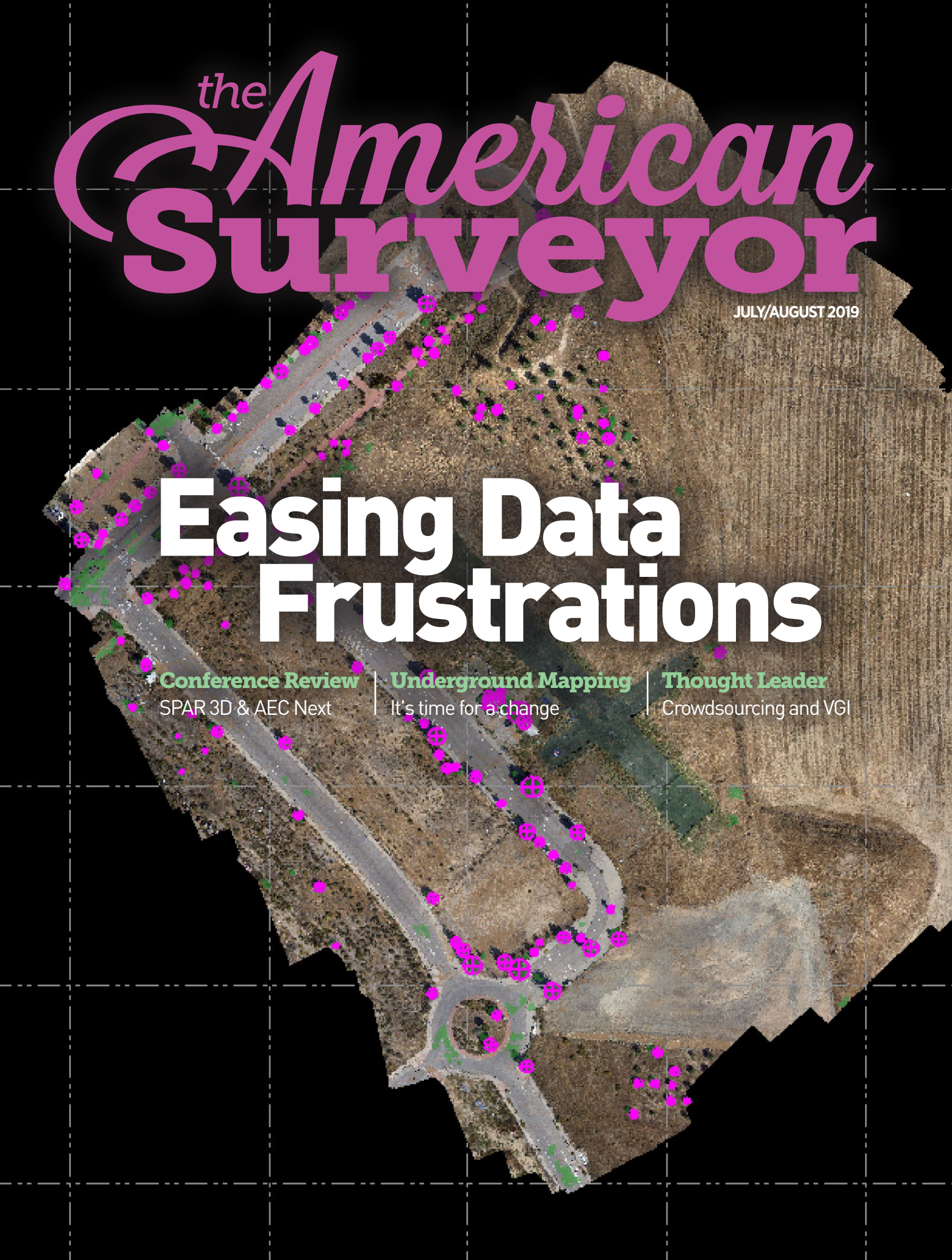
the American Surveyor

JULY/AUGUST 2019



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SPAR 3D & AEC Next

Underground Mapping
It's time for a change

Thought Leader
Crowdsourcing and VGI

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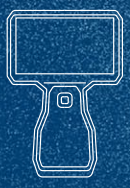

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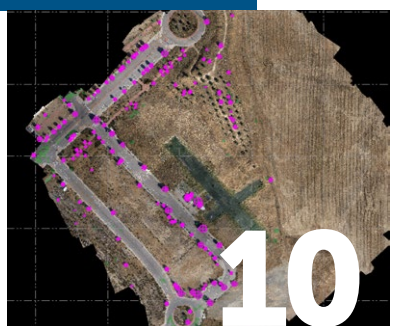

Classified point cloud in Trimble Business Center shows automatically extracted tree features.

features

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departments

in this issue

thought leader

Crowdsourcing and VGI

Crowdsourcing and VGI (volunteered geographic information) have been described by one commentator as "more than a threat to the surveying community" and a "challenge for our community." Another expert has asked, "How is crowdsourcing an application of benefit to surveying," and asks if it is really the crowd or if it "should be thought of as a collection of amateur volunteers."

FIG publication #73, *New Trends in Geospatial Information: The Land Surveyor Role in the Era of Crowdsourcing and VGI*, a report of FIG Commission 3, addresses these questions and more. The publication offers a definition of crowdsourcing as "… the act of taking a job traditionally performed by a designated agent … and outsourcing it to an undefined, generally large group of people in the form of an open call." An example given is a mapping project in Amsterdam showing bicycle routes through the streets and parks of the city. Thus, a transportation system was identified and defined by citizen users, "the large group of people," for the benefit of a surveyor/mapper, the "designated agent." Geographic information was defined by volunteers with a saving of time and effort by the professional surveyor.

The intent is to capture 'authoritative' spatial data "in order to achieve goals whether by 'saving money', 'saving time', or 'saving lives'". A few of the suggested tasks for the application of VGI methods are transportation mapping, hydrographic mapping, zoning, planning and land cover mapping and so on. A somewhat more controversial category from the perspective of the American surveyor is the "compilation of draft cadastral maps for the adjudication of parcels and property owners and for other land management and administrative purposes…" However, the report recognizes that "land surveyors are the experts to identify the methods and tools…" and "are not expected to compromise their professional reputation by using unverified data." Clearly, verification of volunteered data will be of greatest concern to the professional surveyor.

The report discusses conceptual, organizational, fiscal, technical and legal aspects that readers will find informative and logical, while including a few intriguing observations by experts in the field, for instance the example of cadastral surveyors who were "willing to be pragmatic rather than stick strictly to historic methods and high levels of accuracy" in certain countries with developing market economies. The assertion is that the few geographical errors in positioning of properties has "virtually no impact on the functioning of the property market," an arguable assertion from the point of view of the American property surveyor.

The most logical subjects for crowdsourcing and VGI application by surveyors are those spatial data subjects whose dimensions and positions are minimally definitive. Typical subjects could be acoustical levels of noise in urban neighborhoods; distribution of tree species in Central Park; available parking spots in municipal zones; urban escape routes for emergency response and the like, any or all of which would be transferred to the surveyor's base mapping. Collections of statistics on these spatial data could be organized by the surveyor who would also provide training for citizen volunteers and systems for verification at acceptable levels of accuracy. Recruiting and enlistment of the citizen volunteers might be a task for the surveyor or perhaps best accomplished by the client or organization for which the survey is being performed.

For many American surveyors accustomed to taking full professional responsibility for the information displayed on their maps and plans, this will all come as a revolutionary, even potentially perilous service, and one more example that the profession is changing not only in the adaptation of new technologies but in the very form of the services we provide. ■

Robert W. Foster, PS, PE, of Hopkinton, MA, is in private practice, offering professional consulting services nationally in arbitration, dispute resolution and litigation involving surveying and civil engineering issues. He is past president of the International Federation of Surveyors (FIG).

the American Surveyor

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decided guidance: case examinations

Jim Hankins v. *Kandlik*

I want to thank Jim Hankins for steering the ship with his feedback. He offers his thoughts from the dominant perspective in this case. The majority in Kandlik reinforces our need to have a better understanding of acquiescence. Hankins' home state of Illinois encourages the surveyor to assist owners with mediation. Some do and some don't. For the record I equate the surveyor as the first responder on the scene of the incident. This at the least puts us in a position to resuscitate the organs and triage wounds. Hankins reinforces the concept. Jim's thoughts on Kandlik are as follows.

• • •

Jason,

I really enjoyed your article on Kandlik v. Hudek, and thank you for the kind words. One thing that I would like to point out in the Barbershop is the fence. Although you hit the nail on the head that the majority found the fence to be the boundary because of acquiescence instead of because the original grantors purposefully divided their land into equal halves by area and clearly expressed that intent in the deed descriptions, the fence does have bearing on the boundary. What the majority found was that the fence formed the basis for the intent of the grant. It was not called out in the deed descriptions but was very likely erected soon after the survey.

Say for the sake of argument that a recent survey was conducted faithfully retracing the deed calls of the original grant and that none of the "posts" remained or could be recovered, however, an ancient fence was recovered 3 or 4 feet from the retracement line. The fence becomes a monument because it stands as the visible evidence of the intent of the Grantor and the acceptance

of the Grantee. In other words, it becomes the accepted or "acquiesced" boundary line between the parties of the common grantor. It was never intended that a deed should become a document to be followed literally without interpretation. That is why we have monuments. I do not mean that we should accept fences over natural or artificial monuments. What I do want to say very strongly is that we have way too many surveyors out there who "stake the deed" without looking at the evidence. Old fences are evidence. They cannot and should not overcome survey monuments and they must be viewed in accordance with the intent of the Grantor, but they cannot be ignored.

Taking this back to KANDLIK, the majority found the fence to be convincing evidence of acquiescence between owners. I believe that your analysis is correct as is that of Justice Stone that we cannot just survey the fence and walk away. There is a discussion in *Northrop v. Opperman* (a Wisconsin Supreme Court case that you wrote about) in the Law Review which I believe I sent to you. It discusses the difference between Acquiescence as a legal doctrine, and Acquiescence as a finding of fact between owners. I'm not sure that I am lawyer enough to write a paper on this, but I think that it bears on KANDLIK. The owners properly and lawfully divided their property into the north and south "halves". They described it based on what looks very much like surveyors work. Then they built a "fence" on the boundary line based on what appears to be the surveyed line and the deed line. If the fence does not exactly match the 2019 survey of the deed, and the fence is the only remaining evidence of the survey, do we want to send our clients into a civil war over where the boundary is located?

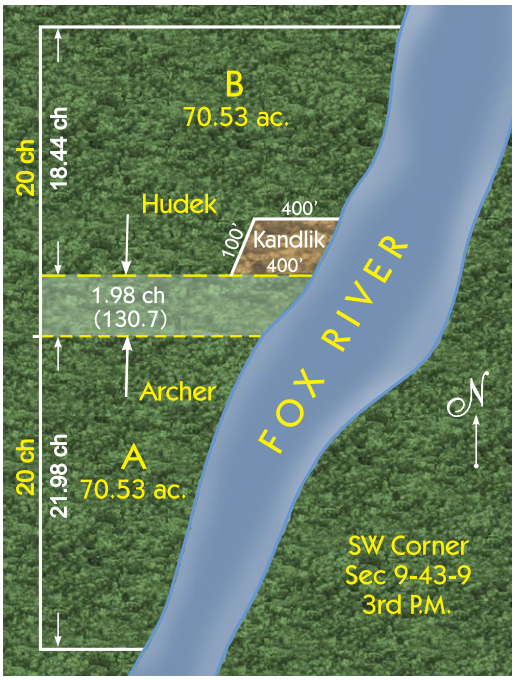
Justice Stone got it right. But, allow the majority to opine that the fence is the manifest evidence of the intent of the original parties to the deed regardless of the measurements. It is our duty to determine if the fence is the boundary or just a fence. I have seen so many bad legal descriptions, as I'm sure you have, to trust that the words adequately convey the meaning of the Grantor. The actions "on the ground" have a profound impact. There is an old saying that: good fences make good neighbors". I'm not and have never been a "fence line surveyor" but the older I get and the more I read, the more tolerant I get of boundary fences; and the more likely I am to mediate a boundary dispute.

Forgive my preaching to the choir. I truly enjoy your work and look forward to every issue. Keep up the good work.

—*Jim*

• • •

I first want to thank Jim for sounding off here. As I focused on Justice Stone's point of order in this case, I glossed right over an equally important concept. Jim gets us back on track with the majority opinion and the meat of the decision."...*allow the majority to opine that the fence is the manifest evidence of the intent of the original parties to the deed regardless of the measurements.*"



> "It was never intended that a deed should become a document to be followed literally without interpretation."

Jim points out *"What the majority found was that the fence formed the basis for the intent of the grant. It was not called out in the deed descriptions but was very likely erected soon after the survey."* While I was blathering on about how *"...There simply was nothing to acquiesce because everyone lived lawfully under the terms of the original grant..."* this little devil lurks among the details. Fences are seldom called out in legal descriptions but they frequently appear on the ground. Albeit seemingly obvious to us as experts, the Courts need a mechanism to take a leap of faith with "undocumented" fences. This is acquiescence. Jim points out with Opperman acquiescence is known as a legal doctrine and it can also emerge as a finding of fact. Best I can tell our expertise is limited to locating fences showing their qualities as evidence. Our opinion of the boundary location leads a court to a finding of fact regarding the true status of a fence. In that obligation we are the eyes of the court. Mediation was brought up as well. As I said, I'm all for the surveyor working toward that end to resolve conflict. I wonder if that's part of a current college curriculum?

So let's rewind the tape and run the play with Jim's focus. Justice Stone cites *Jackson v Dysling "It is a familiar doctrine of law, that title to real estate cannot be transferred by parol. It is settled, however, that proprietors of adjoining tracts of land may, by a parol agreement, settle a disputed boundary line between them. Such an adjustment of the boundary, if followed by corresponding possession, may be binding on the parties, not because it passes title, but because it determines the location where the estate of each is supposed to exist."*

Anybody care to describe what the physical evidence of a parol agreement and corresponding possession might look like? I suspect it might contain a series of weathered posts strung together with rusty wires and so did the majority in Kandlik. To Jim's point, we should show the continuity of location between a fence and legal description where ambiguity is flagrant. This helps the lawyers and courts determine the applicability if we cannot. Conversely, we should apply the continuity of fence evidence with our opinion when owners have harmonized their interpretations.

Regardless of the migration or evolution of the technical language in these grants the tracts did not change on the ground. This seemed to be a no-brainer for the courts. Interestingly the chainees in title chose to re-adopt aliquot terminology after the original subdivision deviated from Tiffin's PLSS schematic. This could color if not cloud or even break a chain of title. However, actions speak louder than words and the courts easily resolved this issue by considering how the folks behaved (i.e. built and respected fences following the original 1848 subdivision). Heck, there's even a description in there that translates a parcel in both terminologies. If you subtract my side swilling and Justice Stone's special concurrence, we are left with only the manifest evidence of the fence delineating the boundary. Great call Jim!

Jim offers his professional observation that *"It was never intended that a deed should become a document to be followed literally without interpretation."* Well, Johnny H. Lawndarts on a popsicle stick! I share that same observation but I was too busy spouting off about how great those descriptions are. Come to find out that the majority subjugated those great deed calls to the owner's interpretation of the boundaries. "*the evidence clearly and overwhelmingly sustains the findings...that the fence... had been uniformly recognized and treated by the owners of such tracts as the division line since 1848".* Hankins crushed it here. Do you know who else nailed that point? Chief Justice Cooley.

Now, brothers and sisters of the congregation turn to page one of the rope stretchers hymnal and join with me in the inspirational recital as the choir backs us up. "*When a man has had a training in one of the exact sciences, where every problem within its purview is supposed to be susceptible of accurate solution, he is likely to be not a little impatient when he is told that, under some circumstances, he must recognize inaccuracies, and govern his action by facts which lead him away from the results which theoretically he ought to reach. Observation warrants us in saying that this remark may frequently be made of surveyors.*" AMEN! ■

Jason Foose is the County Surveyor of Mohave County Arizona. He originally hails from the Connecticut Western Reserve Township 3, range XIV West of Ellicott's Line Surveyed in 1785 but now resides in Township 21 North, Range 17 West of the Gila & Salt River Base Line and Meridian.

conference report

SPAR 3D Expo & Conference

AEC Next Technology Expo + Conference

The SPAR 3D AEC Next exhibit hall is the world's fair of 3D measuring and a "who's who" of hardware, software, and service providers.

Throughout the last half century I have been to my share of trade shows and conferences. When I was a kid, my favorite was the auto show. Then a little later I took a shine to the boat shows. I've managed to put more than my share of survey conferences under my belt. Heck, I've even been spotted at a national public works venue. I enjoy them all but there's one show that still gives me the youthful thrill of that new car smell and the excitement of the unveiled future.

SPAR/AEC is all of the cool stuff about surveying without the old cranks carrying on about some theoretical center of section somewhere in Unicorn Township along the Sasquatch meridian. The crowd stats showed that 44% of the attendees claimed they were Architectural Engineering Construction (AEC) demographic. The next largest single sector was surveying and mapping representing 16.5% of the 1,900 attendees. That's about 300 rope stretchers and enough to hold their own conference in most states. Among the diverse crowd were surveyors of all ages. I chatted

Topcon showcased their latest innovations and product lines featuring advanced robotics.

with Sam Diaz, PS of Bechtel Global Corporation about mobile localization and handheld LIDAR. Sam had mentioned how far back he and old man Cheves went. The number is too big to print. I also had the pleasure of chatting with Wojtek Gawecki of ESRI. Wojtek is licensed in his homeland of Poland and is very familiar with American Surveying. We talked a fair bit about the contrasts in the land tenure and both national cadastres. So there was no shortage of productive shop talk among the rope stretchers at the show.

SPAR/AEC is North America's "who's who" in 3D technology, measurement, and the built environment. As I crossed the red carpet and entered the exhibit hall I was overwhelmed by the size, number, and diversity of vendors. I get a warm and fuzzy when I see surveying vendors headlining a technology show. Sure enough all the big names were there. Trimble held prime real estate at the entry and served as an ambassador of our craft. Trimble crushed it with a souped up F150 off road mapping rig. It is a beast! I wasn't sure if I was at work or a SCORE race but I knew that big "T" would get the checkered flag at both. As expected that lead spot really set the benchmark for the whole show and the excitement didn't end there. Topcon showcased their latest and greatest products on the floor and spent time on their features in corresponding press releases at the show. As I became lost among an ocean of vendors, drones, and VR tents, I recognized the old Leica/HxGN moniker in the mix together with a few other names you might know. FARO, RIEGL, and GeoSlam are all hardware vendors that enhance our industry.

Trimble stole the show with their high riding Ford F150 Off Road mapping rig. The world changed for the better when Trimble bolted an off road race truck and monsterous knobbie tires under their MX9 mobil mapper.

SPAR 3D AEC Next is the vendor's opportunity to hear your feedback face to face and exchange the latest and greatest industrial trends with users.

The best kept manufacturing secret in the survey business has got to be KAARTA. They are synergizing personal LIDAR into our everyday tool kits and boldly claim they are the pioneer of mobile real-time 3D localization and modeling. KAARTA's CEO Kevin Dowling is truly a champion of modern mapping.

Bentley Systems, Inc made a big presence at the show. Bentley is invested in the cause of advancing infrastructure and if you don't believe me just look at their website. Bentley has a global impact that interacts with everything from your sidewalks to your success. Software and services relating public infrastructure, civil design, process manufacturing, mining, petroleum, asset management and BIM are all in Bentley's wheelhouse. Bentley's interests are truly the big picture and encompass every aspect of the SPAR/AEC show. Bob Mankowski, VP of Digital Cities, Bentley Systems, Inc, shared his vision and experience with digital twins. Bob's presentation stood out among the show's endless offering of fantastic topics. In this case Mankowski focused on municipal infrastructure and digital twins. A digital twin is just a fancy way of an accurate electronic model. We ran

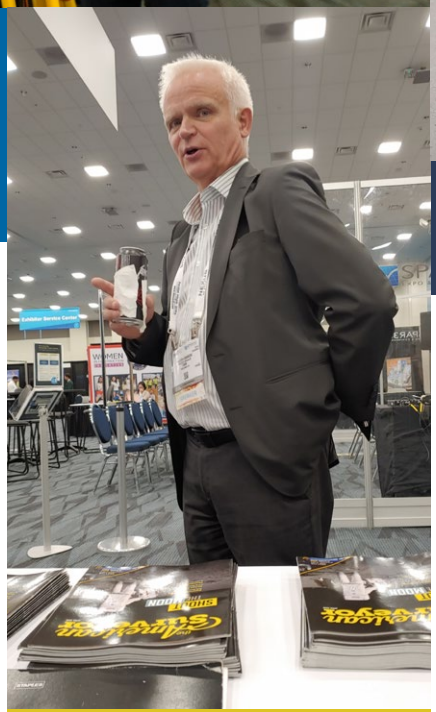
Long time player and pioneer in the laser scanning industry Riegl shares their four decades of expertise with consumers and gets a pulse on the enhancing the user's experience.

The NavVis M6 mobile mapper provides a continuous real time mapping exhibition throughout the span of the whole show while pleasantly commingling with the crowd.

through a few examples of hydrology and preemptive flood modeling leading to disaster response scenarios. The benefits of having digital twins for reconstruction after cataclysmic events is obvious. Mankowski kindly shared personal experience from the 1994 Los Angeles Northridge Quake and emphasized how a digital twin could have mitigated confusion in the aftermath. Bob also touched on the more humble benefits of employing digital twins. Infrastructure is more likely to succumb to rust, corrosion, the elements, and wear, than Godzilla and Armageddon. The folks at Bentley helping municipalities and business manage their infrastructure day to day are the unsung heroes of our generation.

The SPAR/AEC podium is the platform of ideas, trials, and practices in the virtual realm. The great talents in the industry speak about their real world experience in the digitally built environment. Vendors and exhibitors share their greatest assets knowledge and people. The show featured two spectacular keynotes among a host of keynote presentations. MiMi Aung,

Project Manager for Mars Helicopter, NASA talked about "Adding Autonomous Aerial Mobility to Open Doors to New Classes of Planetary Exploration". MiMi is a wonderfully energetic speaker and enthusiastic about our passion with landing



Wojtek Gawecki of ESRI shared his personal expirience as a land surveyor in his home countries of Poland and the United States. Better than 300 surveyors attended SPAR 3D AEC Next.

on Mars. She shared her team's challenges and success story in designing and implementing the first Martian helicopter. In a nutshell she led a team that built the most advanced reconnaissance UAV in history and for a place that has no air to speak of and temperatures ranging between "your ex-spouse and Needles, CA. in July". Big thumbs up to MiMi, the Mars Helicopter Team, and NASA.

So how do you follow that act? Well, IBM let Dr. Bob Sutor out of his cage and he enlightened the crowd on the latest understanding of quantum computing. Dr. Sutor is Vice President of IBM Q Strategy and Ecosystem, IBM Research. His presentation on "Quantum Computing: A View to the Future" was a fantastic showcase of the possibilities in the digital realm. I'm nominating Bob for TAS keynote speaker of the millennium. Who would think somebody could make anything "computing" as comfortable and entertaining as watching SportsCenter on a Saturday in a pair of holey jeans? Bob is a fantastic speaker and of course a master of his subject which lends to his charismatic presentation. He highlighted IBM's open source development platform QisKit and shared the factual details behind quantum computing. Check it out at *qiskit.org*.

This year I was able to get behind the curtains and speak with the SPAR3D/AEC/NEXT show organizer Jason Lavigne of Diversified Communications. Jason and his crew are a contemporary equivalent of a P.T. Barnum and they assemble some of the greatest shows around the globe. Everything including accounting,

buses, food, interior design, kosher food, mapping, marine, medical, organic food, running, seafood, solar, UAV, you name it and Diversified Communications hosts a show. Worldwide locations include Canada, Australia, Canada, Hong Kong, UK, US with shows in Asia, Australia, Europe, and North America. The Diversified Communications team are heavy hitters in the business world and know their trade well. The proof is in the seamless execution of SPAR3D/AEC/NEXT. There's something organic and well played when a 1,900 attendee event doesn't feel congested. Right sizing the venue with the attendance provides a soothing environment and reposed vibe enhances the attendee experience. Next year Lavigne and crew will be hosting the 2020 show June 3-5 at McCormick Place in Chicago, IL. Pencil this one on your calendars folks. ■

Jason Foose is a Professional Surveyor licensed in multiple jurisdictions.

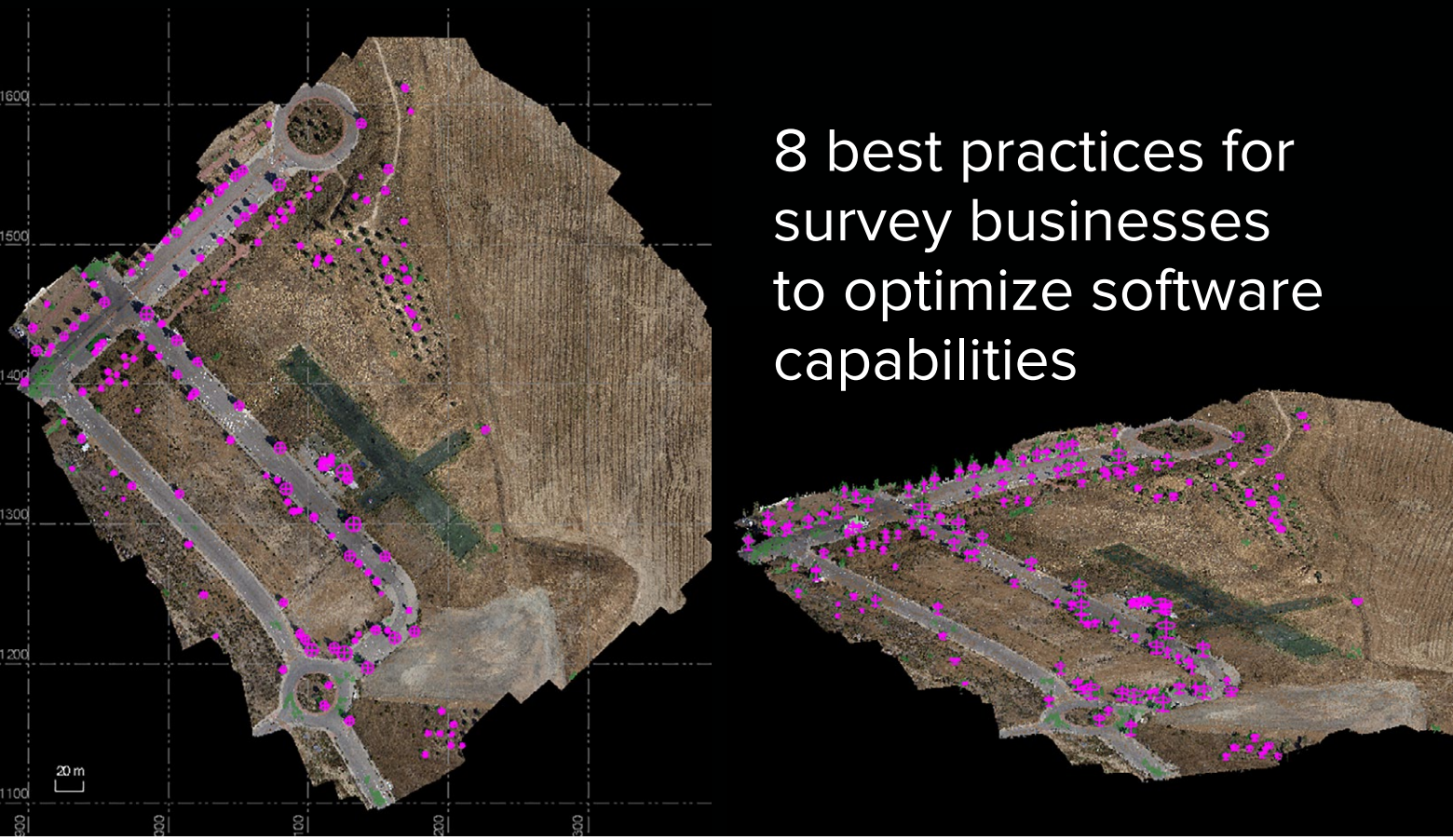
All of our familiar and top notch land surveying vendors support the SPAR 3D AEC Next show with the latest gear and software. Consumers enjoy a depressurized technopalooza and talk turkey directly with the manufacturers.

Spar 3D in a Nutshell

Diversified Communications explains SPAR 3D Expo in a nutshell: SPAR 3D Expo & Conference is the premier international event for the commercial application of 3D technologies focused on 3D sensing, 3D processing, and 3D visualization tools. From sensing with drones, mobile rigs, and hand-held devices to using augmented reality and virtual reality, everything 3D is here at the only vendor-neutral, industry-agnostic event in the market.

EASING DATA FRUSTRATIONS

8 best practices for survey businesses to optimize software capabilities



An example of automation, this classified point cloud in Trimble Business Center shows automatically extracted tree features.

Across the board, software technology is increasingly innovating the way business processes evolve, allowing for greater efficiency and accuracy than ever before.

Surveying industry processes are no exception, with the future trending toward integrated software and collaboration among project teams to extract valuable information from an ever increasing amount of data. The surveyor is now expected to play a key role throughout a project's duration and must be armed with cohesive business software systems that allow performance beyond expectations. The software solutions used by geospatial professionals are often numerous and varied because they are specialized to many different activities, data types and trades. With improved collaboration and open data systems, construction projects can reap the benefits of shared data and reduced rework.

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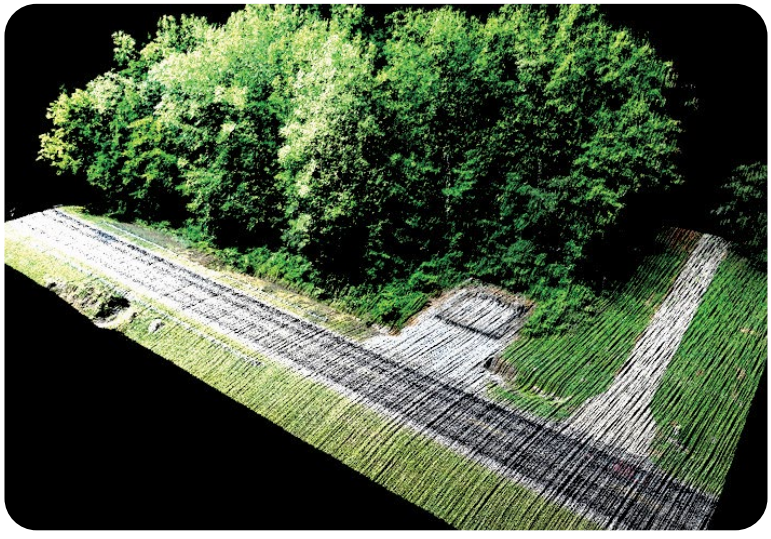

Dual Cameras

LIDAR Scanner

Google Processor

TrueTrack Flightlines

Workflow Software

Applanix Positioning

The True View 410 is the industry's first integrated LIDAR/camera fusion platform designed from the ground up to generate high accuracy 3D colorized LIDAR point clouds. Featuring dual GeoCue Mapping Cameras, a Quanergy M8 Ultra laser scanner and Applanix Position and Orientation System (POS), the result is a true 3D imaging sensor. With its wide 120° fused field of view, the True View 410 provides high efficiency 3D color mapping with vegetation penetration in a payload package of 2.2 kg.

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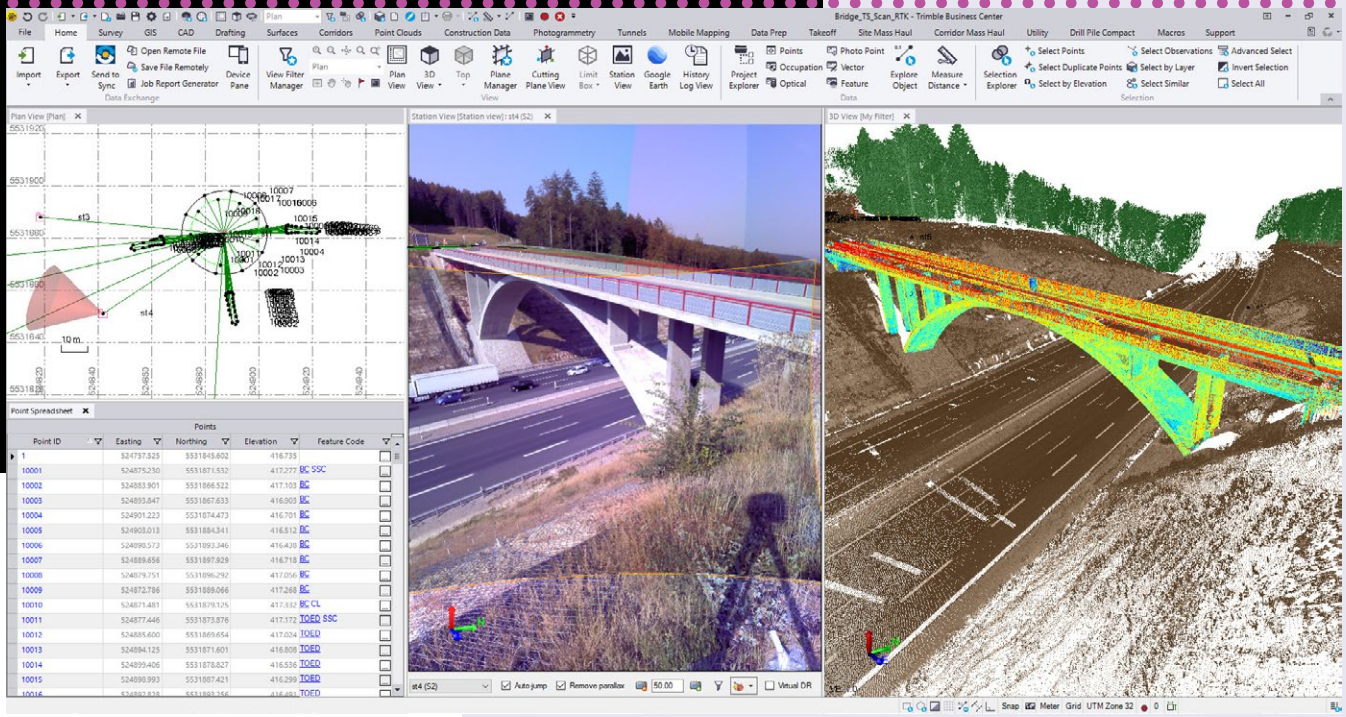


An example of data integration, this image shows data captured by the Trimble SX10 containing traditional total station observations, images and point clouds in a single software environment.

Role of the surveyor

Over time, surveying companies have diversified their businesses, and that trend continues. Survey is integral along a project continuum. Even so, clients increasingly own the process and dictate the rules of engagement, with surveyors needing to deliver or risk losing the work to someone else. Surveyors are highly integrated into project teams nowadays, representing both a challenge and an opportunity to grow and deepen relationships with clients. To grow and expand their businesses, surveyors must be pragmatic in choosing the right tools for the job, which often means changing old habits and embracing new opportunities.

With that in mind, let's explore best practices in evaluating and implementing software solutions for survey teams to ensure they are optimizing capabilities to generate core deliverables and unique services with confidence.

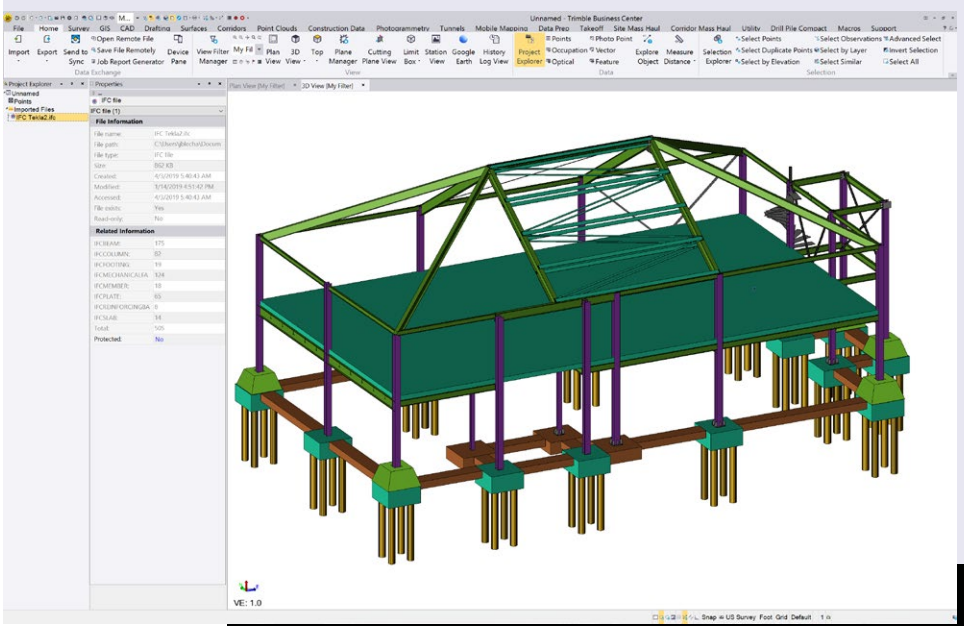
Here are eight actions savvy surveying businesses can take:

1 Be bold and ready to learn.

In a rapidly changing world, the quickest way to learn is to dive right in. With building information modeling (BIM) transforming construction projects today and digital twins and smart cities the view to tomorrow, the adoption of these concepts is still fundamentally based on geospatial information that describes the current state of a physical object or survey techniques to demarcate a virtual object in the real world.

The technology and amount of data used to perform these activities continues to change, but the survey and geospatial principles to ensure accuracy and precise location generally do not change. Your expertise as a geospatial professional is therefore critical to achieve the productivity savings expected by the adoption of BIM, digital twins and smart cities.

Even so, you will need to learn and adapt so your knowledge provides critical



value. Enroll in BIM information sessions, develop connections with industry peers and be bold in bidding for projects adopting BIM methodologies, with the intention to learn. Geospatial leaders are quickly finding their knowledge is more critical than they expected, and solving difficult on-site problems is the quickest way to learn and set themselves up to take on modern projects.

2 Designate a software czar or a team of czars.

If you are a sole proprietor, then this is you. Likely, you are very pragmatic about your choices in software and need to carefully weigh the costs of any changes. But if your strategy is to expand, you'll need to evaluate your well-worn paths and consider whether more efficiencies can be gained from different approaches to your software.

In slightly larger surveying businesses, a designated office professional typically analyzes information and prepares deliverables, while a field person collects the data. Hiring people for these positions who have IT knowledge—IT experts, professionals with dual survey and computer science degrees, or data scientists who are comfortable with cloud platforms and managing large amounts of data— can strengthen the business. These employees often prove invaluable because they know what the company needs to deliver and how to keep technology up to date.

As a best practice, these office professionals should lead continual analysis of new and existing solutions, new integration capabilities, training needs and investments needed to ensure the best mix of software solutions for the business.

3 Consult with an expert.

Sometimes you need to step back and seek out expert guidance, but it is hard to know where to find it. A good place to start is your geospatial solutions distributor. Often, distributors will have experts on hand to demonstrate new solutions and connect you to existing users. They also are a resource for user forums for asking questions and engaging with others in the profession.

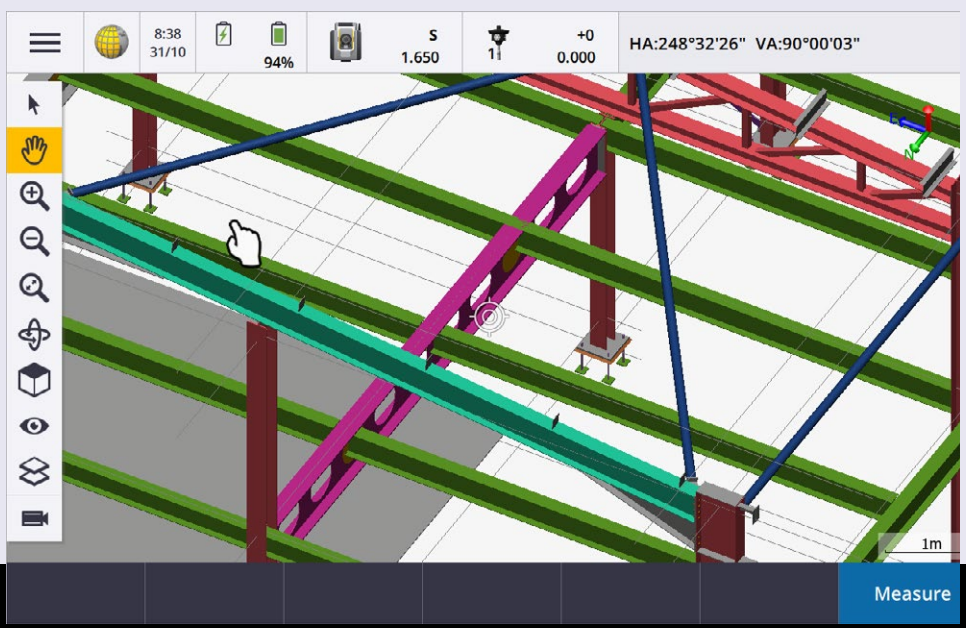
In addition, there are geospatial software consultants who can provide independent analysis of your current field-to-finish setup, explore opportunities and provide implementation recommendations. These professionals take a holistic look at your processes using a digitalization strategy. How do you collect data? How do you transfer it? How do data integration and office validation processes work? And what's the most efficient method to generate final deliverables? Some organizations are getting savvy with these processes and hiring programmers to develop highly efficient, bespoke solutions.

4 Consider your data—protect it and choose flexibility to share.

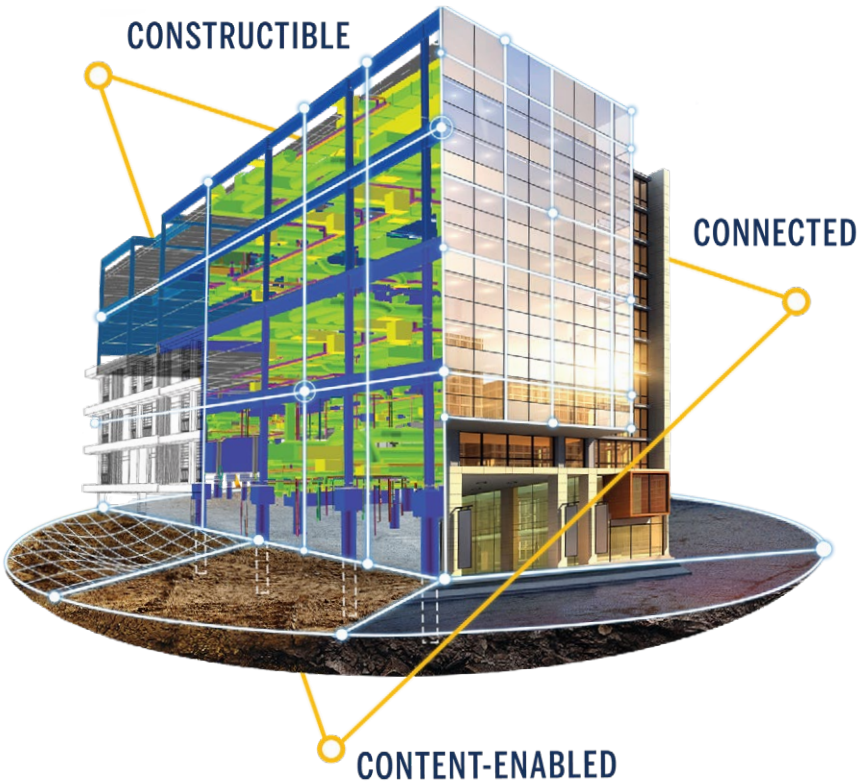
As a geospatial professional you spend endless hours outdoors capturing data that is the foundation for the value you provide clients. Protecting data and client information is essential to protecting your business. Securing your devices, networks and updating software are obvious steps to avoid hacking or infiltration by malware. Backing up data has never been easier by storing across multiple servers or in the cloud.

While you need to protect your data, it's also critical to easily share, move and use your data with a range of different software products or cloud solutions. The adoption of BIM, in particular, is driving the use of rich data throughout the workflow process, demanding the use of more open data standards and improved data interoperability. These changes make it easier to collate data from different sources, track progress, analyze clashes and share information with project stakeholders. Geospatial software is adapting to these needs by ingesting data from multiple sensors, as well as supporting interoperability with industry and open standards or establishing direct connections between systems used to complete a workflow.

Trimble Business Center software exemplifies the benefits of data integration and interoperability by providing geospatial professionals with a data hub that's flexible for choosing sensors fit for purpose. Whether GNSS, total station, levelling, lidar, imaging or photogrammetry—it doesn't matter if the data is collected by walking, driving or flying. The result is one software solution for high-accuracy data, CAD deliverables and rich information with full traceability back to the sensor. Trimble Business Center also is increasingly data agnostic, supporting industry standard data types and interoperability with other solutions, including AutoDesk, Bentley and Esri products.



These two images show a BIM model in Trimble Business Center (office) and Trimble Access (field).



From bidding to building and beyond, the construction industry is moving beyond traditional BIM processes to drive more downstream value and better control fabrication and installation in the field. Connected systems to track, store, and display complex data on the fly help deliver valuable, actionable information to all construction stakeholders.

rich data types with existing workflows and automatic or semi-automatic extraction capabilities will provide your business with the greatest efficiency gains.

The focus is also shifting to how companies can do more with their data. With improved data interoperability, professionals farther down the value chain can view, use and share the data to make fast decisions. At the end of the day, you can collect all the data you want, but you also need to know how to make an informed decision with it.

6 Look for customization flexibility.

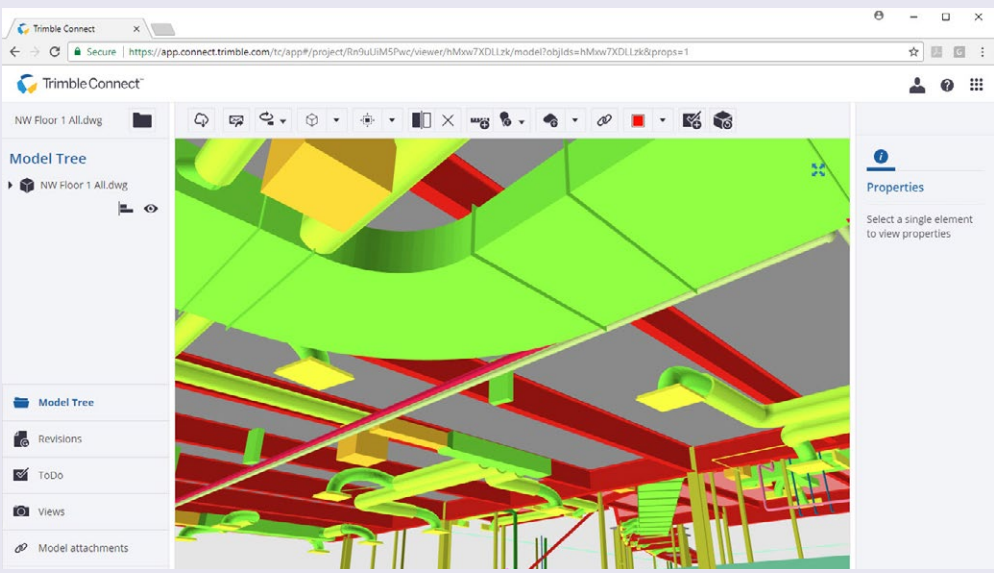
When selecting software, choose a solution that offers flexibility through customization. Many packages today come with application programming interfaces (APIs), which are really handy if you are integrating workflows with existing business process management software for tasks like invoicing and payroll.

You may find software that does 99% of what you need but is short by one command or operation, and the ability to customize makes it possible to add this functionality. Also look for software that offers extensibility via a macro language such as Python, ArcGIS or Trimble Business Center, or packages

5 Select solutions with automated features.

Tools enabling factual decision-making from big data will be a large focus in geospatial software going forward. We are no longer talking about the collection of big data but the efficient extraction of meaningful information from large amounts of rich 3D scanning and imagery datasets.

However, you need to be selective in picking solutions that offer automatic extraction to ensure they match with your main application. While capabilities are rapidly expanding to support different applications and object types, the robustness of automatic extraction is the key to productivity savings. If you spend the same amount of time verifying the result of automatic extraction, then it's quicker to extract objects manually. There is no magic "extract my CAD plan" solution available...yet. Software solutions that blend



Cloud collaboration solutions like Trimble Connect democratize construction data so a wide range of stakeholders are able to view and consume the current files without the need for specialized software.

that come with well-documented software development kits (SDKs), which allow you to define your own workflows and extend the software capabilities.

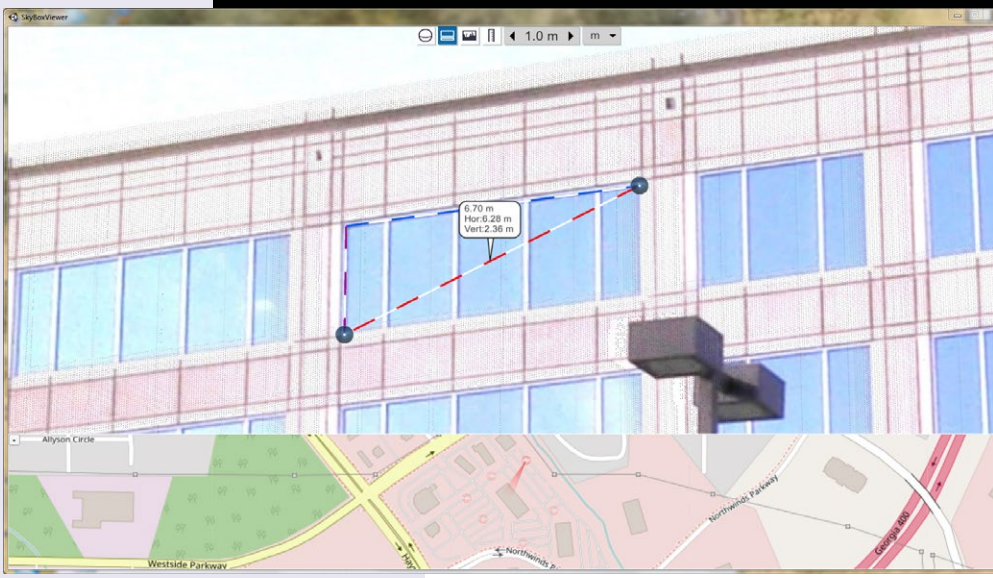
7 Push into the cloud.

Cloud-based products and services are synonymous with global connectivity, information sharing and collaboration. For geospatial professionals, the ability to leverage the cloud for data processing and information extraction can expedite production of final deliverables. Cloud solutions are also proving critical in sharing those deliverables in an open and accessible format—vastly extending the base of potential consumers of that data, and in turn, driving more demand for valuable geospatial information.

Connectivity is a key driver for enabling productivity savings, and the future 5G network will minimize the current limitations of data upload delays and visualization performance, especially with rich 3D point cloud data. Rather than waiting for hours to upload data or shipping a hard drive, geospatial professionals will easily upload and utilize cloud processing solutions across distributed systems to quickly generate results. With the resultant data and information deliverables in the cloud, professionals can take advantage of data sharing and collaboration tools to help clients quickly make informed decisions and maximize the value of their data.

Cloud-based solutions, such as Trimble Connect and Trimble Clarity, provide coordinated construction information for all project stakeholders to share, view, coordinate and comment on visually rich models. Viewers can review the data and collaborate via their web browsers on computers or mobile devices, without compromising integrity, security or performance.

The cloud also reduces the burden of the capital expenditures prevalent with traditional office business processes. Gone are the days of purchasing software licenses, setting up large-capacity in-house servers and having an IT team physically touch each computer in the office.



Clients can better understand project conditions through shared views of the data like this one using Trimble Clarity.

In fact, with cloud-based software, many businesses can forego investing in high-performance office computers by utilizing lower power and lower cost office hardware, including tablets and smartphone devices, to perform the most common tasks. Cloud-based storage provides physical security of the hardware, automatic backups and a strong defense against unauthorized access while allowing organizations to maintain ownership and tight control over their data.

The cloud also enables connected worksites, buildings, farms, cities and other projects a fluid transmission of information, avoiding downtime and allowing continuous progress.

8 Take advantage of the as-a-service business model.

The modern surveyor can't do the job today without specialized software, and the software-as-a-service (SaaS) or software subscription model will continue to evolve to support project workflows.

The as-a-service business model is tied to the benefits of the cloud because it allows companies to more efficiently manage each project and reduce operational costs. Organizations pay for only what they use and allocate software costs to a specific project.

Conclusion

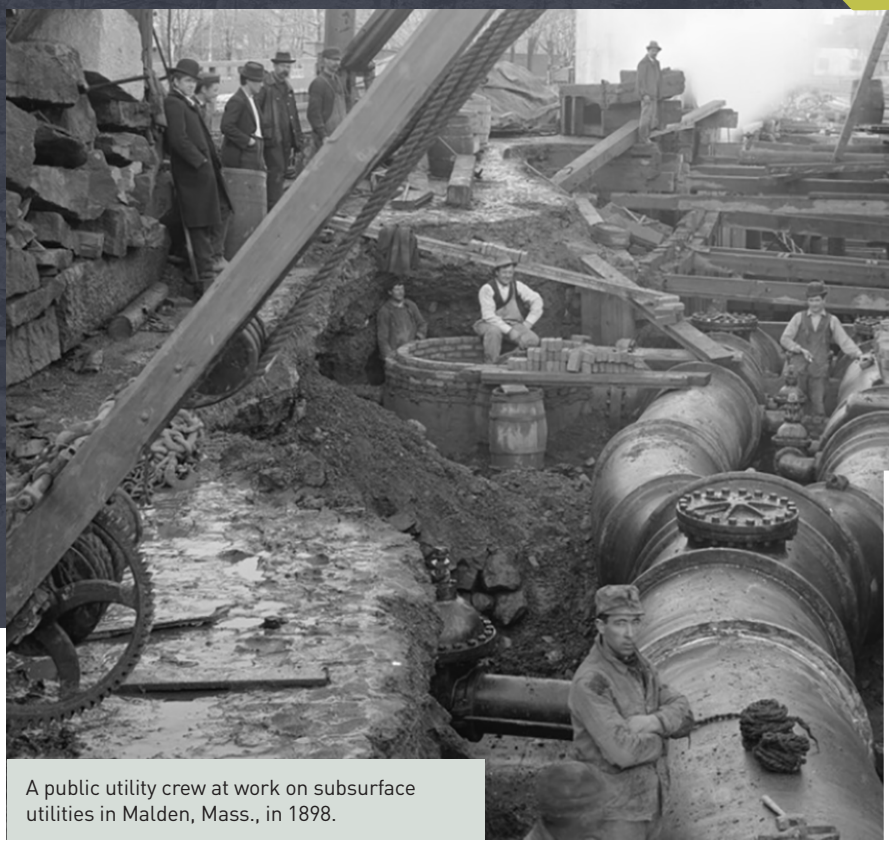
Whether you are just beginning your geospatial software journey or have already conducted considerable research, you likely know how critically important it is to ease data frustrations for your business and livelihood.

These trends are certain: The volume of data will continue to increase, technology will continue to evolve, and processes will continue to automate. As a result, project stakeholders will continue to expect more from survey businesses. And as is characteristic of such an exacting profession, surveyors will find new and innovative ways to stay at the forefront of those evolutions. ■

Boris Skopljak is marketing director, geospatial strategy and analytics, for Trimble.

Tim Lemmon is marketing director, geospatial office software and applications, for Trimble.

A JOB NAMED SUE



A public utility crew at work on subsurface utilities in Malden, Mass., in 1898.

Why It's Time to Change the Way We Talk About Underground Mapping

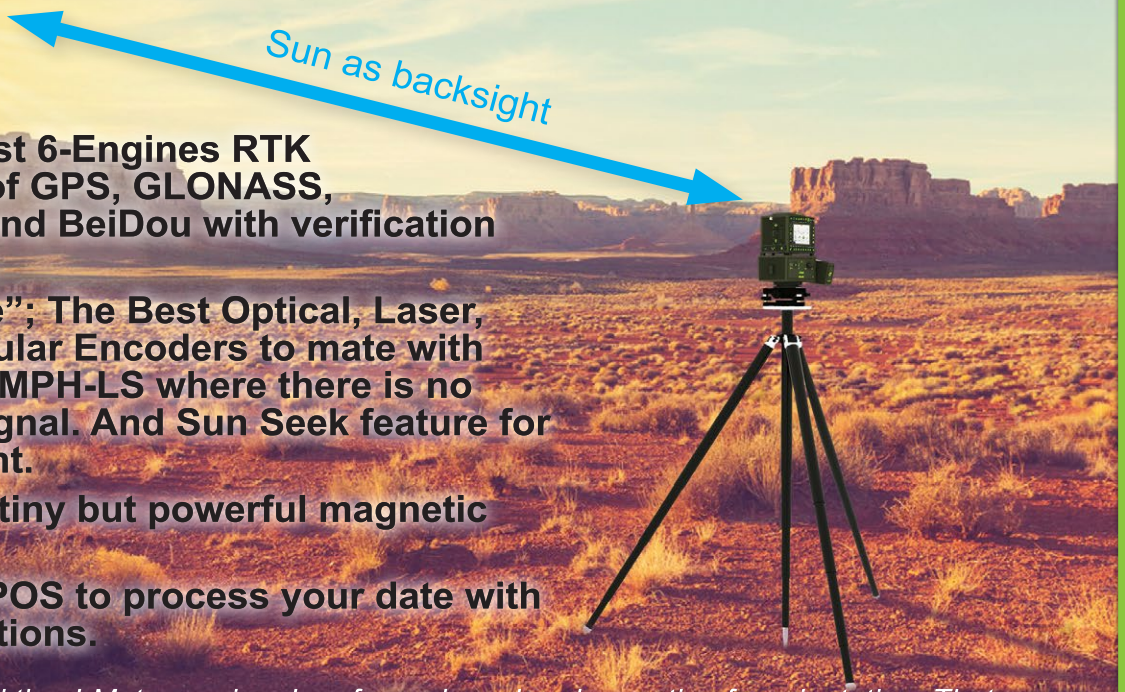
For the last few decades, Subsurface Utility Engineering (SUE) has elevated the architecture, engineering, and construction (AEC) industries in accuracy and quality by promoting greater knowledge and care of underground assets. In fact, a Penn State University study revealed that every dollar spent investing in the SUE process *brings a return of $22.21*.

While SUE as a discipline has propelled the industry forward, the terminology—subsurface utility "engineering"—has caused confusion and division among engineers, surveyors, geophysicists, designers, and owners involved in the planning phases of development projects.

When it comes to the underground environment, engineering refers most accurately to the design, relocation, and handling

» MICHAEL A. TWOHIG, MICHAEL A. CLIFFORD, PLS, & ROBERT S. STAPLES, PLS

Total solution



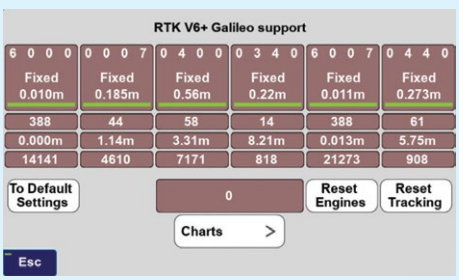
- **The Best 6-Engines RTK system of GPS, GLONASS, Galileo and BeiDou with verification features.**
- **"J-Mate"; The Best Optical, Laser, and Angular Encoders to mate with the TRIUMPH-LS where there is no GNSS signal. And Sun Seek feature for Backsight.**
- **J-Tip a tiny but powerful magnetic locator.**
- **Free DPOS to process your date with COR Stations.**

"While I had the J-Mate running, I performed a solar observation for orientation. That was about the sweetest execution I could imagine. I see so much potential here."

John Evers, PLS

Auto Verify...
Auto Validate...

RTK V6+
GPS, GLONASS, Galileo, BeiDou



six engines plus one support

"I don't know how the other surveyors do it without Javad ! I'll back my data up all day long with the confidence of the Javad system."

see full letter in the last page

JAVAD

www.javad.com

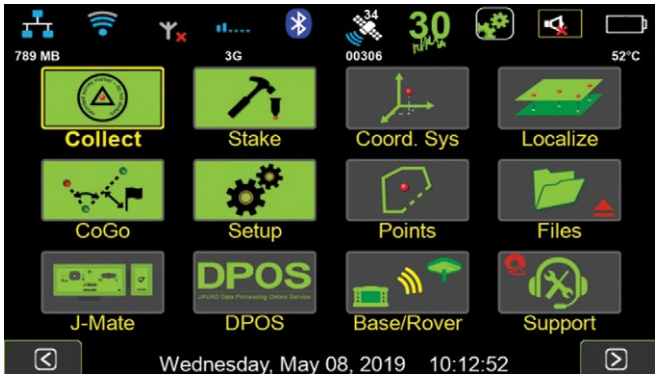
Introduction to J-Mate

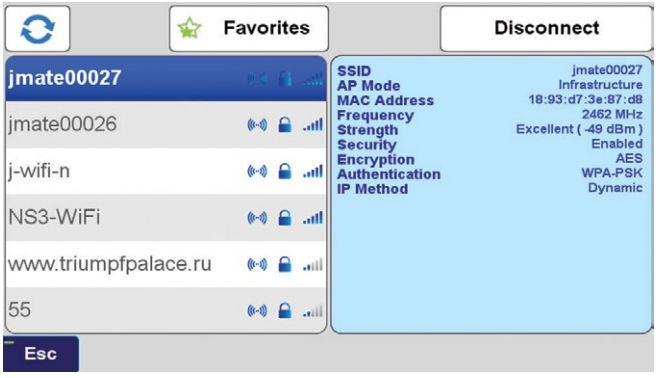
Let's set the record straight: J-Mate is not a total-station. **J-Mate and TRIUMPH-LS together** make the **"Total Solution"** which is a combination of GNSS, encoder and laser range measurements that **together do a lot more than a total station**. For long distances you use GNSS and for short distances (maximum of 100 meters) you use the J-Mate along with the TRIUMPH-LS. Together they provide RTK level accuracy (few centimeters) in ranges **from zero to infinity**.

As with the TRIUMPH-LS, with the J-Mate we also provide software improvement updates regularly and free of charge. Download the J-Mate update in your TRIUMPH-LS and then inject it to the J-Mate. The J-Mate SSID will be in this format JMatexxx, where xxx is your J-Mate's serial number. After a Wi-Fi connection is established, click the J-Mate icon and then click Setup. When you are prompted to connect to the J-Mate, click yes and then follow the remaining prompts.

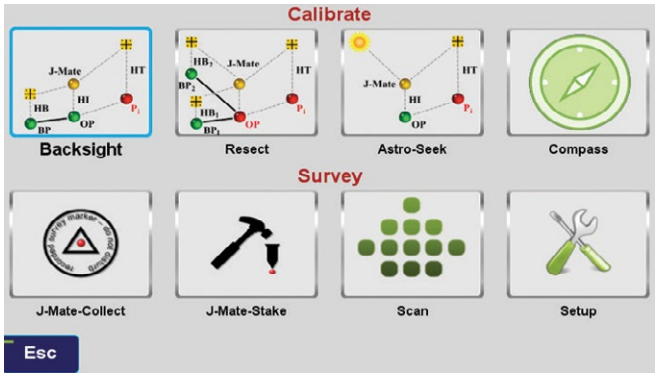
Connecting the TRIUMPH-LS to the J-Mate

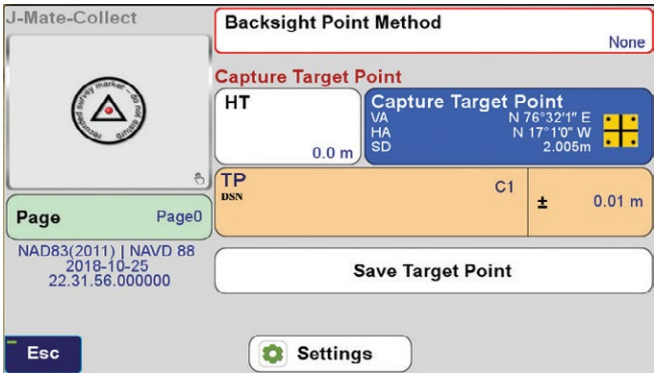
TRIUMPH-LS communicates with the J-Mate through Wi-Fi. Turn on both the TRIUMPH-LS and the J-Mate. Click the Wi-Fi icon on the TRIUMPH-LS Home screen to connect to the J-Mate, much the same way as you connect TRIUMPH-LS to your Wi-Fi access point.





After connection, click the J-Mate icon on the TRIUMPH-LS Home screen and then J-Mate/ J-Mate Collect/Capture Target Point to get familiar with the Main J-Mate screen.





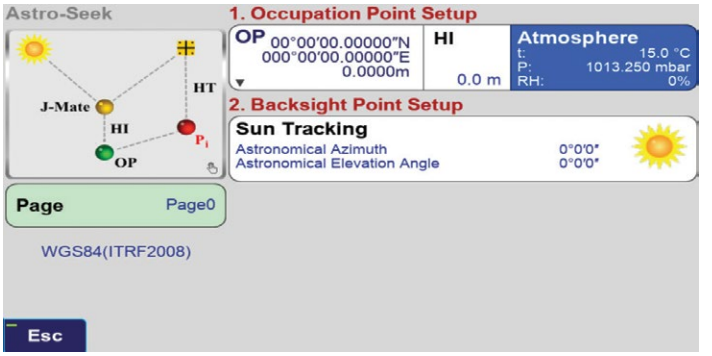
Backsight point and the Sun

Similar to using conventional total station, to use the J-Mate you need to first establish its accurate position and calibrate its vertical and horizontal encoders. Then proceed to shoot the unknown points. This is similar to using any total station, but we have improved and automated the process.

With J-Mate you can do these in three different ways as shown in the J-Mate screen of the TRIUMPH-LS. Via the J-Mate-Backsight; J-Mate-Resect and J-Mate-Astro-Seek icons.

If GNSS signals are available at the site, click the J-Mate-Backsight icon.

This screen appears which guides you to determine the accurate positions of the Occupation Point and a Backsight Point to establish an azimuth and calibrate the J-Mate angular encoders.



The tripod is setup at the “Occupation Point” (OP). The J-Mate is secured on top of the tripod.

Next, TRIUMPH-LS is put on top of the J-Mate with its legs registered to the matching features on the J-Mate.

Next Use the RTK Survey feature of the TRIUMPH-LS to quickly determine the accurate location of the Occupation Point. You can use your own base station or any public RTN.

Next, slide the J-Target on top of the TRIUMPH-LS, lift it from the J-Mate and move to the “Backsight Point” (BP). The camera of the J-Mate will search the J-Target. The camera’s view is visible from the TRIUMPH-LS screen, which mostly focuses on this J-Target. When at the Backsight Point, its accurate position is determined by the TRIUMPH-LS, and the Azimuth from the Operation Point to the Backsight Point is determined, and the J-Mate is calibrated and ready for use.

After this calibration is complete, if the tripod is disturbed, the red LED on the front of the J-Mate will blink to show that re-calibration is required.

We can now replace the TRIUMPH-LS on top of the J-Mate at the Occupation Point and proceed to shooting as many “Target Points” as the job requires. From now on TRIUMPH-LS is used as a controller and you can hold in your hand too, but it is more convenient to put it on its place to have free hands.

If GNSS signals are not available at the Occupation Point, click the “J-Mate-Resect” icon to shoot two known points to establish its accurate position and calibrate its encoders. Then continue to shoot the unknown points.

Astro-Seek feature: Sun as the Backsight point!

We have added a new innovative feature to the J-Mate that it can automatically calibrate itself via its automatic Sun Seeking feature.

Attach the Sun filter to the camera of the J-Mate, click the “J-Mate-Astro-Seek” icon and click the “Sun” icon in the screen which appears and J-Mate will automatically find the Sun, and use its position to calibrate the angular encoders automatically.

VB-RTK

Get on the Grid with VB-RTK. For over a decade American surveyors have been using the National Geodetic Survey's Online Positioning User Service. Surveyors employing RTK have been a significant share of the user segment of OPUS.

A significant share of OPUS users are surveyors using RTK. Often a surveyor will set up his base on a new, unknown position and allow an autonomous (or standalone) position to be used for the base coordinates. While he is performing his RTK work with fixed vectors between his base and rover, he stores data at the base to be submitted at a later time to OPUS. Once he is finished with his work, he downloads this file to his computer, converts the file if necessary, and submits it to OPUS. He then receives an email response back with a precisely determined coordinate for his base station. He then must take this coordinate, relate the coordinate to his project coordinate system, and then translate the work from the autonomous (or standalone) position he used in the field to this new coordinate. This procedure can produce excellent results and anchors the survey to the NSRS. The down side to this is that there are several steps that must be carefully observed and each of these error prone steps costs time.

With J-Field data collection software, JAVAD has been automating many tasks that surveyors have been doing for years, making the tasks more efficient and reducing sources of potential error. One example, **"Verify RTK with V6 Resets"**, is being recognized by surveyors across the country as the most accurate and efficient way to confidently determine RTK positions. Rather than taking a shot, manually resetting (or dumping) the receiver and taking a second shot for comparison, Verify RTK does this automatically with a user defined number of reset iterations.

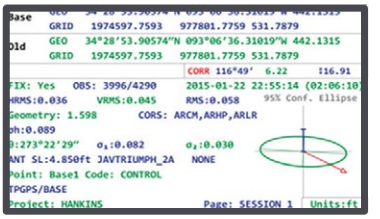
JAVAD has continued this automation philosophy by dramatically simplifying the process of translating a survey from an autonomous base position to precise geodetic coordinates with **VB-RTK (Verify Base – RTK)**. Using the JAVAD GNSS, Data Processing Online Service (DPOS), which is powered by the proven JAVAD GNSS Justin processing engine. **This multi-level process is done in J-Field completely automatically.**

Once an RTK session has been completed, the user returns to his JAVAD base receiver and presses "Stop Base" on the TRIUMPH-LS. **At this point, the raw data file that has been recording at the base during the session, is wirelessly downloaded from the base to the TRIUMPH-LS. When the download is complete, the user returns to his office and connects the TRIUMPH-LS to the internet.**

When internet connection is made, the file is automatically transmitted to one of the JAVAD GNSS servers for post processing. Once data and ephemerides are available for the session, **DPOS** processes the file and returns results to the waiting TRIUMPH-LS. This all takes place within minutes.

Once results are returned, the new coordinates for the base are shown related to your coordinate system (including localization systems).

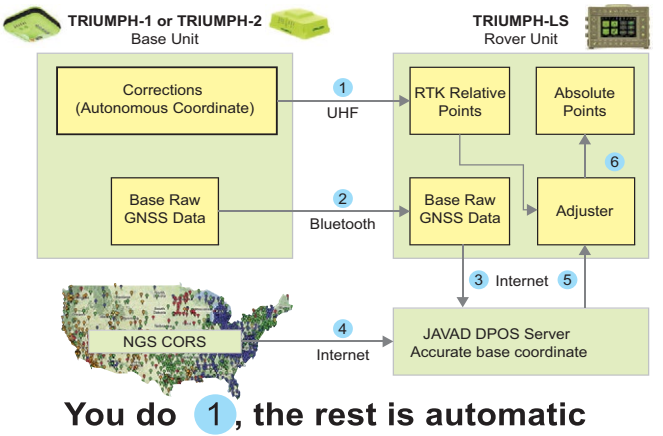
The horizontal and vertical differences between the base coordinates used and the DPOS determined coordinates are shown. **This provides for an instant check of the base coordinates and instrument height** if the base were set up on a known position.



All rover points associated with that base session translate automatically in seconds. Only those rover points associated with that base session translate.

If the user is not satisfied with the results of the DPOS solution and wants to revert back to the original RTK positions, he simply clicks **"Undo"**.This process is immune to base instrument height errors because the internal vectors between base to rover are related to the antenna, not the ground point. So, an accidental entry for the base height of 543' instead of 5.43' can be resolved by VB-RTK.

In addition to the advantages of having your RTK base station near your work area, which gives you much more accurate and faster fixes, especially in difficult areas, and saving you the RTN fees; perhaps most important of all, your work is now precisely related to one of the most accurate geodetic control networks in history – the NGS CORS. Every rover point is only two vectors removed from the CORS (CORS to base, base to rover). This means that you can return again someday to find your monuments easily and accurately. This makes your records incredibly more valuable to both you and future surveyors. J-Field also has the unique ability to load and view every point you have ever surveyed from all the projects in its system. By combining this feature with a **distance filter** in its advanced set of filters, you can easily view all the points you have previously surveyed within a given distance of a point in your current project. Having an easily accessible record of nearby georeferenced coordinates is very beneficial as you may have previously located monuments in past surveys that are beneficial in your current project. J-Field allows you to easily copy these selected points into your current project, eliminating the need for you to resurvey them. All of this is available automatically on the world's most advanced RTK rover – **the TRIUMPH-LS**.



Concepts Behind RTK Verification

Fundamental in the determination of GNSS solutions is calculating the correct number of full wavelengths (so-called ***fixing ambiguities***) in order to figure out the distances from the satellites to the receiver. In doing Real Time Kinematic (RTK) surveying, we need it fast and we need it to be correct.

Multipath, the reflections of GNSS signals from ground and nearby objects and structures create their own indirect measurements from the satellites to the GNSS receiver. It's as if your measuring tape is bent around an obstacle such as a tree instead of a free and clear line of sight between two points. No calculator is going to improve this result.

TRIUMPH-LS has sophisticated hardware to distinguish between the direct and indirect signals and remove most of the indirect signals. It also reports the amount of indirect signal that has been removed. The worst case is when the receiver doesn't see the direct signal at all; e.g., the satellite is behind a building, but it's still receiving the signal reflected off of the nearby structure. It is the task of the RTK engines to isolate such indirect signals and then exclude them from the calculations.

If too many of the signals are affected by severe multipath or indirect signals, no solution may be found. Remember, indirect signals are analogous to the bent measuring tape! When you're preforming RTK surveying, observe your environment and come to recognize that the structures around you are like mirrors for GNSS signals.

The other aspect impacting the veracity of a fixed solution is when there are weak GNSS signals. Frequently, weak signals are due to their penetration directly through tree canopy.

While the **TRIUMPH-LS** can't move the obstacles that are creating multipath out of the way, its sophisticated hardware has advanced multipath reduction sub-system, its tracking software is designed to handle even the weakest signals, and its **J-Field** software provides reliable RTK solutions like no other system with its **Automatic RTK Verification System**. J-Field also has ample tools to demonstrate the reliability of the solution or warn against questionable results. You can readily see that without such tools other systems can provide you wrong and misleading solutions.

J-Field uses six RTK engines (Figure 1) running in parallel plus a support engine to monitor and aid the six engines. Each engine uses a different criteria and mathematical method tailored to resolve ambiguities in different conditions. These six parallel engines not only verify robust solutions but also maximize the possibility of providing solutions in all conditions.

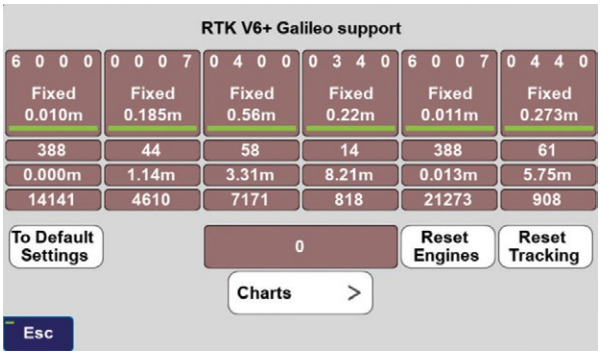


Figure 1 *V6+ six RTK Engines*

User Defined Verification Tools

J-Field provides the option for you to specify the **Minimum Number of Fixed RTK Engines** in verifying solutions **N** times before a position is automatically accepted where **N** is a user defined value.

J-Field employs two metrics to evaluate the performance of its RTK system of six engines: **1) Confidence Counter, and 2) Consistency Counter.** (Figure 2)

Confidence Counter

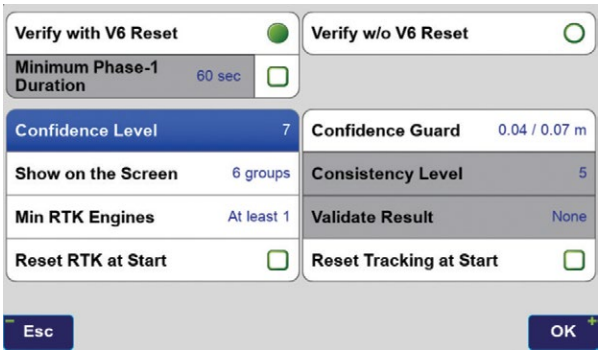


Figure 2 *Verify Settings*

This metric is incremented each time an engine is reset, ambiguities are recalculated, and the solution is in agreement with the previous ones (as defined by the **Confidence Guard (CG)**, default value 5 cm) is achieved. The Confidence Counter increments by 1, 1.25, 1.5, 1.75, 2.0, and 2.5 depending on the number of reset engines that fix in that epoch.

Consistency Counter

The Consistency Counter is incremented each time a solution is in agreement with the previous ones (as defined by the Confidence Guard) irrespective of engines being reset or not. The Consistency Counter is incremented by 0.0, 0.1, 0.25, 0.5, 1.0 and 1.5 depending on the number of fixed engines used in that epoch. Note that one fixed engine gets no credit and 6 fixed engines gets a **Consistency Credit** of 1.5.

Using these Confidence and Consistency verification tools, J-Field has two options to achieve reliable RTK solutions: **1) Verify With Automatic RTK Engines Resets** and **2) Verify Without Automatic RTK Engines Resets.**

Verify with Automatic RTK Engines Resets

This method has two steps: **1) Confidence Building** and **2) Smoothing and verifying**.

• **Step One.** In Step One, fixed engines are reset and solutions are collected into groups. Each group contains all the epochs located within a specified radius (the CG value) from its center and new groups are created as necessary so that all epochs fall into at least one group. Each group has its own Epoch Counter, Confidence Level and Elapsed Time. A point may fall into more than one group. The groups are sorted from best to last by the sum of their Time and Confidence with the current best group being shown within [ ] and others within ( ). Step One continues until a group reaches the Confidence Level. (Figure 3)

• **Step Two.** During Step Two the engines are

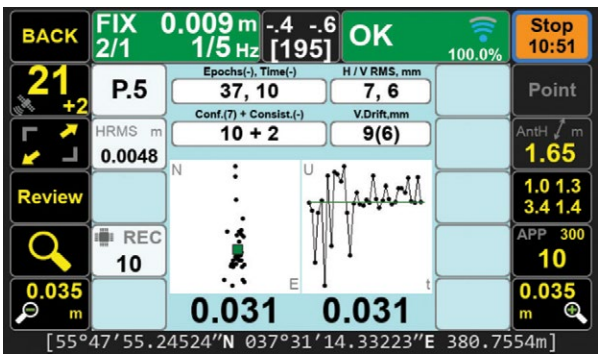


Figure 3 *End of Step one*

not reset and solutions which are located inside the CG of the selected Group are added to that Group for the remaining number of epochs that user has requested (Epoch Number, EN) in the How to Stop screen. Epochs which are outside the CG of the selected Group will be stored in a new (or previously created) group; the RTK engines are reset if the epoch falls outside a sphere with a radius twice that of the CG and the process will then revert back to Step One and the Confidence Level of the current group will be reset to 0.

If the number of epochs falling outside of the current group (but less than 2X outside it) reaches 33% of epochs collected so far, the process will revert back to Step One. Previously created groups will remain intact and once an existing or previously created group meets the Step One criteria, it will pass to Step Two. (Figure 4)

In both steps the Consistency Counter is also incremented as mentioned earlier.

You can manually reset all RTK engines via the V6-RTK engines screen (Figure 1), or assign this

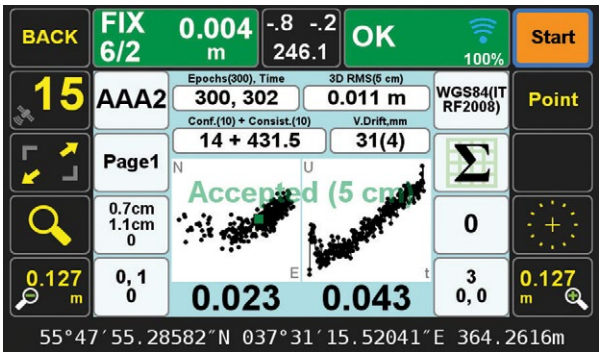


Figure 4 *End of Step 2*

reset function to any one of the U1 to U4 hardware buttons in front of the TRIUMPH-LS for easy access.

Verify without Automatic RTK Engines Resets:

In this method we don't force the RTK engines to reset but rely mostly on the Consistency Counter. There will be only one group as selected by the first epoch. Solutions that are not within the Guard band of the current average will be thrown out. If more than 30% of solutions are thrown out, the process will restart.

The horizontal and vertical graphs presented in both approaches also help the surveyor to evaluate the final solution. The linear drift of the vertical solution and its drift RMS are also shown above the vertical graph. A high linear drift (more than few centimeters) reveals severe multipath or, in rare cases, a wrong ambiguity fix. Pay close attention to the vertical drift and the horizontal and vertical scatter plots of epochs. Consider the scatter plots as doctors examine X-rays to determine anomalies.

The desired **Confidence Level** and **Consistency Level** are user selectable. Default values are 10. These parameters along with the desired number of epochs must be reached before a solution is provided.

In either case there is also a **Validate** option which, when selected, will reset all engines at the end of the collection and continues with 10 more epochs to validate if the solution is within the desired boundary of the Confidence Guard. (Figure 2) Minimum number of engines for the Validation Phase is user selectable.

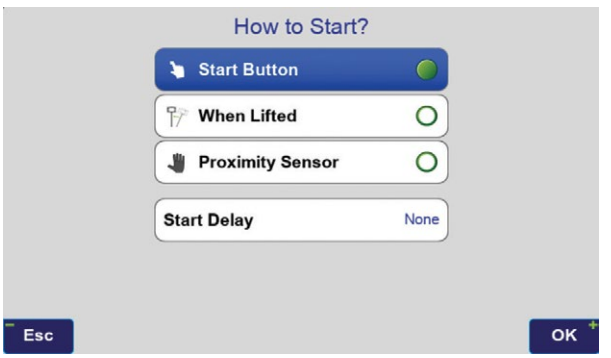


Figure 5 *How to Start*

Figure 6 *How to Stop*

In either case, if Auto-Accept is activated, the position will be automatically accepted if the RMS of the final solution is less than what user has selected in the Auto-Accept screen. (Figure 6)

You can also use **Auto-Restart** if you want to monitor structures or test the RTK system unattended. (Figure 6)

Screen Shots of Action Screen

Action Screen shows detailed information about each point collected. Screen shots can automatically be attached to each point and saved at the end of each collection (Figure 7). In **Verify with Automatic RTK Engines Resets** screen shots at the end of both Step One and Step Two are saved (Figures 3 and 4). In Action screen there are 8 white boxes that selected items can be viewed on them.

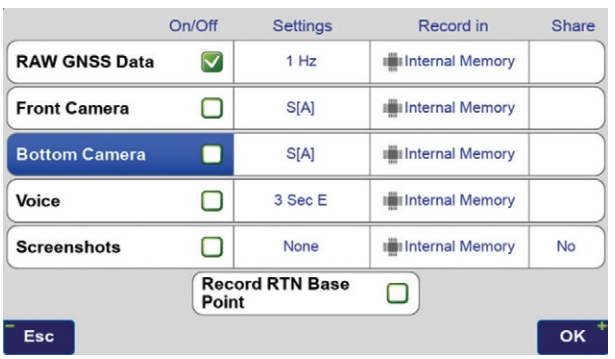


Figure 7 *What to record screen*

Review Screen

View cluster of all points. Select the desired point to see its point cluster (Figure 8). Click the icons to see additional details about that point (Figure 9) including the distance and direction to the current point (Figure 10).

The effects of multipath, ionosphere, orbit, and other sources of problems somewhat exponentially increase as the baseline length increases. In a VRS/RTN scheme your **actual** baseline length is the actual distance to the nearest base station. The **virtual** base station that is mathematically created is not the actual length. We strongly recommend using your own base station near your job site in a Verified-Base RTK (VB-RTK) scheme.

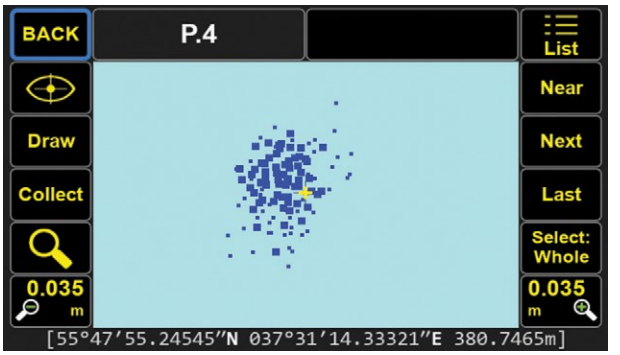


Figure 8 *Review screen shows cluster of 386 points*

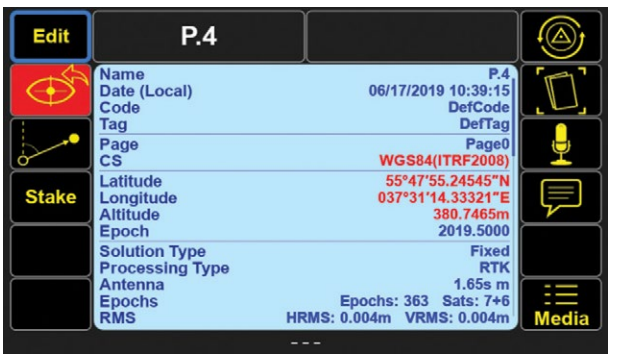


Figure 9 *Detailed information on selected point (scroll to see all information)*

Figure 10 *Distance and direction from the current point to the selected point*

In addition to providing you with the most reliable RTK solutions (especially true in remote areas where cell coverage is hit or miss), using your own base receiver allows you to easily tie your solutions to well-established IGS/NGS spatial reference systems through Javad's exclusive Data Processing Online Service (DPOS) and J-Field's user-friendly Base/Rover Setup. Note that post-processed results returned to the TRIUMPH-LS using DPOS are dependent on the availability of orbital data from NGS and may require several hours. Alternatively, if you don't have access to IGS-type stations to use DPOS, you can select an open area near your job site and use TRIUMPH-LS to obtain its position via RTN networks for about 5 minutes.

J-Tip

TRIUMPH-LS tags coordinates with magnetic values, It also guides you to top of the item to survey it.

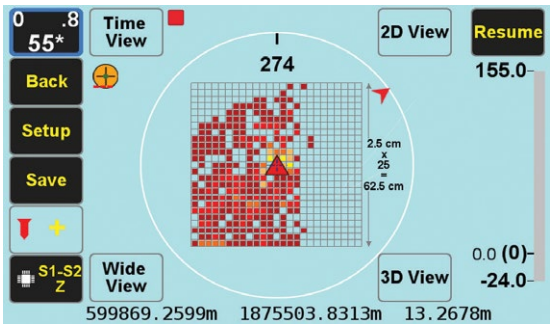
The Mag View focuses only on the mag object with the highest mag value.

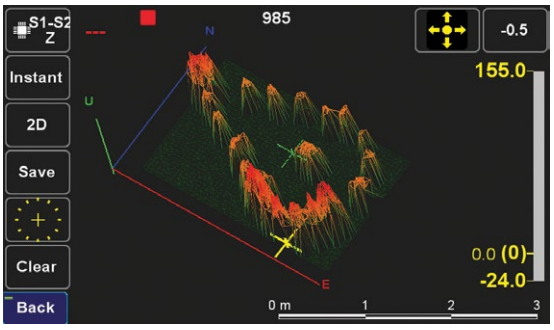
The audio and graphical bar show the magnitude of the magnetic object.

In “Setup” you can select the cell size and the size of the field you want to scan.

2D and 3D views of the field show the magnetic objects that have been scanned.

Zooming the 2D and 3D screens can show the shape of the magnetic objects under the ground.





For many sophisticated features of the J-Tip see its Users Manual in www.javad.com

What a great little system! I’ve been using it a good bit in the last few months since purchased controller back in November. Really appreciate all that I’ve learned here on the forum from folks like Nate the Surveyor, Shawn Billings, Matthew Sibole, others and all the developers on the Javad Team. Although this system has only a quarter of the channels as the Triumph-LS, it still amazes me in high multi-path areas using the RTN. Once you read the manual several times, especially on RTK Verification, everything falls into place. There is so many ways to verify your position if there’s any doubt; i.e., distance to last point, confidence and consistency levels, verification with selected # engines, saving of raw data to post process, etc.

Last project was cutting out 33 acres, part of the boundary was at the corner of a 150 acre tract. Located all the existing corners and the proposed corners with the owner (1 day field work). Computed the acreage (1/2 day office) and then staked out the corners and staked a few lines using my brothers Triumph-LS with radio RTK (1 day field work). This site was very bad with multi-path (pine forests and hardwood lands). I don’t think I could have used the Victor-LS/Triumph-2 in these conditions for stake out (I didn’t try). The Triumph-LS ruled in these conditions and minimal time was spent on station, staking out the actual new corners. Verification of my original locations performed with the Victor-LS/Triumph-2 checked < 0.1’ both horizontal and vertically. Also re-measured all staked points for verification while on station. Surveying is so much fun again when I can get out of the office!!!

I don’t know how the other surveyors do it without Javad! I’ll back my data up all day long with the confidence of the Javad system.

Bryan Enfinger

Thanks a lot Bryan. If you don’t mind, I would like to share your experience in our publications.

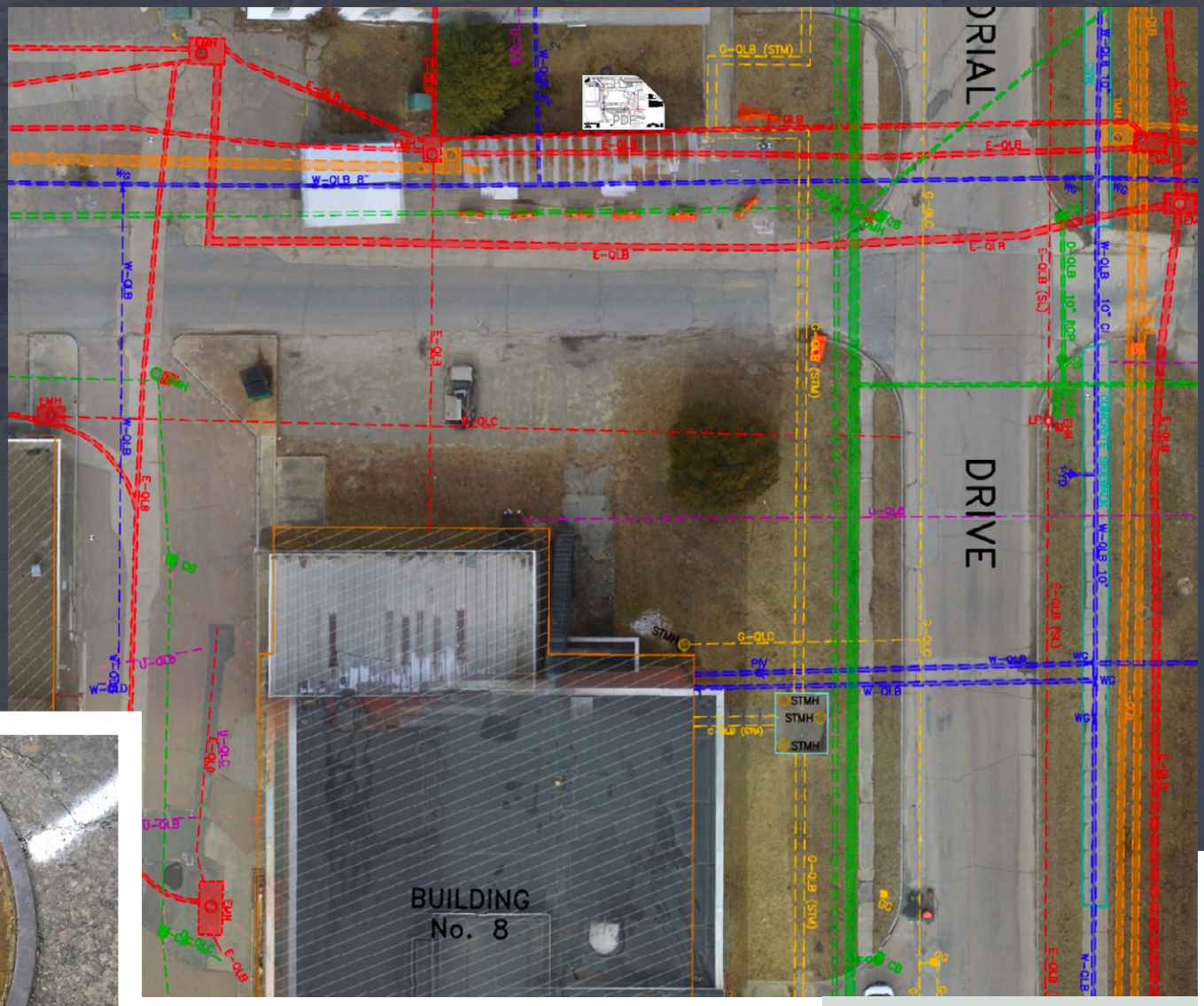
Javad Ashjaee

I just get excited using the equipment, it’s light years beyond anything available! I really enjoy finding time to keep learning on this machine, I’ve always enjoyed learning new things and this is the greatest yet. We were part of the trial team originally, my brother Buck really loves the Triumph-LS/Triumph-2 system.

Here’s an attached pic from the collect screen. I was verifying PT23 with two additional shots with the EPOCH count set at 10, time set at 180 secs and the APP set at 3600 secs (1 hour) for raw data logging if I didn’t get any fixed positions. This was in a wooded area with 25 year old pines and hardwoods with many leaves. I was amazed I got a fix with 5 engines within approx 1 minute and met the confidence and consistency levels set. Notice the “distance to last” measurement, all this with the Victor-LS/Triumph-2 system. While I know this won’t occur in all situations in the time frame shown here, even if it didn’t get a fix I had the raw data to post process using short baselines (i.e., another base <1.0 mile away).

Bryan Enfinger ENFINGER & ASSOCIATES PROFESSIONAL LAND SURVEYORS

A DGT Associates crew member uses 3D imaging devices to map underground facilities.



Drone imagery layered with subsurface utility maps of the underground environment in Weymouth, Mass., captured by DGT Associates.

of underground utilities. Those practices are only one part of the equation, however, and using "engineering" as a generalized term diminishes the importance of the first step in any successful project: mapping the above- and below-ground environment.

The leadership team at *DGT Associates*, an SUE-capable surveying and engineering firm, believes that Subsurface Utility Mapping (SUM) is a more accurate term, and one that better recognizes the importance of what highly trained, professional mapping specialists do to set a strong foundation for projects involving below-ground work.

How SUE came to be

SUE as an industry term was born out of an effort in the 1980s to *standardize methods of handling the underground environment*. Until then, projects were regularly begun with little investment into discovering and planning for what lay under the ground, which led to overbudget projects, delays, and safety issues.

Initially, SUE was dubbed "designating and locating," which was reflective of the core activity of finding and marking utilities with paint on the ground. Recognizing the need for industry support and more sophisticated methods, engineers ran with the discipline, and renamed it "Subsurface Utility Engineering."

In 1991, SUE gained an official endorsement from the Federal Highway Administration (FHWA) and a few years later, the famous *Purdue study* proved its value. This led to the American Society of Civil Engineers (ASCE) National Consensus Standard titled *ASCE C-I 38-02, Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data*. These progressions further solidified SUE's importance and prominence in the field.

The establishment of SUE as a regulated process was groundbreaking in integrating the underground environment into the initial design stage, moving project development away from a practice of digging without proper understanding of what lay below-ground, thereby creating risk of damage and injury, in the construction phase. The resulting ASCE standards also helped to unify and refine how all parties involved in a project approach the underground environment.

Despite the benefits that SUE standardization brought to the industry, it also introduced some confusion between professional roles.

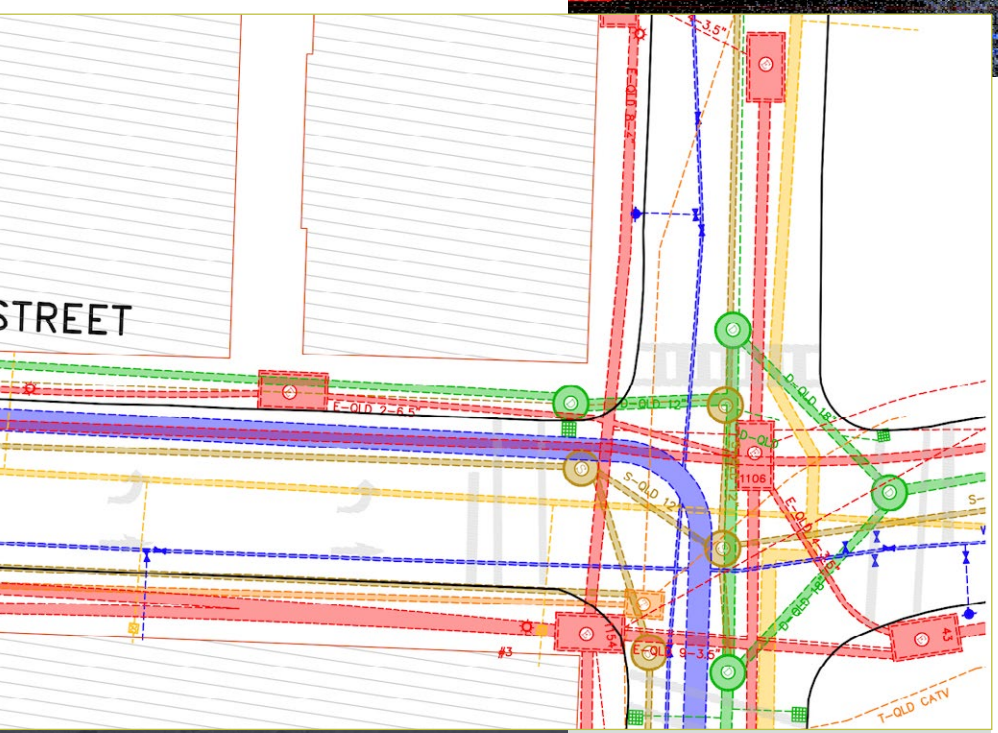
The surveyor's domain

The ASCE Standards list "utility mapping at appropriate quality levels" as the first activity associated with SUE. However, according to standard definitions, that's a surveyor's job.

Globally, the International Federation of Surveyors (FIG) specifies that a surveyor's activities "*may occur either on, above or below the surface of the land.*"

In SUE, the word "engineering" connotes a specific activity that is confined to engineers, yet the first and core activity involved in SUE—mapping—is performed by surveyors. In this regard, SUE is not a new discipline, but rather an extension of an existing one: surveying.

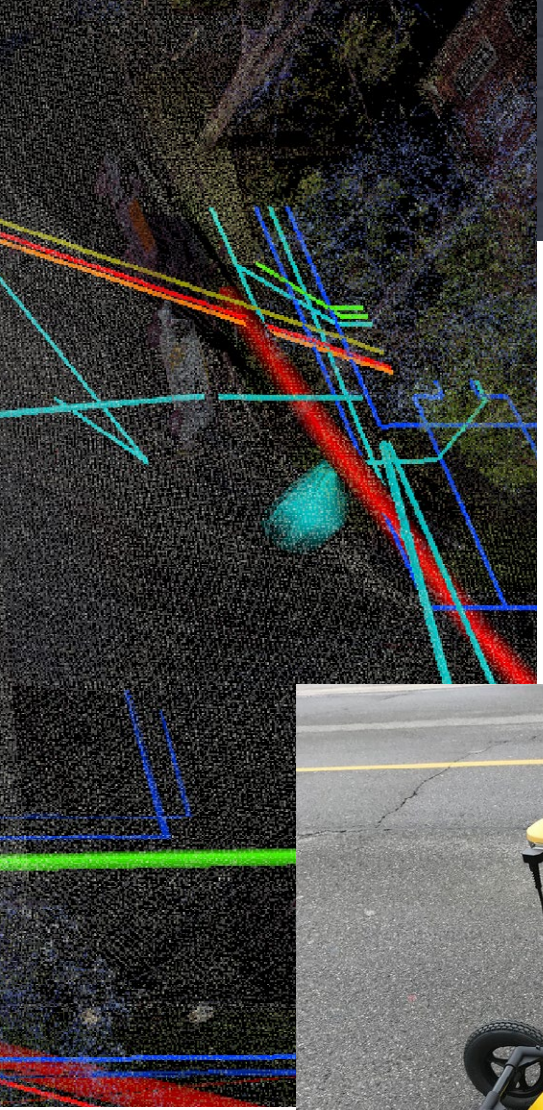
Subsurface utility mapping of underground environment on a university campus performed by DGT Associates.



A 2D rendering of subsurface utilities, mapped by DGT Associates in accordance with American Society of Civil Engineers (ASCE) Standard 38-02 at Quality Level D.

Utilities and other assets in the underground environment have been discovered and documented by surveyors since the discipline of land surveying began to separate itself form the civil engineering discipline in the 1800s. Surveyors are usually the first on site for a project, and they have been recording what's beneath our feet and communicating it to their partners—including engineers—since long before SUE was established in the industry lexicon with the FHWA's official stamp in the late '80s.

Some say SUE was a revolution. We see it as an evolution.



> "Some say SUE was a revolution. We see it as an evolution."

A DGT Associates crew member collects data of underground environment using a push-cart GPR system.

Mixed messages with wide-reaching effects

Because of the natural congruency between SUE and surveying, it's easy to see how the language surrounding the Subsurface Utility Engineering discipline has muddied the waters. The confusion also shows up in laws and regulations, which differ from state to state about which professions may perform the work. Some states recognize the limitations of engineers as mappers, and have barred licensed professional engineers from performing subsurface mapping work that gets categorized under SUE. Others have tried to delegate the practice in the opposite direction and make it the sole domain of engineers, causing even more confusion, and separating the disciplines involved in a typical project.

Many of the tools used in subsurface work, such as ground penetrating radar (GPR) and electromagnetic (EM) locators, are the same tools that geophysics professionals have used for years, making it even harder to delineate between the professions and enforce rules.

It is important that we make the terminology more clear and industry-wide comprehension better, because there are specific purposes involved in the work of surveyors and engineers that cannot always be combined just because the ultimate goal of a completed development is the same.

At its core, the work conventionally called Subsurface Utility Engineering is an exercise in mapping the underground environment for designers, engineers, and others to use in safely planning projects. But mapping and engineering are two distinct ideas, and they should be recognized as such.

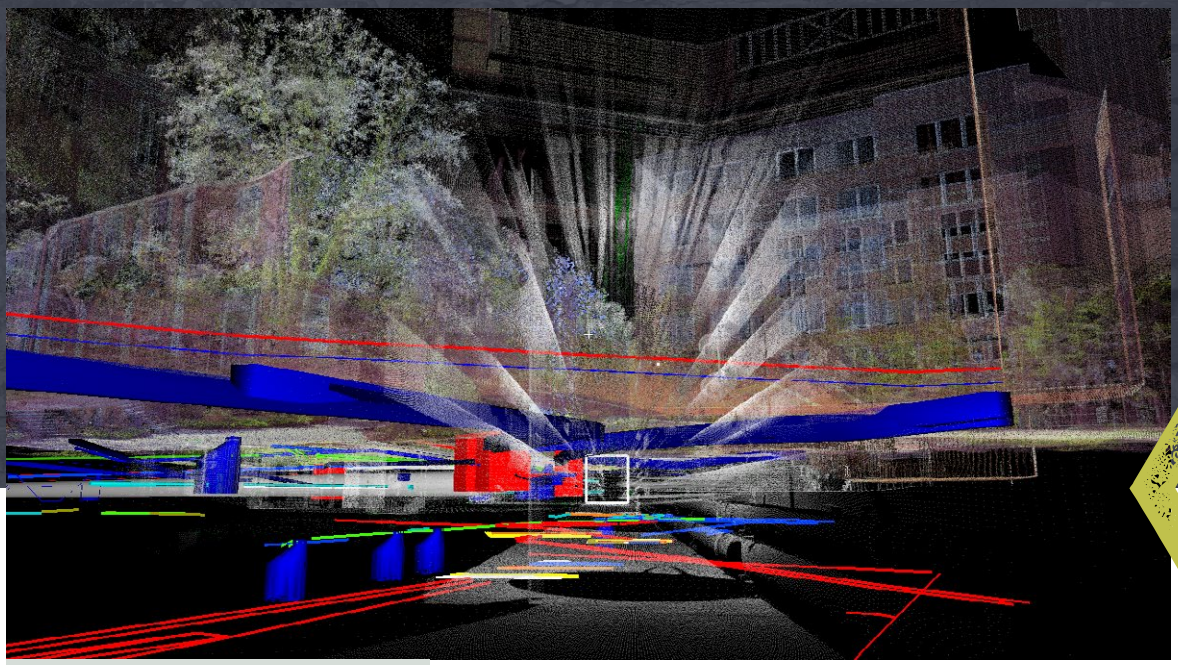
Why high-quality mapping matters

Mapping the existing and man-made environment goes back to the definition of a surveyor. DGT takes this charge seriously and is committed to a holistic approach to the mapping process. That means going beyond the acquisition of data to also include coherent, precise presentation of that data.

Recently, we met recently with staff of a northeastern state's Department of Transportation (DOT) to discuss their approach to utility mapping. One of the DOT engineers brought up recent utility mapping work that had been done by a consulting firm. The end result was a large, bound report that contained a wealth of information in the form of written text and imagery. What it didn't contain was any kind of map, making it only partially usable by rest of the professionals on the project.

At DGT, our work includes maps, drawn to scale, in CAD or GIS format. We also produce a *Digital Utility Atlas* to help campuses and facilities of all kinds shift from clunky paper records to comprehensive digital maps of their underground environments that can be easily updated and used by any party. Those elements are instrumental to proper and effective development, and they're also the kind of deliverable that only a qualified surveying professional can create.

For us, the work goes beyond just locating and mapping the world, but also taking it a step further to present the information in a way that owners, designers and anyone else can use to make informed decisions.



Advances in technologies and techniques allow us to measure and view elements below the ground in the context of what sits aboveground, as seen here in a DGT Associates subsurface utility map.

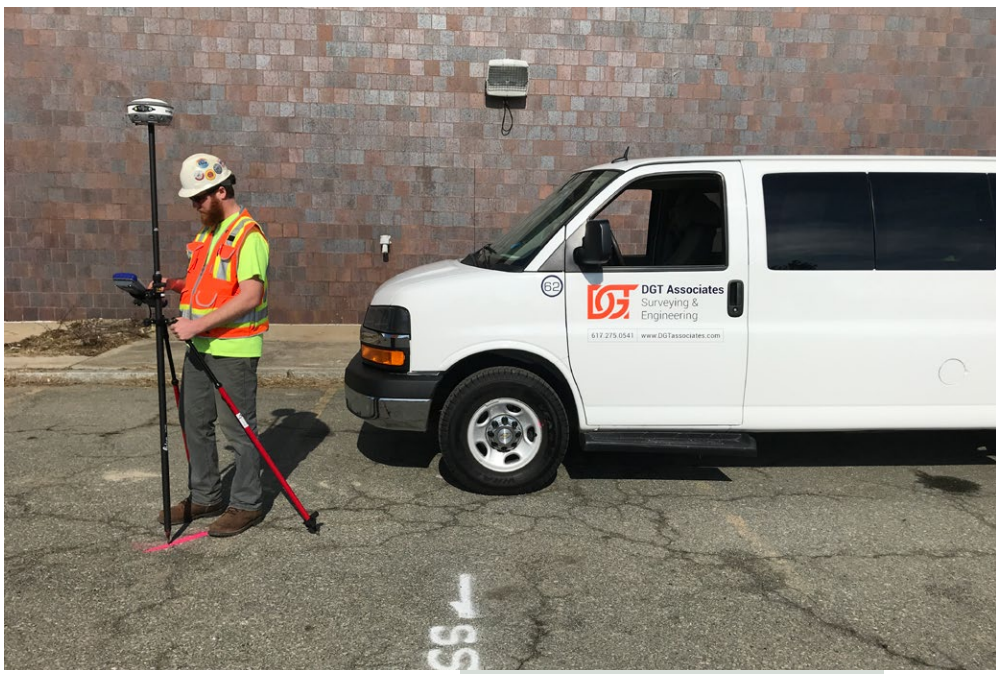
Everyone has a place at the table

While we argue that the terminology of "Subsurface Utility Engineering" is problematic, we don't advocate for eliminating it entirely. Instead, we suggest that adopting "Subsurface Utility Mapping" to refer specifically to the work of mapping underground infrastructure can help to better identify all of the different roles that must be played in development.

The best analogy is that if you were building a house, you would hire licensed professionals—an electrician, a plumber, a contractor. There are a lot of roles involved in a project in a building environment, and that's especially true of the work the industry calls "SUE." But the way we categorize and describe that work should not be discriminatory or exclusive of engineers, surveyors, or any other profession involved.

This effort requires surveyors, GIS professionals, and others involved in mapping to recognize that they must take ownership of the subsurface work they do. That means pushing for the adoption of SUM work as a precursor to any SUE project.

Our history as surveyors is not based on something that was adopted in the '80s. It goes back to the best practices of our profession, which are more than 150 years old. Our justification for the Subsurface Utility Mapping terminology is this: we have been doing this work for a long time before the industry started using "SUE" to describe it. ■



Surveyors have measured the land aboveground for centuries. It only makes sense that mapping the world below the surface be done by a qualified surveyor, using tried-and-true surveying tools and techniques.

Michael A. Twohig is the Subsurface Mapping Project Director for DGT Associates. He is an international subsurface mapping expert with over 35 years of experience in professional utility locating, mapping, damage prevention, and industry safety awareness. *mtwohig@dgtassociates.com*

Michael A. Clifford, PLS, is co-founder and principal of DGT Associates. He believes that the integration of cutting-edge technologies with the traditions of the past can thrust surveying and engineering into the 21st century. *mclifford@dgtassociates.com*

Robert S. Staples, PLS, is co-founder and principal of DGT Associates. He oversees survey and business operations, as well as evaluating and implementing new technologies to assure DGT Associates is not only best in practice, but also ahead of the curve. *rstaples@dgtassociates.com*

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Skytec Completes Frigid Upper Peninsula Hybrid UAS Success

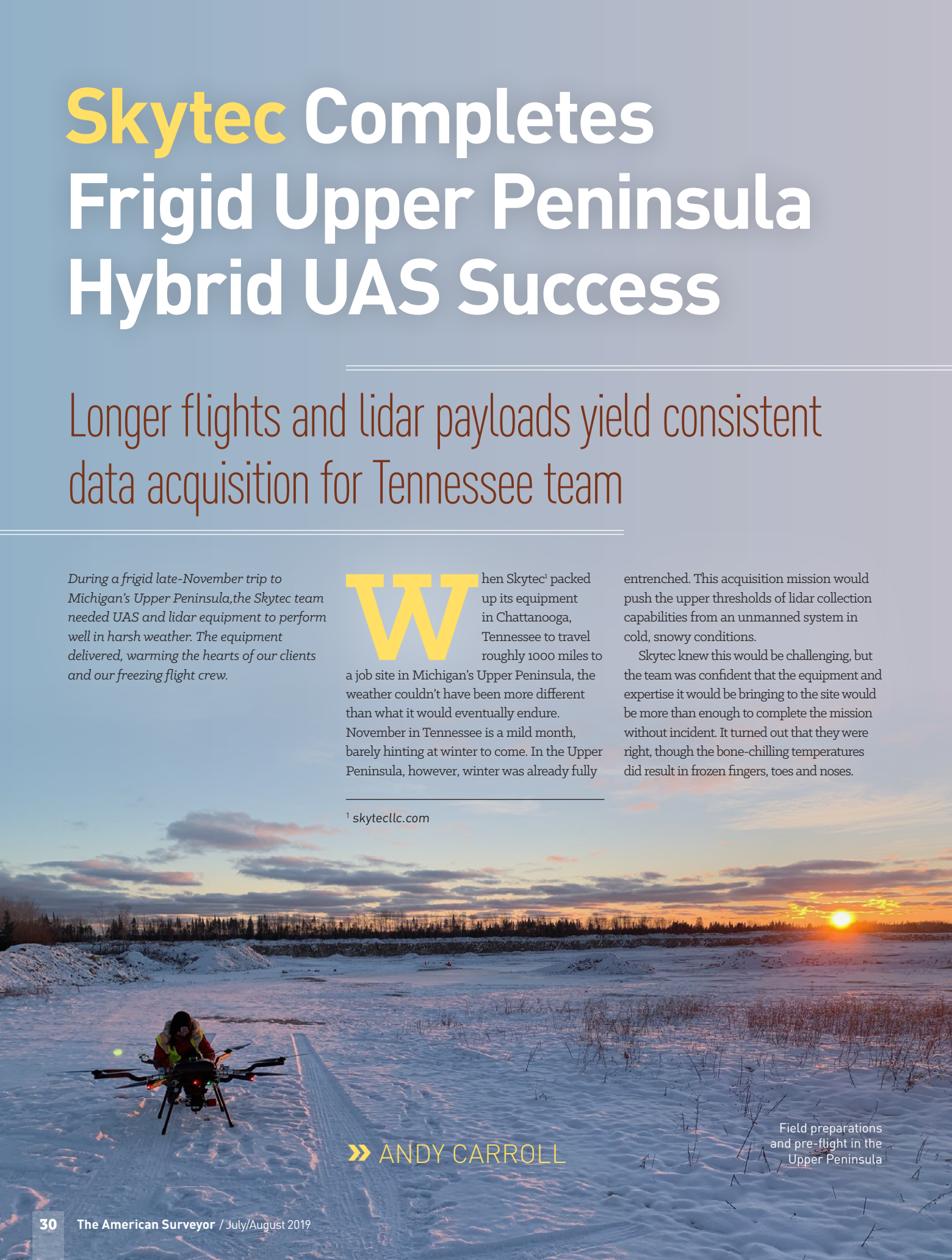
Longer flights and lidar payloads yield consistent data acquisition for Tennessee team

During a frigid late-November trip to Michigan's Upper Peninsula,the Skytec team needed UAS and lidar equipment to perform well in harsh weather. The equipment delivered, warming the hearts of our clients and our freezing flight crew.

When Skytec[1] packed up its equipment in Chattanooga, Tennessee to travel roughly 1000 miles to a job site in Michigan's Upper Peninsula, the weather couldn't have been more different than what it would eventually endure. November in Tennessee is a mild month, barely hinting at winter to come. In the Upper Peninsula, however, winter was already fully entrenched. This acquisition mission would push the upper thresholds of lidar collection capabilities from an unmanned system in cold, snowy conditions.

Skytec knew this would be challenging, but the team was confident that the equipment and expertise it would be bringing to the site would be more than enough to complete the mission without incident. It turned out that they were right, though the bone-chilling temperatures did result in frozen fingers, toes and noses.

[1] skytecllc.com



» ANDY CARROLL

Field preparations and pre-flight in the Upper Peninsula

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Harris H6 and lidar payload in flight on a frigid day.

A two-party Tennessee excursion

Skytec's venture to the Upper Peninsula arose from a combination of interesting relationships and circumstances.

Skytec was co-founded by Andy Carroll and Bill Rogers, who serve as Chief Technology Officer and Chief Executive Officer respectively. The company is a leader in unmanned aerial systems, remote sensing, and GIS technologies. Its tagline, "Acquire, Analyze, Inform", points toward its service model. it uses its UAS fleet and imaging tools to *acquire* site information, *analyze* that data using in-house GIS and remote sensing expertise, and creates the opportunity to help *inform* consequential decisions made by its clients.

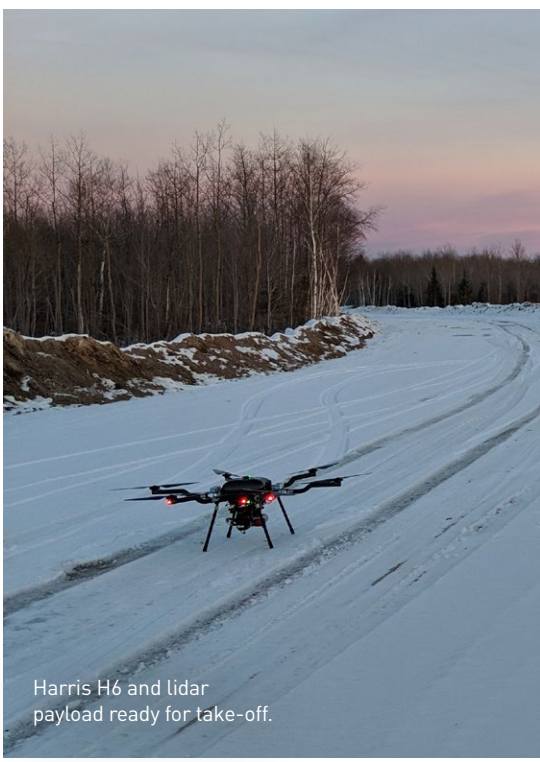
Skytec has teamed with a myriad of partners from across the country on projects ranging the full spectrum of complexity. One of those partners has been *Wingfield Scale & Measure*[2], also based in Chattanooga, which specializes in industrial weighing and measuring solutions.

Wingfield, a third-generation family business, maintains a robust collection of terrestrial lidar systems and expertise. But for a particular client, who needed a two large mining sites assessed in the Upper Peninsula, an aerial lidar option made the most sense. The client needed to measure the volumes of overburden materials that would be cleared from its sites as well as the remaining surface materials. This job would require aerial lidar due to the vast areas to be captured, over 2400 acres, and densely forested conditions on site.

The Wingfield team, therefore, reached out to Skytec.

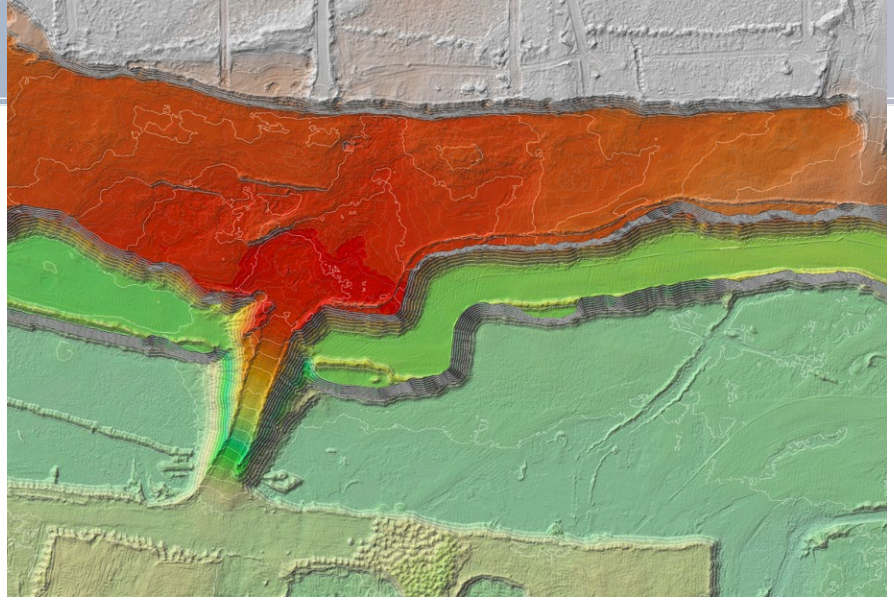
Tough terrain and harsh weather—a good UAS fit

The weather awaiting Skytec in the Upper Peninsula was in stark contrast to what the team had been enjoying in Tennessee. Whereas Tennessee's November tempera-



Harris H6 and lidar payload ready for take-off.

[2] https://www.wingfieldscale.com/.



Lidar-derived deliverable for Skytec/Wingfield shared client.

tures often creep into the mid-60s, snow was already blanketing the ground at the Michigan job site with cloud-filled skies and windy conditions.

Historically, the kind of job for which the team was preparing would require extensive groundwork by field crews or the acquisition of lower-resolution data from manned aircraft. With the frigid weather conditions, snow, and low cloud ceilings, however, manned aircraft would have had a very difficult time collecting the required data.

Skytec's lidar and UAS tools

To meet the client's needs head-on, Skytec decided to use its brand new *Harris H6 hybrid* system.

The H6 is a heavy-lift gas/electric hybrid-powered UAS, capable of flight times surpassing 1.5 hours in fair conditions while equipped with lidar payloads.

The lidar selection was Skytec's LiDAR USA Snoopy A-Series HD system. This Velodyne HDL-32E-based system maintained a low to moderate weight of 2.51 kg and high-density scanning capability of greater than 200 pulses per square meter at an elevation of 60 meters above ground level.

Coupled with the hybrid-powered system, this enabled the flight team to plan for flight times greater than one hour, leaving adequate fuel reserves for unexpected conditions.

Tough weather, no problem

Given the testy weather Skytec knew it would encounter, the team assumed that the maximum performance of the equipment would be tough to achieve. Yet even in those harsh, sub-freezing temperatures, the hybrid UAS performed quite well. Thanks to the high-quality system, Skytec enjoyed three great benefits:

1. **Extended flight times:** The system was able to achieve more than 76 minutes of flight time on a single mapping grid with the UAS. On that grid, the flight covered an area of 700 acres with a dense point cloud through snow, wind and forest canopy. If Skytec had used an all-electric system with lithium batteries only, the team would have been significantly limited due to weather conditions, expecting to see flight times of only 10-15 minutes, at best, in the daily high temperatures of 15°F.
2. **Enhanced Line of Sight Range**: With a 2.3 meter arm-to-arm diameter and 2-stroke engine, the H6 remained easily visible and audible from distances up to 1900 meters away. The system was easily tracked and located on the horizon during mapping grids over the mining site. Skytec's Desert Rotor ground control station, operating at 900 MHz with a dual-antennae system, maintained relative connectivity at 97% signal strength or greater. This ability to fully control and track the H6 at great distances instilled a high level of confidence with the flight team in the field.
3. **Consistent data acquisition:** Because the hybrid UAS could fly for much longer durations, Skytec was able to collect high-accuracy data much more consistently. Before Skytec added the hybrid system to its fleet, the lidar field data collection process was, literally, "stop-and-go". A typical grid flight would consist of starting the system, beginning a grid flight line, collecting data, landing to change batteries, launching

Harris H6 hybrid UAS equipped with LiDAR USA Snoopy A-Series HD sensor.

again, collecting more data, etc.—over and over. The constant change in heading and elevation, sensor restarts, and fluctuating power supplies places additional computational requirements for positioning and sensor inertial measurement units. That increased work typically introduces errors and lowers the overall consistency of the data. With the hybrid, Skytec was able to significantly reduce the introduction of these sources of error.

Great data acquisition equals quality mapping results

Thanks to the exceptional performance of the UAS, Skytec was able to acquire reliable data in a comparatively short time. The next step was to parse that information into a comprehensible, actionable format for the client shared with Wingfield.

Raw lidar data and control points collected by post-processed GNSS base observations were fused with telemetry records in Novatel's Inertial Explorer and LiDAR USA's Scanlook software. LAS files were ground-classified using automatic and manual classification techniques. GeoCue's LP360 and Esri's ArcGIS Pro were used to perform final tiling and accuracy reports. The client received classified LAS v1.2 files and digital terrain model products at USGS QL0 standards.

Elevation surfaces were derived from the digital terrain models and used in CAD software to quantify anticipated volumes of overburden materials and volumetric changes for stockpiles. This provided the client with a greatly increased level of accuracy for volume estimates. These estimates were used for budgeting and progress tracking throughout the year. Overall, the client was provided with a higher accuracy dataset, in a shorter amount of time, representing excellent value in terms of product and price.

Heading home

In all, the combined Skytec/Wingfield team spent roughly a week on the Upper Peninsula site. In retrospect, in addition to a renewed appreciation for Tennessee Novembers, the team learned a great deal about how some of the newest technologies in the UAS and lidar industries function in harsh circumstances.

The team was delighted with how the hybrid performed and yielded downstream results in terms of data acquisition and analysis for the shared client. Without quality unmanned technology, it would have been difficult to obtain the kind of reliable information the client needed about its mining sites.

Skytec fashions itself as a UAS/lidar early adopter. The experience in Michigan was heartening in that it demonstrated a remarkable advance in the technology space in which the company operates. Skytec, therefore, is hopeful further innovations are available to it soon, enabling it to address new client challenges. ■

After 15 years in the higher education space leading the ga Interdisciplinary Geospatial Technology Lab at the University of Tennessee at Chattanooga, **Andy Carroll**[3] co-founded Skytec, LLC in 2015 with Bill Rogers. Andy serves as Chief Technology Officer.

[3] *linkedin.com/in/andrewcarroll67*

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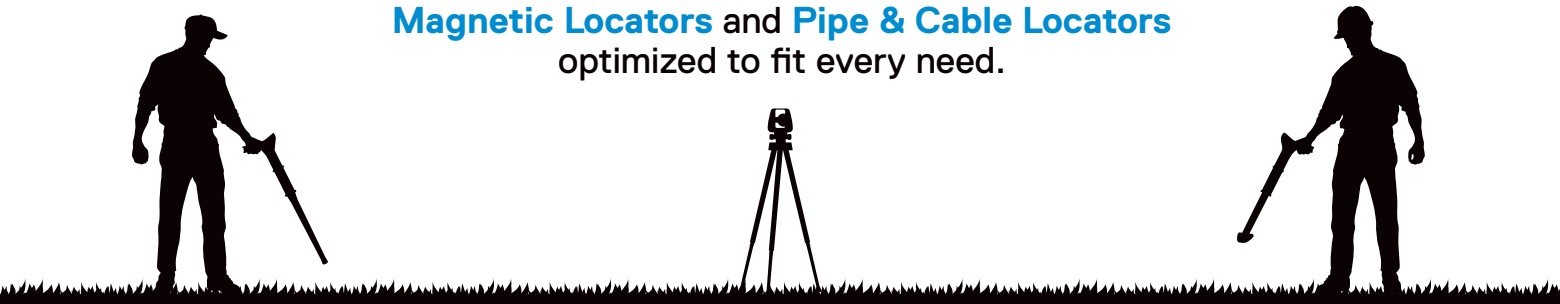

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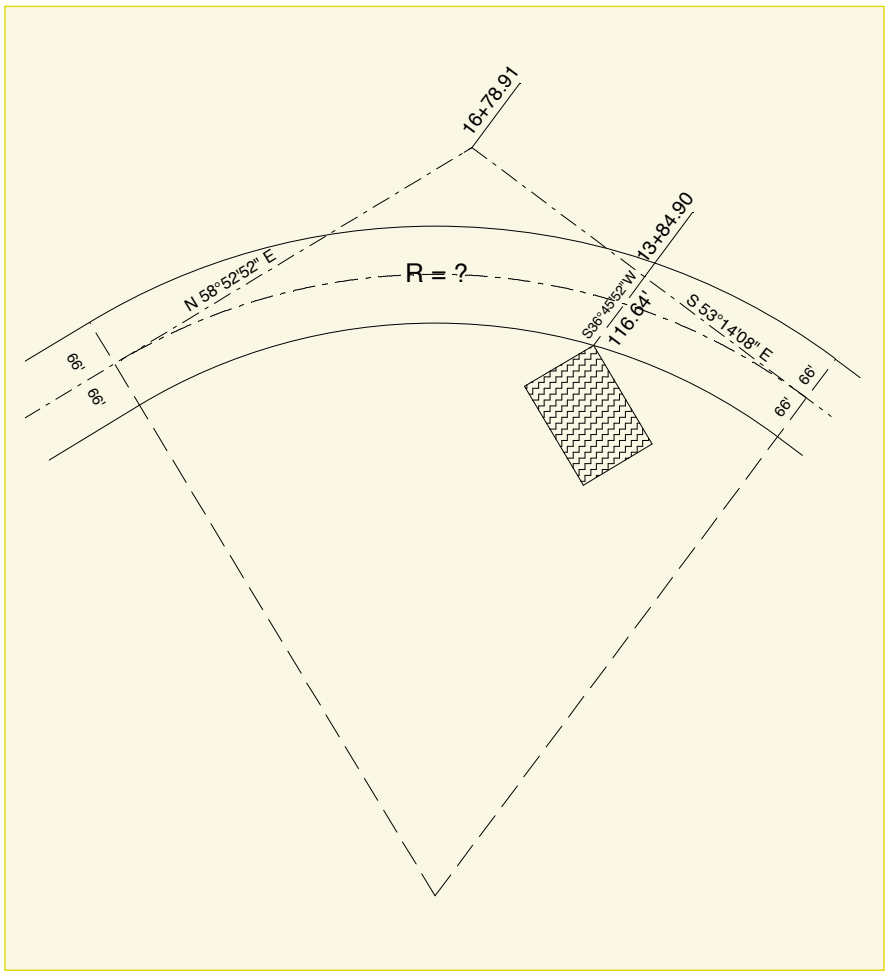
test yourself

Another fine miss, Ollie

What is the centerline radius for the longest radius that will be tangent to the 66' offset sidelines and pass through the corner of the structure? ■

For the solution to this problem (and much more), please visit our website at: *www.amerisurv.com*. Good luck!

Dave Lindell, PS, retired after 36 1/2 years with the City of Los Angeles. He keeps surveying part time to stay busy and keep out of trouble. Dave can be reached at *dllindell@msn.com*.



SURVEYORS HISTORICAL SOCIETY AND UTAH COUNCIL OF LAND SURVEYORS

PRESENT

2019 SHS RENDEZVOUS in Salt Lake City, Utah

September 18-21, 2019

"Surveys and Surveyors of Utah Territory"

We are excited to announce the Surveyor's Historical Society (SHS) is planning its ANNUAL RENDEZVOUS for 2019 in Salt Lake City. This conference will commemorate some of the events that occurred 150 years ago:

- **150TH ANNIVERSARY OF THE GOLDEN SPIKE IN PROMONTORY, UTAH.**
- **150TH ANNIVERSARY OF THE ESTABLISHMENT OF THE LATITUDE AND LONGITUDE STATIONS IN SALT LAKE CITY BY THE USC&G SURVEY.**
- **150TH ANNIVERSARY OF THE PARTIAL RETRACEMENT AND RESURVEY NORTH, SOUTH, EAST AND WEST OF THE SALT LAKE MERIDIAN, UTAH'S PRINCIPAL MERIDIAN. (Originally established in 1855).**
- **150TH ANNIVERSARY OF THE 1869 DESCENT OF THE GREEN AND COLORADO RIVERS THROUGH UTAH BY JOHN WESLEY POWELL. He returned in 1871 completing his surveying and mapping of both rivers. Powell later served as director of the US Geological Survey between 1881 and 1894.**
- **150TH ANNIVERSARY OF THE WHEELER SURVEY IN THE GREAT BASIN. One of the "Four Great Surveys of the West". An astronomical monument still exists in the desert north of Salt Lake.**

Other topics may include:

- **BASE LINE MONUMENTS BY THE USC&GS set in 1896 that still exist in the Salt Lake City area.**
- **JOHN FREMONT EXPEDITIONS IN UTAH TERRITORY.**
- **US TOPOGRAPHICAL ENGINEERS in Utah Territory.**
- **HOW UTAH (NEVADA/COLORADO) GOT ITS SHAPE?**

ACCOMODATIONS will be at the DOUBLE TREE HILTON SALT LAKE AIRPORT @ $109.00 a night.

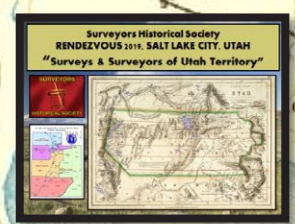


POSSIBLE TOURS:









SURVEYORS HISTORICAL SOCIETY 2019 RENDEZVOUS COMMITTEE:

Denny DeMeyer, Blaine, Washington: SHS #219: denny@nwsurvey.com

Andy Hubbard, Salt Lake City, Utah: Andyh@greatbasineng.com

Bart Crattie, Lookout Mountain, Georgia: SHS #767: bart@nilessurvey.com

Bill Weikel, Missoula, Montana, SHS #828: brweikel@bigsky.net

FOR MORE INFORMATION PLEASE EMAIL: info@surveyorshistoricalsociety.com

vantage point

Dirty Stories

If our homes are our castles, we should be able to do pretty much anything we want there, right? Well, not exactly. There are these pesky things called ordinances and regulations that can influence our rights by restricting them. This may be so even if we are just moving dirt around on our lots. What if we want to do some landscaping? How about our own personal dumping site?

A battle between neighbors has been brewing for years in northern New Jersey over one property owner's insistence on his right to create what looks from online photos and videos to be a construction material landfill at the rear of his four-plus acre residentially-zoned lot. The wooded property fronts on a residential road that culminates in a cul-de-sac.

This isn't just any pile of dirt and debris. It is reputedly about 75 feet high, brought in by innumerable dump trucks (neighbors report counting 15 to 30 trucks daily) and testing positive for volatile organic compounds, PCBs, and pesticides for well over allowable residential amounts. You can watch it grow on Google Earth by using the "historical imagery" slider after searching for 3 Silver Spruce Drive, Vernon, NJ.

I've checked the ordinances for my own township, which are fairly typical. Aside from regulations addressing wetlands, stormwater and floodplain management, on-site sewage disposal (septic) systems, steep slopes, and support of adjacent properties when excavating, I don't see anything about limits of bringing soil into any site. The closest is residential zoning specifying lot size, setbacks, limit of impervious surface, and similar constraints—generally consistent with what I encounter elsewhere.

Vernon, the affected township in Sussex County, has more rural area than my township. Besides the usual ordinances, its code goes into more detail regarding soil removal in terms of doing no harm to public spaces or adjoining properties. It was not until 2018 that ordinances addressing the opposite were enacted, to require permits for minor and major deposits, with 500 cubic yards being the transition from one to the other.

The current concern is about extreme imports of materials that can harm neighbors in terms of leachate and the quality of water in the aquifer that all local wells tap into. The situation is characterized in the lawsuit against the owner—and at long last by the New Jersey Department of Environmental Protection—as being an unlicensed solid waste facility, while the owner has reportedly thumbed his nose at Township and County officials and refused to pay any fines since 2011. In early June of this year, a State Superior Court judge ordered him to halt work and remediate the site. However, this owner apparently has a history of similar activity in New York state, so there is no assurance of how soon he will take any action towards compliance.

Dirty dirt isn't the only kind of restricted deposit we can make onto our properties, though. We are also constrained when working on a site that is mapped on FEMA's Flood Insurance Rate Maps as being in a Special Flood Hazard Area (the 1% annual chance floodplains designated by A-type and V-type zones). In coastal areas, prohibiting fill is an admission of the power of storm surge: V-type zones should be kept free of obstructions to the flow of water to minimize damage to structures by coastal hydrodynamic forces.

Some fill is allowed in riverine floodplains (A-type zones), but we must get permission from the regulating community or county via an acknowledgement document included in the MT-1 Forms for altering floodplains. The reasoning is that changing the pattern of water might improve your situation while causing worse flooding on your neighbors.

Early in my career, I worked for a company that served as the Township Engineer for the community in which it was located. We started getting complaints from residents along the Assunpink Creek that they were suddenly experiencing flooding, ever since a neighbor had decided to dump a lot of dirt in his back yard to divert the creek away from his property. This was by another of those "just do it" kind of individuals, who paid no attention to the fact that by keeping his land drier he was harming other people's property. In that instance the resolution was less antagonistic, although certainly not without grousing and expense on the part of the illicit dumper. He had to pay a fine, remove the dirt he had added, and put the creek back where it had been.

We have other constraints against dirt piles, including the obstruction of viewsheds. Dune construction along coastal areas is prime for these kinds of conflicts, earning quite a few court dates. As with the other examples above, the balance between the rights of an individual and the rights and protection of the larger community can be difficult. ■

Wendy Lathrop is licensed as a Professional Land Surveyor in NJ, PA, DE, and MD, and has been involved since 1974 in surveying projects ranging from construction to boundary to environmental land use disputes. She is a Professional Planner in NJ, and a Certified Floodplain Manager through ASFPM.

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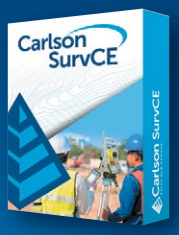

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