product manager and software developer. From 1994 to 2005, he taught surveying engineering at the University of Essen (Germany).

5 Questions to... Jolle Jelle de Vries

Jolle Jelle de Vries is owner and director of Geomaat, a Dutch land surveying company.

What has been the impact of COVID-19 on your business?

“Well, in the beginning things were a little tense since we were not sure what the future would bring. Fortunately, however, most projects continued running well and our clients also helped by bringing certain activities forward. As a result, COVID-19 has had little impact on our business, apart from in terms of sick leave which increased sharply. Luckily none of our colleagues were seriously ill, but the high level of absenteeism due to illness did put enormous pressure on our planning.”

What do you regard as the key market trend in the years ahead?

“One strong ‘trend’, if we can call it that, in the years ahead will be automatic object recognition in 3D point clouds. Artificial intelligence (AI) is definitely not just a hype. At Geomaat, we are using it more and more in conjunction with automatic object recognition in point clouds. The challenge is to deploy this valuable technique effectively. The use of AI is in itself a learning process; it can’t be implemented overnight. This holds true for us too, so we’re applying AI to big data step by step. So far, we’ve succeeded in using automatic mutation detection to automatically search for differences between the real-life

situation (outside) and the digital map data. Another trend that will play a major role in the years ahead is the creation of digital twins (3D city models), and we already have experience in that. A 3D model of a city, town or village can be very useful for local or regional governments. Digital twins can be used to improve citizen participation, environmental legislation, communication, planning and policymaking – they are a very smart way for government authorities to visualize and analyse the areas they are responsible for. But it is also possible to realize a digital twin from just a building or an area instead of a whole region.”

Which technological driver do you expect to be most important in the coming years?

I think artificial intelligence. By using algorithms to process huge amounts of data (3D point clouds and photos), we’re able to extract the right information more quickly. Our Process & Innovation department is working to further improve this every day.”

What do you see as the main challenge in the near future?

“Our profession will need a lot of additional people in order to continue to handle the innovations and challenges that lie ahead. The demand for industry professionals already outstrips the supply. It will be important to enthruse young people for our

sector, to train people ourselves and to help people re-train for new roles.”

Due to the climate crisis, companies and organizations urgently need to contribute to a safer and more sustainable world. What is your vision on this?

“Sustainability is important to us at Geomaat and we have been focused on it for the past 15 years. Our offices in Groningen are completely disconnected from the gas supply, and 20% of our vehicle fleet is already electric. In fact, we’re also replacing some of our company vans with electrically powered vehicles this year.” ◀



Jolle Jelle de Vries is owner and director of Geomaat, a Dutch land surveying

company specialized in the measurement, acquisition, analysis and processing of geospatial data. The company is committed to quality improvement, innovation and partnership. Together with a team of specialists, De Vries is constantly focused on innovating, developing and further improving the use of technology to shorten project turnaround times and deliver even better results.

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5 Questions to... Thomas Harring

Thomas Harring is president of Hexagon's Geosystems division.

What has been the impact of COVID-19 on your business?

Even before the current COVID-19 pandemic, digitalization was a major trend within the geospatial industry. The COVID-19 pandemic has accelerated this development and the trend will continue once the crisis has passed. The adoption of digital solutions in more traditional areas has increased, and the crisis has not delayed planned investment projects. The power of digitally enabled workflows has also shown the benefits transparently to those decision-makers who had previously not been aware of solutions from the geospatial industry. Due to the ongoing convergence of the real and digital worlds, the geospatial industry – with its solutions that capture, measure and visualize the physical world – is ideally positioned to facilitate automation and to provide autonomous decision support. There are several topics which have gained relevance due to COVID-19, such as real-time collaboration between office and field using digital tools, frequent remote progress monitoring as well as increased demand for accurate and reliable digital realities. We, and everyone interested in the geospatial industry, should use the momentum of the 'next normal' to further strengthen the geospatial industry and move towards more customer-centric, sustainable and autonomous digital solutions.

What do you regard as the key market trend in the years ahead?

Autonomy is a key trend that we see and actively shape. Our autonomous technologies 'autonomize' any task or process in a workflow for entire operations or industries. Consider our newly launched products in the BLK series. The Leica BLK ARC, an autonomous laser scanning module for robots, integrates with robotic carriers and enables scanning with minimal human intervention. The Leica BLK2FLY is an autonomous flying laser scanner and easily captures building exteriors, structures and environments from the sky, creating 3D point clouds while flying. The BLK ARC and BLK2FLY connect directly to Hexagon's cloud-based visualization platform

HxDR, where immediate upload, AI-enabled cloud processing and storage of the captured data provide instant delivery of a purpose-built intelligent digital reality to collaborators anywhere. Smart digital realities already help make informed decisions by visualizing as-is conditions and modelling scenarios. However, self-learning digital twins are increasingly autonomous; think, for example, of monitoring systems whose sensors detect minimal movements and, in the event of danger, automatically switch a traffic light to red to close off sections of the road to protect drivers.

Which technological driver do you expect to be most important in the coming years?

Technology has delivered on the promise of vast amounts of useful data. But instead of generating trillions in value, the data deluge is confronting industry with a new challenge. I consider the most important technologies to be those that allow us to put all this valuable data to work in an autonomous way. Exciting technologies, such as 5G, edge computing, cloud processing, artificial intelligence (AI), machine learning, IoT and AR, are all making an impact. I don't see one single technology driving the industry, but rather the interplay of all of these. However, AI has already transformed machine visualizations and image processing, and pervades our solutions and platforms. Customers are benefiting from the use of AI in our smart digital reality solutions to gain previously unobtainable insights.

What do you see as the main challenge in the near future?

I see a bright future for the geospatial industry. However, a talent shortage might become challenging in view of the increasing demand for geospatial data and the growing number of applications. Fewer talented youngsters are entering the industry, while seasoned professionals are retiring. Our innovations respond to that challenge in two ways. Firstly, our developments help surveyors and other geospatial professionals be more efficient. With our robotic total stations, for example, such as the Leica Viva TS16 with DynamicLock, one person suffices to get the job done. Another example is the Leica GS18 I; with the GNSS

rover with visual positioning, surveyors can quickly and efficiently capture areas in images and measure points in the field or later in the office. Secondly, innovative technology such as laser scanners, mobile mapping technology, UAV systems and increasingly powerful software also make the industry more attractive to a tech-savvy younger generation.

Due to the climate crisis, companies and organizations urgently need to contribute to a safer and more sustainable world. What is your vision on this?

We believe that the geospatial industry has a responsibility to contribute to making our world safer and more sustainable. In fact, at Hexagon, sustainability is at the core of our strategy. We envision an autonomous, sustainable future in which industry, humanity and the environment sustainably thrive. We constantly strive to minimize our own environmental footprint and that of our value chain. And we see a great opportunity in supporting customers to become more sustainable. Our solutions contribute to making renewable energy farms more productive, coastal areas more resilient, cities greener, mining and heavy construction more efficient, building construction leaner and building maintenance smarter. ◀



Thomas Harring is the president of Hexagon's Geosystems division and CEO of Leica

Geosystems. In 2011, he was appointed COO/CFO of Hexagon's Geosystems division and Leica Geosystems. Prior to that, he held various management positions at Leica Geosystems. Before joining Leica Geosystems in 2003, Harring worked for many years in international consultancy and served on the academic council at the Technical University of Cottbus, Germany. He holds a degree in technically oriented economics from the Technical University of Stuttgart, Germany.



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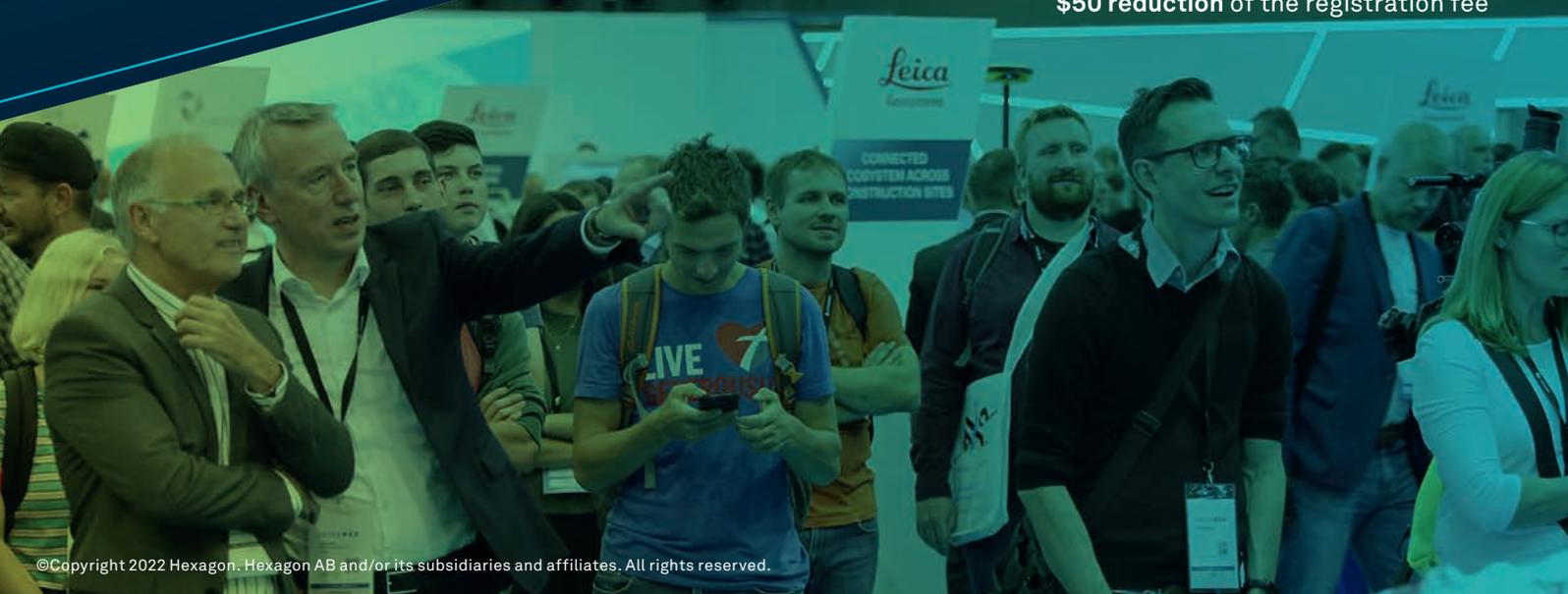
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Training the Future Geospatial Workforce

The coming years look promising for the geomatics sector, but the new generation of professionals must be prepared to face the challenges ahead. In view of the looming labour shortage in the surveying industry, is it time to take a fresh approach to training the future geospatial workforce?

The surveying profession dates back to ancient times and has played a transcendental role in the development of different civilizations. Early evidence of surveying practices and techniques can already be found in many historical documents in places such as Egypt, Greece or Rome. The evolution of the practice was relatively slow during the Middle Ages, until the arrival of the Italian Renaissance. This period of huge scientific and technological advancement laid the foundations for the surveying profession as we know it today. Since then, surveyors have been carving out a niche for themselves and creating new opportunities in the employment market by meeting the rising demands of construction and industry. After very little change for hundreds of years, the new tools and technologies that were introduced from the mid-20th century onwards enabled surveyors to work even more quickly and accurately. Yet while the equipment has evolved over time, the fundamentals have not actually changed that much throughout history.

In today's internet era, however, the surveying profession is changing much faster than ever before due to the explosion of various global technologies (smartphones, IoT, big data, etc.) and the current accentuated value of location-based data. The profession has been rebranded as 'geomatics' as the skills offered by these specialists have diversified and moved ever further away from the classic concept of surveying. Geomatics practitioners are still able to generate geospatial information from measurements, as they always have done, but there is now a much wider range of measurement methods and data capture techniques. Therefore, they need to be constantly adapting their skills in this rapidly changing environment.

There is unprecedented demand for skilled manpower in geomatics, since geospatial information now plays a more essential role in society than ever. There are multiple and varied applications for geospatial skills and knowledge, with wide integration in urban and regional planning, natural resource monitoring, infrastructure management and precision agriculture, among others. In spite of this, there is currently considerable concern among businesses and academics involved in the geospatial field about the fact that job opportunities in the industry far outweigh the supply of qualified personnel.

Traditionally, due to the specificity and the relative complexity of the instrumentation used, the education and training in all geomatics-related fields would normally take place at universities. Perhaps surprisingly in view of the existing labour demand and the future prospects, an insufficient number of students are enrolling for geospatial-related university degrees almost everywhere. In fact, the lack of enthusiasm for land surveying, geodesy, GIS or geomatics programmes in some countries means that it is no longer feasible for university departments to continue offering them, which is creating a vicious circle. In that sense, perhaps it is time for the industry to increase its efforts to encourage youngsters to develop the knowledge and skills necessary for a future in geomatics at secondary school level, or maybe even earlier. Previous science, technology, engineering and mathematics (STEM) experiences promoted by universities have demonstrated that students who are exposed to field-specific activities at an early age are more interested in pursuing the subject later on.

Paradoxically, given what seems to be happening within geomatics education itself, there is a clear increase in demand for geospatial courses and training activities from experts in other fields and even from a non-specialist audience. We are witnessing the democratization of many geospatial techniques, such as GIS and photogrammetry which are enjoying great popularity these days. The boom in high-tech devices such

as drones and 3D printers is contributing to this and stirring up more fervour for mapping and recording geospatial data among the general public. In this context, many students and professionals from a wide range of fields are also considering strategies to enhance their portfolios and boost their credentials by acquiring new geospatial knowledge and skills.

This growing external interest in the geospatial field should be seen as a good sign of its appeal. To take advantage of this opportunity to attract new talent from other fields, perhaps it is time to modernize geospatial training programmes and to provide relevant instruments and resources for new learners. One way to do this would be to develop training activities with different degrees of complexity, specifically targeted at each type of audience. This could be the solution for ensuring a sufficient supply of skilled and qualified geospatial professionals to meet the industry's future needs. ◀

ABOUT THE AUTHORS



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Marcos Arza-García is a postdoctoral researcher with the CIGEO-Civil & Geomatics Research Group at the University of Santiago de Compostela (USC), Spain. His research interests include the use of spaceborne and unmanned aerial vehicle-based data focused on civil applications. He has been involved in several capacity-building and professional training projects within the geospatial field.

OPPORTUNITIES AND THREATS FOR THE GEOSPATIAL SECTOR

Digitalization in the Construction Industry

Besides the surveying hardware & software and the intricacies of BIM and data exchange, this article explores broader aspects of digitalization in the construction industry. How are they affecting the geospatial sector? What are the opportunities and threats? What about the human factors? And how is the geospatial data actually used in practice?

Whether on brownfield or greenfield sites, most construction projects start with a site survey. This can be done using conventional surveying equipment or with modern tools such as unmanned aerial vehicles (UAVs or 'drones') for photogrammetry and laser scanners for mapping. Surveyors can then

support the project by monitoring progress, measuring spoil heaps and excavations, and eventually doing a full as-built survey using mobile and terrestrial mapping equipment which produces both a point cloud and panoramic photographs. All these efforts contribute to deliverables such as the

Common Data Environment (CDE), building information modelling (BIM) datasets and digital twins.

Accurate point clouds, models and imagery produced by surveyors can reduce the need for others to visit the site. This can save



▲ The **tsurveys** surveying team works in collaboration with the 3D modelling department to produce high-detail BIM models to incorporate geomatics and physical features combined. (Photo courtesy: **tsurveys** Ltd)

time and reduce the carbon footprint due to transport. Easily available reality capture data will also encourage project team members to check details more frequently, which can save time during the design process and reduce mistakes. Finally, minimizing the number of people on site is obviously an advantage during the ongoing pandemic. In line with this, it is beneficial for surveying professionals to become more familiar with BIM and how it is used in the construction industry – not only in order to do their own work more effectively, but also to best understand and support their customers.

BIM IN THEORY AND PRACTICE

One important consideration is that not all clients may be fully familiar with BIM, especially if it has been imposed on them by their own customers. For example, some people may think that BIM and the Revit model are one and the same, rather than realizing that Revit is a tool that relates to BIM. As a surveyor, it pays to take the time to explain that BIM is not Revit, how BIM fits into the client's business, and how you can support them with activities and advice to implement BIM effectively. You may have to emphasize that the 'M' in BIM stands for 'modelling' rather than 'model'. In other words, it is not a single 3D model, but a continuous process to ensure effective exchange and management of information covering the whole lifecycle of the structure.

However, BIM is not a panacea. Smaller construction businesses may simply be overwhelmed by BIM and everything it entails. They may not have the financial or human resources to adopt it – yet many construction projects depend on such contractors. Clients may also be sceptical, or feel that BIM is not relevant to their property portfolio. A surveyor with a large UK housing association commented: "I haven't seen BIM in a live environment. It's a fantastic concept, but none of the developments I've been involved with could justify the cost. Maybe in a few more decades it might become commonplace." Nevertheless, BIM is already widely adopted in other parts of the construction industry.

FOCUSING ON CLIENT NEEDS

As geomatics professionals we only produce data because our clients need it. That



▲ *Scan-to-BIM deploys 3D laser scanners on location to build a precise point cloud dataset and model, operating at speed and scale according to the needs of the job.*

means we have to focus on how our GIS data interfaces to the BIM systems of our clients (see also a previous article in *GIM International*, 'Bridging the Gap between Geospatial and Construction'). This can be a challenge because geospatial data usually refers to points, while BIM data refers to objects. Therefore, it is important to be aware of the needs of each client and how far advanced they are in terms of BIM and other aspects of digitalization.

PEOPLE AND ORGANIZATIONS

The fact that digitalization and, specifically, BIM are processes rather than technical products means that everything revolves around people and the organizations they work in. Dealing with those aspects can be a challenging experience for a surveyor who is more used to working with hardware such as total stations than with the human aspect. A report by McKinsey called 'Culture for a digital age' identified cultural and behavioural

THREE INNOVATIVE DIGITAL SOLUTIONS FOR CONSTRUCTION SITES

1) Robot Plotter

The Tyker company, a spin-off of Wageningen University in the Netherlands, has developed the Robot Plotter. This small autonomous vehicle to apply surface markings was originally developed for road paving applications, but is now finding broader use such as in setting out foundation engineering projects. The unit navigates using GNSS-RTK outdoors and can be controlled by a total station in areas of poor GNSS reception, such as inside buildings.

2) Robotic laser scanning dog

Trimble has mounted one of its X7 laser scanners on the Spot robotic dog produced by Boston Dynamics. This works with the company's FieldLink construction layout and scanning software and is intended for work progress monitoring. Spot can negotiate obstacles and even stairs, which makes it perfect for deployment on construction sites. After completing a scanning assignment, the unit returns to its docking station which not only recharges the batteries of the scanner and the robot, but also transfers the geospatial data back to the office.

3) Smart Construction project

Earthmoving equipment manufacturer Komatsu has developed a digital workflow solution for the full construction process, from bidding to the final handover and reporting. Smart Construction is an open project with over 20 partners. It includes design software, machine sensors, fleet management and survey tools. Smart Construction applications can upload 3D models to earthmoving equipment such as excavators and bulldozers. Automatic machine control then ensures that the right contours are followed during the operations. Sensors on the machines automatically provide as-dug data. This reduces the need for minor survey operations, although major works still need to be followed up by a verification survey. Richard Clement of Komatsu Europe comments: "Technology will help us turn construction sites into better, safer and more up-to-date workplaces. This is especially important for the future of our industry, with many companies struggling to attract both young and skilled people."

challenges as the key obstacles to meeting digital priorities. It also suggested that cultural changes are slower and more complex than the changes in technology which drive them. This is likely to apply both to geomatics businesses and their customers, and to

creativity, as a result of which BIM would harm rather than enhance the project outcome. He calls for team leadership and shared values to ensure that data and digital technology benefit the deliverables. He also feels that software vendors should price their products such that

overdigging or underdigging, but can also reduce the need for regular surveys of the excavation. Some handheld laser scanners are now affordable enough that even smaller construction companies can buy them. Photogrammetry can now be done using a drone or smartphone and affordable (or even free) software.

OFF-SITE CONSTRUCTION WILL ENCOURAGE FURTHER DIGITALIZATION AND IS LIKELY TO HAVE AN IMPACT ON THE DEMAND FOR GEOSPATIAL SERVICES

digitalization in the construction industry in general. The changes associated with digitalization will be particularly challenging for smaller and more traditional construction businesses.

In the context of gauging BIM maturity, David Shepherd (BIM leader at the UK House of Commons project) has written about the need to focus on collaboration between people and businesses, and not solely on prescriptive processes. He is concerned that overly prescriptive processes can discourage

they are accessible to small and medium-sized businesses. Those observations are likely to be relevant to other aspects of digitalization in the construction industry too.

POTENTIAL THREATS

Geomatics professionals need to be aware of technical developments which can reduce the need for specialist surveyors. For example, modern earthmoving equipment fitted with GNSS and a range of sensors can be controlled directly from the construction designs. This can not only avoid costly

These aspects of digitalization mean that surveyors need to convince clients that they are still relevant because of the assured quality of their work or more efficient workflow, and independence. So how can you prove that? It may help if you explain that an apparently cheap survey could turn out to be very expensive in the long run if it leads to problems during the construction project. Even so, some surveying markets may be eroded. This is all the more reason for the geomatics community to monitor and anticipate developments in the market, and aim to develop new applications and markets.

MODERN METHODS OF CONSTRUCTION

In many construction-related markets, the need for greater efficiency and the shortage of skilled labour are leading to various degrees of prefabrication or off-site construction. This will encourage further digitalization and is likely to



▲ The R bot Plotter uses RTK-GNSS and local sensors for control, or it can also be controlled by a total station. (Photo courtesy: Tyker)



▲ Technological solutions such as augmented reality are currently being used in construction. A good example is Trimble SiteVision.

have an impact on the demand for geospatial services.

Projects to refurbish or extend existing buildings, especially older ones, frequently rely on traditional, on-site construction. This is because the geometry is often complex and irregular. Consequently, new components are cut and offered up to the existing structure on site to ensure a good fit. In some cases, laser scanning can now be used to scan the site to a high degree of accuracy. This can enable off-site fabrication of components such as cross-laminated timber panels and piping assemblies. Such digitalization developments can increase efficiency and save the time spent both on site and travelling to sites by construction workers. Similarly, detailed laser scans with panoramic photographs make it much easier to check even small details during the design process. This can help architects, consultants and designers to do their work more efficiently, and avoid clashes and problems which need to be resolved on site during the construction process.

DIGITALIZATION AND MUDDY BOOTS

The mining industry has already implemented a number of digitalization projects using autonomous or remotely controlled equipment. This is sometimes combined with full or partial electrification of the equipment to reduce greenhouse gas emissions. Digital advancements are continuing to enable the introduction of a range of innovative equipment on construction and civil engineering sites.

Existing digitalization of construction and civil engineering equipment ranges from fully autonomous robots through to seemingly conventional construction plant fitted with a range of digital systems to assist the human operator. UAVs are already widely used for regular site surveys to monitor progress. Technological solutions such as augmented reality (AR) and virtual reality (VR) are currently being used in construction. The applications include remote site visits and inspections, training, presentations, etc. Geospatial applications include displaying previously gathered information while undertaking a site survey. Trimble SiteVision, Topcon MAGNET Vision and Leica Captivate are examples of this.

Digital twins based on laser scans or photogrammetry are already proving very useful for the maintenance of existing assets. For example, public housing providers in Sweden and the Netherlands have used UAS photogrammetry to inspect thousands of properties, as covered in earlier articles in *GIM International*. In the Netherlands, Rijkswaterstaat has commissioned digital twins (based on laser scans, combined with photographs) of eight tunnels to be refurbished. The first one immediately proved its value when the COVID-19 epidemic started; the tender for the refurbishment could be continued by giving the bidders access to the digital twin instead of organizing site visits.

In another example, the HS2 railway project in the UK is planning to use VR, BIM and a

digital twin to optimize future maintenance. This will include live data from thousands of trackside and on-train sensors which is sent to the Network Integrated Control Centre. Before going out on site, engineers will use VR headsets to investigate issues from the control centre. This will help them prepare the maintenance operations more effectively and resolve issues remotely where possible.

FUTURE OUTLOOK

This article has shown that the opportunities for the geospatial sector related to digitalization in the construction industry outweigh any threats it may pose. Moreover, by focusing on the needs of their clients and educating them on the benefits of BIM and other digitally enabled technologies, surveyors can help their clients to improve the quality of their work while saving time and money. As a result, surveyors can reinforce their relevance and cement their existing client relationships, plus also branch out into new applications and markets for an even brighter future. ◀

ABOUT THE AUTHOR



Hans van Bemmelen is a technical writer and translator serving the construction and engineering industries. He has a special interest in surveying and unmanned aerial system (UAS) applications.

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The Abundance of Prospects for Surveyors in the Building Industry

Although the construction sector currently has a lower level of digitalization than nearly every other industry, the sector is evolving – and geospatial technology will play a key role in its future. Building information modelling (BIM) is one example of digitalization in the construction industry, and it is changing the way surveyors work, collaborate and do business. We have selected a number of articles that provide an overview of the architecture, construction & engineering (AEC) industry's needs and the associated opportunities for mapping and surveying professionals.

BRIDGING THE GAP BETWEEN GEOSPATIAL AND CONSTRUCTION

There is a gap in information exchange between the geospatial and construction domains. This is a serious issue, mainly because geospatial systems and engineering surveys are not yet aligned and integrated with BIM. The BIM method is expected to move construction activities from plan-based individual work to model-based collaboration. Such a paradigm shift will bring huge opportunities regarding planning, building and management of the built environment in a more productive, open and sustainable way. Although it is still difficult to entirely close the gap between these two fields, this article shows how that gap can at least be narrowed.



► Scan the QR code for the full story

HOW CAN SURVEYORS OPTIMALLY PROFIT FROM THE DIGITALIZATION IN THE CONSTRUCTION INDUSTRY?

Topcon, a global positioning partner for construction and geospatial businesses, sees BIM as not just a benefit, but a requirement. Here, Cesar Mendoza, the company's product manager for vertical construction, discusses how surveyors can optimally profit from the digitalization in the construction industry and the trend towards BIM. He believes the UK government's Construction Strategy, published in 2011, serves as a good example and has had a major impact on the uptake of BIM in the UK.



► Scan the QR code for the full story

THE ROLE OF SURVEYORS IN THE EVOLUTION OF BIM

Building information modelling is becoming more commonplace within construction sectors globally, combining technology with improved collaboration to better manage projects and give them the best chance of complying with time and budget constraints. However, the BIM life cycle and efforts to espouse it are almost futile if surveying is taken out of the equation or, more realistically, brought in too late. It can be good to have a structure that is successfully using BIM to be delivered on time and within budget, but if it or any of its components are in the wrong position, the consequences can be catastrophic.



► Scan the QR code for the full story

3D MODELLING FOR CONSTRUCTION

When it comes to 3D modelling for construction, what are the advantages and disadvantages of photogrammetry versus Lidar in terms of accuracy, complexity and cost? Breaking away from laser measurement in construction is a taboo subject, perhaps hampering the use of photogrammetry. In construction, aerial survey has enormous time-saving benefits for measuring groundwork areas. Data can be used for asset classification and construction validation as well as health and safety. In particular, regular scans provide a time series of work in progress to detect new issues, managing risk rather than responding to it. This article looks at the state of the art.



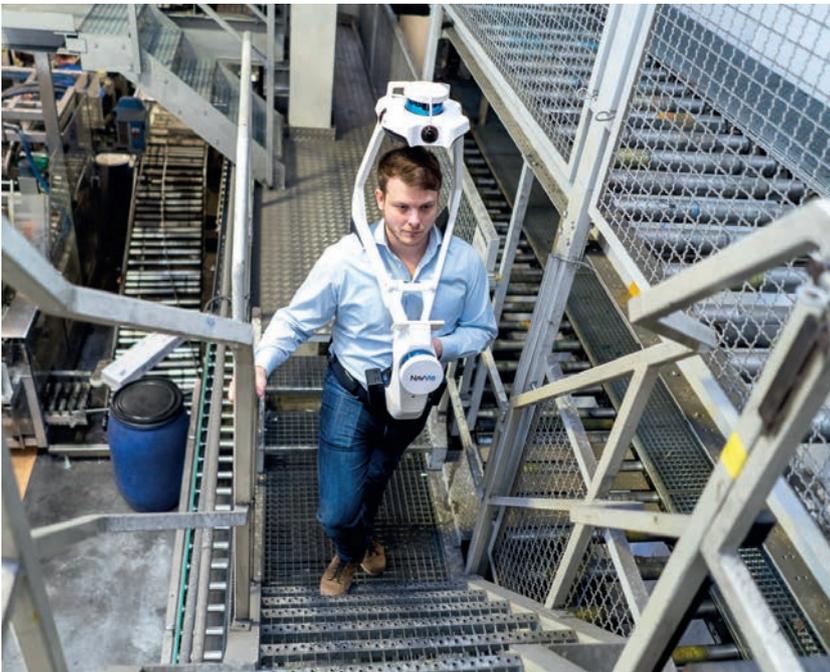
► Scan the QR code for the full story



▲ Survey and geospatial professionals are major stakeholders and often gatekeepers in the BIM value chain.

Exploring the State of Mobile Mapping

What is the current state of acceptance of mobile mapping, and what are its most common applications? A worldwide survey, commissioned by NavVis and supported by *GIM International* plus three other publications, was recently conducted to find out. Here, we highlight some of the key findings and share the reactions from a number of suppliers of mobile mapping products.



▲ The NavVis VLX wearable mobile mapping system in action.

The NavVis survey into the State of Mobile Mapping 2021 was conducted among approximately 150 companies in over 20 countries. Most respondents were surveying or laser scanning experts working for specialist contractors. In terms of their customer base, the majority of respondents provide scanning and surveying services to a variety of external clients across a wide range of sectors. Clients in the architecture, engineering and construction (AEC) sector score the highest percentages and are currently the biggest users of mobile mapping services (Figure 1).

WORKING ENVIRONMENT AND APPLICATIONS

The most important working environments mentioned by the respondents are topographic and site surveys (53%), residential and office buildings (47%), construction sites (46%), industrial buildings (44%), and road, rail and bridges (44%) as shown in Figure 2. Many surveys are carried out inside buildings, where GNSS reception is poor. One benefit of mobile survey equipment is that it causes little disruption to operations; it can often be undertaken while work continues, or during breaks in production. Furthermore, many mobile mapping solutions have software features to remove elements such as people and vehicles in the scanned area.

DELIVERABLES AND SOFTWARE

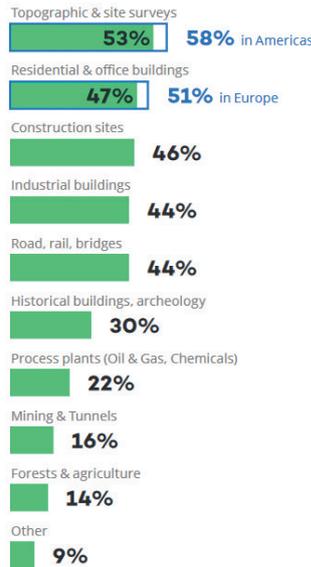
The most popular application of mobile mapping is to produce as-built documentation. The full range of deliverables includes point clouds, 3D/BIM models, imagery, survey reports and 2D floor plans.

KEY SURVEY FINDINGS

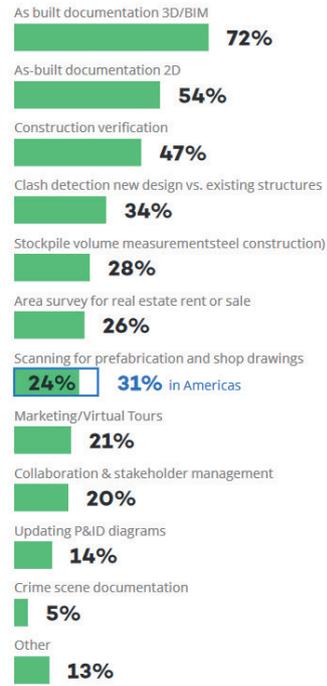
- Mobile mapping equipment is already widely accepted. At the time of the survey, 28% of the respondents owned and operated a backpack mobile mapping system. This figure is predicted to rise to 51% within 12 months. Handheld systems are even more popular: currently at 39%, expected to rise to 60%.
- The top three requirements in a mobile mapping project are: 1) point cloud accuracy and high-quality imagery, 2) scanning speed and time spent on site, and 3) an integrated seamless software workflow from scanning to deliverables.
- Around 75% of respondents are confident that mobile mapping meets their accuracy requirements.
- A large majority of respondents envisage a hybrid workflow, combining mobile mapping hardware with terrestrial scanners.



▲ Figure 1: Users of mobile mapping services. (Image courtesy: vVis)



▲ Figure 2: In which types of mapping environments do you work most often? Figure 3: What are the most common scanning use cases for you or your clients? (Image courtesy: vVis)



Construction verification and clash detection are also widely mentioned (Figure 3).

The respondents were also asked about the software they use. As expected, various AutoDesk applications are particularly popular. Bentley MicroStation also made it into the top five. Surveyors intending to use mobile mapping need to spend time with clients to determine their needs (accuracy, resolution, file formats, etc.), especially as clients may be unfamiliar with concepts such as point clouds. Often, a combination of 2D/3D plans, BIM and panoramic photographs will be needed. Most

suppliers of mobile mapping solutions supply tools for this. Another option is to use software which imports data files from laser scanners of different makes, such as Gexcel Reconstructor. There is also software for hybrid workflows.

CURRENT AND FUTURE HARDWARE OWNERSHIP

The survey provides interesting information about the current and planned use of hardware, including mobile mapping systems, total stations, terrestrial scanners, GNSS rovers and unmanned aerial vehicles (UAVs or drones), and all these hardware types are covered in more detail in the survey report.

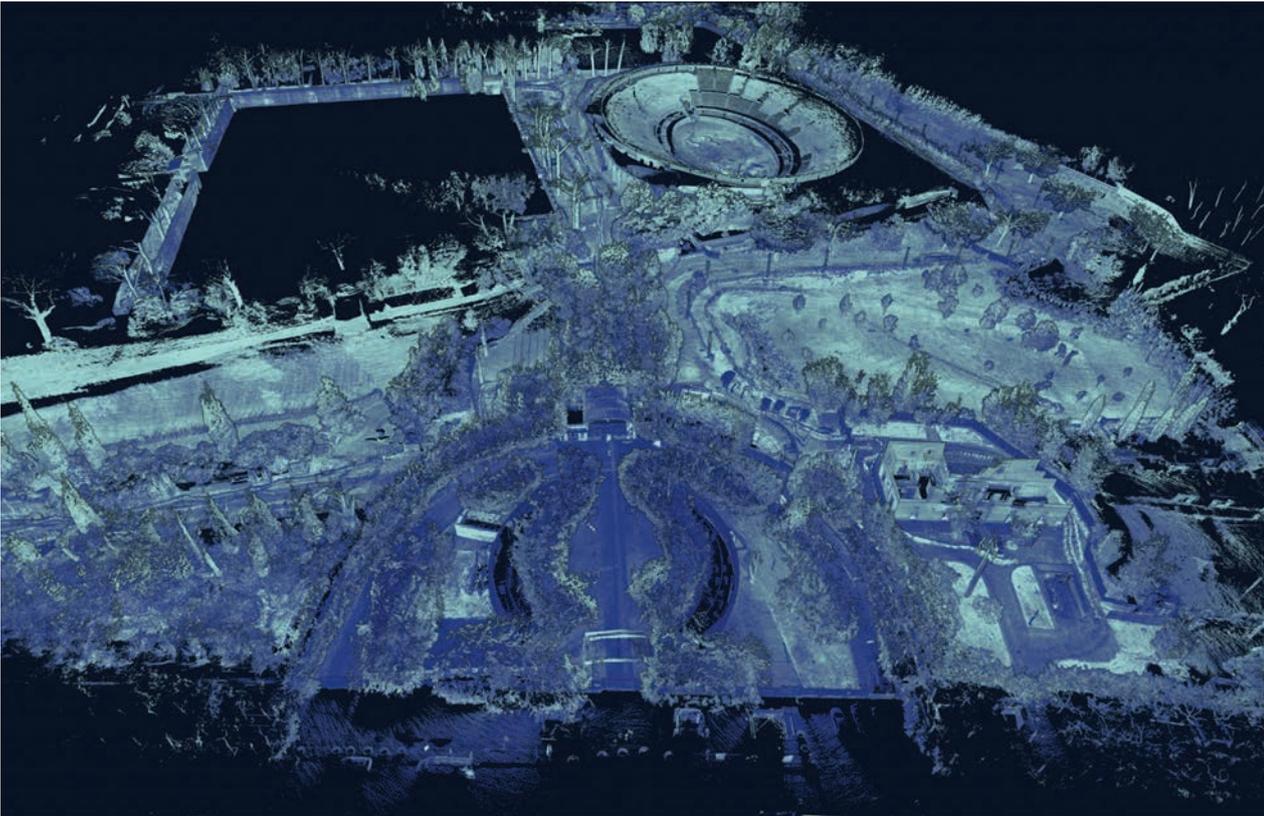
In terms of mobile mapping systems, 39% of respondents currently use a handheld system and 35% expected to invest in such a system in the next one or two years. Wearable systems are used by 28% of respondents, with 41% planning to acquire one within two years. When it comes to the preferred options for future investments, the NavVis VLX wearable mobile mapping device takes the lead (43%), followed by the handheld Leica BLK2Go (28%) and GeoSlam handheld products (26%). All these systems are user-friendly and can be used for a range of applications including as-built surveys



▲ Gexcel's B1 portable Lidar mapper is used to survey stockpile volumes at one of Europe's leading steel manufacturers in order to optimize its production process.

ABOUT THE SURVEY

The survey was developed by marketing specialists and industry experts, with input from four publications: *Geo Week*, *B M+*, *Lidar* and *GIM International*. The survey targeted industry professionals, selected through the networks of the publications and the commissioning company. Around 150 responses were received, from over 20 countries. Most respondents were surveying or laser scanning experts working for specialist contractors. For the purposes of the survey and this article, 'mobile mapping' refers to mapping with laser scanners (Lidar), supplemented by cameras, carried by the operator or trolley-mounted. These units are also known as portable or wearable mapping systems. 'Terrestrial mapping' refers to the use of static units mounted on tripods.



▲ Point cloud showing the Amphitheatre of Pompeii (top right).

MOBILE MAPPING IN PRACTICE: POMPEII TREE SURVEY

Besides being used to survey buildings and construction projects, mobile mapping systems have also been deployed in projects in underground mines, caves and – as this case illustrates – even for a tree survey at an important archaeological site in Italy.

When the city of Pompeii was buried by ash and pumice from the eruption of the Mount Vesuvius volcano in 79 AD, many buildings and artefacts were preserved. A large part of the site has been excavated and it now receives around 2.5 million visitors every year. When some of the trees on the site became affected by disease, it was decided to undertake a comprehensive tree survey. This had to be done without inconveniencing visitors to the site and without the use of an unmanned aerial vehicle (UAV or drone). The route to be surveyed was around 13km long and included narrow passageways, stairwells, hallways, tunnels, valleys and overgrown areas. Conventional surveying would have been impractical and a test with a terrestrial scanner proved that this approach was too time-consuming. A test with a handheld scanner was also unsatisfactory due to various limitations associated with the unit and its software.

Paolo Mistrangelo from the company Magellano Progetti suggested the use of a Kaarta Stencil 2-32 mobile mapping system combined with a GeoMax Zenith 40 GNSS receiver. After tests showed this combination to be effective, the survey was conducted and the whole route was surveyed in just six hours. After post-processing, the final dataset amounted to 650GB and comprised 5.8 billion points, accurate to 3cm.

The data was then analysed to map over 3,000 trees and identify their size and species. This information enables the tree maintenance team to monitor the health of the trees and plan their work effectively.

<https://www.kaarta.com/case-study/pompeii/>

and producing the digital twins which many customers are now looking for.

Among those respondents who are not currently using or planning to invest in mobile mapping systems, budget limitations are given as the main perceived barrier to adoption. Some respondents are concerned about the expense compared with the deliverables, the perceived lack of accuracy, and compatibility with existing workflows. Kathy Pattison of Kaarta comments, “Users do not like it when vendors only provide ‘walled gardens’ for processing and sharing their data. Open standards and flexibility of the use and sharing



▲ Kaarta’s Stencil 2-32 mobile mapping system was used to scan the Pompeii site.

of data will be important across many sectors. We expect better integration of point clouds and large datasets into existing software tools. Vector or surface-based CAD will not always be the end result; we could live in the point cloud rather than doing many conversions.”

MAKING LIFE EASIER

The reactions to a number of ‘agree/disagree’ statements in the survey indicate that a large majority of respondents expect mobile mapping to contribute significantly to construction quality, and to the internal workflows and growth of surveying businesses. Current and potential users of the mobile mapping systems are also keen to operate modern technology in order to maintain their competitive edge. Most respondents see significant potential for offering new services to their customers.

There are certainly opportunities for improved integration with data obtained by terrestrial mapping equipment and equipment mounted on drones and vehicles. “We expect to see integration of mobile mapping with other sensors – for example, combining SLAM-based systems with subsurface sensors (underground infrastructure, UXO), radiation sensors, chemical detection, thermal, etc.,” observes Kathy Pattison of Kaarta. Dr Stefan Hrabar, CEO and co-founder of Emesent agrees, commenting: “There are so many more areas where mobile mapping could be making life easier for those in the surveying industry. Combining mobile mapping with drone autonomy makes even more areas accessible, such as the underside of a bridge or an underground mine. Having a single unit which can be mounted on a backpack or a drone makes it possible to capture the inside and outside of a building with one unit, driving efficiencies for the customer. We also expect that the workflow will move towards a full digital model, for example the digitization of cities for civil planning or the digital mine.”

INDUSTRY REACTIONS TO THE FINDINGS

Zhaoxuan Li of GreenValley comments: “The results of the survey are in line with our perception of the market. The mobile mapping industry is still in the early stage of development. GreenValley International is taking extra steps towards paving the way for a smooth transition.” Charles Mackenzie of NavVis states: “We are very pleased with the results of this survey. It is good to see changed perceptions – a few years ago, most people thought mobile mapping was nice but not good enough for professional work.

As a result of the advances, mobile mapping devices are now becoming part of a surveyor’s standard toolkit, sometimes combined with existing technology or other new technology such as drones.” Prof Giorgio Vassena, CEO of Gexcel, agrees, saying: “The mobile mapping approach, for indoors especially, opens up new business opportunities with respect to those covered until now by terrestrial laser scanners or standard surveying technologies.”

GROWTH POTENTIAL

The survey shows that mobile mapping is already widely accepted and adopted in a number of markets, and many more respondents are planning to invest in the equipment in future. The barriers to entry will be reduced as the accuracy of equipment continues to improve and prices drop further. The resulting shorter payback period will make investments in equipment and the associated workflow more attractive. For some potential users, the current accuracy of mobile mapping

equipment may already be already high enough. Greater familiarity with the strengths and weaknesses of mobile mapping equipment is also likely to lead to greater acceptance and more widespread use. There is clearly still great potential for growth of mobile mapping systems, both in established and new markets. ◀

FURTHER READING

www.navvis.com/resources/survey/state-of-mobile-mapping

ABOUT THE AUTHOR



Hans van Bemmelen is a technical writer and translator serving the construction and engineering industries and has a special interest in surveying and UAS applications.

WHAT IS MOBILE MAPPING?

Mobile mapping is based on simultaneous localization and mapping (SLAM), developed in the 1980s for autonomous robots. The first vehicle-mounted systems were large and heavy. Portable or wearable systems are a more recent development, made possible by smaller and lighter sensors (Lidar scanners). For example, survey sponsor NavVis introduced its first system in 2015 and other suppliers entered the market in the same period.

Mobile mapping units use Lidar scanners to measure the distance between the unit and features in its environment. As the unit moves around in space, more and more data is captured and used to create a point cloud. While point clouds are valuable deliverables for surveying professionals, other specialists – such as architects and building services engineers – find them less easy to work with. Hence, mobile mapping solutions also incorporate cameras. The resulting deliverables are both geometrically accurate (point clouds from the laser scanners, where each point also has an RGB value) and easy to understand (panoramic photographs). Many systems can use control points to link the scans to conventional surveys.

The systems are generally supported by software suites which provide features such as:

- processing the point cloud
- interfacing with other software
- integration with data from terrestrial mapping (hybrid workflow)
- making the scans available in the cloud, accessed through a browser so the end-user does not need a powerful computer or a local copy of the full dataset.

Thanks to rapid advances in mobile mapping systems, the resolution and accuracy of the data is now sufficient for many surveying applications. The applications are hugely varied, not only in the construction industry, architecture, infrastructure and engineering, but also in search & rescue, video games and the film industry.

Mobile and terrestrial mapping compared

One advantage of mobile systems is that the operator can walk around a site and even go up and down stairs while scanning. Mobile systems support the fast and efficient delivery of accurate results (generally to within 10mm) without disrupting on-site operations. Another advantage is that there is often just one dataset, avoiding the need to align multiple datasets. Terrestrial scanning provides similar deliverables. Although it can produce a higher accuracy, the process is slower as the scanner needs to be relocated regularly, and the datasets for each scanning location must be merged. Some projects therefore benefit from a hybrid approach of mobile and terrestrial scanning.

Besides asking **GIM International** readers about their views on the current and future state of the geospatial industry, we also conducted a survey among the readers of our sister publication, **Hydro International**. The responses from hydrography professionals around the world generated a wave of interesting insights. Here, we have selected the most relevant findings for geospatial professionals. The full report is available on the **Hydro International** website.

AN ANALYSIS OF THE KEY FINDINGS OF THE ANNUAL INDUSTRY SURVEY

Hydrography: Growth Prospects on the Horizon

Every year, *Hydro International* conducts a survey to gather the latest insights into the status of the hydrographic industry. Based on the contributions of 500 respondents, this article represents an attempt to identify the most interesting trends, developments and views on the sector for the years ahead. To summarize the outcome in a single sentence: the shift towards an economy based on renewable energy and growing efforts to enhance nautical charting are two driving forces behind a business that will increasingly turn to autonomous, uncrewed surveying methods – with the lack of skilled personnel as the main constraint.



▲ The energy transition will require a lot more survey activities, in particular for offshore wind farms. Pictured here is the 'Patriot', one of the advanced survey vessels of Braveheart Marine – an international survey company based in Uuk, The Netherlands, with geophysical survey work in the offshore wind industry as one of their specialities. (Courtesy: Braveheart Marine)

COVID-19 LEAVES ITS MARK

We had hoped not to have to mention the COVID-19 pandemic again when writing our report on the outcome of our annual hydrographic industry survey. However, unless we bury our head in the sand, there is no escaping having to take a closer look at how the coronavirus crisis is affecting our businesses. To get a good picture of how the ongoing pandemic is impacting our profession, we had no choice but to repeat last year’s question on the effects that the pandemic is having. The trend shows a stable pattern: this question was answered in almost exactly the same way as a year ago: 14.7% of the survey participants rated the impact as very negative, 41.3% as somewhat negative, 30.4% experienced no impact, and about 13.5% even experienced a positive impact.

WORLD ECONOMIC OUTLOOK

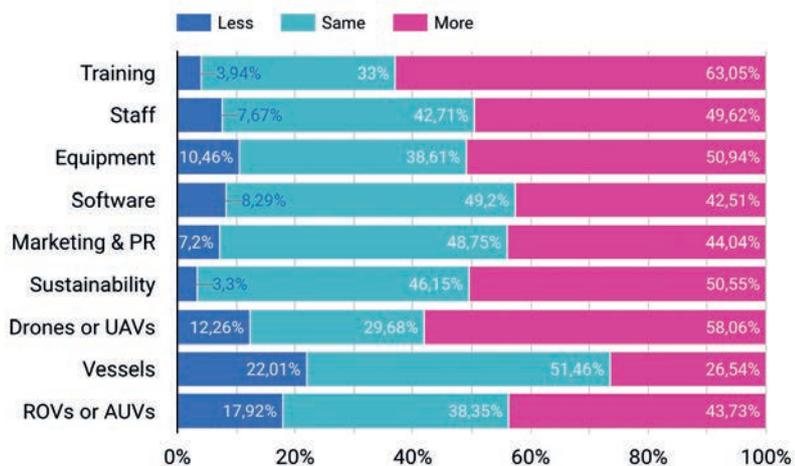
It is impossible to consider the status of the global economy separately from the coronavirus as, in most parts of the world, countries are combatting the pandemic not only for the sake of public health but also to keep the economy running. Lockdown measures – sometimes very strict – have led to an economic downturn or even standstill. Government interventions such as large-scale financial aid programmes have proved vital for many companies, and have also played a role in keeping many hydrographic businesses on track.

In October 2021, the International Monetary Fund (IMF) reported that the global economy is projected to grow by 4.9% in 2022: “The global economic recovery is continuing, even as the pandemic resurges. The fault lines opened up by COVID-19 are looking more persistent – near-term divergences are expected to leave lasting imprints on medium-term performance. Vaccine access and early policy support are the principal drivers of the gaps.”

THE MOOD IN THE HYDROGRAPHY SECTOR

It is interesting to see how investment readiness relates to the global economic situation, but this cannot be analysed without considering the predictions of industry professionals for the growth of their companies in 2022 and the next couple of

▲ Intended investments for 2022 sorted by average priority with a breakdown into smaller, equal or larger investment expectations compared to last year. It is worth noticing that organizations that indicated that they already use [] s are much more likely to plan to invest in [] s.



years. The findings give reason for optimism: no fewer than 20.9% of the respondents foresee more than 10% growth from 2022 onwards, while another 16.9% expect a 5–10% increase in their business, and 18.4% think growth between 2% and 5% is within reach. With 11.8% expecting neither growth nor decline, and 2.4% predicting a decline in growth, it is safe to say that optimism is high in the hydrography branch.

The following figures summarize the mood properly: although 63% of respondents expected growth for 2021, a whopping 82% expects growth for 2022. Furthermore, while 10% expected no growth but a decline for 2021, only 3% expect a decline for 2022. More respondents therefore expect growth compared with last year, and more of these respondents also expect higher growth than last year.

RENEWABLE ENERGY VERSUS OIL AND GAS

The transition towards a low-emission economy is widely considered as an important growth area for the hydrographic industry. For our survey, we made a division between ‘traditional’ renewables – wind farms – and upcoming renewables, such as tidal and wave energy. 15.7% of the respondents indicated that they regard wind farms as their number one growth area, whereas 10.8% consider tidal and wave energy to be a key opportunity. One survey participant said that the uptake of renewable energy sources offshore should improve prospects for major offshore projects. Many respondents also mentioned how governments across the globe are putting a

strong emphasis on investments in the blue economy. One of the respondents noted a downturn in oil and gas exploration, but this is being replaced by a strong increase in wind farm and cable route surveys.

With renewables so prominent in the spotlights, we could be tempted to lose sight of the importance of the oil and gas industry to the hydrographic surveying profession. However, they always have had and still have a harmonious relationship, as reflected by the outcome of the question concerning in which domains of hydrography our respondents work. 34.3% indicated that they work in the oil and gas industry. Although the share of fossil energy in the hydrographic sector may decline over the decades to come, it will still be a vital element for the years ahead. One of the comments can be summarized as follows: the survey demand for oil and gas will also increase due to sustainable prices above US\$60 per barrel. Another respondent expects an increase in the demand for oil and gas as a result of the post-COVID economic recovery. ◀

READ THE FULL STORY HERE:
www.hydro-international.com/content/article/hydrography-growth-prospects-on-the-horizon

3Dsurvey



The software suite of 3Dsurvey is designed by surveyors, for surveyors to fully serve the ambitious and unique needs of your team. It is made to empower you and help you succeed. The company's comprehensive digital surveying

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Applanix



As your business evolves in today's complex and dynamic world, you need a partner that can adapt with you and help orient your business for success. For nearly 30 years Applanix has offered complete and customized mobile mapping solutions while championing the technology revolution that allows pinpoint positioning under any conditions. Applanix is the standard for organizations that depend on accuracy and quality and who value experienced partners. The turnkey and OEM GNSS-inertial

solutions from Applanix are designed for pinpoint accuracy, efficiency and ease of use, supporting applications for aerial survey and remote sensing, land-based mobile mapping, marine survey and autonomous vehicles. Whether you require a complete airborne mapping solution for generating directly georeferenced orthophotos or real-time guidance of robotic vehicles, Applanix has the right solution. The company's engineers are recognized as industry-leading experts who understand every component of the systems

required to provide the most accurate positioning data from the air, land and sea. They are available to help orient you and your business to achieve the most reliable and accurate results. The company's R&D teams are constantly pushing the limits of what can be obtained through almost any sensor in ever-more challenging environments and developing software solutions that are practical, user-friendly and powerful enough to provide fast, efficient results. With Applanix, you can trust your position.

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CHC Navigation



CHC Navigation (CHCNAV) is a global technology provider of precision positioning solutions covering a wide range of professional applications, including land and airborne surveying, GNSS surveying, 3D data acquisition, precision agriculture, unmanned navigation and robotics, real-time GNSS infrastructure, and more. With a global presence in over 120 countries, and more than 1,500 employees,

CHC Navigation is today recognized as one of the fastest-growing companies in geomatics technologies. CHCNAV provides advanced GNSS positioning solutions to make surveying and engineering projects more productive. From post-processing geodetic GNSS receivers to the latest GNSS-IMU RTK smart antennas, the company delivers reliable and accurate positioning solutions covering a broad spectrum

of surveying and mapping applications such as construction surveys, geodetic and control surveys or engineering layout. CHCNAV's mobile mapping solutions include 3D Lidar scanners, terrestrial, marine and aerial drones, and advanced 3D point cloud algorithms for geospatial mass data acquisition, processing and maintenance.

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ComNav Technology

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ComNav Technology is dedicated to being an innovator and leader in high-precision GNSS technologies and applications. As of the end of 2021, ComNav Technology had sold its products and solutions in more than 120 countries, with a total quantity of more than one million units of modules (receivers) in over ten different industries, including land survey, machine control, UAV, UGV, deformation monitoring, personnel positioning, precision agriculture and marine. It is an R&D-driven company and nearly

half of its employees have extensive experience in high-precision GNSS or engineering. Owning more than 40 technology patents and more than 50 software copyrights, ComNav Technology continues to invest at least 20% of its annual revenue back into R&D every year to pursue the best of GNSS technologies and solutions for global users. ComNav Technology believes that quality, performance and reliability make a difference. Every ComNav Technology product is subject to strict quality control and has

been certified by international authoritative certification bodies. Every day, more than 400 employees are working at the 26,000m² ComNav Technology GNSS Industrial Park in Shanghai. With a dedicated team of people who are passionate about GNSS technology, ComNav Technology is committed to providing best-in-class positioning solutions for various applications to delight engineers and users with high-precision requirements.

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Gexcel

GEXCEL
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For more than 15 years, Gexcel has been developing and offering innovative software and solutions to make the work in surveying, Lidar data processing, monitoring and 3D control more competitive and effective. In addition to developing and designing software and systems to capture reality in 3D, the company provides sales, support, training and service directly from its Italian and Vietnamese offices or through its international network of resellers. Gexcel works with love and

passion, networking with other companies in the industry to provide users with the best experience in terms of product performance and usability. That is why the company designs software and systems that are fully compatible with sensors from leading laser scanner manufacturers (i.e. DotProduct, Faro, Geomax, RIEGL, Stonex, Teledyne, Topcon, Trimble, Velodyne and Z+F) and with several software platforms (i.e. Autodesk, 3DUserNetVISION, Cintoo Cloud, ClearEdge3D,

3DFlow, etc.). For the same reason, Gexcel is permanently involved in many international R&D project partnerships. Taking part in the innovation process is an ongoing commitment to the technological challenge and a source of improved product performance. Gexcel's main products are HERON (portable 3D mapping system), RECONSTRUCTOR (Lidar data processing software) and OPMMS (open pit mine monitoring system).

 gexcel.it  +39 30 6595001  sales@gexcel.it

GINTEC

GINTEC

Founded in 2013, GINTEC is a high-tech company which specializes in R&D and selling high-accuracy position information instruments and software. Meanwhile, GINTEC also offers professional technical services. Its products are widely applied in surveying, mapping and deformation monitoring industries. Adhering

to the concept of "Based on Integrity, Success in Quality", GINTEC is devoted to supplying high-quality, stable and reliable products for its customers. Thanks to years of hard work and integrity management, the business has spread to over 30 countries around the world, and the company has won strong appreciation

and trust from its clients and partners. In the future, the GINTEC team will continue to move forward and forge ahead through innovation. By further improving its products and services, the company continuously enhances the user experience to make surveying and deformation monitoring even more convenient and efficient.

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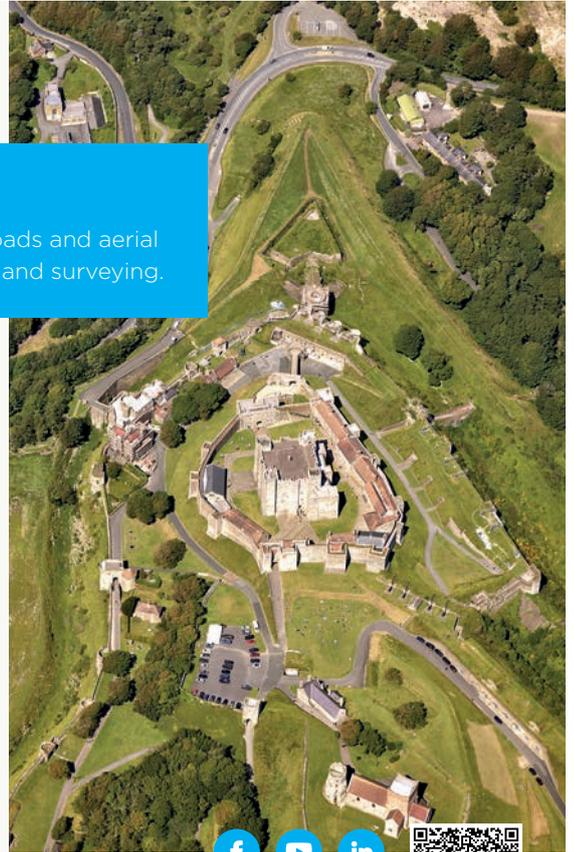
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Hexagon's Geosystems division enables industry-wide sustainable growth with its comprehensive portfolio of digital solutions designed to capture, measure and visualize the physical world – powering the data-driven transformation of industry ecosystems to enhance efficiencies,

reduce waste and cut emissions. Reality-capture technologies from Hexagon's Geosystems division create digital worlds from different views – from a single dimension between two walls, to 3D models of cities, infrastructures, utilities or even entire countries – providing

actionable information for sustainable planning and maintenance. These technologies are key in shaping production-related and people-related ecosystems to become increasingly connected and autonomous – enabling scalability and a sustainable future.

hexagon.com/divisions/geosystems [+41 71 727 3131](tel:+41717273131) info.hexagongeosystems.geo@hexagon.com

Hi-Target



Established in 1999, Hi-Target is the first professional high-precision surveying and mapping instrument brand to be successfully listed in China. Hi-Target produces a wide range of surveying equipment including GNSS receivers, CORS stations, total station, 3D laser scanners, GIS data collectors, UAV/

UAS and hydrographic products to provide complete commercial solutions for various industries. As a leading brand in the geospatial industry, Hi-Target invests heavily in research and development on top of collaborating with more than 100 universities globally to bring the latest positioning technology and innovation for

product development. Hi-Target will continue to develop products and technologies to meet the ever-increasing demands of the geospatial arena. Customers can count on Hi-Target to be the best in its field with professional solutions and superior services.

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OxTS



OxTS – Oxford Technical Solutions – offers a range of survey-grade INS navigation devices for measuring position and orientation by tightly combining measurements from GNSS receivers, inertial measurement units and

other aiding sources. The INS devices have a number of interfacing options to make sensor integration as straightforward as possible and the 6-axis navigation data offers surveyors the measurements they need for accurate mapping.

OxTS also offers Lidar georeferencing software for producing point clouds and precisely calibrating hardware setups using raw Lidar data.

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Phase One

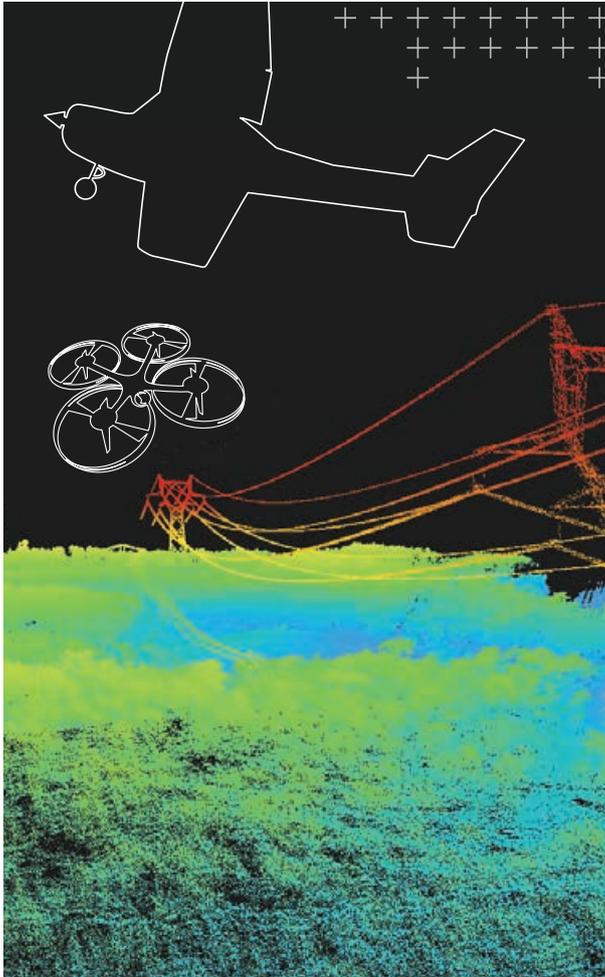


Phase One is a leading researcher, developer and manufacturer of medium-format and large-format digital cameras, software and imaging solutions. Founded in 1993, Phase One is a pioneer of digital photography. The company has developed core imaging technologies and a range of digital cameras and imaging modules. Phase One provides the world's highest image quality in terms of resolution, dynamic range,

colour fidelity and geometric accuracy. As such, Phase One has grown to become the leading provider of high-end imaging technology across many business segments. This includes both hardware and software for aerial mapping, industrial inspection and cultural heritage digitization, as well as serving the world's most demanding photographers. Based in Copenhagen, Denmark, and with regional offices

in New York, Denver, Cologne, Tel Aviv, Tokyo, Beijing, Shanghai and Hong Kong, Phase One nurtures long-term relationships with customers, technology partners and its global network of distributors, often playing the role of digital imaging partner to customers with special requirements. It is with this passion for service that Phase One continually exceeds expectations and drives the imaging industry forward.

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Premium Positioning



Founded in 2019, Premium Positioning offers its solutions in over 25 European countries serving thousands of clients. Backed by its partner CNH Industrial, the company delivers the best possible network and service. Premium Positioning's centimetre-accurate positioning services help customers to enhance the

efficiency of their surveying activities. The plug-and-play system enables any GNSS rover to automatically connect to the RTK premium network via virtually any mobile internet connection. Within the surveying industry, the network is commonly used in building and topographic survey, monitoring, cadastre

applications, boundary determination and mobile mapping. There is no need to set up base stations and waste time to get the right signals. Premium Positioning's services deliver RTK correction data on demand.

premium-positioning.com +31 850 606 338 info@premium-positioning.com

Racurs



Racurs has almost 30 years' history of success on the Russian and worldwide geoinformatics markets. Since its foundation in 1993, the company has been developing innovative mapping software for processing aerial, satellite and terrestrial imagery. The flagship product, PHOTOMOD, was one of the first digital photogrammetric systems on the market that was designed to work on off-the-shelf PCs. Today, PHOTOMOD is the most popular photogrammetric software in Russia and well

known all over the world. PHOTOMOD provides a closed production cycle, and involves the generation of many kinds of value-added products: digital maps, DEM, orthomosaics and 3D vectors, without the use of third-party solutions. The main Racurs business activities are:

- PHOTOMOD development and further integration into Russian and international markets
- Photogrammetric production services using

both airborne and satellite imagery

- R&D in the field of RSD processing software, methods and algorithms
- Remote-sensing data distribution in Russia and the CIS countries.

Racurs has been an ISPRS Sustaining Member since 1998 and a Special Committee I2AC Member since 2016. Racurs is also the organizer of the well-known International Scientific and Technical Conference 'From imagery to digital reality: ERS & Photogrammetry'.

racurs.ru +7 495 720 51 27 info@racurs.ru

RIEGL



RIEGL is a leading international provider of cutting-edge airborne, mobile, terrestrial, bathymetric and UAV-based laser scanning technology for a wide range of applications in surveying. In addition to the headquarters in Horn, Austria – where research & development as well as production are also located – RIEGL provides sales, support and service through its offices in Vienna and Salzburg, the RIEGL USA headquarters in Orlando, Florida, its subsidiaries

in Japan, China, Australia, Canada and the UK, and its worldwide network of distribution partners. RIEGL has been producing Lidar systems commercially for more than 40 years and focuses on pulsed time-of-flight laser radar technology in multiple wavelengths. RIEGL's core 'smart waveform' technologies provide pure digital Lidar signal processing, unique methodologies for resolving range ambiguities, multiple targets per laser shots, optimum distribution

of measurements, calibrated amplitudes and reflectance estimates, as well as the seamless integration and calibration of systems. RIEGL's various 3D scanners offer a wide array of performance characteristics. The professional advice of the RIEGL experts ensures that each customer finds the optimum solution for their specific applications. From initial purchase to system integration as well as training and support, RIEGL stands out as an industry leader.

rieggl.com +43 2982 4211 office@rieggl.com

SBG Systems



SBG Systems is a leading supplier of inertial motion sensing solutions, from miniature to high accuracy. Combined with cutting-edge calibration techniques and advanced embedded algorithms, SBG Systems' products are ideal solutions for surveying applications whether they are aerial, marine or land-based. The company has renewed its popular line of miniature inertial navigation systems with high-end functionalities. The Ellipse-D 3rd Generation now embeds a dual-frequency and quad constellation GNSS for centimetric positioning and higher orientation accuracy. This

lightweight dual-antenna RTK GNSS/INS brings high-end technology to the smallest factor, offering surveyors a cost-effective solution. SBG Systems' in-house full-featured post-processing software, Qinertia, gives access to offline RTK corrections and processes inertial and GNSS raw data to enhance accuracy and secure the survey. Qinertia has recently been upgraded to support third-party IMUs and all GNSS receivers, and now covers all surveying projects with its new GNSS licence to post-process both static and kinematic GNSS data. It also now includes a brand-new virtual base station (VBS) feature.

The VBS consists of computing a virtual network around projects in which position accuracy is maximized, homogeneous and as robust as for PPK short baselines. Surveyors can collect data far from base stations or over large areas, making it ideal for corridor mapping. SBG Systems also offers custom solutions to cover all surveying applications. For example, Quanta is a direct georeferencing solution that delivers precise orientation and centimetre-level position data in real time and for post-processing.

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Shanghai eSurvey GNSS Co., Ltd.



Founded in 2005, Shanghai e-Compass Science & Technology Co., Ltd. is affiliated with the Unistrong Group. Located in Shanghai, e-Compass is specialized in the surveying and GIS industry, integrating R&D, manufacturing

and sales. The main products include data acquisition and positioning equipment such as high-precision GNSS receivers, GIS data collectors, combined inertial navigation products, UAV positioning products and data application

solutions such as displacement monitoring systems, intelligent driving test systems and precision positioning service systems.

esurvey-gnss.com +86 21 54467213 info@esurvey-gnss.com

SingularXYZ



SingularXYZ Intelligent Technology Ltd. focuses on high-precision GNSS positioning, navigation and timing (PNT) technology. Its coverage extends to horizontal and vertical industries including geospatial information, precision agriculture, machine control, robotics, telecommunications, IoT and more.

SingularXYZ provides customers with reliable, stable and professional products, solutions and service. Based on its thorough understanding of user needs, mastery of positioning technology and the deep integration of various industries, SingularXYZ has seen the importance and innovative driving force of high-precision

positioning attributes in the digital world. The company is committed to popularizing precision and intelligence into all aspects of people's lives, contributing to building a digital, smart and efficient open society.

singularxyz.com +86 21 60835489 singularxyz@singularxyz.com

SOMAG AG Jena



SOMAG AG Jena is a worldwide operating specialist for high-precision gimbal systems. Since 2004, the company, consisting of hand-picked experts in the fields of electronics, mechanics and software, has been focused on the development of gyro stabilization mounts for data acquisition and surveillance applications. SOMAG is an ISO 9001-certified company and maintains a

strict quality control system. All products are assembled and tested with the highest precision at the headquarters in Jena, Germany, and at independent test facilities. The gimbal specialist works as an OEM partner to well-known camera and Lidar manufacturers but has always maintained its status as an independent supplier in the market. SOMAG's clients include commercial,

governmental and defence organizations as well as research institutions. The uniqueness of their customer projects and the multitude of different applications drives the SOMAG team to provide customized solutions and to improve performance with each newly developed device. This is why SOMAG's mounts set the pace for gyro stabilization devices worldwide.

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South



Every technological revolution holds the immense power to change the world. South, a leading national brand in the geoinformation industry, has created its own legacy over the past 30 years and presented a new picture of 'Mind in China'. In the air, the company helps to capture data of each part of the globe to digitize 3D spatial reconstruction; on the ground, it can position each location with high precision to digitize the living

environment; indoors, it is striving for SLAM mobile mapping to bring new innovation; and in the water, it supports the collection of highly accurate data for environmental protection and ecological balance. South is changing the methodology of information exchange and data capture, and getting intelligence into daily life. The company provides professional turnkey solutions for a variety of industries, creating greater value with

expertise and vision and making surveys much easier than before. South is striving to realize every incredible idea and make dreams come true. It sees every step as a new advancement of the geospatial industry, as a way of shaping history and creating new opportunities. South Group is committed to becoming and remaining a world-class survey equipment manufacturer and geoinformation solution provider.

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Teledyne Geospatial



Teledyne Optech and Teledyne CARIS have united to form the new Teledyne Geospatial, offering holistic solutions to seamlessly map land and sea through the integration of industry-leading Lidar sensors and world-renowned software workflows. This collaboration empowers customers with a competitive edge in mapping and delivering data products inside of one

complete workflow. Ease of collection and processing through to final products is enhanced with efficiency-driving AI noise-classifying algorithms and real-time quality control. CZMIL SuperNova is the latest topo-bathy solution from Teledyne Geospatial boasting the best depth performance and highest green laser point density in its class. Completed by CARIS Base

Editor software for seamless data processing capability and leveraging AI techniques for land/water discrimination and noise classification, the CZMIL SuperNova bathymetric solution effectively delivers on marketplace demands for efficient workflow processing. Discover how the new Teledyne Geospatial and its solutions can effectively solve your problems.

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TI Asahi



TI Asahi was established in 2009 and inherited the business of manufacturing Pentax-branded surveying instruments. The origin of these dates back to 1933, when Fuji Seisakusho started producing surveying products in Japan. As a leading company in developing and manufacturing state-of-the-art surveying instruments, TI Asahi has been continuously

introducing various high-precision and high-quality products such as optical levels, total stations, GNSS receivers and 3D scanning systems. These have been used and appreciated by countless professionals in various fields of surveying and construction worldwide. The company's mission is to develop and provide products that fully meet surveyors' needs by

focusing on true performance. At TI Asahi, they believe the products they provide can offer substantial solutions to both technological and economical obstacles. They acknowledge it is essential that they continuously learn and develop their products and practices to match customers' needs.

pentaxsurveying.com/en +81 487930118 international@tiasahi.com

Topcon



Topcon Positioning Group designs, manufactures and distributes precision measurement and workflow solutions for the global construction, geospatial and agriculture markets. Since being founded in 1994, Topcon has worked to provide cutting-edge technology across these sectors, helping to enhance accuracy, efficiency and productivity. Topcon provides a wide range of

solutions across these industries, from its precise GT-1200 and GT-600 robotic total stations, to its state-of-the-art workflow management software, MAGNET. Headquartered in Livermore (California), USA, the company operates throughout North America, Europe, the Middle East and Africa, and has just opened a new European distribution centre in Zoetermeer, the Netherlands. The company also

owns a variety of product families operating across these regions, including Sokkia, Tierra, Digi-Star, RDS Technology and NORAC, alongside having a worldwide network of trusted distribution partners. Across the globe, Topcon offers a comprehensive range of leading technologies and customer support, always striving to provide the right solution for every project.

topconpositioning.com +1 925 245 8300 infota@topcon.com

Vexcel Imaging



Developing cutting-edge digital aerial cameras and photogrammetric processing software with constant product upgrades and world-class support has made Vexcel Imaging a market leader in the geospatial arena. The industry-leading UltraCam aerial sensor portfolio covers all applications in airborne photogrammetry, from nadir to oblique to wide-area data collection. Processing of the UltraCam data is handled by the UltraMap photogrammetric software suite

that offers a processing workflow for highly automated generation of exceptional-quality point clouds, DSMs, DTMs, ortho imagery and 3D-textured TINs. This end-to-end technology is the basis for Vexcel's cloud-based aerial image library providing organizations with location-based insight and intelligence. Industry-leading UltraCam sensors provide up-to-date high-resolution vertical and oblique imagery along with other digital representations of the world,

and precision geometry enabling AI and machine learning. The Vexcel Data Program (VDP) allows businesses and organizations to make better strategic decisions through intelligent imagery to uncover crucial location insights. VDP is already powering the Geospatial Insurance Consortium (GIC), an initiative launched by the National Insurance Crime Bureau (NICB) to provide its 1,100 members with best-of-breed aerial pre-disaster and post-disaster imagery.

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