VOLUME 13 ISSUE 1

LIDAR MAGAZINE

JAN/FEB 2023

SPECIAL ISSUE

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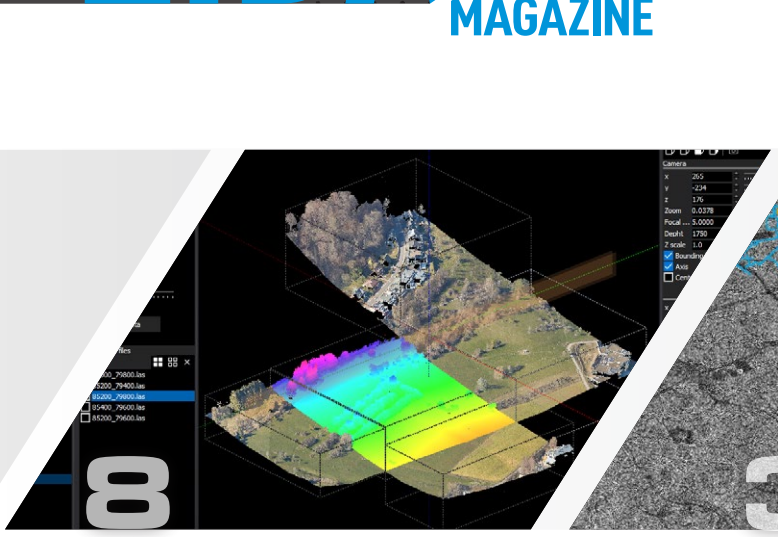
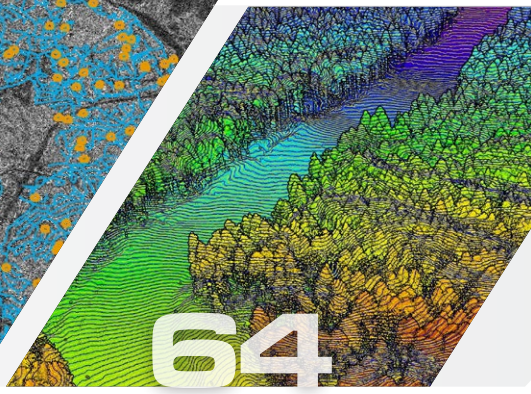
ADVANCED NAVIGATION

LIDAR MAGAZINE





IN THIS ISSUE

COLUMN

◀ ON THE COVER

Airborne lidar scan of the Don Plant located in Pocatello, Idaho. Image courtesy of Aero-Graphics, Inc.

SPECIAL SECTION

LIDAR To Go!

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DR. A. STEWART WALKER

A Lidar New Year!

You may read this in a copy of the magazine that you picked up at the Geo Week conferences in Denver on 13-15 February 2022. Be inspired by growth of the event and its vibrant exhibition, with more than 175 companies, most of which are in UAVs, cameras, lidar, photogrammetry, software and geospatial services. Exciting, vibrant, expanding!

This editorial, however, was written when a less vaunted event was in progress. The Point Cloud Processing Workshop took place in Stuttgart on 26-27 January, organized jointly by the University of Stuttgart and EuroSDR. The program featured speakers entirely from the European mainland, giving a stimulating series of updates and insights, from the academic world, government agencies and research institutes, and software suppliers. AI's central position in modern lidar was confirmed in one session, "Semantic Segmentation—State-of-the-art and Generation of Training Data." I'm intrigued by the title of one of the papers therein, "Casting the paid crowd and the machine into a hybrid intelligence system for 3d point cloud segmentation," by Michael Kölle, who is a co-author of an article that will be in the next issue of this magazine. Deep learning, hard to understand though it may be, actually works and is penetrating more and more areas of life; lidar processing is on a springboard, ready to jump to much higher levels of automation in the extraction of information from point clouds. We have become accustomed to impressive improvements in lidar hardware over the years—both automotive and airborne lidar are testament to this—but deep learning will not disappoint as it becomes standard in off-the-shelf-software. The proceedings of this meeting will be essential reading.

We bring you three articles in this issue that are important in different ways. Following our trip to Germany last fall, we have tried to lay to rest the sad story of Martin Isenburg and move the spotlight to focus on the resurrection of his company, rapidlasso GmbH. We hope to have preserved Martin's legacy while at the same time highlighting the tragedy of mental illness. Equally, Martin's customers and prospects will want to know that the products are not only available but also evolving.

Secondly, our periodic peregrinations into radar have unearthed a company in San Diego, which uses L-band to detect water leaks. Given the scarcity of water in vast areas of the globe and the potential to avoid tragedy where water leaks are a portent of failure in dams or seawalls, this matters. The article also contains insights into managing a startup, i.e. creating a sustainable business while working on perfection of the underlying idea at the same time.

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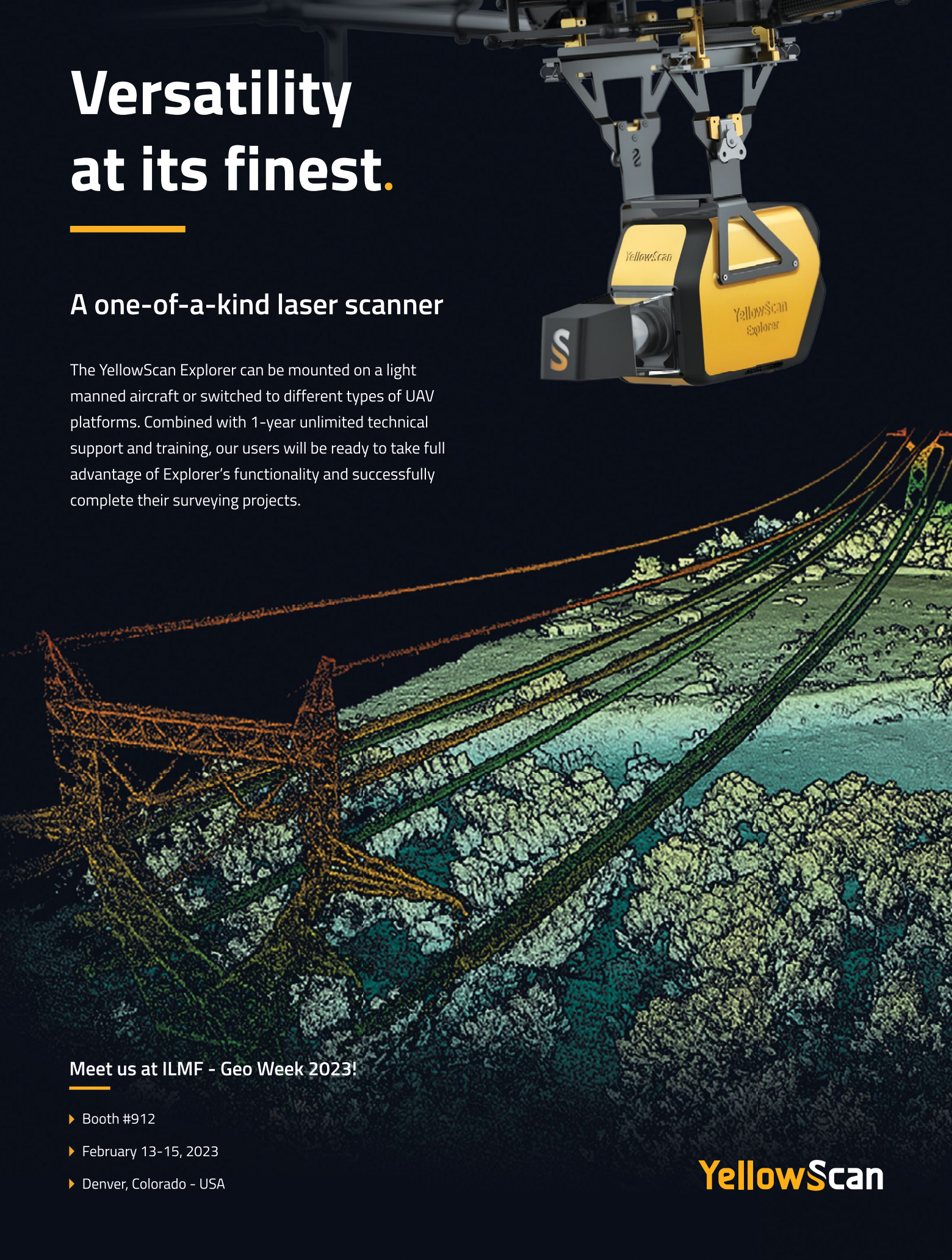

Meet us at ILMF - Geo Week 2023!

- Booth #912
- February 13-15, 2023
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YellowScan

Lastly, we feature a Romanian survey company using a UAV system with both lidar and cameras from a Swiss company to map a Romanian ski resort and its environs for planning purposes. The lesson here is that we Americans, while proud of the incredible lidar integrators successfully doing business in the US, must be conscious that there's a lot going on elsewhere in the world. The YellowScan event last year was a vivid example[1].

I've lamented in previous editorials the lack of space to bring to you gems from the recent literature or online. Let's squeeze in a few.

Our world today is burdened by conflict and warfare. Ukraine is one of many. Some wars, nevertheless, come to an end, but the work of recovery is daunting. Mine-clearance is one of the riskiest parts, but without it normal civilian life, especially agriculture, cannot recommence safely. It's heartening to know that the HALO Trust, a British mine-clearance charity, has been using UAVs equipped with thermal sensors and lidar to detect landmines in Angola[2]. Other sophisticated approaches, for example ground-penetrating radar, are available too and it is heartening that technologies used to generate geographic information have immediate, successful humanitarian applications too.

Do you sometimes become irritated when starting to read a paper because the authors cite far too many references just in the introduction? Are they showing off their erudition, their mastery of the field, do they want to ensure they mention works by people who may be influential in their future funding, or is that too cynical a view? Perhaps. Our ability to create knowledge and store it for future generations seems boundless: "The more knowledge humans have, the longer it takes a budding researcher to get to the frontier, and thus to push things forward."[3] Ideas are becoming harder to find. Different models for funding research, therefore, could be the answer. DARPA could be a clue. The article from which the above quotation was drawn applies not specifically to geospatial research but all across the sciences. Worth pondering.

Let's end by moving from this worrying, but rather philosophical thought about science to recent technological developments. Most of us have heard about the merger of Velodyne and Ouster[4]. The CEO of the new operation will be Angus Pacala—you've read his thoughts on these pages![5] Meanwhile, a major competitor, Luminar, has announced that the Volvo EX90 electric SUV is the latest car to have its lidar fitted as standard, claiming a range of 600 m[6]. These firms—and their competitors—could be helped in the future by researchers at the Fraunhofer Institute for High Frequency Physics and Radar Techniques, who have announced a new approach to combining multiple sensors into a car's headlight[7]. Enabling lidar and radar to follow the same path as the LED light is no mean feat. Although we go to our traditional airborne lidar suppliers for high-end, high-accuracy, low-noise UAV-lidar systems, we benefit enormously from the opening up by the automotive lidar firms of this geospatial market space.

Thus we're well into 2023 and lidar seems poised to make great advances. This year the remarkable USGS 3DEP program will comfortably exceed 90% in its national coverage, a triumph not only of securing funds but of managing a host of partners all committed to using rapidly changing technologies to best advantage. We're excited about the next generation: "The 3D National Topography Model (3DNTM) is a new initiative that updates and integrates USGS elevation and hydrography data, and the relationships between them, into a 3D model to deliver higher-quality data and support improved geospatial analysis."[8] At Geo Week, at events further into the calendar, online and in the daily life of suppliers, services companies and end users, lidar will become more pervasive. Thank you for reading *LIDAR Magazine*. It's an honor to bring you news about how our technology matters.

A. Stewart Walker // Managing Editor

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3 Anon, 2022b. In search of a bright light: billion-dollar experiments aim to end a period of scientific stagnation, *The Economist*, 445(9319): 72, 29 October 2022.
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5 Walker, A.S., 2022. Digital lidar for everything, *LIDAR Magazine*, 12(3): 4-16, Fall 2022.
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LIDAR LEADERS

LIDAR LEADER AWARDS

BROUGHT TO YOU BY
ILMF & LIDAR MAGAZINE

In conjunction with GeoWeek, we've opted to celebrate the accomplishments of leaders in our field at the Lidar Leader Awards, a joint initiative of LIDAR Magazine and the organizers of the International LiDAR Mapping Forum (ILMF). Over the pages that follow, we've highlighted some of the finalists from each award category. As you'll find, the nominations embody a galaxy of lidar talent. All winners will be provided the opportunity to highlight their perspectives in an upcoming edition of the magazine.

Five categories were offered this year:

Outstanding Personal Achievement in Lidar

Outstanding Team Achievement in Lidar *(2-99 members)*

Outstanding Enterprise Achievement in Lidar *(groups of 100+)*

Outstanding Innovation in Lidar

This category was created to honor recent projects or products that appear to be ground-breaking.

Outstanding University Achievement in Lidar

This category is open to all universities, students and teams within the university, who must demonstrate an exceptional achievement within the realm of lidar technology.

Editor's note: The text that follows has been excerpted from original nominations and in no way defines the views or opinions of the award committee, the organizers of ILMF or LIDAR Magazine. Some text has been edited for clarity and length.

Congratulations to the following finalists...

Personal Achievement in Lidar
Dr. Qassim Abdullah

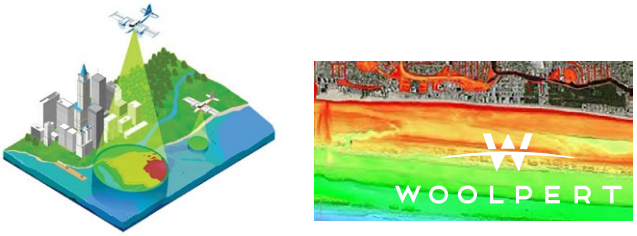
Dr. Abdullah is an accomplished scientist with more than 40 years of combined industrial, research and development, and academic experience in analytical photogrammetry, digital remote sensing, and civil and surveying engineering. He pioneered early high-altitude lidar systems and helped introduce the geospatial community to single photon lidar (SPL). Most recently, Dr. Abdullah has been involved in establishing specifications and best practices for lidar obtained via unmanned aircraft systems (UAS). Currently, Dr. Abdullah is the chief scientist for Woolpert and helps lead the firm's expansive research and development team. He is responsible for designing and managing strategic programs to develop and implement new remote sensing technologies.

Outstanding Enterprise Achievement
Cepton, Inc.

In February 2022, Cepton successfully completed its IPO process and became one of the youngest lidar companies to go public. Cepton also achieved key milestones to deliver on the industry's largest ADAS lidar series production program, currently shipping D-samples of its Vista®-X90 lidar to General Motors. This will result in an unprecedented lidar deployment across multiple vehicle models, beyond the luxury class. Cepton is also shipping Nova, the world's first miniature, wide field of vide near-range lidar. Over the past year, Cepton has also invested in lidar education across multiple sectors as a member of the Lidar Coalition and the Automotive Safety Council.

Team Achievement in Lidar
The Advanced Geomatics team at Colorado Springs Utilities

The Advanced Geomatics team at Colorado Springs Utilities has spent the last 11 years implementing new lidar tools, processes, and strategies. They have implemented the use of aerial lidar for their complete service territory to help with ground surfaces, elevation modeling, transmission line surveys, and slope analysis. In addition, they have implemented terrestrial scanners to collect information on utility vaults, substation rendering, wastewater lift stations, water tank inspections, and more. This information is frequently used to create 3D models of the collected features. The team has also implemented a mobile mapping lidar solution to help with corridor mapping for water and gas main replacement and design.



Outstanding Commercial Innovation
Bathymetric Unmanned Littoral LiDar for Operational GEOINT (BULLDOG) by Woolpert

BULLDOG is a multispectral, multichannel, topobathymetric lidar system. The patented lidar system maximizes the use of three different wavelengths of light—532, 647 and 1064 nm—by distributing them into five distinct detector channels designed for shallow water, deep water, Raman and infrared. The infrared light is further split into a linear mode and Geiger-mode channel utilized specifically for the sea surface and topographic measurements. BULLDOG can collect over a half-mile-wide swath of data at 10,000 feet in an aircraft traveling at 160 knots. At that altitude, flying in a straight line, BULLDOG can collect approximately 100 square kilometers of coastline every 40 minutes.

Tools for a Better Tomorrow

The Lidar Legacy of Martin Isenburg

Founded in 1952 20 km east of San Francisco Bay and 20 km northeast of Silicon Valley, Lawrence Livermore National Laboratory (LLNL) applies science and technology to make the world a safer place. Its defining responsibility is ensuring the safety, security and reliability of the nation's nuclear deterrent[1]. Often in the news, it recently caused a worldwide stir with an announcement from its National Ignition Facility about a new approach to nuclear fusion[2]. It's equally apparent that the scientists and engineers who form the backbone of LLNL are the very best—the intellectual air is rarified indeed. To work at LLNL, then, would be a feather in any scientist's or engineer's cap.

Martin coding hard in Sámara, December 2019.

Martin Isenburg's motivation for joining LLNL, however, was much simpler: he loved the Bay Area and wanted to stay. It was summer 2007, he was 35, holding a MSc from the University of British Columbia, a PhD from the University of North Carolina Chapel Hill and a freshly minted post-doc from the University of California Berkeley. An extraordinarily brilliant scientist, he received job offers from all over the world, including the National University of Singapore, Hong Kong University, and the Environmental Systems Research Institute (ESRI). Martin had been a nomad all his life, but he fell in love with the Bay Area while he was a post-doc at Berkeley. He felt so comfortable in the Bay Area that he wanted to settle down and stay there for the rest of his life.

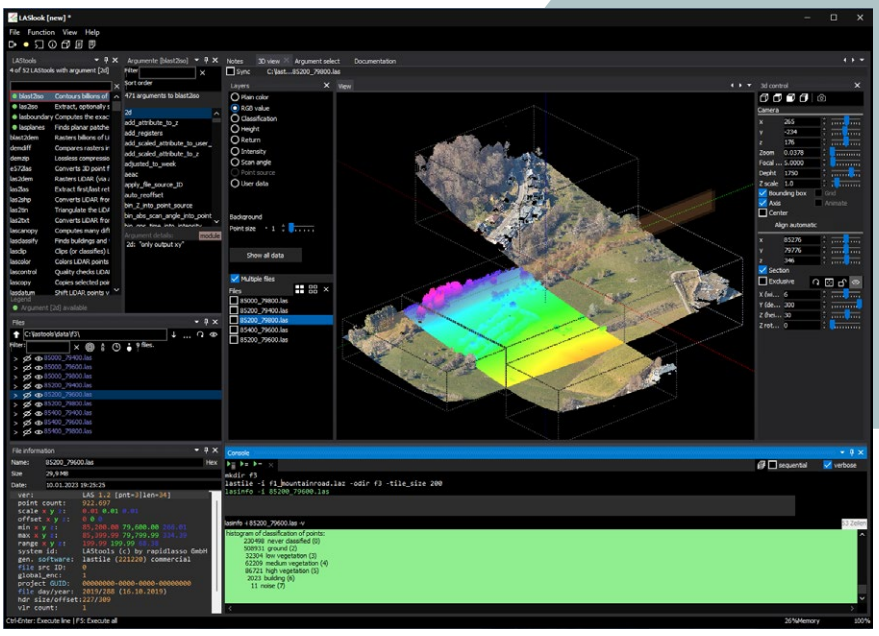
Home to the world's most powerful laser, LLNL was honing the cutting-edge

1 https://www.llnl.gov/about
2 https://www.llnl.gov/news/national-ignition-facility-achieves-fusion-ignition

BY ALLEN **CHEVES**, SILKE **KÄMMERER** AND STEWART **WALKER**

of photonics science. Martin was employed as a computer scientist from July 2007 to July 2010. His duties included: parallel mesh smoothing with Mesquite software; surveillance with the Constant Hawk airborne intelligence system; streaming and parallel ghost node generation; and land-mine detection using lidar and radar.

Martin's grand vision for streaming geometric processing had begun to coalesce on the heels of his PhD studies at the University of North Carolina, which led to work with Jonathan Shewchuk at Berkeley[3]. The duo pursued technical feats such as "streaming Delaunay" capabilities[4], synonymous with the famously efficient triangulation method that would ultimately underpin Martin's commercial solutions, namely "blast2DEM", part of the LAStools package. Martin's idea, even at that early stage, was to create lidar-processing tools that would enable rapid transition of lidar from raw data to deliverable products, all on a vanilla desktop or laptop. One of the best known components remains the compression of LAS lidar data files into LAZ, which is fast and saves remarkable amounts of storage space[5]. Indeed, even before joining LLNL, Martin had taken his code and tools, zipped them into a folder called LAStools, and put it on his website for others to use. Later he added the LAZ compression.



rapidlasso announced a graphical user interface for the software in June 2022, the most significant development since Jochen came on board.

The dark turn

Martin's first two years at LLNL went well. He bought an old farmhouse in downtown Livermore where he grew vegetables and raised chickens.

Early in 2010 however, he was afflicted with a severe bipolar disorder, which dogged him throughout his days. The predisposition to this was genetic: his mother had suffered from this insidious disease for decades before she died in 2007. Martin was enveloped by a strong manic episode that lasted several months. Owing to his untreated disorder, he began behaving strangely in society and on social media. He sent long, bizarre, and sometimes offensive emails to many recipients, spreading paranoid accusations and alienating his co-workers and many of his friends. He was out of control and acting like a different person.

A giant enlargement of this pixelated image of Dr. Martin Isenburg was used as the backdrop in the rapidlasso booth at the Intergeo expo and conference, Essen, Germany, 10-12 October 2022.

3 https://people.eecs.berkeley.edu/~jrs/martin/

4 Isenburg, M., Y. Liu, J. Shewchuk and J. Snoeyink, 2006. Streaming computations of Delaunay triangulations, SIGGRAPH 2006, 8 pp.

5 Isenburg, M, 2013. LASzip: rapid compression of lidar data, *Photogrammetric Engineering & Remote Sensing*, 79(2): 209-217.

Martin's house in downtown Livermore. He loved this house—the first home he had owned—and it was one of the reasons for preferring the LLNL position to the others he was offered.

Martin's family, especially his father and sister, as well as many of his friends, recognized the signs of his growing insanity and tried everything they could to help him, but his mania was simply too strong—and Martin was too smart: he successfully tricked the doctors every time he was hospitalized. He refused treatment, because he did not realize that he was ill, which is characteristic of mania.

Owing to his odd behavior, Martin became increasingly unpopular. He verbally abused people and business owners in Livermore and aggressively solicited funding for his project, obsessively describing his plans to build an urban chicken farm in which he would use laser-scanning and surface reconstruction algorithms to transmit online, 24-hours per day, three-dimensional live animations of his chickens in action to the world—"laser chickens". Irritated by his behavior and unpredictability, people became increasingly afraid of him, though he never harmed a fly.

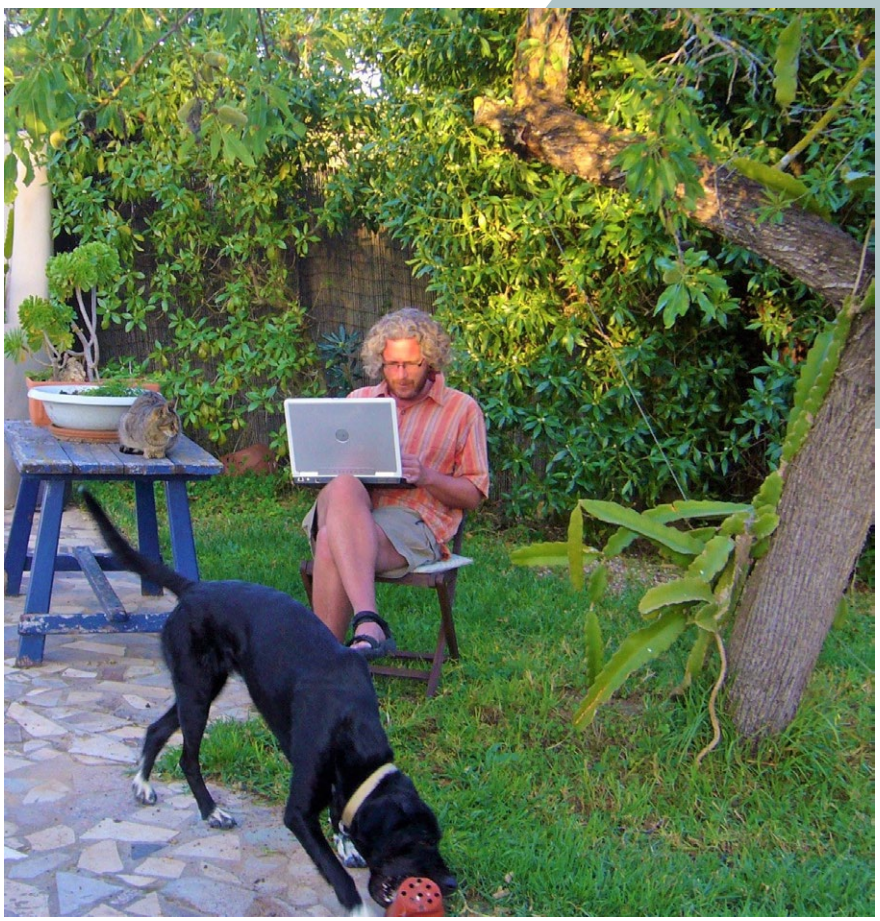
When Martin's mania reached its peak in spring 2010, a chain of coincidences connected him to Silke Kämmerer, the current CEO of rapidlasso. Martin sent numerous friend requests to people on Facebook. One of these inquiries reached Silke while on a business trip in Turkmenistan. Silke explained: "I accidentally accepted Martin's request, mistaking him for someone else. We're from neighboring villages in Germany, so we had some common acquaintances, including one who joined the Turkmenistan journey. I soon realized that I didn't know Martin. He was frequently posting about his obsessive ideas on Facebook. He seemed to be smart, but his demeanor was weird. However, I didn't kick him out and sometimes even communicated with him. To me personally he was always very respectful."

In July 2010, Martin was arrested on two occasions. The first was bizarre. While he was sitting outside a church in which his ex-girlfriend was attending a ceremony, the police issued him with a restraining order, then instantly arrested him for not complying with it! He bailed himself out, then was subject to a citizen's arrest (a Livermore woman

Happy times. Martin and Silke outside Martin's home in Sommerhausen, Bavaria, after the formation of rapidlasso GmbH

Martin's avatar, the "laser chicken" he created in his first mania in 2010. It became quite famous. He gave laser-chicken talks on YouTube* and in a conference, and even printed business cards.

** https://www.youtube.com/watch?v=t4DHKmpR0JY*



Silke was in Ibiza in February 2011, staying in a finca with elements of a communal lifestyle such as group dinners, while she pursued a Spanish language course. Martin followed along, to escape the dreich German winter. He sat in this corner every afternoon to catch the last rays before the sun went down, programming LAStools.

accused him of "stalking", though no evidence was ever produced). A few days before his arrest, he had contacted Silke, stating that the police were "hunting" him, and asked her if she would come to "rescue" him if he was arrested. Silke ignored this, thinking he was paranoid. Some weeks later, while she was in Java, a woman reached out to her, introduced herself as a farmer from Washington State, said that Martin had been arrested and asked her if she was in contact with his family. Silke wasn't close to Martin or his family in any way, but the story became increasingly odd, so she was triggered to find out what was going on. She spent some hours researching about Martin's arrest and was surprised that all information about this was available on the Internet. She summed up, "I was torn between 'he is a stranger, it's none of my business' and 'he is a guy from my neighborhood, I need to help'"[6].

Silke liked challenges, decided to check it out, returned to Germany and reached out to Martin's father and sister, who explained about Martin's mania and their previous efforts. Next day she jumped on a plane to San Francisco, drove to the Santa Rita Jail, and stood in line for six hours to get a 10-minute slot to talk to Martin, who was undoubtedly at the lowest point of his life. He looked desperate, sitting behind a bulletproof window, so they had to talk on a phone. Silke hired some of the most qualified attorneys in the Bay Area and Martin granted her full power-of-attorney. She took time off from work and university, moved into Martin's house, managed his possessions and began to resolve the problems that Martin, in his mania, had caused in many ways.

6 Silke's more personal thoughts about Martin were summarized in her address after receiving, on his behalf, the Lidar Leader Award for Outstanding Personal Achievement in Lidar in 2022: https://lidarmag.com/2023/01/18/the-martin-i-knew/.

It transpired that Martin had never done anything but talk, so the criminal charges against him were dropped. He never hurt anyone; he simply annoyed people by spreading his unusual ideas during his mania, and some of them had had enough. Since LLNL had fired him, Martin lost his immigration status while in custody, so he was deported to Germany for overstaying his visa in November 2010. In addition, he received a 10-year travel ban. These circumstances were unfortunate, and Martin suffered terribly. After his arrival in Germany, he was extremely depressed.

Return home—charting the course

Martin's return home was riddled with desolation, yet it marked the beginning of a prolific phase, lasting more than ten years, of both software and commercial development of his ideas. He realized that he had to make a living now he was back at the family home in Sommerhausen and wisely decided to leverage his lidar expertise. Programming LAStools kept him alive—he was hardly interested in anything else. With the progress of LAStools, Martin's condition stabilized, and he regained perspective. The founding of rapidlasso GmbH in September 2012 marked a turning point. From then on, there was only one direction: forward. The company was registered in Munich, because funding for an ongoing project came from the German Aerospace Center, DLR[7].

Martin expanded rapidlasso into a successful company and enjoyed himself hugely, writing code and giving lectures, seminars and training courses across the globe, non-disposable coffee cup always

The first supper. Martin and Silke toast the formation of the new company by attending the Sommerhausen wine festival in 2012. This annual event—not a bacchanal but a celebration of fine food and wine—takes place every autumn. My goodness, that's a strong pour!

Sámara, September 2018. Waiting for Martin to SUP coffee...

to hand. Martin generously shared his knowledge and helped many young lidar scientists and users to understand lidar in all its aspects. Through his LASmoons program, he gave access to the full version of LAStools to many significant projects.

All good things come to an end

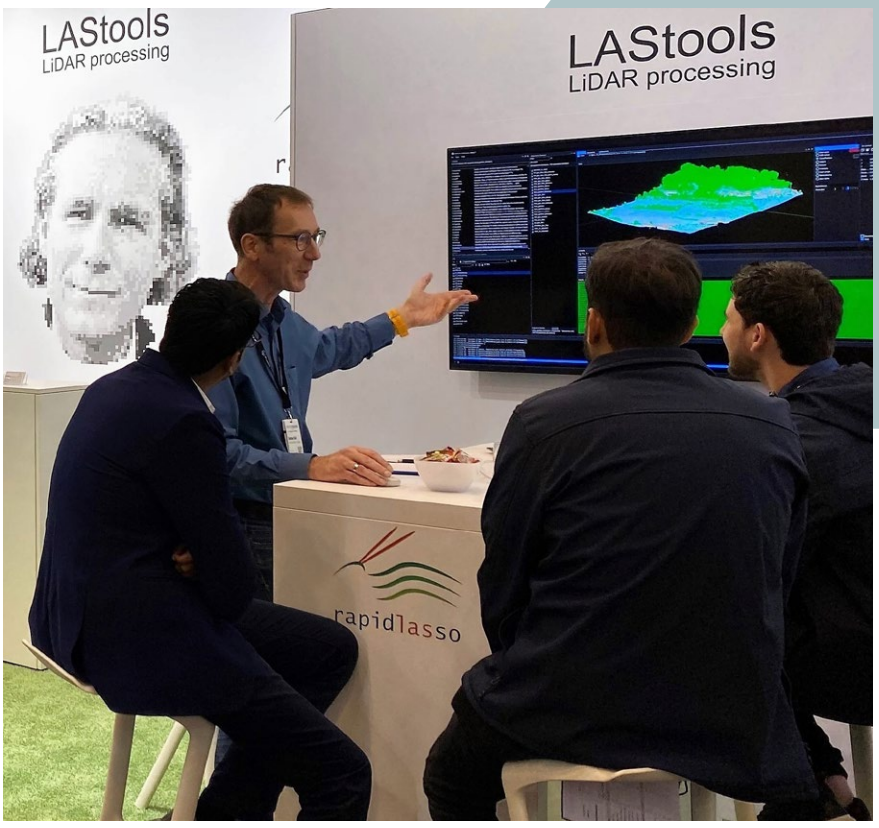
Martins's craving for the sun led him to buy a vacation home in Sámara, on the Pacific coast of Costa Rica, in 2016, where he spent his vacations writing code in the mornings and surfing in the afternoons. In March 2020, during one of these vacations, covid hit. Within a few days, the lockdown caused a spectacular recurrence of Martin's mental health issues of ten years previously and it appears that he ceased to take his essential medications. He bought a large lot in Sámara, raised chickens and revived the idea of his "laser chicken" online project from ten years before. Again, he broke with family and friends. Again, bizarre behaviors and communications occasioned pushback from customers and contacts not only in the Sámara community around his vacation home, but also in the wider lidar world. When Martin's manic episode suddenly ended in summer 2021, he fell into a deep depression, which is characteristic of the

7 Deutsches Zentrum für Lauf- und Raumfahrt.

course of bipolar disorders. Realizing how his mental illness had once again wrecked his life, he felt threatened and tied down by his own body. He lost all hope and ended the pain.

His family in Germany, from whom Martin did not accept any help during his mania, as had happened 10 years earlier, was completely in shock after receiving the terrible news. In addition to the sadness and helplessness over Martin's death, there was a mountain of tasks to be faced. Customers whose licenses were about to expire sought contact via all possible channels and wanted to know what was going to happen. Silke remembers those days: "We sat in Martin's father's house in despair, discussing how to proceed. It was clear to everybody that Martin had left a tremendous legacy and there was a great sense of responsibility towards customers and users. However, it was also clear that Martin's family would not continue to run the company. When I finally said I didn't know how, but I would do it, I heard the heavy stone rolling away. This process had elements of déjà vu compared to 11 years ago, but the difference was that this time it was terrifyingly final."

Silke had endured a difficult time herself. Her beloved father, whose carer she had been for two and a half years, had died of leukemia shortly before Martin's death. In addition, she was a newcomer to the lidar industry and had to start from scratch. Martin had left no instructions—there were only a few folders of old receipts together with Martin's computers and hard drives, which Martin's father and his wife checked for relevant content. Fortunately, Silke's partner, a successful entrepreneur with an extensive network, was able to pull a contact person out of the hat for almost every task. Another source of support in those early days was Howard Butler. Silke elaborated: "Since it was the only name I could remember from Martin's professional contacts of ten years ago, I googled Howard and contacted him shortly after Martin's death. Having no idea about lidar made me feel like an idiot in the presence of specialists, but Howard patiently answered all my questions. Fortunately, I learn quickly and I haven't doubted or regretted my decision for a second. It would be a shame not to continue Martin's impressive legacy. Unfortunately, that's the last thing I can do for him."



Jochen Keil, senior software engineer, explains rapidlasso software and new features to customers on the company's booth at the Intergeo trade show and conference, Essen, Germany, October 2022.

rapidlasso today—fast tools to catch reality

Howard Butler explained[8], "By constructing out-of-core techniques for processing large geometry data collections, Martin was able to demonstrate memory-efficient tools to chew through the oncoming rush of lidar data captures beginning to appear for natural science and morphological uses."

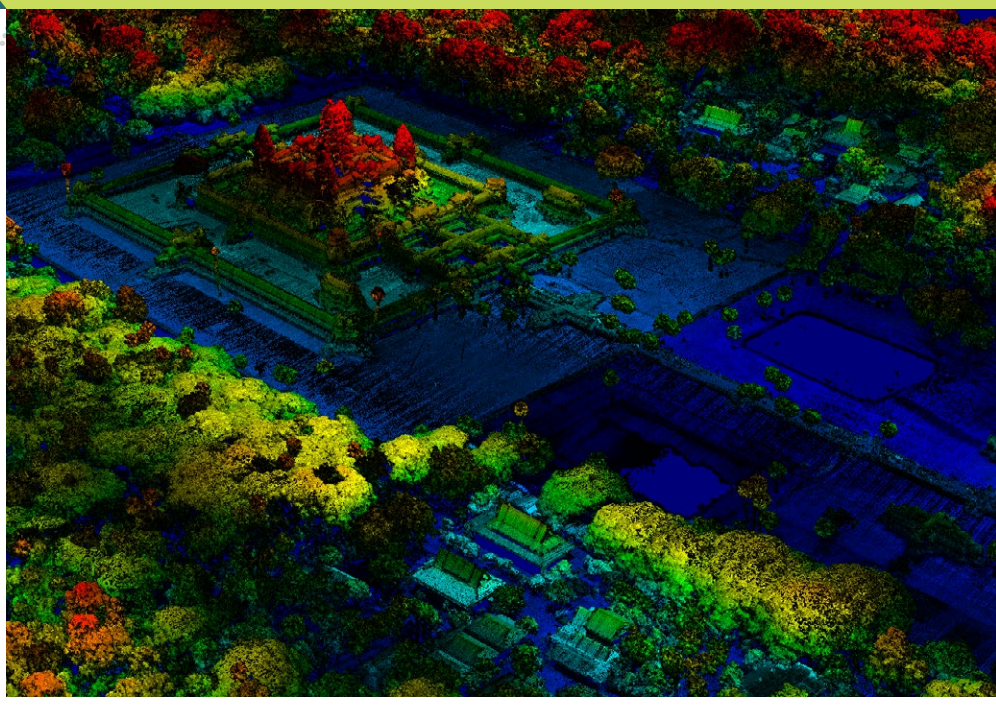
The rapidlasso portfolio consists of three product lines, LAStools, BLAST and LASzip.

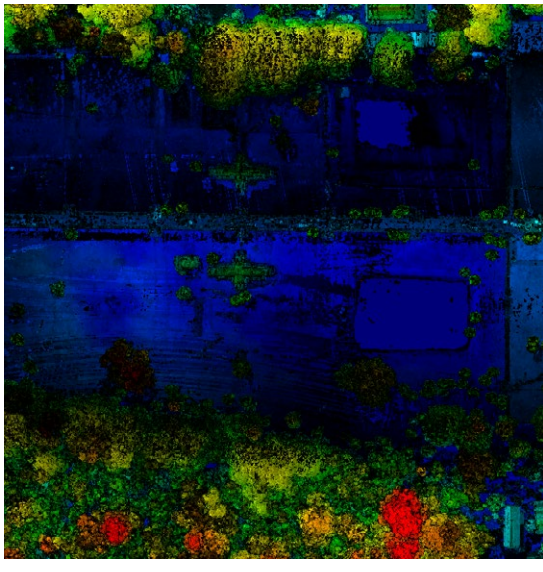
8 Butler, H., 2022. In memoriam: Martin Isenburg, 1972-2021, *LIDAR Magazine*, 11(5): 46-48.

LAStools

LAStools, the flagship product, is a collection of highly efficient, batch-scriptable, multicore command-line tools for processing point clouds. It includes more than 50 tools to classify, convert, filter, raster, triangulate, contour, clip, and polygonize lidar data—to name just some. All tools can be run from the command line via a native GUI or via toolboxes (e.g. QGIS, ArcGIS, FME, ERDAS IMAGINE).

LAStools are popular for their blazing speed and high productivity. The software combines robust algorithms with efficient I/O and memory-efficient management to achieve high throughput for datasets containing billions of points. The software runs on Windows and Linux. It has deep market-penetration and is widely used across industry, government agencies, research labs, and educational institutions. The ability to script the modules makes them ideal for use on web servers or in the cloud.





These fabulous lidar visualizations of the remarkable Angkor Wat temple complex in Cambodia were generated using software from BayesMap Solutions* and rapidlasso. They form deliverables in a project being conducted by École Française d'Extrême-Orient (EFEO†). The subcontractor was Khmer Geographic Institute (KGI)‡.

** http://bayesmap.com | † https://www.efeo.fr | ‡https://kgi.xyz*

BLAST

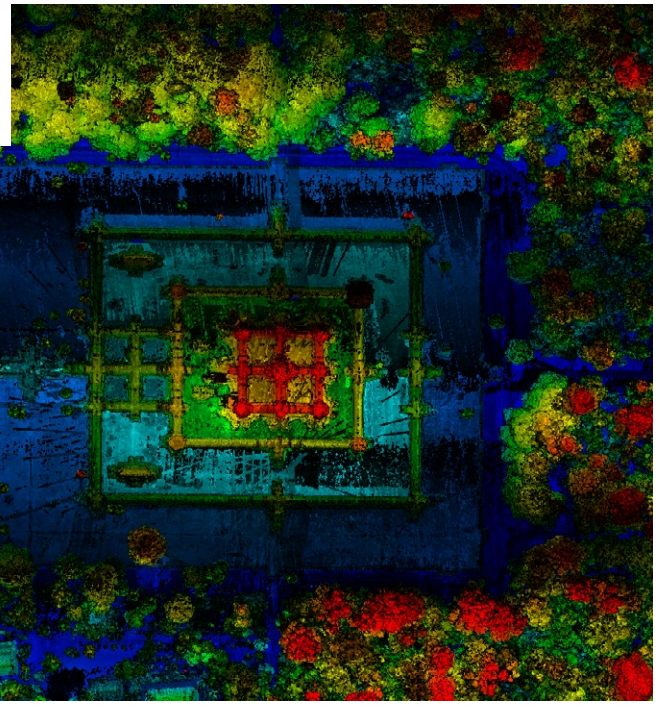
The BLAST extension of LAStools consists of two highly efficient, batch-scriptable, multicore command-line tools. BLAST is the fastest and most memory-efficient solution to process billions of lidar points into DTMs, DSMs, CHMs, or elevation contours. It utilizes unique "streaming TIN" technology to seamlessly triangulate billions of points for subsequent rasterization into a DEM with blast2dem or extraction of elevation contours with blast2iso. The BLAST extension is available for standalone licensing or as an add-on to the LAStools software suite. BLAST can be run from the command line via a native GUI or via toolsboxes (e.g. QGIS, ArcGIS, FME, ERDAS IMAGINE).

LASzip

The open-source lidar compressor LASzip has become the de facto standard for compressed point clouds in the lidar industry. Winner of the 2012 Geospatial World Forum Technology Innovation Award for LiDAR Data Processing, LASzip squeezes the 5.3 TB of LAS files that the National Land Survey of Finland serves on its public servers as part of an "open data" campaign into only 0.8 TB of LAZ files. Other success stories are OpenTopography, which has been serving LAZ for two years, and the comprehensive open lidar archive of the Minnesota Department of Natural Resources, which is exclusively provided in the LAZ format.

LASzip is completely lossless: a LAS file can be compressed into LAZ, then uncompressed into a bitwise identical LAS file. Another advantage is that the user can treat compressed LAZ files just like standard LAS files. They can be loaded directly from compressed form into an application without needing to decompress them on to disk first.

LASzip is offered as a laszip.exe Windows binary and as a minimalistic open-source code distribution (since November 1, 2021, LASzip has been licensed under the Apache Public License 2.0). LASzip is also available through its tight integration with LASlib—the core library used by LAStools. A standalone DLL for adding LAZ support to other software packages can be built from source.



The new team assembles

We traveled to Germany in October 2022 to find the company thriving[9,10]. The intellectual property and the company passed to Dieter, Martin's father, who had been a photogrammetrist in his early days. Dieter appointed Silke CEO and she abandoned a successful career in aviation to step into the role. An experienced engineer, Jochen Keil, was recruited to lead the software effort. Jochen, who had spent time with Mercedes Benz developing automotive software, including user interfaces and databases, mastered Martin's code, and began to develop new functionality while familiarizing himself with lidar and introducing himself to the community, for example by participating in the ASPRS LAS Working Group. On taking up his new position, Jochen commented, "After many years in various areas of industrial software, it was a great pleasure for me to enter a different area of application and I am looking forward to the challenge."

The company is moving fast. Various product improvements have been rolled out, especially a new GUI and a Linux version of the code. Several new tools are nearing release. No less than 52 video tutorials for all existing tools are in progress. The customer database has been significantly upgraded. Fortunately, the company has been able to continue Martin's philanthropic work through the LASmoons program and the granting of licenses to eligible projects.

All this requires energy and talent. Silke is responsible for all strategic decisions and ensures that the company continues in Martin's spirit. A team of software developers around Jochen takes care of the maintenance and further development of the software. A web developer is currently building a new website[11]. An administrator and an accountant complete the team. In addition, rapidlasso receives massive support and advice from countless experts in the lidar community, many of them former acquaintances and friends of Martin.

Almost two years after Martin's death, rapidlasso is financially and technologically stable and takes its deserved place in the lidar world with people, products and communication. Profits are re-invested to accelerate the course of development. The stream of existing and prospective customers seeking information and advice on the rapidlasso booth during the Intergeo event in Essen in October 2022 bore witness to the hunger for the capabilities that Martin created and nurtured. The new team seems well able to respond to the demand, while injecting a stream of fresh features in the years to come.

If you or someone you know is having thoughts of suicide, visit www.finda-helpline.com for a global list of resources.

Allen Cheves is Publisher of the magazine.

Silke Kämmerer is CEO of rapidlasso GmbH. She holds MSc and MA degrees in economics and cultural studies from the universities of Frankfurt and Salzburg. She worked in various positions for Lufthansa German Airlines for more than 20 years. She has traveled to over 120 countries for business, research, and personal purposes.

Stewart Walker is the Managing Editor of the magazine. He holds MA, MScE and PhD degrees in geography and geomatics from the universities of Glasgow, New Brunswick and Bristol, and an MBA from Heriot-Watt. He is an ASPRS-certified photogrammetrist.

9 https://lidarmag.com/2022/12/23/harvest-time/

10 https://lidarmag.com/2022/10/21/lastools-rises-from-the-ashes

11 https://www.rapidlasso.de/

SPONSORED LISTING INDEX

The following pages provide an overview of key service provider, sensor hardware, software and component part manufacturers, in addition to system integrators. Visit the online directory at *www.lidarmag.com* for additional listings.

We encourage you to visit our sponsors.
Thanks to all that participated in this year's edition.

LISTING INDEX

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navvis.com/reality-capture

Advanced Navigation

APPLICATIONS

- MAPPING
- GIS
- MARINE SURVEYING
- AUTONOMOUS NAVIGATION

COMPANY PROFILE

Advanced Navigation is a privately owned Australian company that specialises in the development of navigation technologies and robotics. By leveraging our capabilities in AI neural networks and deep learning algorithms, our solutions deliver unparalleled capabilities and exceptional performance across land, air, sea and space applications. Made possible with extensive research, testing and automated manufacturing, we develop transformative technologies from inertial and sonar navigation to photonic and quantum sensing. Customers choose Advanced Navigation for ultra-high accuracy, proven reliability, and advanced design.

ADVANCED NAVIGATION

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Australia
info@advancednavigation.com

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ADVANCED NAVIGATION

TOPODRONE

COMPANY PROFILE

TOPODRONE is a Swiss based designer and manufacturer of high-precision surveying equipment for installation on UAVs, vehicles and backpacks. TOPODRONE's hardware (LiDARs, high resolution cameras and PPK) are used for mapping and 3D modeling. Application areas include but are not limited to forest and agricultural monitoring, construction and urban planning, and bathymetry. TOPODRONE's advanced post-processing software provides users with easy-to-use innovative data processing workflows for automatic data generation, georeferencing and alignment using GNSS and IMU data post processing, and SLAM algorithms.

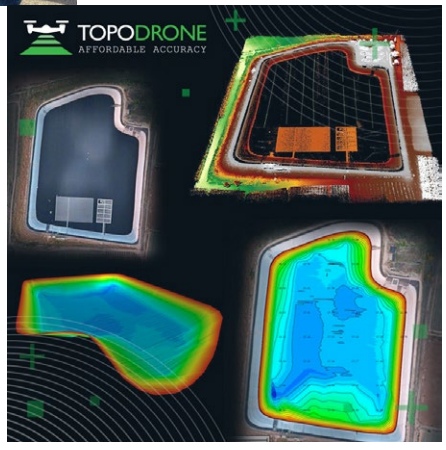
TOPODRONE
AFFORDABLE ACCURACY

TOPODRONE, Rue de la Gare 13,
1820 Montreux, Switzerland
+41 21 588 02 11
info@topodrone.com

topodrone.com

APPLICATIONS

- MAPPING
- SURVEYING
- 3D MODELING
- BATHYMETRY
- FOREST MONITORING
- AGRICULTURE
- CONSTRUCTION
- MINING



5 Years of Affordable Accuracy

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TOPODRONE offers a wide range of multipurpose surveying hardware and software both developed in-house and through upgrading partner solutions. The company focuses on the production and distribution of PPK solutions, photogrammetry payloads, LiDAR-based equipment, and UAV-based bathymetry integrations. In-house R&D includes equipment to enable PPK on small-size UAVs, high resolution mapping and multispectral photogrammetry payloads, survey grade LiDAR systems and AQUAMAPPER to perform bathymetric surveying. All TOPODRONE photogrammetry and LiDAR hardware can be used together and can be mounted on a UAV, a car or a backpack while collected data is easily processed with TOPODRONE PPK and LiDAR post processing software. TOPODRONE AQUAMAPPER is an addition to the TOPODRONE hardware family which performs accurate underwater studies. The compatibility of data collecting and processing approaches make it possible to accumulate and synchronize all types of data: aerial, terrestrial, bathymetric.

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5 YEARS
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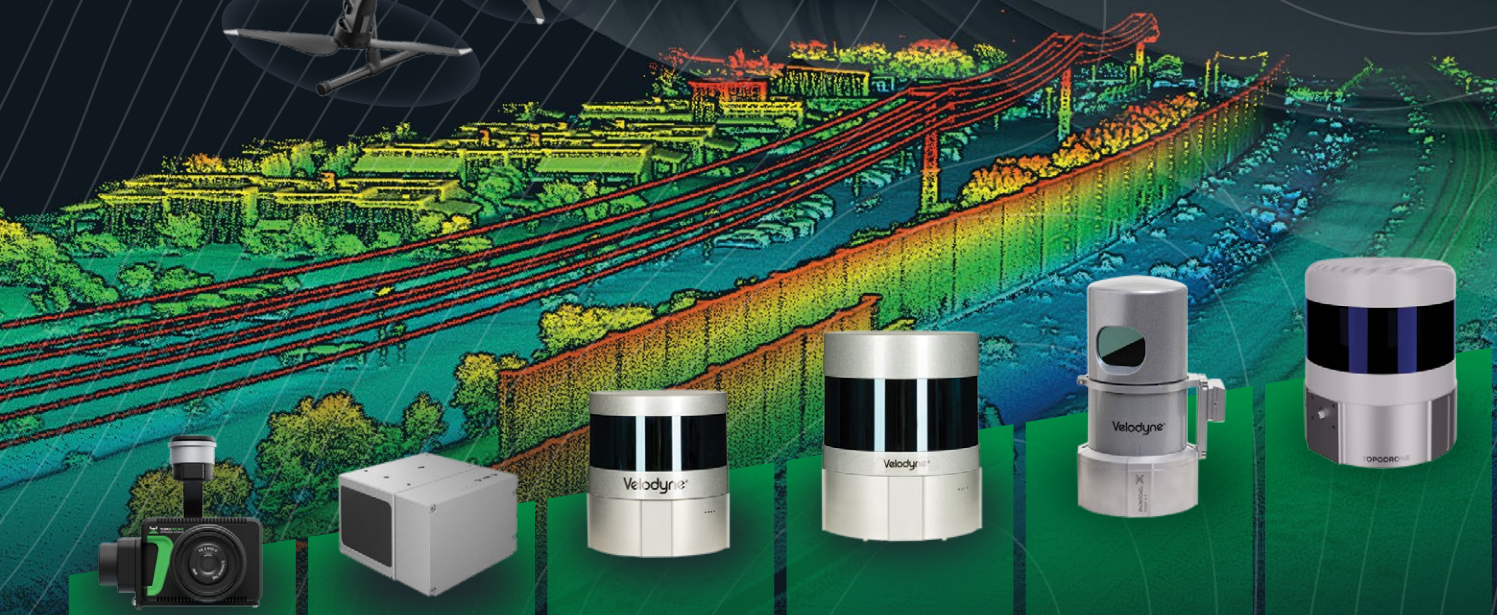

P61
61 Mpixel
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HI-RES
Laser sensor
Velodyne Hi-Res
Weight 900g
Working distance 100m
Accuracy 3-5cm
FOV 360° x 20°
Point rate, pts/s 300000-600000

ULTRA
Laser sensor
Velodyne Ultra Puck
Weight 1100g
Working distance 200m
Accuracy 5-7cm
FOV 360° x 40°
Point rate, pts/s 600000-1200000

HDL
Laser sensor
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FOV 360° x 41.33°
Point rate, pts/s 695000-1390000

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- MINING
- ENERGY & UTILITIES
- OIL & GAS
- TOPOGRAPHIC

COMPANY PROFILE

As a US-based company with over 20 years of experience, Aevex Aerospace Home of Geodetics Products is the go-to provider for Assured Positioning, Navigation and Timing (A-PNT) systems and state-of-the art LiDAR and multi-modal imaging solutions for mobile and UAV (drone) operations in both domestic and international markets.

Geodetics' Defense-grade proprietary technology tightly couples LiDAR, RGB, multispectral and other data types in fully integrated, turnkey mapping solutions for operations in the air and on the ground.

All Geodetics' products are designed, manufactured and tested in the United States.

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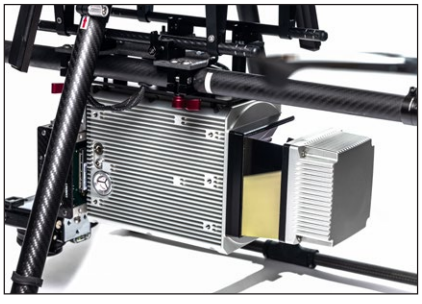

AEVEX
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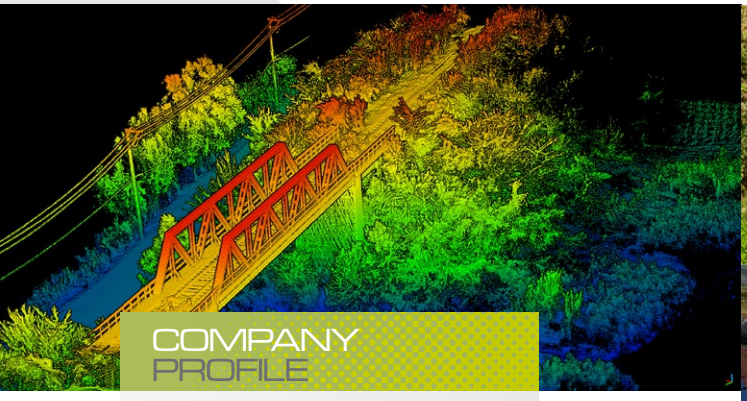
Oxford Technical Solutions (OxTS)



APPLICATIONS

- NAVIGATION
- GEOREFERENCING
- AUTONOMY
- MAPPING
- SURVEYING
- LOCALISATION & GROUNDTRUTH

COMPANY PROFILE

At OxTS we're passionate about inertial navigation and how we can help our customers with our technology. Our hardware and software solutions are used across the world for a range of applications including mobile mapping, LiDAR survey and more.

With over two decades of experience in combining the best of high precision GNSS receivers with inertial navigation expertise, OxTS' products have become the go-to inertial navigation systems (INS) in a wide and varied range of industries—particularly those where LiDAR is prominent.

If there is LiDAR-based project or application you're working on that requires highly accurate position and inertial measurements, speak with OxTS—we have the experience needed to help.

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OxTS INS Solutions

Create exceptionally accurate georeferenced 3D pointclouds

OxTS INS hardware and software solutions provide LiDAR surveyors with the tools they need to create the most visually appealing and accurate 3D pointclouds.

Users of OxTS INS devices for LiDAR surveying can be confident in the knowledge that they will receive centimetre-level position, and highly-accurate roll, pitch and heading measurements. Furthermore, using OxTS Georeferencer, the measurements from both OxTS or third party INS devices can be used to quickly and easily georeference raw LiDAR data, enabling the creation of 3D pointclouds that any LiDAR surveyor would be proud to present.

OxTS hardware devices and software applications have been developed with the user in mind. They are suitable for many data collection methods whether that be on land or in the air.

Our flagship INS, the Survey+, is our most accurate INS used primarily for land-based mobile and manned aircraft mapping. It's more cost-effective counterpart, the xNAV650, is our smallest and lightest INS to date making it ideal for LiDAR surveying with a UAV or drone. However, despite its small size and light weight, the xNAV650 is equally suitable for mobile mapping applications owing to the accuracy of the data it creates.

Other software solutions within the OxTS product portfolio serve to provide users additional benefits. NAVsuite, OxTS' complimentary software suite, gives users the ability to configure, monitor, post-process and analyse their INS data. The step-by-step configuration wizard is particularly useful when setting up your INS for a LiDAR survey.

For areas where GNSS signal is intermittent such as under tree canopies and in urban canyons, OxTS gx/ix tight-coupling software ensures OxTS INS data is the best it can be.

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The Sanborn Map Company, Inc.

(Sanborn or Sanborn Geospatial)

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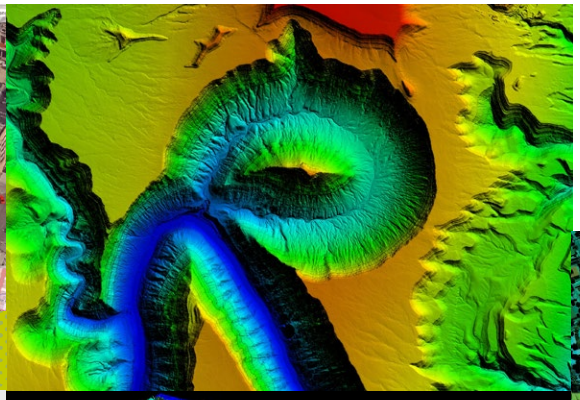
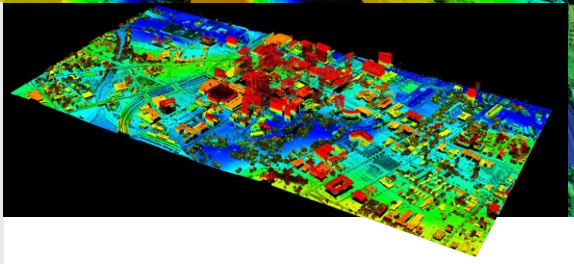
- ORTHOIMAGERY
- LIDAR
- OBLIQUE
- ANALYTICS
- SAAS
- VISUALIZATION





COMPANY PROFILE

The Sanborn Map Company (Sanborn or Sanborn Geospatial) is a complete geospatial solutions provider and leader in the modern geospatial industry. Sanborn specializes in state-of-the-art mapping, visualization, and 3D solutions. ISO 9001:20 certified and using the latest sensors and processing techniques, Sanborn collects, processes, and delivers high quality data: oblique aerial imagery, aerial, ground and mobile lidar, aerial orthophotography, High Definition maps and 3D models, and indoor maps. With the acquisition of Applied Geographics (AppGeo), Sanborn further expands its geospatial IT capabilities in analytics, enterprise GIS strategic planning, commercial data and API licensing, new SAAS solutions, and custom application development.

sanborn + AppGeo

Corporate Office:
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Colorado Springs, CO
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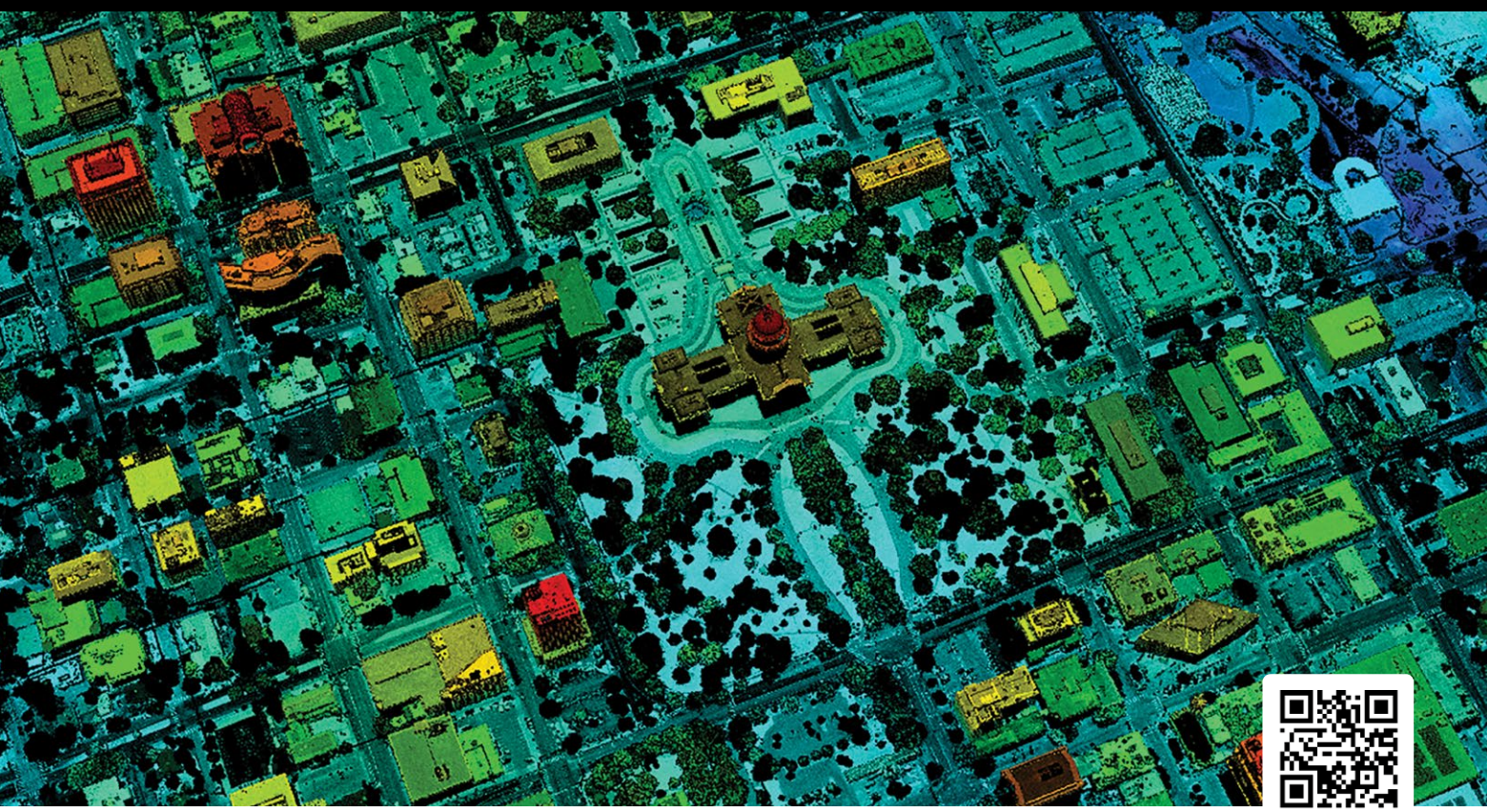
Comprehensive Geospatial Solutions

Sanborn is a national leader in providing state of the art collection, processing, analysis, storage and serving of spatial data at scale using the latest hardware, software, and methods. Sanborn operates a fleet of aircraft located strategically across the US—along with UAS, marine, mobile and fixed ground data collection platforms—and deploys sensors that collect oblique, ortho, lidar, and sonar data. Sanborn maps landscapes, streetscapes, facilities, buildings, and building interiors to customer specification. With expert data processing and photogrammetry capabilities, Sanborn maintains the highest quality, accuracy, and frequency of collection. Using AI/ML, Sanborn automates feature extraction and interpretation, and streamlines the transformation of data inputs into information products. With 14+ petabytes of in-house data storage under secure management, Sanborn can cost-effectively store and serve the large volumes of data that customers need to access. Among the data types and products that Sanborn creates are:

- Digital ortho and oblique imagery
- Airborne, survey grade lidar
- Landcover, vegetation, terrain, hydrographic models
- Digital elevation, Surface and Bare earth models
- 3D mapping and building models
- Street views and building or facility walkthrough imagery
- Utilities, pipelines, infrastructure
- And much more...

Sanborn's strategic value to customers is having all their needs for geospatial data, solutions, strategy, and support met by a single dependable partner with a proven track record.

DATA & SOLUTIONS THAT EMPOWER DECISION MAKING



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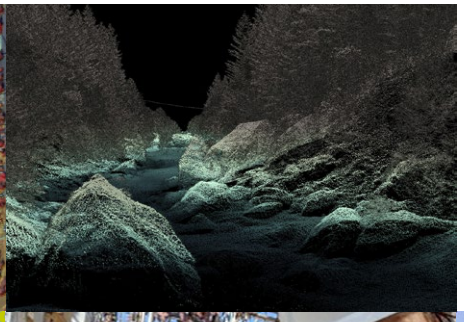
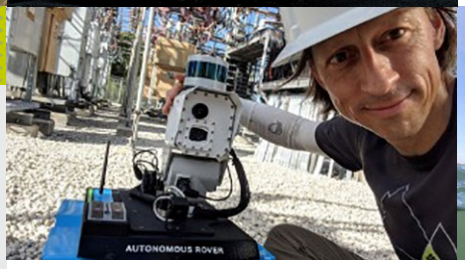
NV5 Geospatial

APPLICATIONS

- ACQUISITION
- DATA & IMAGE PROCESSING
- ANALYTICS
- APPLICATIONS
- DATABASE MANAGEMENT





COMPANY PROFILE

NV5 Geospatial is the geospatial pioneer pushing the boundaries of data and analytics to deliver actionable intelligence to those who need to map, model, and manage their world. We lead the nation as the only end-to-end geospatial solutions provider with the capability to deliver the highest quality data and geographic insights.

NV5 GEOSPATIAL

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1-800-558-6707

NV5geospatial.com

End-to-end Geospatial Solutions

NV5 Geospatial drives change in the acquisition and production of high-resolution, high-accuracy datasets. We transform these dense unstructured data into structured datasets optimized for our geospatial scientists and industry experts to create data analytics and software applications specifically designed to meet our clients' needs. Our R&D investment in next-gen solutions keeps us at the forefront of the market.

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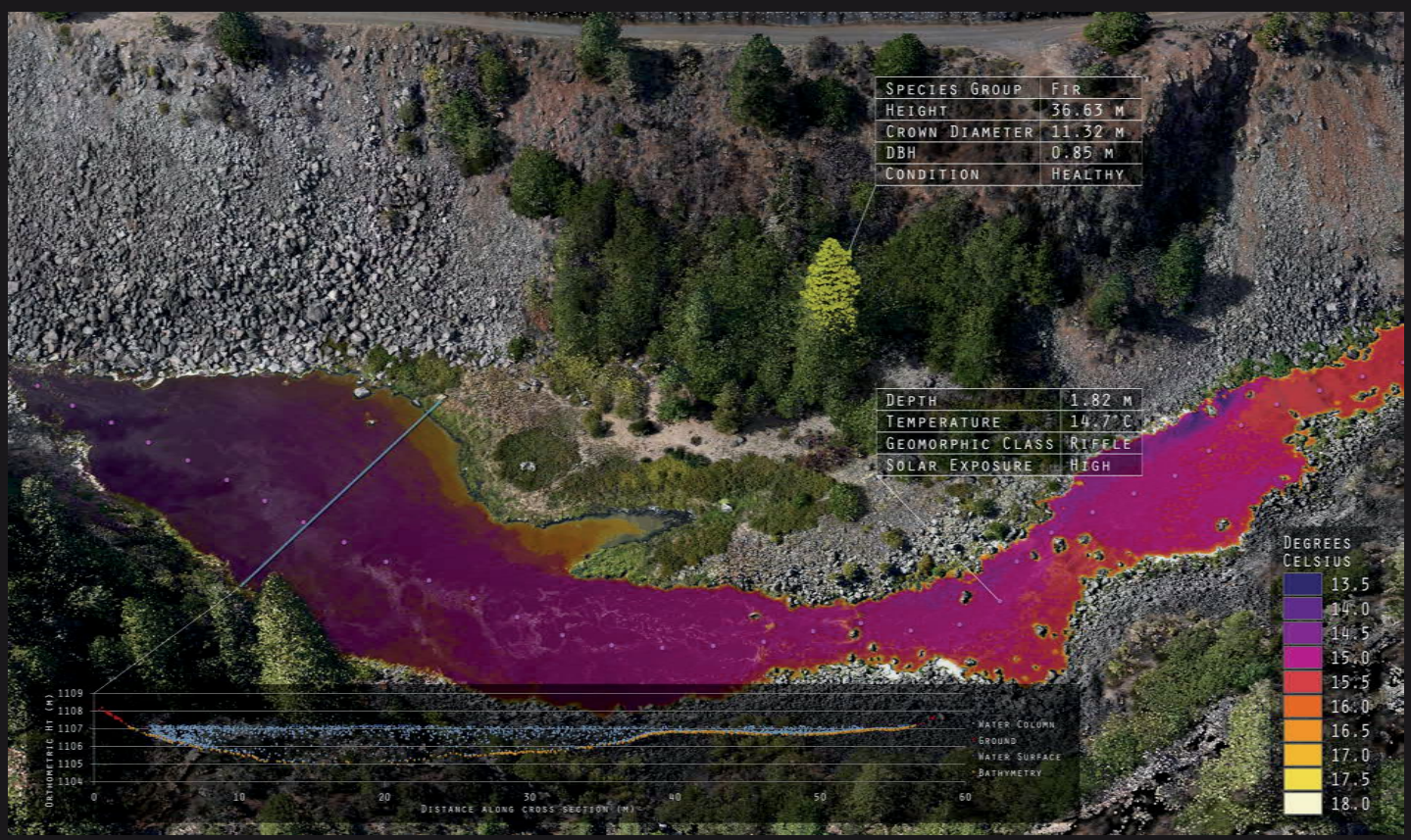
ANYONE CAN TAKE A PICTURE
WE TELL ITS STORY

NV5 GEOSPATIAL

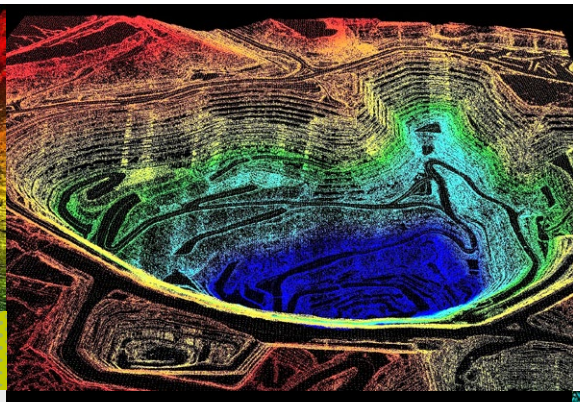


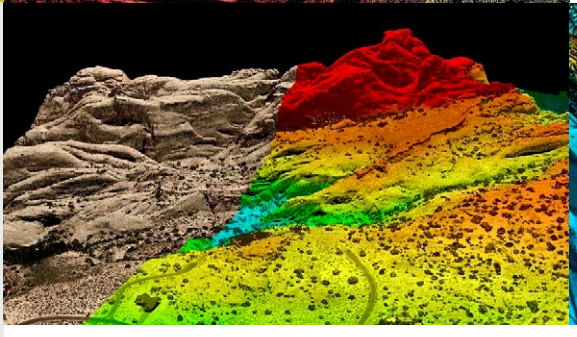
NV5geospatial.com

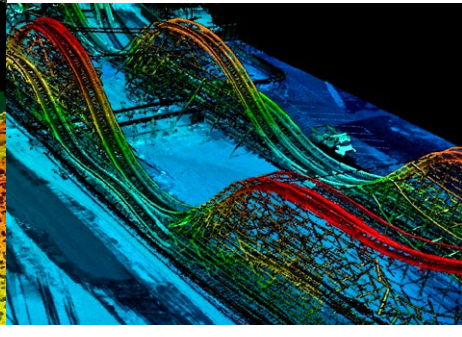
Aero-Graphics Inc

APPLICATIONS

- MAPPING
- SURVEYING
- PHOTOGRAMMETRY
- LIDAR
- INFRASTRUCTURE
- ENERGY
- AEC
- TRANSPORTATION







COMPANY PROFILE

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Passionate about helping our clients discover solutions that uniquely meet their challenges making their jobs easier and projects more successful, we'd like to welcome you to Aero-Graphics.

Since 1965 we have established a nationwide reputation for helping our clients with high-resolution Photogrammetry, LiDAR and orthoimagery, UAS, and applied GIS. In fact, we've pioneering aerial mapping and imaging technologies to meet our client's most demanding schedules and budgets. We'd like to get to know you and how we can help advance your successes. Call us at 801.487.3273

aero-graphics
GEOSPATIAL SERVICES

info@aero-graphics.com
(801) 487-3273
40 W Oakland Avenue
Salt Lake City, UT 84115
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Under Our Wings, Your Deliverable is Success.

We stand ready to quickly mobilize your project sites and our decades of aerial acquisition expertise ensure that we will deliver you the imagery and LiDAR that will make your project a success.

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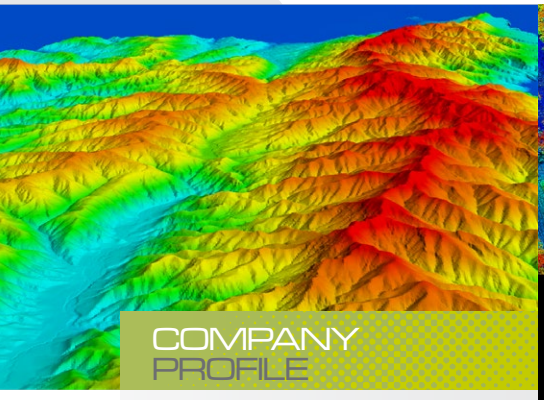

COMPANY PROFILE

Dewberry is a leading, market-facing firm with a proven history of providing professional services to public- and private-sector clients. Established in 1956 and headquartered in Fairfax, Virginia, our professionals are dedicated to solving clients' most complex challenges and transforming their communities. The firm harnesses the power of geospatial science to offer complete end-to-end remote sensing and mapping services starting with state-of-the-art airborne lidar sensors to automated processing, surveying, web/mobile GIS, and advanced data analytics. Dewberry creates, analyzes, and builds geospatial data and tools, to help clients integrate, share, and simplify the use of information allowing for more effective and efficient decision making. To learn more, visit www.dewberry.com.

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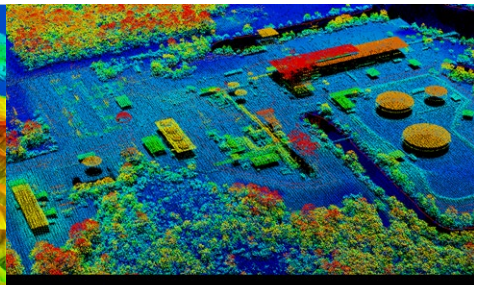
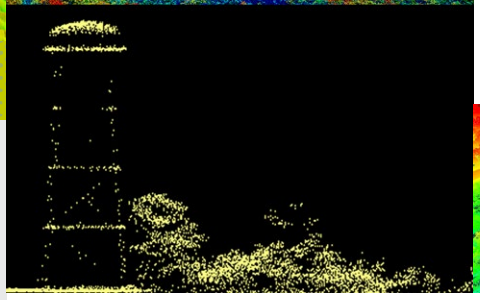
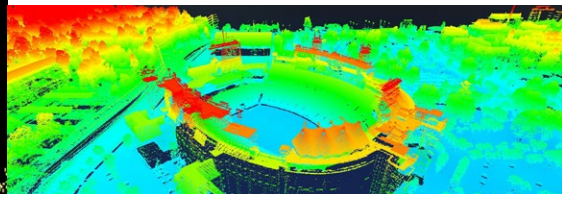




APPLICATIONS

- REMOTE SENSING
- TOPOGRAPHIC LIDAR
- TOPOBATHYMETRIC LIDAR
- GIS
- APPLICATION DEVELOPMENT
- MODELING
- ASSET MANAGEMENT
- ANALYTICS



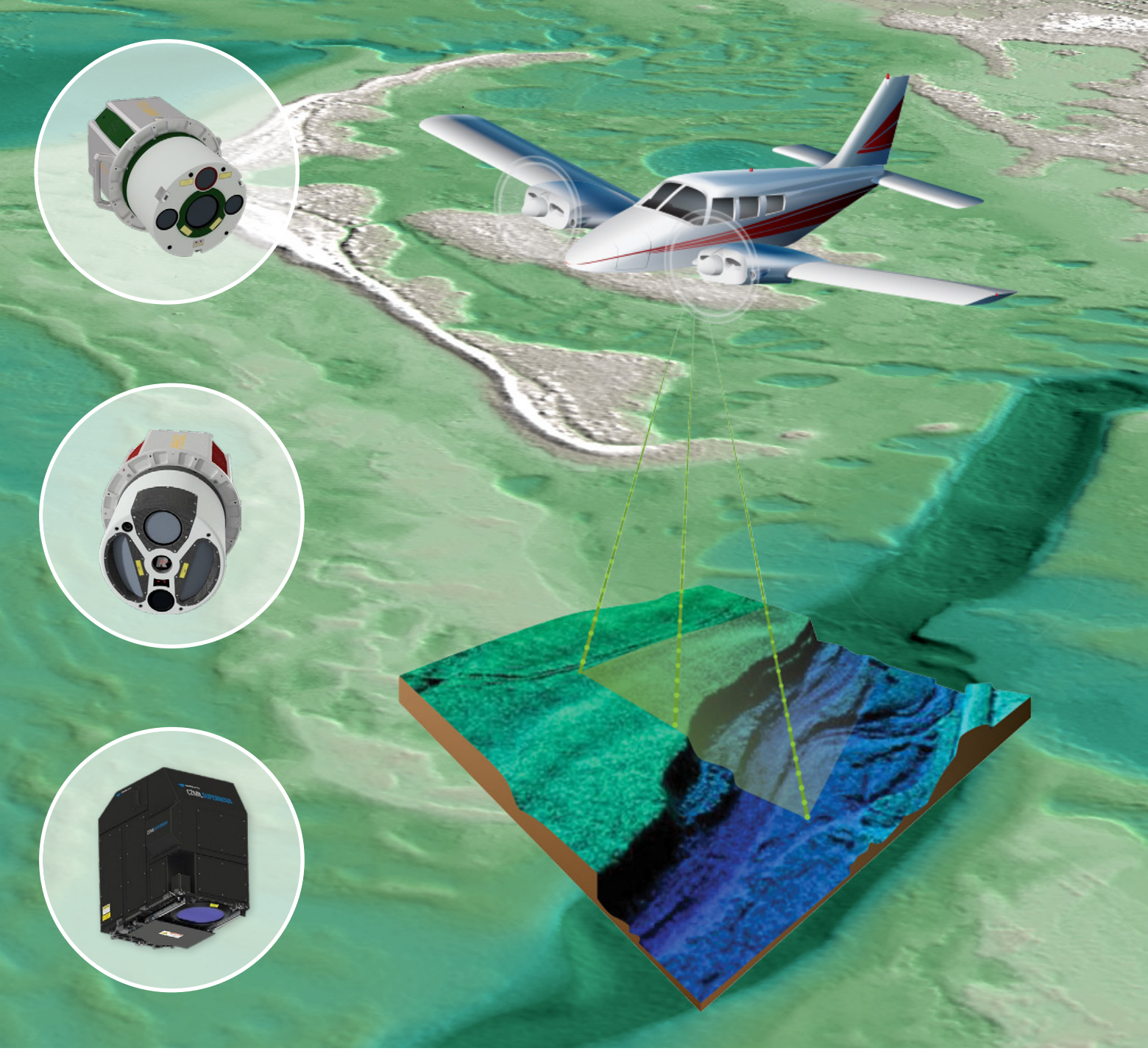
Dewberry's Geospatial and Technology Services

Dewberry's geospatial and technology services team creates, analyzes, and builds tools to share geospatial data, and helps clients integrate these tools into their daily lives. By fusing multiple data sets together, Dewberry provides clients with easy-to-use tools that simplify the use of information to allow for more effective and efficient decision making.

Dewberry recently purchased three sensors—the RIEGL VQ-1560 IIS topographic airborne lidar sensor and two topobathymetric lidar sensors—RIEGL VQ-880-G-II and the CZMIL SuperNova. This investment allows Dewberry to expand its mapping capabilities with current clients, keep the entire acquisition lifecycle in-house, and monitor the quality of its products. The firm is excited to empower their clients with access to the most innovative technology to meet their topographic/lidar needs, delivering hi-definition lidar datasets quickly and efficiently.

The firm's solid performance processes in geospatial technologies and corporate IT services led to it being appraised at Level 3 of the CMMI Institute's Capability Maturity Model Integration (CMMI) in Services and Development Models. In 2022, Dewberry also received the MAPPS Geospatial Excellence Award for GIS/IT/Remote Sensing Analysis and the Esri Systems Integrator Award for Innovation.

Dewberry works seamlessly to provide geospatial mapping and technology services across various market segments. With more than 30 years' experience, the firm is dedicated to understanding and applying the latest tools, trends, and technologies. Dewberry employs the latest GIS software and database platforms, including the full suite of ESRI products. The firm's products and services include application, web, and cloud-based development; system integration; database design mapping; data fusion; and mobile solutions.



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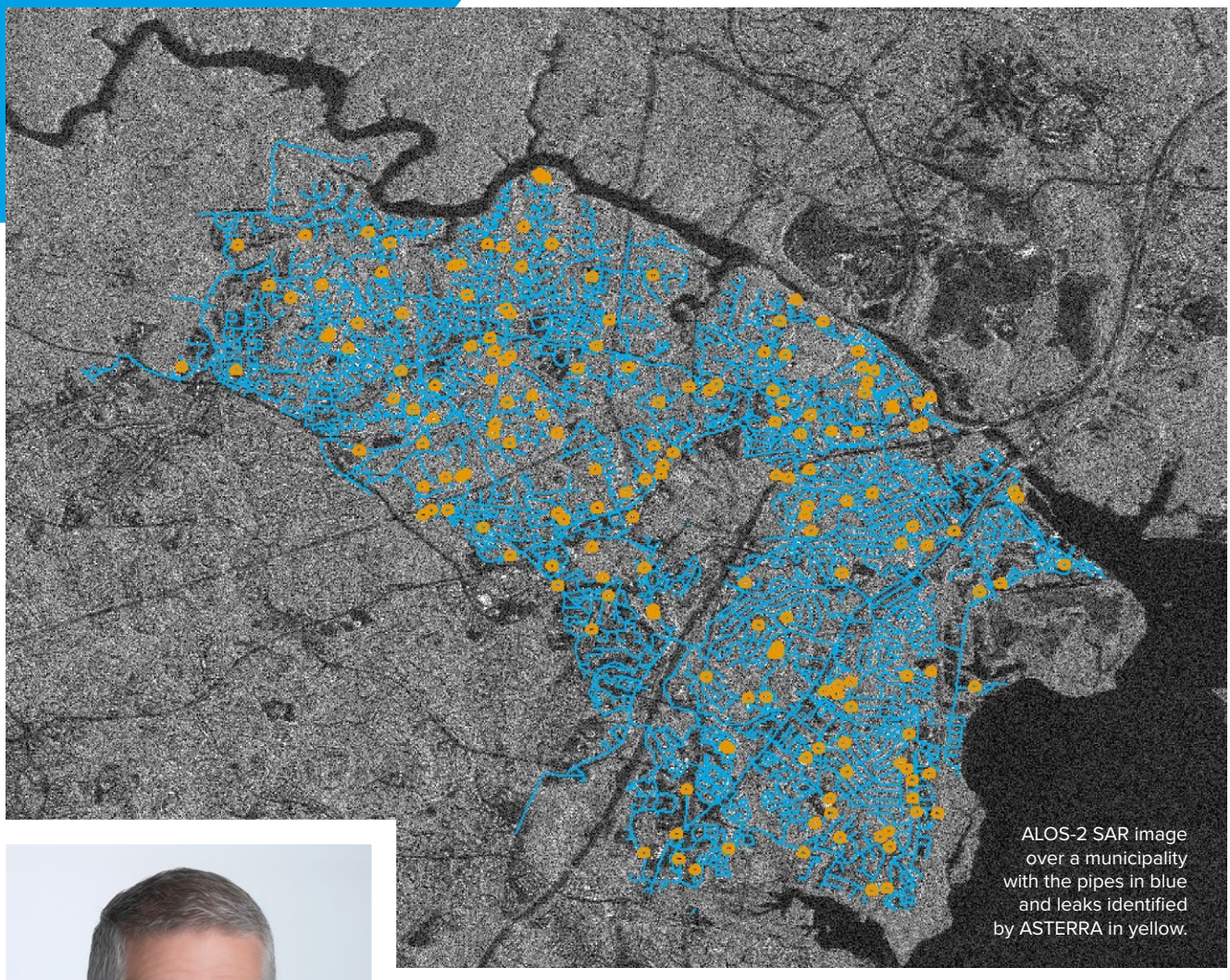

ALOS-2 SAR image over a municipality with the pipes in blue and leaks identified by ASTERRA in yellow.

James Perry, executive vice president Americas, ASTERRA.

L-Band Locates Leaks

ASTERRA uses radar to find unwanted moisture

BY STEWART WALKER

ASTERRA's CEO, Elly Perets (left), and founder, Lauren Guy (right).

LIDAR Magazine learned that a startup, ASTERRA[1], was using L-band radar (frequency 1-2 GHz; λ = 15-30 cm) to detect leaks and enable clients to reduce unwanted waste of water. The company has an office in La Jolla, on the Pacific coast just north of San Diego, so managing editor Stewart Walker was despatched to talk to executive vice president James Perry, who joined ASTERRA in 2016 after spending the lion's share of his career with Hewlett-Packard.

LM: James, thank you very much for taking time to talk to us. Please start by telling us something about yourself and how you came to be in a leadership position in ASTERRA.

JP: I had acquired experience, during an earlier part of my career at Hewlett-Packard, developing new businesses. HP is always looking for new inventions and Israel is a startup nation. Networking in Israel helped me find Utilis, which is now ASTERRA. I met Elly Perets [CEO] in 2016 and learned that he was looking for someone to lead the operations in USA.

LM: Please introduce us to ASTERRA. When and where was the company founded and why? Who were the founders and what was their motivation? How did the leadership team come together? How many employees are there? Is it public or privately owned? If it is private, I'm sure the financial data are very sensitive, but could you at least say whether the company is profitable and whether it is growing?

JP: The company was founded in 2013 by Lauren Guy, who is also CTO. He had participated in a grant by NASA to find water on Mars. He was working in the public sector and became conscious of how water is precious in Israel. Lauren used ALOS-2 PALSAR-2 to look for water in his parent's yard. The control point was a garden hose. From there, he was able not only to develop views of soil moisture, but to develop a patented algorithm to differentiate water types. Using L-band, which is very sensitive to the dielectric constant of water, he was able to run an algorithm and find the signature of drinking water.

Many PhDs in remote sensing say what we're doing is impossible. Part of the challenge of invention in Israel, being a startup nation, is trying not to take no for an answer and look for creative ways to do things. To date, using our technology, which we provide to water utilities around the world, where we've done over 750 projects in over 60 countries, over various terrain, topographies and soil types, we have verified over 75,000 points of interest, finding leaks. So it's an amazing success story, significantly better than the benchmark of how many leaks are found per day by manual inspection versus what you find when you're using our technology, that digital approach to traditionally looking for leaks in water pipe systems.

Being an engineer, Lauren was looking at the size and repeatability of that signature to see if he could determine where pipes were leaking. Elly joined the organization in 2015 and he's a businessman, not looking for perfection, but wanting to know, is it good enough to problem solve? Elly has the skills to be able to take complex issues and help find them a home. He took what we had and started to bring it to market. He tasked me with running

1 www.asterra.io

North America, trying to do the business development and grow.

Recently, we added Central and South America, so we're now the Americas organization, covering Latin America and North America. As you can well imagine, North America is the key market, half the business roughly, plenty of opportunity, enough homogeny to be manageable, even though there's regional or application complexity.

Our second largest country is the UK, which has the right market dynamics for us with a lot of regulatory drivers. There are seven or so water utilities managing the entire UK, versus 50,000 in the US. We have a good partner in SUEZ Advanced Solutions UK. Italy is similar.

We've also started in China. It's been a challenge. We've had some successes and we've learned a lot. We were doing well enough that we hired a resource, who is helping us run the market, which leads us into the potential to use the Chinese satellite for L-band that's recently gone up. As in Italy, there are water scarcities and aging infrastructure—it's the same story worldwide.

ASTERRA is a shareholder-owned organization with 75 employees. We started it like any startup. It's usually aunts and uncles and family who are funding. After that, you go for more formal funding. We've done our Series A and, most recently, Series B. Some of the investors who actually knew Elly—again, it's the Israeli tight community—saw that there was a need to move quicker from pure science into business. We're in the midst of cycling into Series C. So you get investment, you still have to perform and get the right people who understand. It's a real challenge to reach that tipping point for scaling, demonstrating doing one thing right; one time isn't enough. We've been fortunate to bring in a good mix of investors who can help us with problems on scaling in the right way at the right time.

Initially we were very laser-focused in our problem solving. But our management has a skill set that not every startup has. We've moved from what we did first, which was essentially leak detection. We recognize that the skills that we develop are much more associated with Earth observation and monitoring. Our experience started with working with JAXA. As we've diversified and looked at new sectors, market segments and applications, we recognize that working with the data collectors, no matter what platform, is key—using it and commercializing it, the way that really no one has done, particularly in the sectors and segments in which we play. The winner of how this is going to look will be those who collaborate across the data that's coming in—the downstream users of that data—and the problems and challenges that they're going to solve are going to be the game changer.

We're looking for subterranean soil moisture with the expectation that failure will begin below ground before you see it and before being able to sense it with an in-ground sensor or something that's going to read the surface. We're going to be the first indication that there's something going on. In any application, such as earthen dam monitoring, there are ways to use lidar, X-band, bands that are not going to penetrate below the surface, and to look for deformities. We can see below ground and estimate the percent of concentration of moisture, repeating it if you want to see change over time. By doing it consistently time over time, you're going to build a profile of change and that really becomes the power of what we're doing.

> "Lauren used ALOS-2 PALSAR-2 to look for water in his parent's yard. He was able to run an algorithm and find the signature of drinking water."

LM: Can you please sort out for us the difference between ASTERRA and Utilis?
JP: The company began as Utilis Ltd., and in the USA we were Utilis Inc. Utilis has been rebranded as ASTERRA. We changed the name because we were being identified as a leak-detection company only. We were struggling to get any awareness in other myriad applications that we see as key for growth. The name ASTERRA is derived from the Latin astra (stars) and terra (the earth on which we live) and the Greek Asterion (one of the three river gods). This rebranding will help us penetrate new markets around the world.

LM: Now we can move on to the technology! *LIDAR Magazine* is increasingly covering radar, so it's exciting for

us to encounter the novel applications for which ASTERRA is using it. Can you please describe the solutions you provide and the technologies you use to do so? We understand there are three—MasterPlan, Recover and EarthWorks. Is your approach unique? What technologies do your competitors use?

JP: It *is* unique. ASTERRA is the only company to do this. We use synthetic aperture radar to penetrate through snow, vegetation and ground. Water is a very important factor in any engineering project, so ASTERRA provides value by giving water data.

Yes, there are three key solutions: Recover, MasterPlan and EarthWorks. Recover and MasterPlan facilitate the recovery of water going through pipes—drinking water, wastewater or reclaimed water. Recover is the points of interest and MasterPlan is a full system survey. We can provide a deficiency layer for every single inch and don't just pinpoint areas of interest. A single image covers up to 1400 square miles.

EarthWorks is field-verified, field-tested and field-proven to give soil moisture estimates underground. We are cost-effective and there is *no* competition. EarthWorks is the game-changer. We're going into the mining industry, earthen dams and levees, and roads and rail. It's a big market for us. It's much more of a b2b play, including engineering firm work. That's going to be our tipping point.

We know that traditional analog leak detection in the water industry can find about three quarters of a leak a day. These firms cover an entire system blindly, because it's below ground. They're trained to acoustically pinpoint below ground. When they went to our points of interest, they were finding four leaks a day. So instantly, you have a 400% improvement in the amount of leaks being found. We're applying that methodology on some really key items like tailing dams with nasty chemicals in them that aren't being monitored, that can fail. There's no subterranean moisture view until we come along. In Brazil, there was a massive failure, 245 people died and chemicals were spilt. It happens every day: you hear about the big ones, but there are thousands of dams, some on mines that are shut down, that are supposedly monitored by the Bureau of Land Reclamation in the US—or not. They have limited tools. There are around four earthen dam failures a week. It could be a small pond. But they're releasing, causing floodplain and channel damage. We're looking at providing enough information covering big areas to make it cost-effective, working with engineering firms that will be tasked to monitor these things and do it in a way never done before.

> "We use synthetic aperture radar to penetrate through snow, vegetation and ground. Water is a very important factor in any engineering project, so ASTERRA provides value by giving water data."

LM: Which satellites do you use? What type of radar sensors do these satellites carry? Do you ever supplement the satellite radar data with data from satellite-borne multispectral or hyperspectral sensors or, indeed, from crewed aircraft, UAVs or ground systems?

JP: PALSAR-2 (1.27 GHz) data from JAXA's ALOS-2 satellite is the primary data source. We're the number one customer for JAXA! Secondly, we use L-band (1.275 GHz) data from SAOCOM-1A and -1B, an Earth-observation constellation from Argentina's space agency CONAE in cooperation with the Italian space agency ASI. We've worked with the agencies on business plans. All three use L-band. By using these constellations, we can achieve an image around every five days. Indeed, many countries are recognizing the power and utility of L-band satellites. For example, China has launched L-SAR 01A—we're helping them too. JAXA has plans for ALOS-4, NASA/Indian Space Research Organisation for NISAR, and DLR for TANDEM-L. The next big tech company that conquers the market for using satellite data hasn't emerged yet, but it will combine data to provide solutions. There's a good spirit to do that—people are willing to get together. We've shown how to develop a market and commercialize it profitably.

We also use small aircraft with L-band sensors for a different level of flexibility. In the future we plan to work with radar sensors in different parts of the spectrum, for example X-, P- and

Images of an underground leak that was identified by ASTERRA in Greenville, Mississippi, after it was unearthed (left), and the subsequent repair (right).
Credit: David Hangar, Water Maintenance Division, City of Greenville.

C-band, to provide complementary data and articulate movements below ground.

We worked with a company in Europe called MetaSensing[2], which has a Cessna 185 and developed an L-band sensor, a quad-pole, airborne technology that is being used in Italy. The resolution is slightly better, you're lower to the ground, you can use a stronger power source, etc.—a lot of advantages for us. The challenge has been operationalizing it. There have been some tax advantages that make it feasible for us to do operationally, profitably. We schedule flights around Padua and all over Italy daily. We've been working with it in the US, but have significant challenges with FCC certifications, and also costs. Flying a Cessna around at a moment's notice has an associated cost, even though Cessnas generally are cheap and there are a lot of them up there willing to add multiple remote-sensing devices. There is a business model to be had, but we haven't been able to get it to the point of an advantage operationally, or commercialize it, and satellites have been just fine for us.

LM: Have you explored making a deal with one of the large US commercial survey companies? I know them very well and they're brilliant at what they do.
JP: We would love to talk to more of them. It can be a real challenge for us to match the point on the imagery to the ground. We used to do it successfully manually, but it takes time and money. So we've come up with ways to automate it and we've collaborated with people who do that in the mapping world, because it's a pretty common challenge.

We have been able to work with MetaSensing in Europe to figure out a commercial model where they would build a second system and release it to someone here. The struggle has been getting FCC approval to be able to fly anytime, day or night. We've been able to coordinate some potential paths and times avoiding airports and that kind of thing. It's more of an overabundance of caution than a real concern that you're going to interfere with communication.

LM: Do you use lidar?
JP: We use lidar all the time, particularly for new applications, and setting up

2 https://www.metasensing-group.com/

DEMs for areas of interest. We know that when you start to combine our subterranean moisture with other information, let's say lidar, the greater the slope, the greater moisture equals significant likelihood of failure. So there are places like the Arizona cut on highway 101 in Oregon—there are only two north-south highways in Oregon and a lot of mountainous areas. If those roads are out, you risk shutting down, besides the people movement, the pulp industry, and instantly the CEO of Warehouser is going to call the governor and remonstrate. So they spend something like $35 million per year on one five-mile area where they constantly are using every tool currently available. They're extraordinarily interested in the subterranean view, because they're using surface-reading radar to be able to see what's going on and, with what we're providing now, they can add an additional data layer that will help inform them on where they want to pay attention. There are multiple examples of using slope with moisture to show hotspots, essentially, areas of concern for further field investigation.

We have many opportunities in coastal flooding, predictive analytics around failure. Insurance companies want to know, how high will the water go and how far inland. We can tell them and it involves lidar.

For example, we were working with a company that wants to buy a warehouse on the Chicago River. The seawall looks bad. The lender is saying the insurance is going to be very high because the seawall is going to fail. They contract us to see where the moisture is coming from. And then they fixed it, had lower insurance rates, and didn't have to do the entire seawall but a small portion of it. It's a private entity, so the insurance company was going to charge a lot of money that they didn't need to charge because they didn't have enough information. We gave them the information and they were able to save rates.

LM: So you must use a mixture of lidar where you actually commissioned flights, and lidar that is available off-the-shelf from federal, state, local government?

JP: For most of what we're doing, with the exception of Italy, where we have access to more lidar information, off-the-shelf is good enough for us.

LM: You make extensive use of artificial intelligence. This is clearly an important part of your IP and you cannot disclose small details, but can you tell us something about how AI benefits ASTERRA?

JP: We take responses from field investigations. We have hand-verified over 75,000 leaks at the points of interest provided. These data points are fed back to our analytics team and this helps them strengthen our machine learning and AI models. We can leverage machine learning/AI along with our georeferencing data analytics to further develop markets and provide more solutions.

Dripping spigots on the side of a house cause a reflection strong enough for us to be able to differentiate. We have a buffer zone for field investigation, but that is more around the inherent properties of moisture: capillary effects like a sponge can combine multiple leaks. We had to find the sweet spot between what's too small and what's too big. Too small means too many points of interest to investigate; too big means low return on investment. How many miles do you walk in a field? How many leaks are you finding? How much water are you recovering? What is the water return?

"We take responses from field investigations. These data points are fed back to our analytics team and this helps them strengthen our machine learning and AI models."

Wastewater and reclaimed water are also part of our portfolio. But with gravity waste lines, there's intrusion of groundwater, which leads to SSOs - sanitary sewer overflows. Systems with limited capacity can get inundated and nasty waters come to the surface. In the design-build phase, you need to know if there's moisture below ground; in the operational maintenance phase you must make sure that the systems are tight and robust - we can inform.

We're data scientists using remote sensing. The results are useless information if they are not comprehensible to the "plumbers", who are out doing the field investigation work, who don't have the

James Perry celebrates after ASTERRA wins an American Water Works Association innovation award in 2021. The celebration was virtual owing to the pandemic.

same level of expertise. We had to walk in their shoes. I walked around many cities on the street, helping to find leaks as a proof point, not so much to prove empirically what we found, but to help them understand how to adopt the new technology, how to apply it, what it does and what it doesn't do. It's a real challenge not to be didactic and look like we're telling them what to do when they have decades of managing a water system.

LM: Let's talk about the business side. Do you provide your customers with one-off solutions, like a project, or do you offer them a service on some sort of subscription basis, whereby you provide regular updates? You are working in a market which, as yet, is not so well known to *LIDAR Magazine* readers, so please tell us, who are your customers—is there a clear categorization by, for example, public/private, type of industry, or geography? Is there a typical size for the area covered by solutions used by your customers? Can you give us some examples of customers?

JP: Our initial market strategy was to interview customers and understand their challenges. ASTERRA helps them save money. We work with water utilities, wastewater utilities, government agencies, AEC companies etc. by offering them a tool they never had before. In the early days, we ran pilots/projects to prove that our technologies work for customers to adopt. We provide a subscription model for all our solutions, and customers have access to data for problem-solving. East Bay Municipal Utility District (EBMUD) has been our customer from the beginning and we help reduce non-revenue water. We are active in 64 countries, working with all soil types to solve problems.

We're orienting from a task-based model, for example a contract with a city to take an image and deliver what we learned from that, to much more of a SaaS or DaaS model, where you're buying a data license for a period of time. We always knew we needed to do it that way, because of the depth and breadth of applications. The first thing customers want to do in the morning is download the latest data for any application or any location. That's more of the data license model for us and shareholders like it, because it's reliable, repeatable income. That's the future of Earth observation and data analytics.

Central Arkansas Water, in Little Rock—a pretty innovative organization—they use our points of interest, which gets them close, but you still need to pinpoint below ground—not something you can see. Before you shovel, you need to field-confirm. They pinpoint with a dog that can sniff the signature of water; the chlorine in it. The annual American Water Works Association conference, ACE, was in San Antonio this year and the dog came to our booth!

LM: How do the UN Sustainable Development Goals impact ASTERRA's strategy and business development?

JP: Sustainability is key for us. In our mission statement, we consider the importance of water (drinking water and wastewater) and saving this precious resource. We have worked with IDB[3], UN, FEMA and EPA to raise

3 Inter-American Development Bank

awareness. Everyone at ASTERRA believes in campers' rules (leave the place better than we found it). We recognize SDG goals 6 (ensure availability and sustainable management of water and sanitation for all) and 13 (take urgent action to combat climate change and its impacts). Sustainability is the key in all the segments and we believe in it.

> "No-one is using subterranean soil-moisture L-band to solve the problems, partly owing to our patent, and, probably even more, our IP and jumpstart."

LM: ASTERRA has its headquarters in Israel and, in addition to this office in San Diego, has an office in the United Kingdom. Is that correct? In addition, ASTERRA's operations are supported by networks of partners, certified leak detection teams, and resellers. Could you please say more about how this all works?
JP: About half of our business is based in the US. The technology center and headquarters is in Israel. The UK is our second-largest market. We also have an office in Japan. We have significant business in China. Every country is covered by our reseller network and we sell direct in the US for the most part. We are pushing never-before-seen technology offerings into the private and public sector organizations, which are key on managing sustainability goals.

The leak-detection teams are third-party companies. We work with partnered leak detection teams; we call them "plumbers" in the field. We certify them, not to teach them how to pinpoint a leak, or work in the field, but regarding our best practices that we've seen from verifying 75,000 leaks. We've made sure that they're up to date. We call them business partners, they're subcontractors to us or they go direct. It's not a business we prefer to be in, but we recognize we have to support the ecosystem for field investigation.

LM: There is no competition?
JP: No-one is using subterranean soil-moisture L-band to solve the problems, partly owing to our patent, and, probably even more, our IP and jumpstart. People are using other sensors to look for deformities at the surface, or moisture-reading sensors, or acoustic sounding sensors that go on hydrants. In the early days of doing this, there were tech wars: innovation officers at water utilities were asking which one works and why. Really, we all complement each other to solve problems.

LM: James, thank you very much for answering our questions. We look forward to publishing more about ASTERRA in the future.

Stewart Walker is the Managing Editor of the magazine. He holds MA, MScE and PhD degrees in geography and geomatics from the universities of Glasgow, New Brunswick and Bristol, and an MBA from Heriot-Watt. He is an ASPRS-certified photogrammetrist.

RIEGL

APPLICATIONS

- AIRBORNE
- BATHYMETRIC
- MINING
- MOBILE
- INDUSTRIAL
- TERRESTRIAL
- UNMANNED
- WIDE-AREA

COMPANY PROFILE

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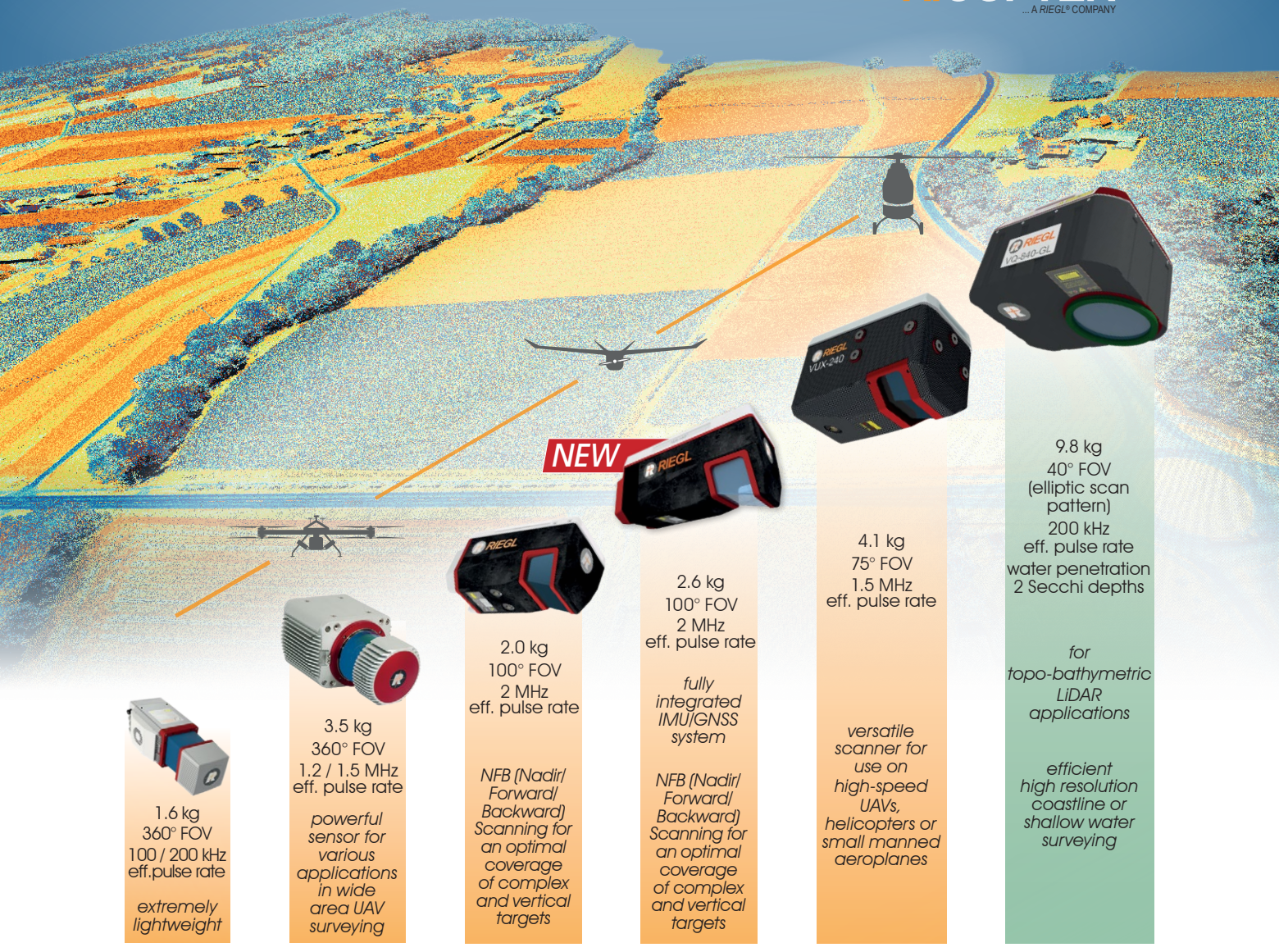


miniVUX-1UAV miniVUX-3UAV	VUX-1UAV[22] VUX-1LR[22]	VUX-120[23]	VUX-160[23]	VUX-240	VQ-840-GL
1.6 kg 360° FOV 100 / 200 kHz eff.pulse rate *extremely lightweight*	3.5 kg 360° FOV 1.2 / 1.5 MHz eff. pulse rate *powerful sensor for various applications in wide area UAV surveying*	2.0 kg 100° FOV 2 MHz eff. pulse rate *NFB (Nadir/ Forward/ Backward) Scanning for an optimal coverage of complex and vertical targets*	2.6 kg 100° FOV 2 MHz eff. pulse rate *fully integrated IMU/GNSS system* *NFB (Nadir/ Forward/ Backward) Scanning for an optimal coverage of complex and vertical targets*	4.1 kg 75° FOV 1.5 MHz eff. pulse rate *versatile scanner for use on high-speed UAVs, helicopters or small manned aeroplanes*	9.8 kg 40° FOV (elliptic scan pattern) 200 kHz eff. pulse rate water penetration 2 Secchi depths *for topo-bathymetric LiDAR applications* *efficient high resolution coastline or shallow water surveying*

for applications using low-flying small or mid-sized multi-rotor UAVs
e.g. mining, topography, forestry, landslide and avalanche monitoring

for applications using fixed-wing UAVs
e.g. corridor mapping, city modeling

for applications using higher-flying large UAVs or helicopters
e.g. mapping with the need of detailed high-resolution data

Explore the full portfolio of proven RIEGL LiDAR sensors and systems
www.riegl.com

RIEGL®

*Austria | USA | Japan | China | **RIEGL WORLDWIDE** | Australia | Canada | United Kingdom*

GreenValley International

COMPANY PROFILE

Headquartered in Berkeley, California, GreenValley International is a leading innovator of 3D mapping technologies. We provide a wide range of advanced aerial, terrestrial, and mobile LiDAR surveying and mapping hardware systems, as well as cutting-edge software and service solutions. we strive to bring to our customers the most effective products that will get the job done.

GreenValley International

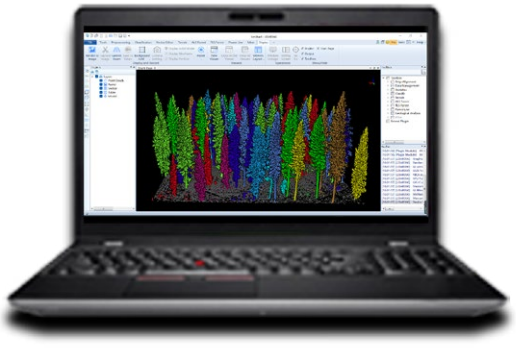
+1(510)345-2899
info@greenvalleyintl.com
2120 University Ave
Berkeley, California 94704

greenvalleyintl.com

APPLICATIONS

- GIS
- SURVEYING & MAPPING
- FORESTRY & FARMING
- POWER SYSTEM
- MINING
- BIM & AEC
- INFRASTRUCTURE
- CONSERVATION

Accelerate Your Surveying



Our high-precision lidar scanning systems, such as LiAir (UAV/Fixed-Wing), LiMobile (vehicle-mounted), LiBackpack, and LiPod (terrestrial), help create smart cities and provide intelligent solutions in energy, agriculture, forestry, roadwork, mining, and more. GreenValley International's LiDAR360, LiPowerline, LiStreet, and other software solutions provide core processing and analysis for accurate point cloud editing and visualization.

While expanding, our primary business efforts focus on innovation and producing breakthrough technology to help create a sustainable future.

GREENVALLEYINTL.

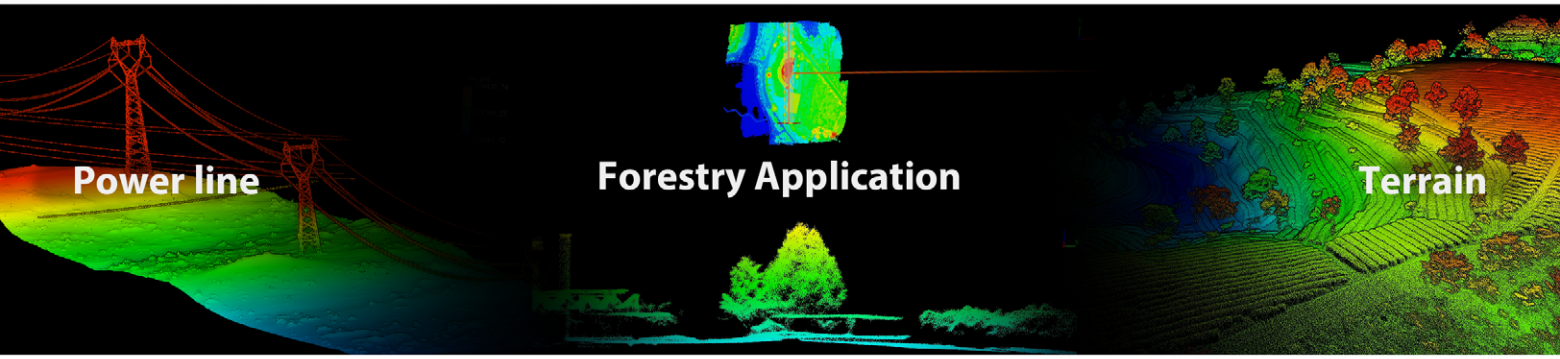
LiAir X3

Enhanced Lightweight UAV LiDAR System

Highly Accurate IMU & GNSS
For the Best Positioning & Details

Upgraded RGB Camera - 26MP -
Providing Ultra-Clear Resolution

LiPlan Flight Assistance Software
Making Field Work Easy



Scan here to learn more about LiAIR X3
or explore GVI's full array of products at greenvalleyintl.com

@GreenValleyINTL

+1 (510) 345 - 2899
info@greenvalleyintl.com
2120 University Ave. Berkeley, CA 94704

LIDAR LEADER AWARDS
OUTSTANDING INNOVATION

GEOCUE

COMPANY PROFILE

GeoCue and Microdrones have something for everyone. GeoCue and Microdrones have joined together to offer the very best in drone surveying equipment, geospatial software, workflow, training, and support.

Does your business need only software to process LiDAR data and images? LP360 allows you to process, analyze, and maximize drone survey data, producing valuable information and deliverables.

Are you in need of only software and the LiDAR payload? TrueView offers innovative drone LiDAR and photogrammetry sensors integrated into lightweight payloads compatible with all platforms that can carry the weight.

Or, if you prefer a fully integrated system then our product line from Microdrones offers complete end-to-end systems that include the drone, the LiDAR and imaging payload, software, workflow, training, and support.

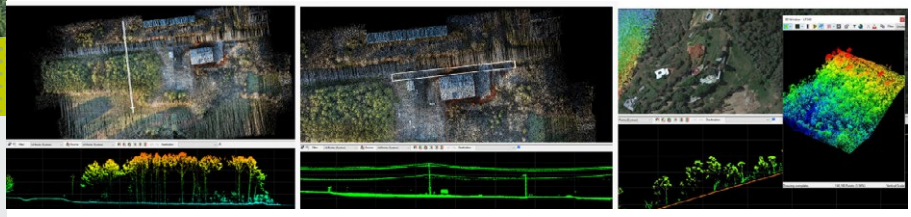
GEOCUE

Founded 2003
11-50 Employees
520 6th Street Madison, AL 35756

geocue.com

APPLICATIONS

- MAPPING
- PROCESSING
- SURVEYING
- UNMANNED
- AERIAL
- CONSULTING



True View 3D Imaging Sensors

Powerful LIDAR + Dual Camera Sensor integrations, post processing software and data management for high accuracy drone mapping applications.

Fly, Process, Deliver—All in One Solution

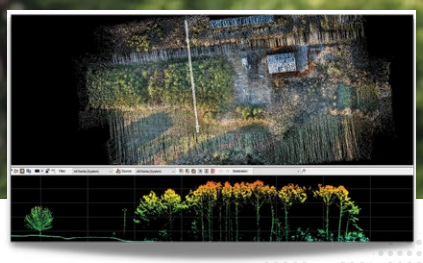
GeoCue's True View 3D Imaging Sensors offer an innovative drone mapping solution supporting LIDAR, photogrammetry, and direction geo-referencing solutions integrated in lightweight payloads. GeoCue focuses on offering full solutions rather than individual parts. Unlike other drone LIDAR providers, GeoCue includes post-processing software and a data management portal to provide users with a complete solution from flight to post-processing and data delivery.

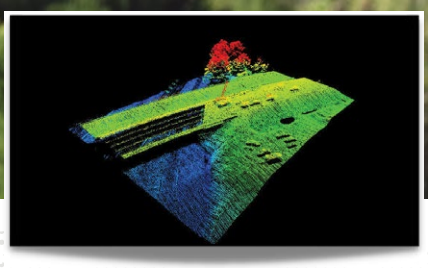
Utility-Grade to Survey-Grade 3D Imaging

GeoCue offers a series of True View 3DIS systems ranging from utility grade to survey grade ensuring successful drone mapping projects no matter the application. The True View 3DIS includes all the components and software necessary to collect LIDAR and RGB image data and process these data to a 3D colorized point cloud in LAS format. True View systems use Applanix POS for best-in-class position and orientation accuracy.

Drone LIDAR Sensor Subscription Offering

Explore drone LIDAR at low risk and low cost. This unique business model that allows customers to acquire a True View 3DIS under a subscription model for periods as short as ONE MONTH! This is an excellent model for seasonal use and surge capacity.





3D IMAGING SENSORS

Drone LiDAR + Photogrammetry Integration

Data Collection

Collect LiDAR and Photogrammetry in a single flight. TrueView 3DIS can be mounted on any UAV that can carry a 2-3 kg payload.

Data Processing

LP360 Drone software is bundled with every TrueView sensor. LP360 generates a colorized 3D LIDAR point cloud in LAS format, provides a vast array of product generation tools, and geotags collected images.

Data Management

LP360 Cloud provides a range of services from sensor calibration management to product data hosting and visualization tools.

info@geocue.com

www.geocue.com/trueview

GEOCUE

TRIMBLE APPLANIX

COMPANY PROFILE

Position and Orientation Solutions
Trimble offers leading mobile mapping solutions while championing the technology revolution that allows pinpoint positioning in any condition. Trimble Applanix products set the standard for organizations that depend on accuracy and quality and who value experienced partners.

Our turnkey and OEM GNSS-Inertial solutions are designed for pinpoint accuracy, efficiency and ease of use, supporting applications for aerial survey and remote sensing, land-based mobile mapping, and autonomous vehicles. Whether you require a complete airborne mapping solution for generating Directly Georeferenced lidar data or guidance and Advanced Driver Assistance Solutions (ADAS) for vehicles, we have your solution.

Trimble

Founded 1978
Over 10,000 Employees
Westminster, Colorado

applanix.com

APPLICATIONS:

- AIRBORNE
- MAPPING
- MOBILE
- OEM
- SURVEYING
- INERTIAL/IMU
- GNSS
- UNMANNED/UNCREWED

APX-18 UAV

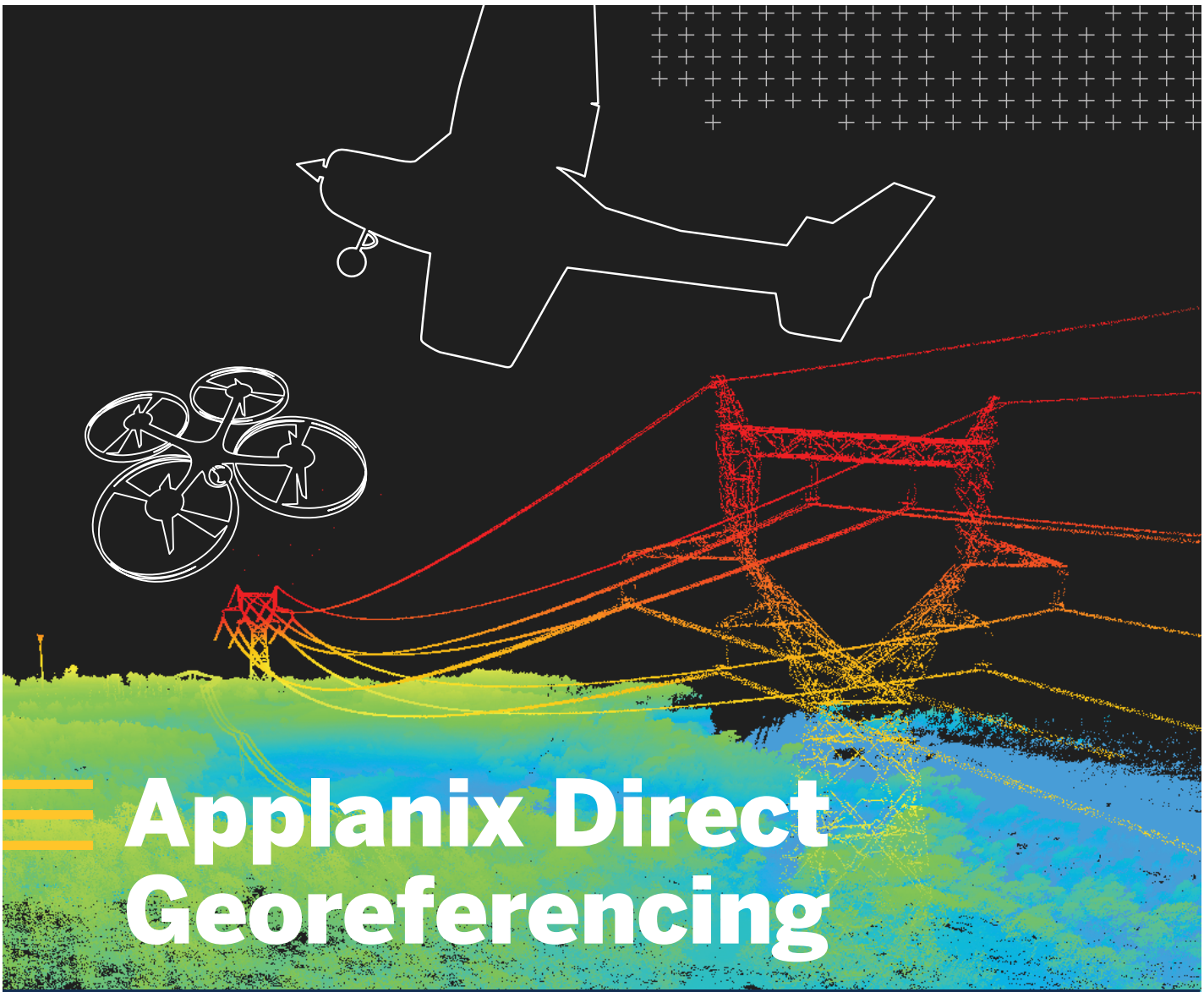
The Trimble APX-18 UAV is an OEM GNSS Inertial solution with dual GNSS antenna input, designed to georeference lidar and other imaging data when collected from Unmanned Aerial Vehicles (UAV) at low speeds or when hovering. Comprised of a small single OEM board containing a precision GNSS receiver with two antenna heading and inertial sensor components plus POSPac UAV Differential GNSS-Inertial office software, the Trimble APX-18 UAV produces a highly accurate position and orientation solution for directly georeferencing lidar point clouds and imagery.

High accuracy, extremely small package

Measuring just 100 x 60 mm and weighing only 62 grams, the APX-18 UAV provides unparalleled performance in an extremely small package. With the included POSPac UAV post mission software, it produces a highly accurate position and orientation solution for direct georeferencing of cameras, lidars and other UAS sensors.

Key features:

- High-performance Direct Georeferencing solution for improved efficiency and accuracy of mapping from small Unmanned Aerial Vehicles
  - Reduce/eliminate GCP's
  - Reduce sidelap
  - Accurate lidar georeferencing
  - Instant alignment through dual GNSS antenna heading
- Compact single-board OEM module complete with survey-grade multifrequency GNSS receiver and MEMS inertial components
- Applanix IN-Fusion™ GNSS-Inertial and SmartCal™ compensation technology for superior position and orientation performance
- POSPac UAV Differential GNSS Inertial post-processing software for highest accuracy
- RTK real-time position for precision landing applications
- Supports all common RTK corrections such as CMR, CMR+, RTCM



Applanix Direct Georeferencing

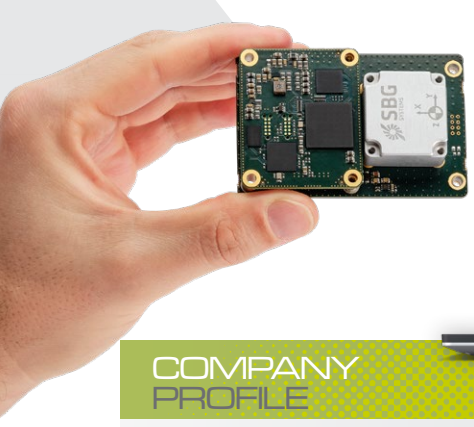
Turn your aerial vehicle into a professional mapping solution, no matter what you fly!

- GNSS-inertial technology specifically designed for Direct Georeferencing airborne sensor data without base stations.
- Applanix DG™ is used with cameras, LiDAR, and hyperspectral sensors for highly-efficient, automated mapping and surveying.
- Experience the accuracy of POSPac MMS/POSPac UAV with Trimble CenterPoint® RTX™.
- Discover Applanix IN-Fusion™ GNSS-Inertial and SmartCal™ compensation technology for superior position and orientation performance.

Trimble Applanix
85 Leek Crescent, Richmond Hill, ON L4B 3B3 Canada
T +1-905-709-4600, F +1-905-709-6027
www.applanix.com
airborne@applanix.com

Trimble®

SBG SYSTEMS



APPLICATIONS

- AIRBORME
- AUTOMOTIVE
- DEFENSE
- INERTIAL
- MAPPING
- MARINE
- SURVEYING
- UNMANNED

COMPANY PROFILE

SBG Systems is a fast-growing supplier of miniature, high-performance, and innovative motion sensing solutions. SBG Systems is headquartered in Carrières-sur-Seine, France and operates in North America from its subsidiary in Santa Anna, CA, and in Asia with its subsidiary in Singapore. SBG Systems offers a complete line of inertial sensors, such as Attitude and Heading Reference System (AHRS), Inertial Measurement Unit (IMU), and Inertial Navigation Systems (INS), based on the state-of-the-art MEMS technology. This technology combined with advanced calibration techniques offers miniature and low-cost solutions while maintaining a very high performance at every level. Our sensors are ideal for projects such as unmanned vehicle control, antenna tracking, camera stabilization, and all surveying applications. From hydrography to mobile mapping and aerial cartography, SBG Systems offers a complete solution including the IMU, PPK software, and services.

SBG SYSTEMS

Founded 2007
11–50 Employees
Carrières-sur-Seine, France
Santa Ana, CA

sbg-systems.com

SBG Systems Unveils Quanta Plus

The Next-Gen OEM GNSS-Aided INS

SBG Systems, a leading provider of navigation technology, is excited to announce the launch of Quanta Plus, its latest Inertial Navigation System (INS). Quanta Plus is a small, lightweight, and high-performance OEM product that can be easily integrated into survey systems with LiDAR or other third-party sensors.

New Quanta Plus: Optimized SWaP and Stellar Performance in Harsh Environments

Quanta Plus is engineered to deliver accurate and reliable navigation data even in the most demanding environments. It combines a high-performance miniature tactical IMU with a GNSS receiver that is resilient to harsh covering conditions, providing RTK fixes even in challenging situations (0.015° roll/pitch, 0.04° heading, 1cm positioning in RTK).

Quanta Plus also benefits from easy integration within Qinertia, SBG Systems' state-of-the-art post-processing software.

The system boasts a wide range of features to make it easy to use and customize for various applications and features a built-in datalogger, ethernet interface for seamless integration, and a user-friendly web configuration UI for simple setup and control.

Quanta Plus is a must-have device for any survey professional or navigation-dependent company looking for a high-performance and robust navigation solution. With its cutting-edge technology, outstanding SWaP-C, and ease of use, Quanta Plus is set to become the new industry standard.

Enhance Performance with Qinertia Post-processing Software

Qinertia improves the performance of data acquired during a mission using reliable RTK corrections from a wide range of CORS networks, or by importing base station data during the process. It also improves accuracy of the position and attitude using forward and backward processing and by integrating a tight coupling between GNSS and IMU data.

Specific Qinertia solutions are available for integrators and OEMs who want to use Qinertia as a library in their application-specific post-processing solutions.

SBG SYSTEMS

Data Sheet

0.02° RTK Roll/Pitch | **0.06°** RTK Heading | **1 cm** RTK/PPK Position

QUANTA MICRO

Outstanding Performance/ SWaP-C

- Tactical grade IMU: 0.8°/h Gyro Bias Instability
- Robust to Vibrating Environments
- Post-processing with Qinertia PPK Software
- Quad-Constellation Multi-Band RTK GNSS receiver

Single or Dual Antenna

Highly Tested and Calibrated

Qinertia PPK Software

Visit our website: **www.sbg-systems.com**

Stonex USA

COMPANY PROFILE

STONEX is one of the world's leading companies in the production of measuring and survey instruments, with over 200 qualified distributors worldwide. The company places the maximum attention on innovation and development of solutions for surveying, precision positioning, GPS networks, and 3D Scanning. The company aims to offer a portfolio of services and products of high quality that meets every need both during the purchase phase and after-sales.

Stonex produces high-quality survey instruments and sells them all over the world thanks to its partners.

The products offered by STONEX include:

- Total Stations
- High precision GNSS receivers
- Handheld GPS/GNSS solutions for GIS and Mapping
- CORS networks systems
- Rugged instruments for the construction sector
- Laser Scanners
- GIS, Topography and 3D scanning Software
- Precision Farming solutions
- Machine Control solutions

STONEX U.S.A.

Stonex USA
54 Regional Dr
Concord, New Hampshire 03301
603-715-5771
sales@stonexamerica.com

stonexamerica.com

Stonex Headquarters—Italy
Viale dell'Industria 53
20037 Paderno Dugnano (MI) – Italy
+39 02 78619201
info@stonex.it

stonex.it

APPLICATIONS

- SURVEYING
- MAPPING
- GNSS NETWORKS
- GIS
- 3D SCANNING
- MONITORING
- PRECISION FARMING
- CONSTRUCTION INSTRUMENTS

Stonex Laser Scanners are the perfect companions for your field surveys

Compact, Easy, Reliable

Stonex laser scanners are precise and easy-to-use instruments, collecting detailed point clouds will not be a problem. X100 is a compact and lightweight tripod scanner that allows you to scan indoors and outdoors quickly, and thanks to the integrated panoramic camera you will obtain coloured point clouds.

With the Stonex SLAM technology present in the X120^{GO} SLAM laser scanner, mapping an environment has never been easier. The system has a 360° rotating head, which can generate a 360°x270° point cloud coverage. X120^{GO} is equipped with three 5MP cameras to generate a 200°FOV horizontal and 100°FOV vertical, capable of synchronously obtaining texture information and producing coloured point clouds and partial panoramic images.

The new XVS vSLAM Scanner is something unique on the market! This handheld scanner uses a technology based on the integration of high-resolution images, inertial systems and a complex algorithm: capturing a scenario with XVS, 3D model will be generated through photogrammetric techniques. Easy like a phone, powerful like a scanner.

STONEX U.S.A.

Stonex USA | 54 Regional Dr. | Concord 03301 - New Hampshire
For a Stonex dealer near you contact us:
Phone: 603-715-5771 | sales@stonexamerica.com

XVS
3D SCANNER
VISUAL SLAM

New Generation Photogrammetry

www.stonexamerica.com

CONEXPO CON / AGG
MARCH 14-18, 2023
LAS VEGAS

Come see us:
WEST HALL
BOOTH W44173

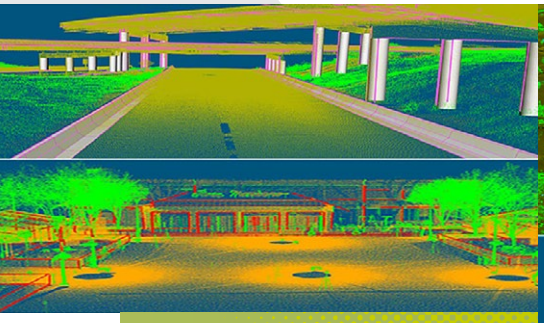
GEO WEEK
FEBRUARY 13-15, 2023
DENVER, COLORADO

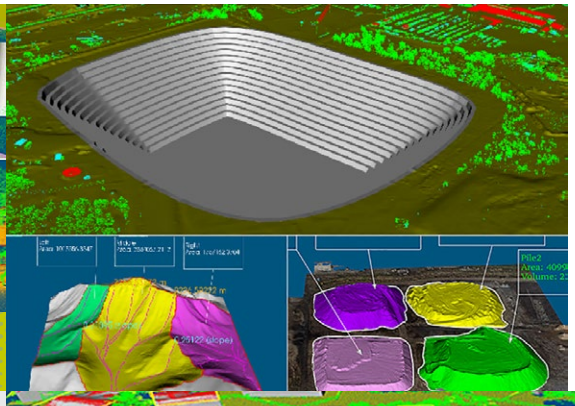
Come see us:
BOOTH 328

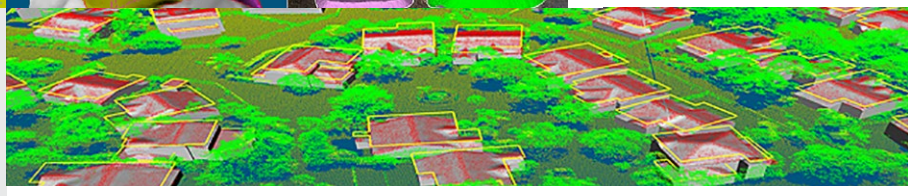
VRMESH

APPLICATIONS

- LAND SURVEYING
- CONSTRUCTION
- CIVIL ENGINEERING
- MINING/TUNNELING
- ENERGY/UTILITIES
- ARCHITECTURE
- ENTERTAINMENT







COMPANY PROFILE

VRMesh is an advanced point cloud and mesh processing software tool that excels at processing large point clouds generated from LiDAR and UAV images. It provides automatic point cloud classification, intelligent feature extraction, and accurate point cloud meshing.

The cutting-edge technology of VRMesh provides the best solution for creating digital twins. It is well known in the geospatial and reverse engineering industries. Our customers span across various fields such as land surveying, construction, civil engineering, mining, energy/utilities, architecture, VR entertainment, etc.

Today, VRMesh has grown to be a notable technology leader in the AEC industry by providing a streamlined workflow and the most comprehensive toolset in the market for making engineers' jobs easier and maximizing productivity at work.

VRMesh

1400 112th Ave SE
Bellevue, WA 98004
United States

www.vrmesh.com

Key Modules:

Point Cloud Classification

Point Cloud Classification tools are easy to use. With one click, you can detect vegetation, ground points, and building roofs. It automatically classifies points which greatly eliminates the post-processing procedure and works well even for extreme terrains.

Feature Extraction

Feature Extraction provides you with an essential tool kit to identify building footprints, breaklines, powerlines, poles, tree crowns, railways, curbs, pipes, and many more. It not only excels at detection variety and accuracy but also presents you with the flexibility between manual and auto detection.

Point Cloud to Mesh

Point Cloud to Mesh delivers unparalleled functionality and reliability. VRMesh can convert point clouds to meshes in any size and produce an accurate mesh with high details. It also allows you to create a solid mesh for visualizing large-volume scans such as construction sites.

Mesh Editing

Mesh Editing covers a wide variety of tools that enable you to design shapes and to seam multiple parts together into one mesh, such as curbs and open-pit mines. With the clay tools, you can simply brush to edit and update the surface mesh. Mesh Editing is an especially crucial resource for industries including but not limited to 3D mining and civil engineering.

Inspection & Measurement

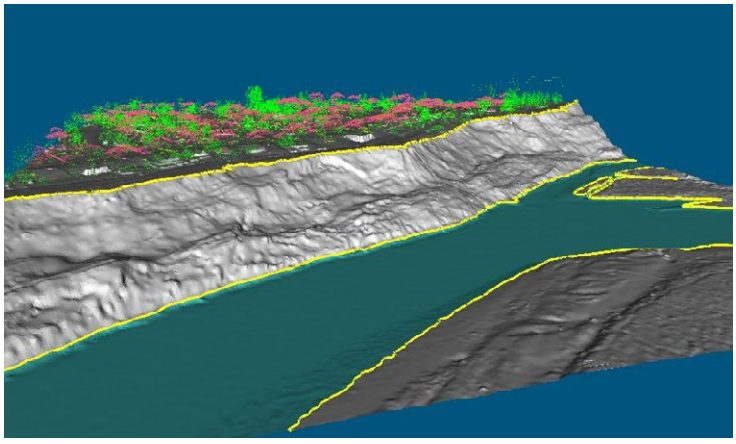
VRMesh supports IFC, STEP, and IGES files. With manual and auto registration tools, you can easily transform CAD files to match point clouds or meshes for inspection. It also equips you with key measurement tools including cross-section deviation measurement, water flow analysis, and volume calculation.

VRMesh

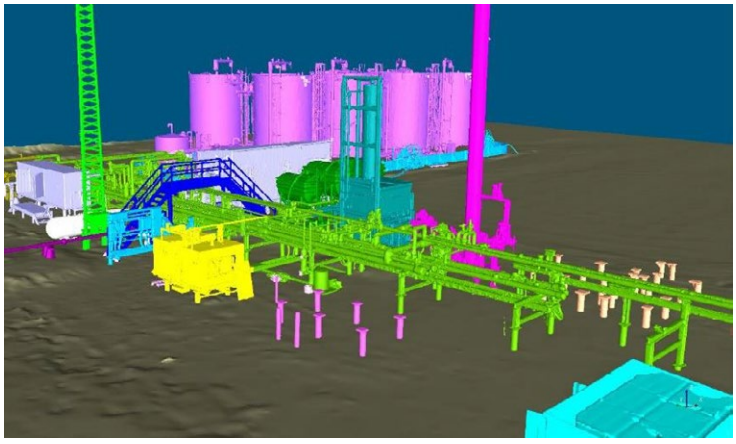
Point Cloud and Mesh Processing

One Software for Multiple Industries

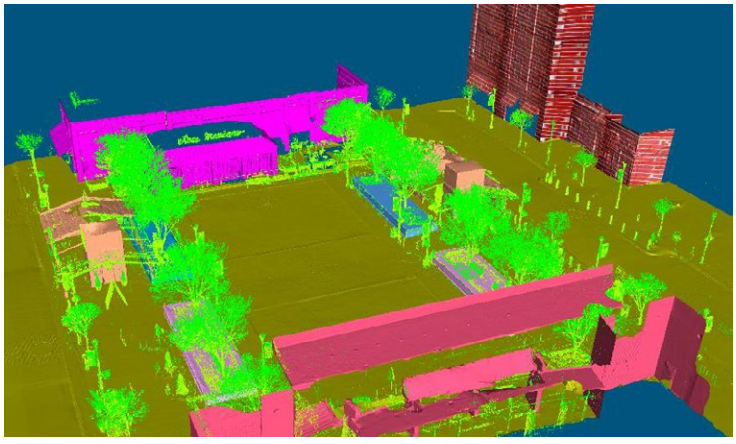
Best Technology for Digital Twin Applications



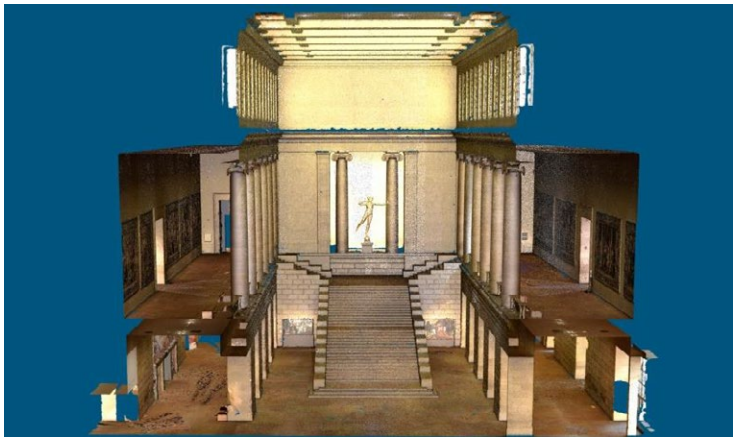
Land Surveying



Oil and Gas



Construction



Architecture

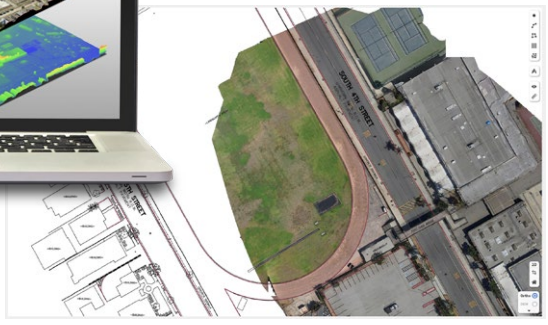
Point Cloud Classification | Building Extraction | Breaklines | Powerlines | Poles | Trees | Curbs | Road Markings | Point Cloud Meshing | Mesh Editing | Clay Tools | Shape Extraction | Tunnels | Contour Lines | Sections | Texture Mapping | Registration | Inspection & Measurement | Water Flow Analysis | Volume Calculation |

www.vrmesh.com | info@vrmesh.com

Carlson Software

APPLICATIONS

- (LAND) SURVEYING
- MINING
- (CIVIL) ENGINEERING
- GIS
- MAPPING
- MACHINE CONTROL
- CONSTRUCTION



COMPANY PROFILE

Carlson Software has innovated for the land development and mining industries with software and hardware solutions built to work for the clients that depend on them every day. As a one-source solution, we provide CAD design software, field data collection, and laser measurement products for the surveying, civil engineering, GIS, and construction industries.

We have a large user base, and an exceptional rate of customer retention over our 37-year history, and we are the only company with free tech support since the day of our founding.

Our wide product range includes Carlson PhotoCapture for photogrammetry and UAV mapping, Carlson Precision 3D for engineering design in 3D, and solutions that include SurvPC data collection software, data collectors, GNSS receivers, robotic total stations, and laser scanners.

33 East 2nd Street
Maysville, KY 41056
606 564 5028
info@carlsonsw.com

carlsonsw.com

Integrated Photogrammetry Solutions

Carlson's photogrammetry solutions take you from flight planning, through image processing, to point clouds, to surfaces, elevation models, and CAD deliverables.

Pre-flight, Carlson's CAD office software provides flight planning. Post-flight, Carlson PhotoCapture provides powerful, versatile, scalable photogrammetry processing. It is available in two versions:

Carlson PhotoCapture Online may be used on any device with access to the internet. All that's required is a yearly membership and the purchase of processing capacity as needed. No minimum monthly fees, and projects may be shared for collaboration with coworkers and clients.

Carlson PhotoCapture Standalone is for customers who need Carlson's photogrammetry solution but want to process locally. Now anyone lacking high speed internet, working in remote locations, or requiring enhanced security now has the option of bringing the ease and power of PhotoCapture to their own computers.

Carlson Point Cloud provides powerful tools for processing of point cloud files from aerial or surface sources, whether of laser or photogrammetric origin. Employ the bare earth filters to create surfaces, or use the identified above-ground cloud for feature extraction of point clusters. Use point cloud files to create profiles, sections, contours, breaklines, and finished plats, or export surface models, points, etc. to CAD.

Whether you're working with free LIDAR data, fly your own UAV, or work with terrestrial scanner files, Carlson's industry-proven solutions provide the workflow options to produce the deliverables you need for your clients.

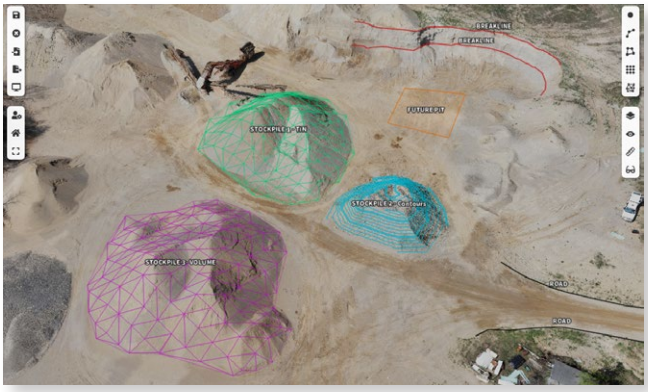
Carlson Software for Photogrammetry

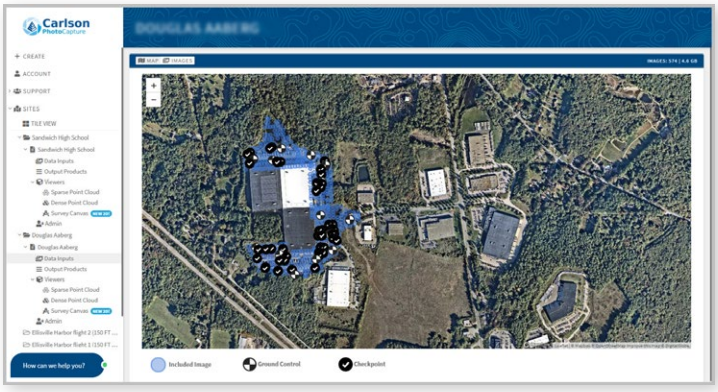
Bridging the Gap Between UAVs and CAD

Carlson PhotoCapture

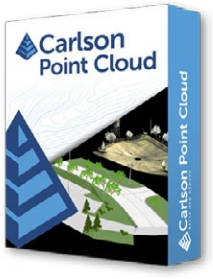
- Choose a perpetual license or cloud-based pay-as-you-go model
- Accuracy through control points and full RTK UAV support
- Output point clouds, volumes, surfaces, elevations, and more
- 30-day free trial

Powerful, versatile, scalable photogrammetry processing. **Online or standalone.**





- Sparse or Dense point clouds
- Orthoimages
- Digital Elevation Models
- Project Quality Reports
- Survey Canvas – Virtual Drafting
- Calculate distances, areas, and volumes
- Create points, linework, grids, TINs, and contour lines
- Export in a wide variety of file formats



- Powerful tools such as bare earth and feature extraction
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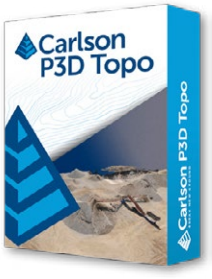

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Screenshot from Map Pilot Pro with the main screen showing the view from the drone's FPV cam. Bottom right: Map with flight route and area of interest.

Bruma, *continued from page 64*

Raising interest in the Rarau ski resort

The Rarau ski resort is located in the Rarău massif, a subgroup of the Moldo-Transylvanian Carpathians, located in Romania. It is a part of the Romanian municipality of Câmpulung Moldovenesc and is built according to international standards. It is a wooded area on the northern slope of the legendary mountain. Thanks to the northern exposure and the location in an area where the snow does not melt completely until April, the slope attracts many tourists both from EU and globally.

The municipality approached Simion Bruma, general manager of BDS Topografie, to contribute to the strategy of the Rarau ski resort development and perform advanced airborne surveying using a combination of photogrammetry and lidar techniques to cover the resort infrastructure and nearby forest area.

BDS Topografie specializes in topographic surveys required for investment projects in road and railway infrastructure, as well as establishment of geodetic networks for measurements and stake-out. It is well known for surveying in Romania: the company was launched back in 2012 as a land surveying service company and purchased its first drone to diversify its services portfolio in 2017. Thus, it has been performing UAV-based photogrammetry since 2017 and lidar since 2020.

Challenging CAD and point-cloud data delivery

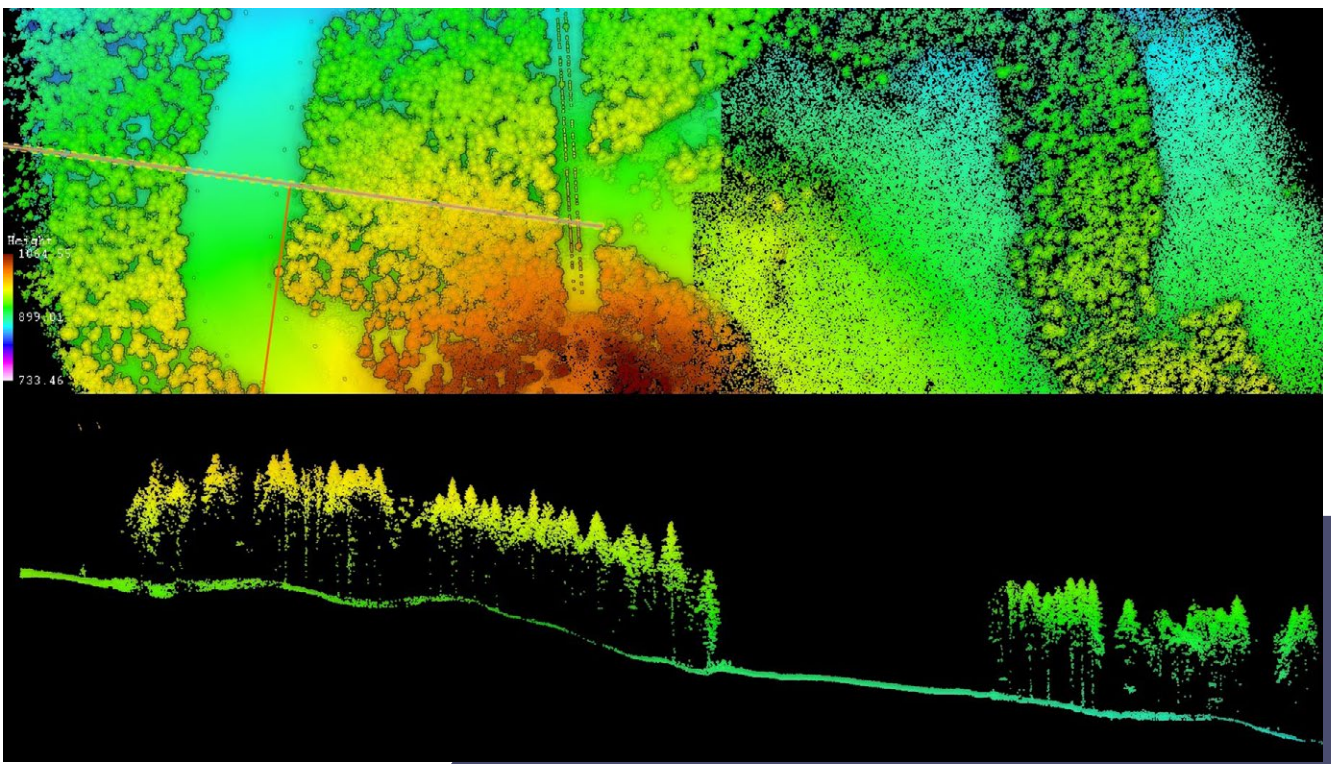
In the surveying project for the Rarau ski resort BDS Topografie used a UniStrong G10 System GNSS base station, a DJI Matrice 210 V2 with a DJI Zenmuse X4S camera payload,

together with TOPODRONE PPK module, TOPODRONE LiDAR 100 system, including Velodyne Puck sensor (VLP-16), survey grade GNSS receiver, IMU and microcomputer. The hardware can capture data over many square kilometers of mountain areas in heavy snow, the only limitation being the batteries. This area, like many others in Europe, had not previously been comprehensively surveyed with drone-based approaches. Moreover, it could take authorized land surveyors several months to conduct the same project with traditional methods—and even then there would be limitations on the information collected about trees.

The combination of photogrammetry and lidar equipment mounted to the same drone enabled BDS Topografie to perform two types of surveying during the same flight and obtain simultaneous, multisensor data acquisition.

"I was challenged with a few things in addition to weather conditions. I had to perform the flights keeping in mind the existence of rocks and running cables. That is why the terrain-aware mission planning was crucial for me in order not to damage the equipment," Simion Bruma explains. He performed six missions in the field, planned the same day in advance in the office with the use of Map Pilot Pro software.

Once flights were completed, the trajectories were calculated and lidar post-processing was performed with TOPODRONE software. Within 15 minutes the post-processing software solution allowed the team to check the accuracy of flights and obtain point-cloud data. "I have been working with TOPODRONE LiDAR systems, both hardware and software, since 2020 after I completed the training in the company's Swiss office," Simion Bruma clarifies. "I like working with lidar data for dense forest surveying purposes—data can be obtained and processed fast, giving very accurate information about the size and height of trees as well



Upper: Lidar point cloud colorized by elevation of the existing Rarau ski resort.
Lower: Profile of the terrain level beneath tree canopy.

Simion Bruma operating a drone by visual line of sight (VLOS), constantly evaluating altitude and flight path.

as the space between them. The most important requirement is obtaining the digital elevation models (DEMs), which allow me to produce all kinds of maps, in different formats like tiled, vector or raster maps."

According to Simion Bruma, however, the local Romanian community still prefers regular topographic maps in addition to point cloud data. "It took me two days to extract CAD vector data from the point cloud obtained from lidar and photogrammetry. We use custom software that we developed for the purpose of converting WGS84 survey projection coordinates into the local projection, Romania Stereographic 1970." When he was at Intergeo in 2022, he discussed with participating surveyors the issue of how to shift clients' mapping habits from CAD vector data to point clouds.

Advancing mountain airborne surveying

Using the latest airborne data acquisition and processing technologies, BDS Topografie was able to conduct a time- and cost-effective study of the requested area with complex terrain. Used in comparison with traditional mapping, such a survey can facilitate enhanced and more accurate assessment of mountain areas at multiple scales from a resort to regional levels. This in turn can inform strategies to best manage and mitigate not only trail and slope planning with minimal interference in forest ecosystems, but also to protect local communities and support the prevention of avalanche risks.

Simion Bruma is a certified land surveyor with over 15 years of experience in cartography, cadaster and forestry. He is CEO at BDS Topografie (www.bdstopografie.com) and a vice-president at the Union of Surveyors from Romania Cluj branch (www.ugr.ro).

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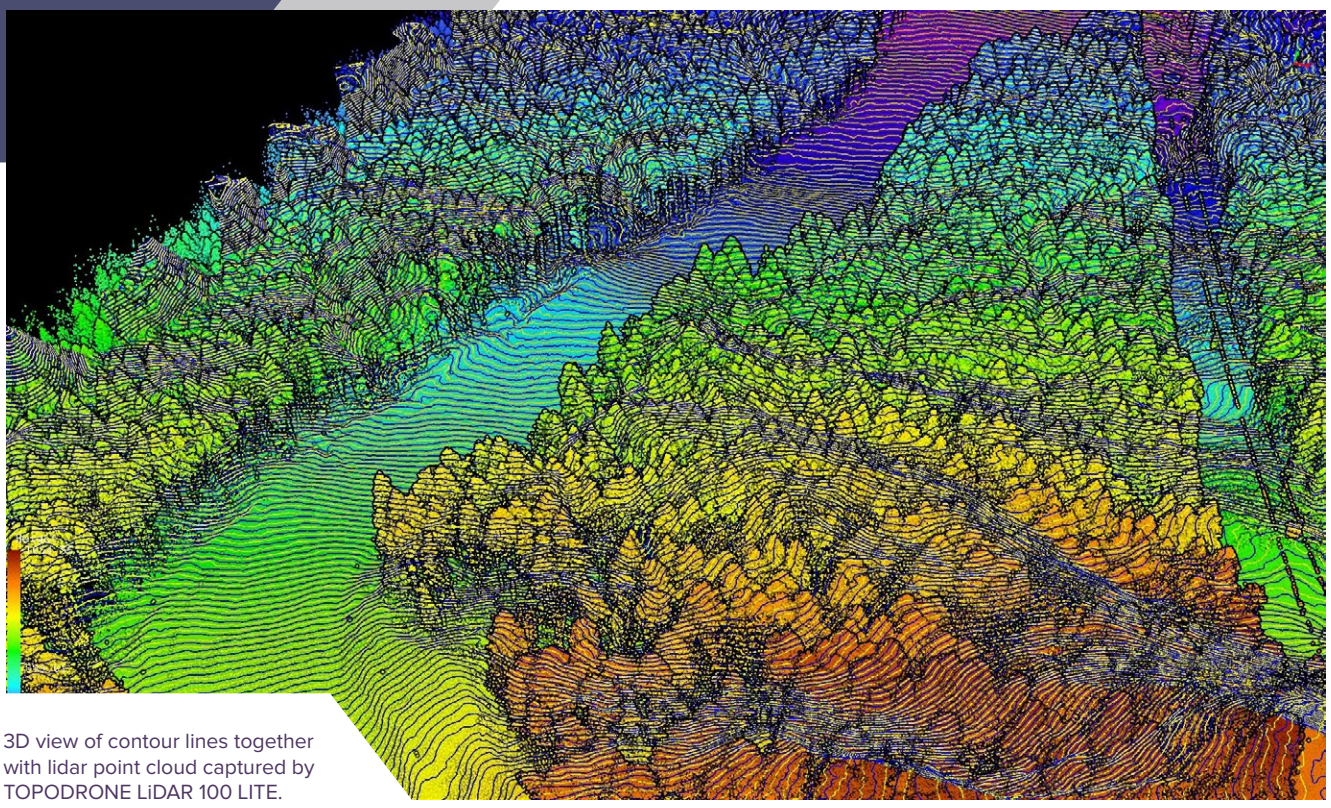

3D view of contour lines together with lidar point cloud captured by TOPODRONE LiDAR 100 LITE.

Ski Resort Surveying in One Day

Romanian firm offers fast turnaround from airborne lidar

BY SIMION BRUMA

A local government client granted BDS Topografie, a leading Romanian surveying company, a project to acquire with a UAV, process and deliver for municipal use high-resolution photogrammetry and lidar data of the Rarau ski resort. BDS Topografie carried out a drone survey to deliver maps and 3D elevation models to support a ski resort development strategy. The aim was to study the situation of existing slopes and identify possible areas for new trails and slopes that would minimize the scale of tree cutting. The workflow from mission planning to data collection and post-processing took one day.

continued on page 60

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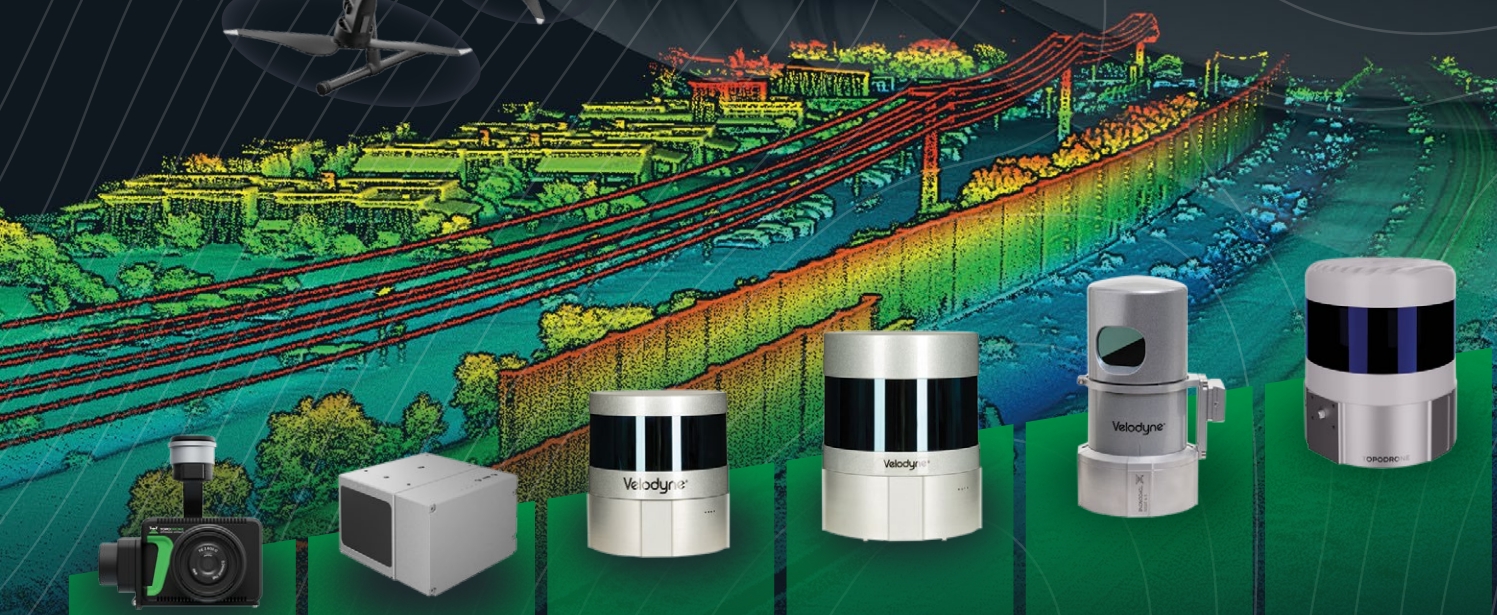

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