the American Surveyor

DECEMBER 2019

HISTORIC RESTORATION

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Geodesy and boundaries

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Historic restoration presents a growth opportunity for surveyors.

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A Paradigm Shift

The ultimate judicial function of a surveyor is to help maintain a stable society through artistic measuring of land boundaries. Our most valuable service is keeping the neighbors out of the courtroom. Reasonable individuals and corporations that own land understand the economics of a legal fight. They are happy to employ a land consultant that can work through issues rather than pull the fire alarm and walk away.

The paradigm shift begins with adopting logic that neighbors only need one surveyor to resolve their issues and without litigation. This means our contracts should include verbiage that addresses resolution as a necessary part of the completed survey. We are well poised to assemble the evidence and guide the concerned parties cohesively to resolution before we finalize our survey. A strange phenomenon occurs when a lawyer is approached by an upset client. The client's attitude and pocketbook trigger the lawyer's "fight or flight" switch. Surveyors have adopted a binary switch as well. It flips between 1.) "I'm right/you're wrong" and 2.) "That's just a big ol' mess out there, see ya later". Can you see how the surveyor's response professionally trips the lawyer's trigger? Land owners view both surveyors and lawyers as costly but necessary evils. With those binary options who wouldn't?

An important metric here is the definition of "fulfillment of services". What are your services? Well, we know the courts have shown that deed staking doesn't necessarily rise to the level of an accurate boundary survey. Conversely, harm is manufactured when the surveyor confuses ropes for robes and tries to self-adjudicate the boundary. When conflicting evidence emerges during the survey the most probable wrong action is to assert our professional opinion and walk away. Our services are uniquely paid for by one party but serve the adjoining owners including the public rights-of-way and overall cadastre. All of these interests have an authoritarian stake over our services. Are the stakeholders being addressed through your services?

A paradigm shift in the business model is on the horizon. The science of measuring has been automated. Just about everyone can physically perform measurements on a cadastral scale. The great postwar era "land development booms" that fueled construction surveying service companies finally died in 2008. Providing billable topo staking services is no longer a hot commodity in the world of UAV mapping, Lidar and machine control. The courts are screaming at us to understand that boundary retracement surveying includes more than just measuring. The delineation between a service business and a professional practice lies within the expectations of the contract. A service business delivers a negotiated quantity. Conversely the professional practitioner guides the client to remedy. A stable land cadastre requires maintenance. The fundamental operation is recovering evidence of the original marks and putting them to paper. If this retracement survey reveals serious conflict or abrasion with the owner's actions, beliefs, or record then the owners as adjoiners have an opportunity to resolve or live with the discrepancy and a boundary survey can truly be finalized and recorded in perpetuity. The professional service lies within organizing impartial information and documenting the adjoiner's authoritative resolution of the boundary. The economics of acquiescence may appeal to reasonable and corporate interests. Formalizing acquiescence or the adjoiner's lawful resolution is a prerequisite to completing a boundary survey and maintaining the stability of a healthy cadastre. Providing the service of a collection of abrasive measurements is nothing more than a pig in a poke. The paradigm shift occurs when the professional awakens to this true function. ■

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the American Surveyor

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Voyageurs

Voyageurs National Park is located on the international border with Canada, in northern Minnesota approximately 35 miles east of International Falls. About forty percent of the park is water, making it popular for boating, canoeing, and camping lakeside. Fortunate visitors can witness the aurora borealis dancing across the night sky over the park.

The park is named to commemorate the voyageurs—French-Canadian fur traders who enjoyed the ease of travel along the navigable rivers and lakes and were the first European settlers traveling the area. The fur trade was unregulated until France created a system of limited licenses for fur traders known as "congés." Voyageurs (French for "travelers") were licensed traders and represented a trading company, traveling to collect pelts from trappers and transport them back to trading posts.

Ojibwe people lived in this area for hundreds of years, navigating the rivers and lakes in their birch canoes. The Ojibwe, also known as the Chippewa, lived in Canada and the United States in the Great Lakes region. An Algonquian speaking group of bands, the Ojibwe became organized as a tribe in the 17th century. As independent bands of migratory fishermen and hunters, the Ojibwe were ideally suited to trade with the Voyageurs. The park has also been home to the Cree, Monsoni, and Assiniboine tribes.

The original survey of this Township was conducted by deputy surveyor George F. Hamilton. In his field notes, Hamilton begins his introduction with, "Survey commenced with a Burt's improved solar compass adjusted to the true meridian."

The solar compass was invented by Deputy Surveyor William Austin Burt. Burt patented the solar compass on February 25, 1836, with the United States Patent Office.

The solar compass truly revolutionized surveying and significantly improved the quality of surveys conducted in the public domain. Burt, while surveying in Michigan, had observed the needle on his magnetic compass spinning "unusually violently" while performing his work in Marquette County, Michigan, due to the magnetic influence of the Marquette Iron Range.

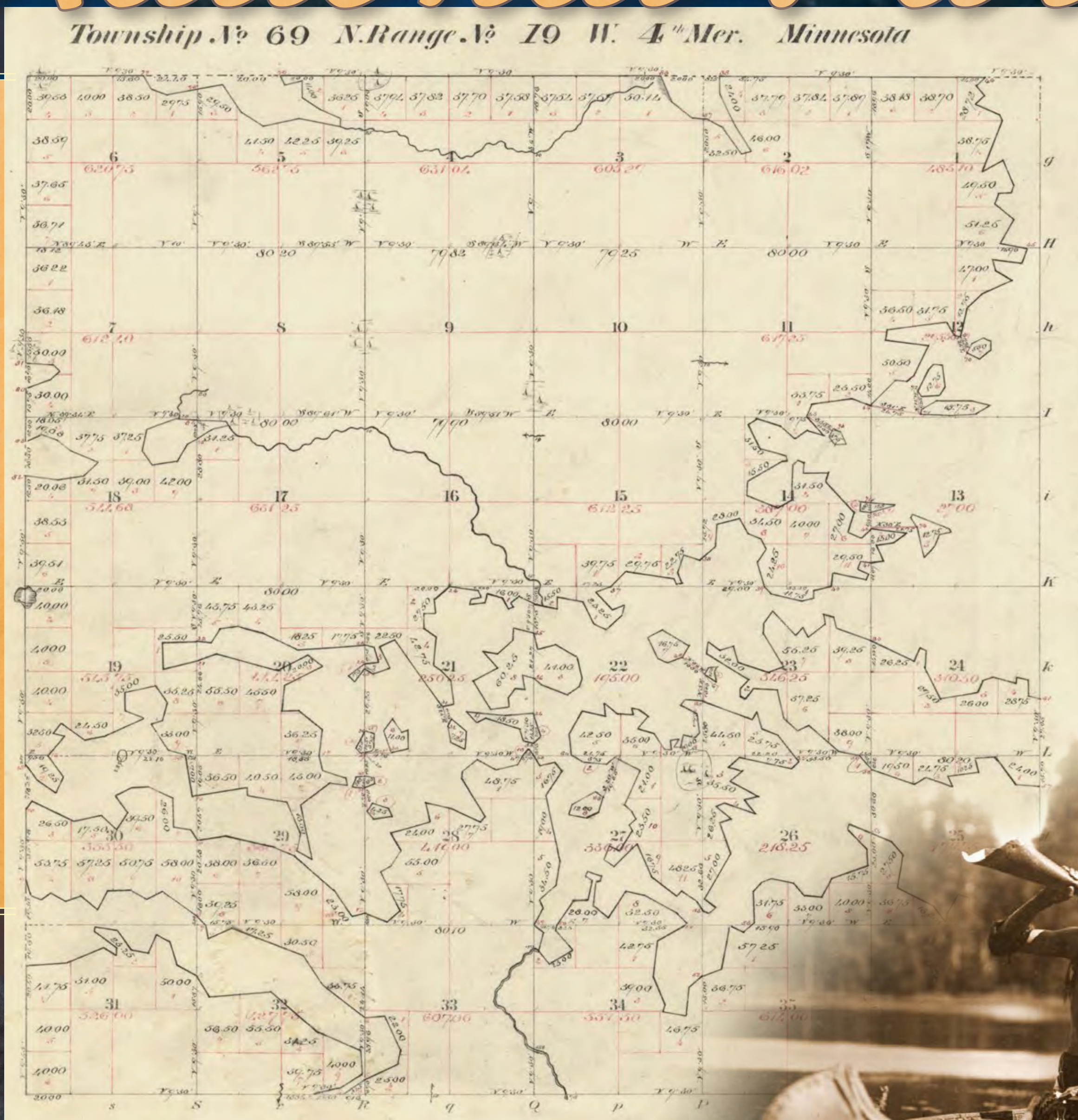
The solar compass allowed surveyors to determine true north from an observation of the sun without the need of a magnetic needle. Adjustments for latitude, declination of the sun, and hour of the day are set to allow the sun to pass through a lens to point north.

The survey plat of Township 69 North, Range 19 West, of the Fourth Principal Meridian in Minnesota was approved on October 29, 1883.

Pursuant to the John D. Dingell, Jr. Conservation, Management, and Recreation Act of 2019, lands managed by the Bureau of Land Management within the boundaries of the park were transferred to the National Park Service.

» BUREAU OF LAND MANAGEMENT/GENERAL LAND OFFICE

National Park



JASON E. FOOSE, PS

Gaines vs. Sterling

This month's case is a real humdinger from the Centennial State. Colorado is of course a PLSS state littered with mining claims. There's also riparian meandering issues along the lower Arkansas, Spanish Land Grants south of the Arkansas, Homestead Entry Surveys and even a few hills and hollers bending the squares on old T-Jeff's 6th Principal checkerboard. Sterling is a remote farm community way out on the northeastern plains where even the antelope don't know if they should route for the Broncos or the Chiefs. Unbeknownst to me there's some "Torrenized" land out there. This case is an appeal by Gaines who is referred to as "*Plaintiff in error*" which is synonymous with appellant. We're going to break this case down hard so hang on kids because it's a crazy ride full of robes stretching ropes and a bob dangler dangling his dangle bob where he shouldn't have dangled diddley.

The court rolls out the red carpet by laying down some evidence. "*...prior to the acquisition of their respective properties by plaintiffs and defendant both tracts of land were in one common ownership and while so owned in the year 1919 were registered along with other lands under the Torrens Title Registration Act.*" Once again the court establishes the common grantor right off the bat. We've seen this time and time again throughout our case studies. Despite all of the courts' deeply established standard of care to establish the common grantor, I have yet to see any state incorporate an examination of title back to the common grantor in their surveying minimum standards...and you wonder how Johnny Deedstaker keeps his license? Fffffffttttt!!! Okay, back on track.

Current owners are listed as Gaines (blue) and the City of Sterling (airport). As expected the PLSS is a little bit cockeyed and not perfectly cardinal after a few generations.

We have a bit of a twist here. The Torrens Title Registration Act comes into play but the court quickly established inapplicability to the case. The court kicks this whole thing off with the 1st Commandment of the land surveyor's authority. "***We point out that while construction of plaintiffs' deed and its legal effect are questions of law, the location of a boundary line is usually a question of fact**...*" I'm reiterating this for the gazillionth time in The American Surveyor and the kazillionth time for you Brown, Robillard, and Wilson subscribers. All of you Lucaspaloozers, Knudsters, Broadusians are far more than aware of the concept as well. Okay, we're all on board and know the difference, right?

Well, the court decoupled the legalities of Torrens from the facts of location in this boundary dispute and kept the show on the road. "*...thus the Torrens Act can have no application to the settlement of a boundary dispute arising after registration of title whether between two registered owners or a Torrens holder and a non-registered owner. This, of course, would not be true if the boundary question had first been raised in the proceedings to register the title for it could be properly determined at that time too. See Balzer v. Pyles, 1932, 350 Ill. 344, 183 N.E. 215.*"

Okay, we got the lawyerin' out of the way so let's watch as the court pulls on its boots and picks up the ropes. The court establishes some context with this "...*Section 35 is one of those parcels of land which is not standard in size, and that all original four section corners, as well as the original quarter section corners in question, had been obliterated, and at the time of suit were unmarked as to the original government survey. This does not mean that the section corners were "lost" corners, however, in the sense that they could not be relocated with some degree of accuracy by recognized natural or permanent monuments, or even by re-survey from township lines some miles away.*" Okay, the robes deem these corners as obliterated so this is a retracement job and not the double bubbling of a lost corner.

I'm going to fast forward right to the bad scenes (FYI: the Commissioner is court appointed surveyor) "...*the (lower) court held that the Commissioner's report more nearly coincided with the original government survey than the two surveys of plaintiffs...*" That sounds promising, right? Here's what he did "*The record discloses that the Commissioner appointed by the trial court proceeded to the nearest original governmental markers located some three miles away and then surveyed in to what he determined to be the north quarter corner of section 35. He then correlated this with an old irrigation filing and other monuments, including some grown over road ruts in the south half of section 35, to arrive at what he concluded was the original dividing line between the two properties in question.*" That sounds like some diligent retracement surveying from my perch, especially in lieu of original existing monuments. Well, the girdle hit the floor and so did everything else. While the Commissioner's *Plat of Pertinent Survey Data To Divide The W ½ From The E ½ Sec. 35 T 8 N R 53 W 6 P M.* was admitted and favored by the lower court, the Supreme Court took a tone with him and asserted "*The surveyor's certificate thereon is replete with such unacceptable wording as "* * * As shown above by superimposing a theoretical section from the returned government distances from the east side of the Township we find such a section as respects the line in question does intercept the old line and that fence which was probably on the west side of an old road did start and continue north for a half mile very nearly on such a line. At that time in all probability, the fence was continued north from the end of the road and necessarily would have deflected to the east if it was established at a corner***.*" There's an awful lot of self-righteous "maybe-isms" and conjecture in those words. I've seen my share of star spangled babble on surveys and it rarely does any good. According to the court here's why,

1. *"The theoretical reconstruction of the original government survey of the north-south center section line, with reference to the old fence line, has no application to this dispute, there being no evidence that the so-called old fence was established as a boundary line or agreed upon or accepted as such by these parties or by their predecessors prior to the registered owner."* These next two statements are compiled out of sequence but relevant nonetheless.
2. "*(The Commissioner's plat) showed a final division of the section (and we*

Barbershop Barrister

Boy, did I need a haircut and some tonic with this case. The lower court ruled that the Commissioner's report more nearly coincided with the original government survey than the two surveys of plaintiffs. I had trouble with the Supreme Court overturning an apparently good retracement survey in an obliteration case. I also suffered some indigestion with the Supreme Court saying *"It also runs afoul of the rule of law which provides that no state can make any rule or law providing for apportionment contrary to Acts of The Congress."* Again, this is retracement and obliteration case, not a double whammy with the rubber band of righteousness. Boundary common law decisions are repeatedly contrary to the acts of congress. In fact, Congress surrendered their authority when the president signed the patent. Regardless, the court is focused on the authority of the grant and preserving the simultaneous rights created with it. I did not see the correlation with "apportionment" until this happened *"...(The lower court) proceeded to apportion the strip in dispute by holding that plaintiffs own that portion which lies east of the old fence and west of a line drawn from a point which is 30 feet east of the old fence beginning at their southeast corner, said line running thence northerly to where the old fence line intersects the north line of section 35...Thus the disparity between the amount awarded plaintiffs as against that given to defendant could also result in a disturbance of other long established land titles in section 35."* ...and there I stood like a magpie on a telephone wire watching the lower court twist this evidence like it was Chubby Checker's ankle in a gopher hole during a tornado. The Supreme Court put on its daddy pants and laid down the law! *"The theoretical reconstruction of the original government survey of the north-south center section line, with reference to the old fence line, has no application to this dispute, there being no evidence that the so-called old fence was established as a boundary line or agreed upon or accepted as such by these parties or by their predecessors prior to the registered owner."* The end result was the two plaintiff surveyors followed in the footsteps of the original surveyor by retracing the notes, plat, and reproducing the ¼ corner halfway between which was clearly the uncontested record intention. This decision is a keeper!

note that none of the other owners of the section were parties to this action)... Thus the disparity between the amount awarded plaintiffs as against that given to defendant could also result in a disturbance of other long established land titles in section 35."

3. *"Commissioner appointed by the trial court was in error in proceeding upon the theory that the property line in dispute should be based upon his theoretical reconstruction of the original government survey of the center line of section 35. This error is further magnified when the evidence discloses, as it did here, that all three surveyors agreed (and there was no evidence to the contrary) that the original government survey called for equal subdivisions within the section."*

Now this is where things get narrow. The court deemed the corners as obliterated rather than lost, right? And I quote "*The evidence discloses that Section 35 is one of those parcels of land which is not standard in size, and that all original four section corners, as well as the original quarter section corners in question, had been obliterated, and at the time of suit were unmarked as to the original government survey. This does not mean that the section corners were "lost" corners, however, in the sense that they could not be relocated with some degree of accuracy by recognized natural or permanent monuments, or even by re-survey from township lines some miles away."* The court is operating in the era of the 1947 Manual of Instructions (1947) and appropriately adopted 1947 as the standard. A perusal of 1947 reveals some very rigid standards for obliterated and lost corners. 1947 also calls out some standards for collateral evidence and testimony. The bottom line for the court is that any evidence has to be directly tied to the original location it's purporting to represent. Unfortunately the old adage of "*the large print giveth, and the fine print taketh away*" held true in the Supreme Court's eyes and torched the credibility of the Commissioner's survey like a doobie at a Dead Concert. The terms "probably" and "in all probability" are certainly not evidence of an original corner. The court sure as hell didn't appreciate the sentiment in a certification. Apparently the "old irrigation filing" lacked relevance or authority despite its potential as positive collateral evidence. The Supreme Court was concerned about the disturbance of other long established land titles in section 35. This leads me to believe that the monuments correlated by the commissioner's survey may have lacked an authoritative pedigree. Lastly, the old ruts and roadway need some authoritative support. The preponderance of evidence is reinforced by intention, public notice, and deliberate use. For example, a blanket easement over "all section lines as public roads" is a pretty flimsy tie between ruts and an original GLO corner. A stronger bit of evidence might be a county highway declaration calling out the north/south centerline of Section 35 as a public road and then some indication of sustained use and maintenance. Unfortunately and without some stronger and authoritative correlation a set of ruts may only amount to a good time in a 4x4 on a Sunday afternoon. Granted, in 1950 the Commissioner may have been looking at historic wagon ruts; nonetheless they are still just unauthoritative ruts. So the long and short of this case is that the court found no other evidence that would give pause to us falling back on the plat, notes, and manual as the best evidence to replace the obliterated corner. As an aside, a quick peek at the SEARCH GLO RECORDS website reveals a few curve balls with a resurveyed correction line at the bottom of our section and the locals know that the sand of eastern Colorado swallowed up the 6th P.M. survey long ago. Regardless, the evidence shows "*...two surveys also prepared by registered professional engineers and land surveyors. Both of these surveyors proceeded to locate the lost corners of section 35 and then applied the rule of single apportionment within the section. This arrived at a north-south line that is the approximate line where the new or easternmost fence is now located, and equally divided the north half of the section from north to south.*" And finally here's why the court duct taped this thing back together using record info "*...all three surveyors agreed (and there was no evidence to the contrary) that the original government survey called for equal subdivisions within the section.*"

So along with our decided guidance that speculative statements and conjecture are garbage, and that a few of us needed to google "Torrens land" for grins and giggles, the original field notes reveal a true historic precedent. Buffalo bones were buried as a memorial all along the correction line below section 35. Colorado may rue the day that someone digs up two piles of Tatanka pickins a half mile apart along that 2nd Correction Line of T-Jeff's 6th iteration of squares. Check out the notes on the BLM website and as always feel free to contact me at *rls43185@gmail.com.* ■

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.

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RETURN TO GLORY

The splendor of Notre Dame Cathedral in Paris is evident before the April 15, 2019, fire, which destroyed the building's spire and most of its roof, and severely damaged its upper walls.

GEOMATIC SOLUTIONS AID RESTORATION OF HISTORIC STRUCTURES

This colored point cloud of the Notre Dame Cathedral in Amiens, France, shows orange triangles that are scanner positions. The ones that appear to be inside the building are actually scanner positions going around it.

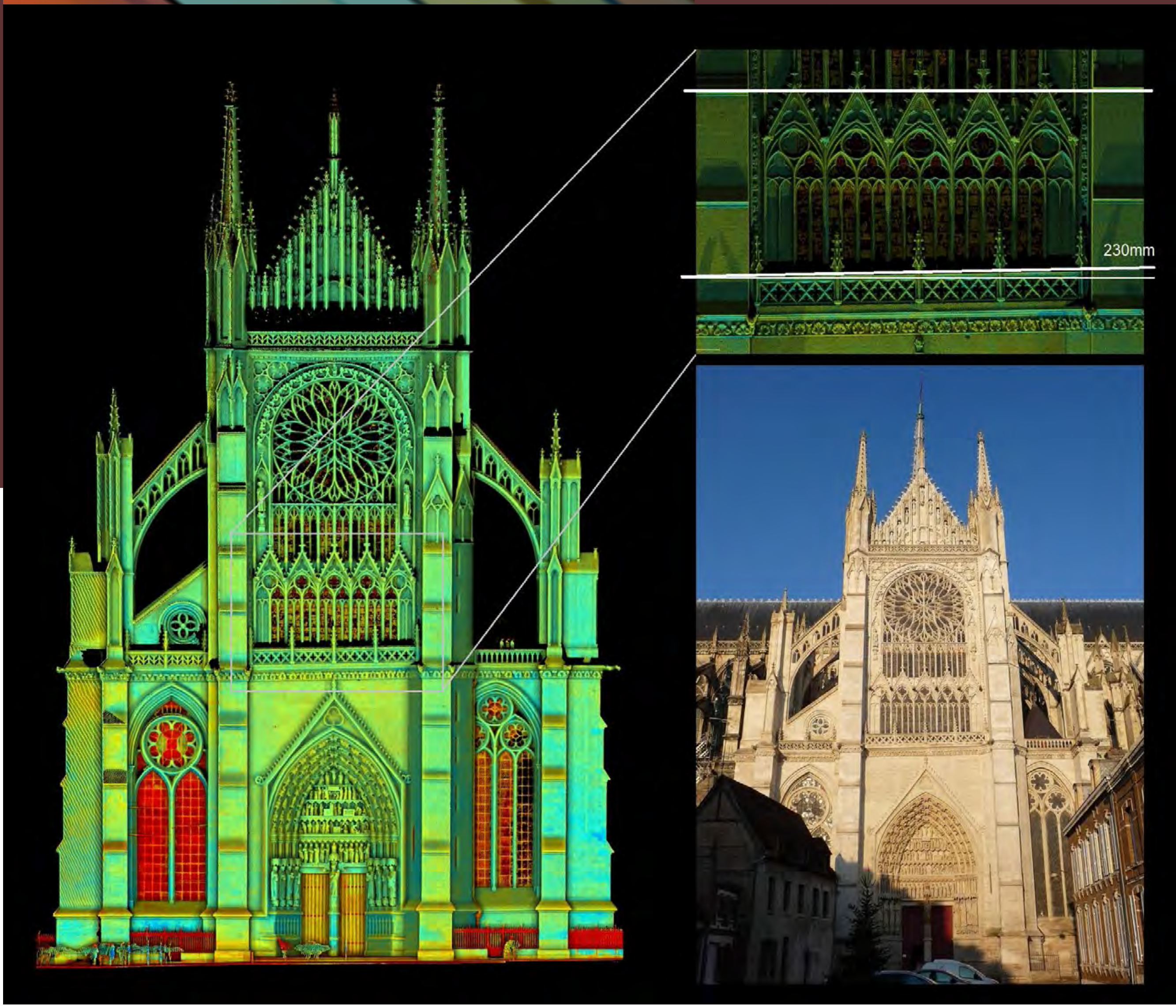
Historic structures and architectural wonders like the Notre Dame Cathedral in Paris rely on the inventions of their era to stay standing for hundreds and thousands of years. But when natural or human-caused destruction strikes in modern times, it is often geospatial data that holds the most promise of restoring them to their former glory.

As 3D digitizing becomes increasingly valuable in historic restoration, the technical aspects of surveys and point clouds will only grow in importance. Let's take a closer look at setup, instrumentation, project examples, and the potential benefits of technology advances in 3D laser scanning.

Geospatial data supports revival of world-famous church

With the Notre Dame Cathedral, it was obvious from the moment of the April 15 fire that the structure would be scanned multiple times to accurately determine damages and structural stability and compare with past scans. Point clouds from scans will support the restoration lifecycle, including knowing how to handle the destruction, determining how to support work around existing architecture, and finally, informing decisions on building features, such as replicating what existed before or creating something new.

» GREGORY LEPERE



In these images of Notre Dame Cathedral in Amiens, France, the zoomed portion (top right) of the point cloud of the south facade that includes the Golden Virgin Mary reveals the right side of the balcony is 230 millimeters, or about nine inches, higher than the left. The misalignment may be perceived as a perspective issue from the ground, but scan data confirm it is tilted. Historians dated the stones and found both the right and left of the facade were built first, and when it came time to link them, the architect apparently decided to tilt the balcony to fix the alignment issue.

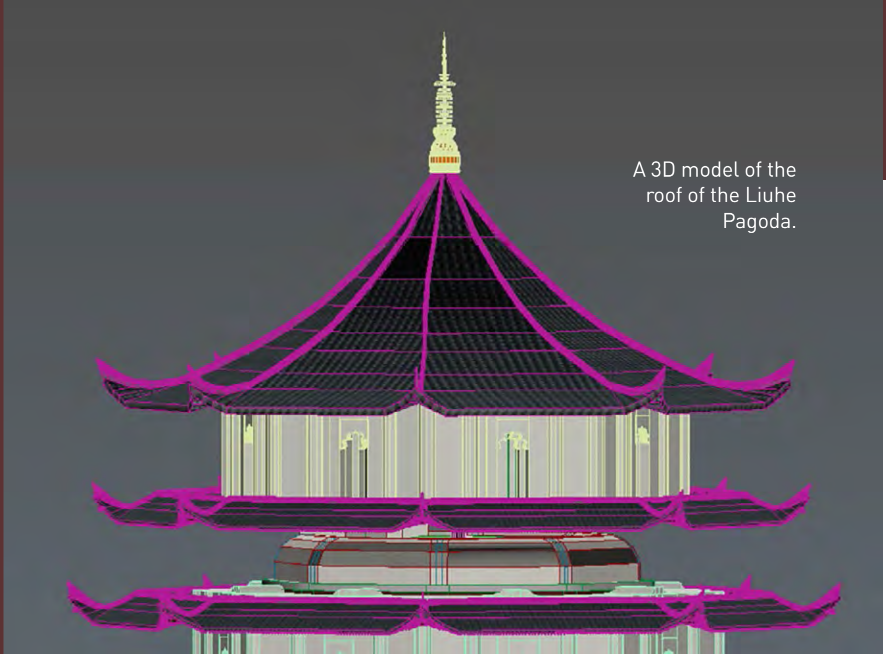
Such a project benefits from using surveying companies with specific knowledge of the best workflows for historic preservation and restoration. These specialized companies often have teams that include surveyors, scanning technicians and restoration professionals trained and experienced in historic building materials and techniques.

Instrumentation and setup support restoration

The Notre Dame Cathedral restoration also heightens the sense of urgency for structures and monuments without digital records to get point clouds created before disaster strikes or natural elements erode their splendor.

With this in mind, let's explore the measurement configuration inside and out, as well as the setup process to create a digital record to aid historic project restoration:

- For scanning small or medium sites, use one or multiple 3D laser scanners, with the setup dependent on size, budget and criticality. Solutions could include a laser scanner and/or a scanning total station, tripods, batteries, and data storage (USB key or SD card). Also recommended, but optional, are black and white targets, spheres and/or survey prisms, as well as an external high-end camera and panoramic head for higher-quality imaging.
- For larger sites, in addition to the above list, black and white targets, spheres and/or survey prisms must be used. If you aren't using a scanning total station, you will need one total station or one GNSS receiver to establish a control network, which is a skeleton of precise known targets covering the entire site and serving as a reference for all scans to guarantee accuracy over the entire site.
- For continuous monitoring of the critical elements of a building, you will want one, or more often, multiple high-accuracy total stations mounted 24/7 on stable permanent pillars. The setup should also include a number of



A 3D model of the roof of the Liuhe Pagoda.

monitoring prisms to be installed on the critical elements of the building, monitoring controller(s) to provide a continuous connection between the total station(s) and the monitoring control center, and real-time control software.

Techniques reveal more detail

While missing elements, such as roof segments, can't be measured, fallen or partially destructed elements can be scanned, measured and virtually repositioned to understand what is really missing and provide understanding on how it has been destroyed.

A major consideration in point clouds is photo texture, or the addition of color and texture to a point cloud or mesh to add rich visual detail. To get photo texture, you have two options: an internal camera of 3D laser scanners, selected most often for simplicity and productivity, or an external high-end camera and panoramic head for more expert control and higher-quality imaging.

Historic restoration with 3D models: Three examples

Liuhe Pagoda (China): Reviving a cultural landmark

Liuhe Pagoda (or Six Harmonies Pagoda) in China's southern Hangzhou, Zhejiang province has a rich cultural tradition dating back to its construction in A.D. 970. In its more than 1,000 years of existence, the 13-story octagonal building made 95% of wood has lived several lives, including destruction by warfare in 1121 and full reconstruction by 1165.

In 2013, the tourist attraction began its fourth major repair and renovation. To preserve the complete, true appearance, the owner entrusted Beijing TiTest Technology Corp. to scan the whole interior and exterior, which occurred over six months to allow for the gradual restoration of missing parts, one by one.

The workflow included scanning of the original building (3 minutes per station), modeling the original building to find the missing parts (2-3 hours per station), designing the missing parts and testing their assembly (4-6 hours), crafting the missing parts by hand (3-5 days), assembling the missing parts on site (4-5 hours), scanning again for quality assurance (QA) and quality control (QC) (3 minutes per station), processing point clouds for the harshness inspection (QA/QC) (3-5 hours), and lastly, processing a very detailed 3D model for documentation (2-3 days).

Using a compact 3D laser scanner to scan the whole 527 station, the original point cloud data volume reached 363 gigabytes, with 23.03 billion three-dimensional points collected.

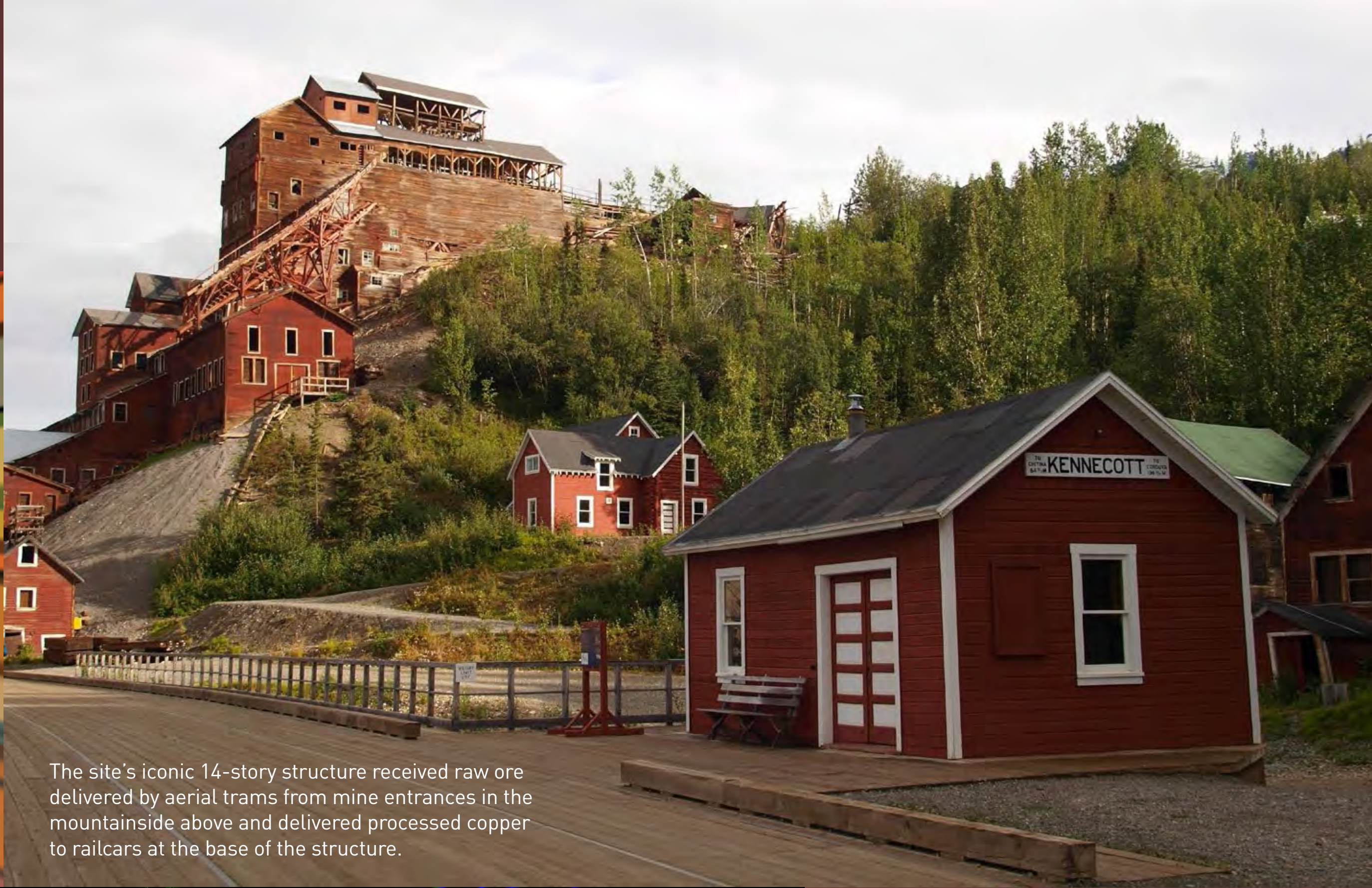
Kennecott Mines National Historic Landmark (Alaska, USA): Restoring a treasure

Located in eastern Alaska, the Kennecott Mines site was declared a U.S. National Historic Landmark in 1987. When the National Park Service (NPS) acquired Kennecott in 1998, it began the lengthy effort to preserve the site and determine which buildings should be stabilized or rehabilitated after nearly 80 years of neglect.

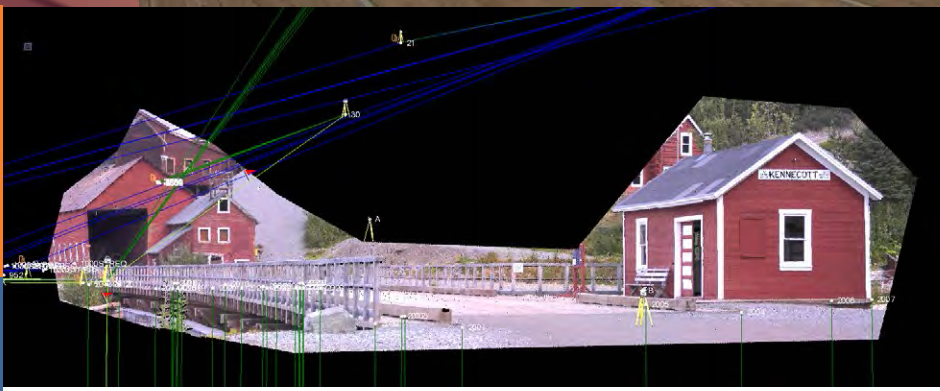
Archaeologists worked to map the site, but by 2018, the NPS started gathering additional data as part of a project to stabilize the upper seven stories of the mill and found the 2000 data lacking in detail and accuracy.

To provide the necessary precision, 3D laser scanning was deployed. A team from Frontier Precision Inc. selected the Trimble SX10 scanning total station and the Trimble TX8 laser scanner for the bulk of the work, which tied scans to existing control points

The intricacy of the design of Liuhe Pagoda, at 13 stories high, made it a challenging restoration project.



The site's iconic 14-story structure received raw ore delivered by aerial trams from mine entrances in the mountainside above and delivered processed copper to railcars at the base of the structure.



A georeferenced Trimble VISION photo mosaic of the Kennecott mill from the valley floor. Blue lines show GNSS measurements, green are from SX10 traverse and direct reflex data.

and used traverse or resection functions to establish georeferenced 3D positions on each setup point. The team also used Trimble R8 and R10 GNSS receivers to extend control throughout the site. In addition to scanning, the Trimble SX10 used direct reflex (DR) measurements to capture individual points on the building that could identify key features and be compared to the point cloud for quality assurance.

Technicians processed the data using Trimble Business Center (TBC) software to combine the traverse and GNSS results and work on scanning data from the SX10. They used the Trimble RealWorks survey workflow to process TX8 data to project coordinates. Multiple scans were merged quickly, and teams created colorized point clouds for visualization. At the end of the three-day project, technicians delivered a single TBC dataset containing all point clouds, images and survey data.

Church of Saint Simeon Stylites (Syria): Promise of restoration

Initially scanned for preservation, the Church of Saint Simeon Stylites—in the north of Syria—dates to the fifth century and now stands partly destroyed by a Russian rocket attack in 2016. If it becomes possible to restore the church, the scans can be used as a historical record of the structure, making them very valuable.

Since 2003, the site has been the object of digital surveys, according to a paper published in 2011 in the International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences.

Authored by M. Kurdy, J-L. Biscop, L. De Luca and M. Florenzano, the paper includes a description of work done at the site by Yves Egels, ENSG, in 2004. Using a Trimble GX scanner, Egels did 36 stations to collect 250 million points all over the cruciform church, which is composed of four basilicas in cross formation around an octagonal drum centered on the famous pillar where Saint Simeon lived and preached for four decades. Registration was done using spheres.

Once the data was gathered and georeferenced, the whole point cloud was cleaned of unnecessary points, sampled and cut into various elements, following construction logic consistent with reconstruction techniques. The data made it possible to determine how the building was created, including the central octagonal drum. It also enabled the creation of a 3D hypothetical reconstruction.

Simplicity increases accessibility

While manufacturers are working hard to simplify the process of completing a single scan, high-level expertise is still required for a full project like a cathedral. The registration process, or the combining of scans in an accurate way, is one of the remaining barriers to simplifying large projects.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The Church of Saint Simeon Stylites was heavily damaged in a 2016 air strike.

The first developments to provide a pre-registration in the field were only a half-step in the right direction. Extensive processing and validation were still necessary back in the office. To make scanning really simple, a project should be done and final when finishing on site, with no disappointing surprises later. Full registration in the field including refinement to obtain an accurate registration, colorizing, reporting and exporting data in the right file format is a game changer.

Conclusion: Maturity brings benefits

3D laser scanning has come a long way since its beginnings in the late 1980s. Performance, size, weight and productivity have greatly improved, while the total cost of ownership has come down.

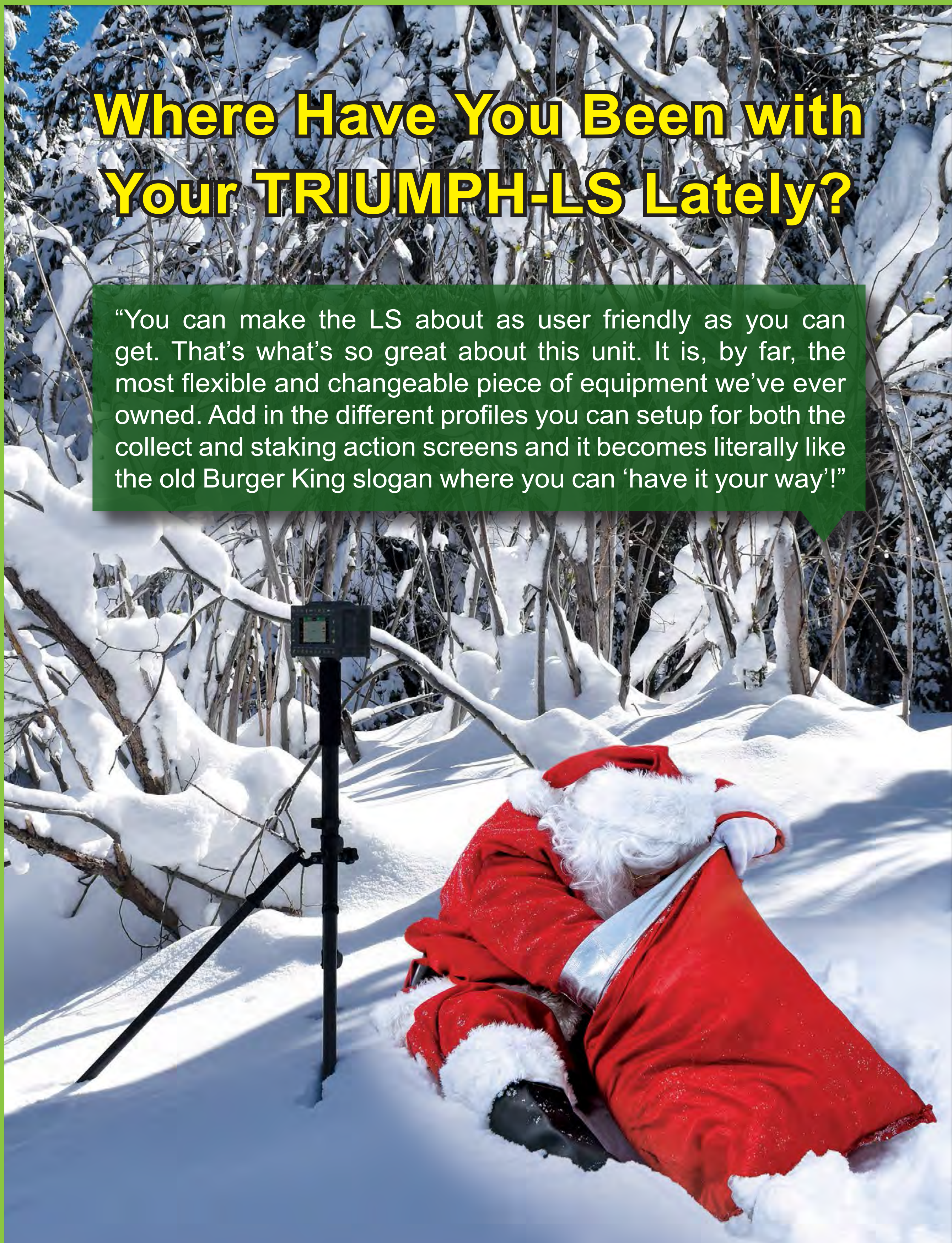
Still, compared to other optical measurement instruments like levels, theodolites or total stations, maturity in 3D laser scanning isn't completely there. Most manufacturers still recommend a yearly calibration to maintain the expected specifications; and standard warranty periods are in general just one year, while all other optical instruments provide two years. With its automatic calibration feature, the recently announced Trimble X7 scanning system is addressing this and other challenges users previously faced with 3D laser scanning technology.

As 3D laser scanning becomes a more mature technology, similar to optical instruments, we will see a much broader use of this fantastic technology. Each new innovation is making it easier and faster to capture precise 3D scanning data to produce high-quality deliverables.

With this growing accessibility, geospatial professionals won't have to be scanning experts to also benefit from the technology, enabling them to branch into new lines of business, like historic restoration. ■

Shown inside the Landesmuseum in Zürich, the Trimble X7 scanning system, available in early 2020, exemplifies the maturation of 3D laser scanning technology that can support the collection of critical data on historic structures to enable their future restoration after disaster or deterioration.

Gregory Lepere, marketing director of Optical & Imaging for Trimble Geospatial, has been fascinated with cathedrals since he was a boy growing up in France and has participated in 3D laser scanning of many historic structures during his geospatial career, including Notre Dame in Amiens, his hometown.
Email: *gregory_lepere@trimble.com*



Front

JAVAD

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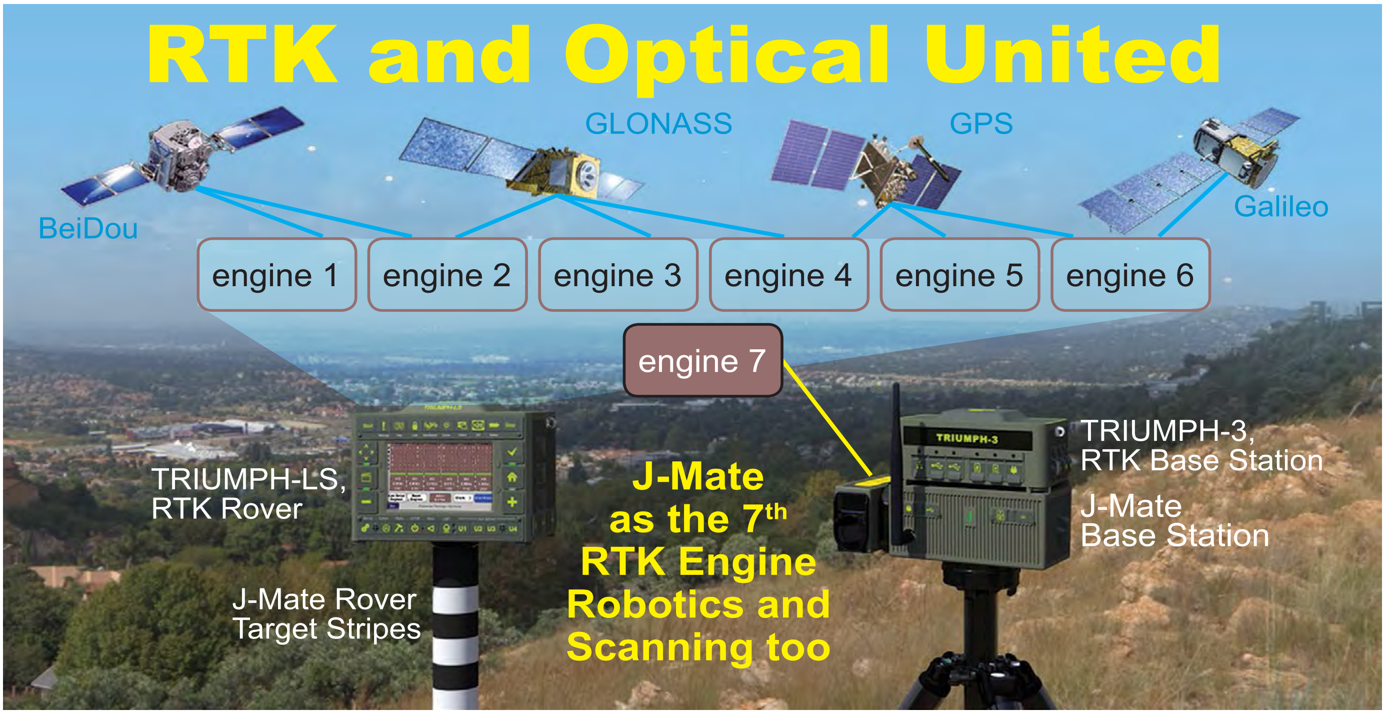
Stephen Drake TRIUMPH-LS user and J-Mate Volunteer.

"I don't know if I'd still be in business if it weren't for Javad"

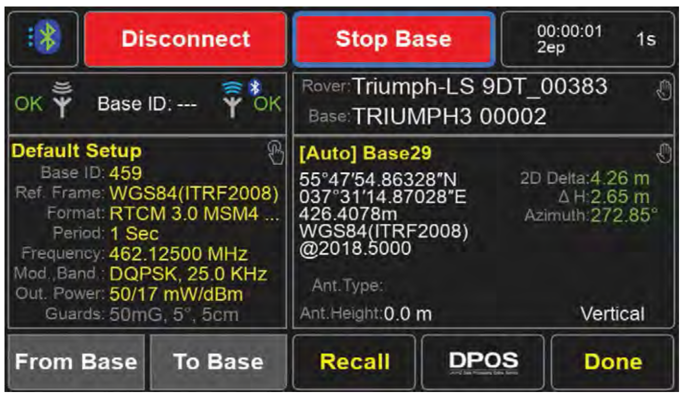
Adam Plumley, PLS

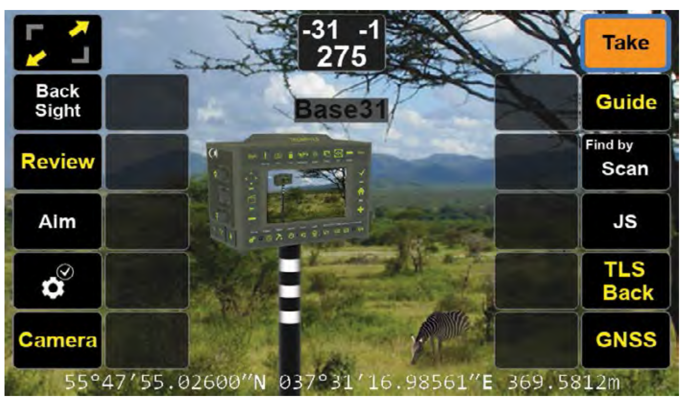
Locating fence posts...

If you notice the LS center is on the inside face of the post. That is where I will be placing the wire. I staked out each point where a metal tpost will be driven between the larger wooden posts. I will cut the wooden posts to height later. For now I had to climb up on the roof of the buggy to shoot them. I've done about 500 ft of tposts so far and they line up great. Much better work flow than the old school way of tying Mason twine to the posts and using that for line and pulling tape or flipping tposts (if you know what I mean). I've flipped a few in my time.



Your Own Complete RTK & Optical





Setup TRIUMPH-3 on top of J-Mate. Set up TRIUMPH-LS on top of the Zebra rod.

TRIUMPH-3 is the RTK base station and TRIUMPH-LS the RTK rover. J-Mate is the optical base station and the Zebra rod is the optical rover.

Now RTK and optical solutions are available simultaneously and can verify each other's solutions. They also can cover each other, when one is not available.

RTK has six engines. We treat the J-Mate solution as the seventh engine of the system.

The system is self-sufficient for all jobs. No need to pay RTN service providers for RTK base stations and no need to pay communication service providers. The communications are done via integrated and included Bluetooth, UHF, and Wi-Fi embedded in the system.

Another major advantage is that because your own RTK base station is not far from your rover, RTK solutions will be provided much faster and more reliably.

We added the "Aim" option for stake-out. In this mode J-Mate points to the selected stake point and you follow the laser to reach the intended point. This is in addition to the robotic mode which J-Mate follows your Zebra pole.

At TRIUMPH-LS = 2.13 kg (4.40 lb), TRIUMPH-3 = 1.26 Kg (2.20lb), and J-Mate = 2.17 kg (4.41 lb), the total package of 5.6 kg (11.02 lb), weighs less than one conventional optical total station alone.

J-Mate does have complete geodetically encoded scanning (3 points per second) and robotic features too.

J-Field, the Embedded Controller

J-Field is the embedded application program of TRIUMPH-LS. It has the following unique features for each point surveyed:

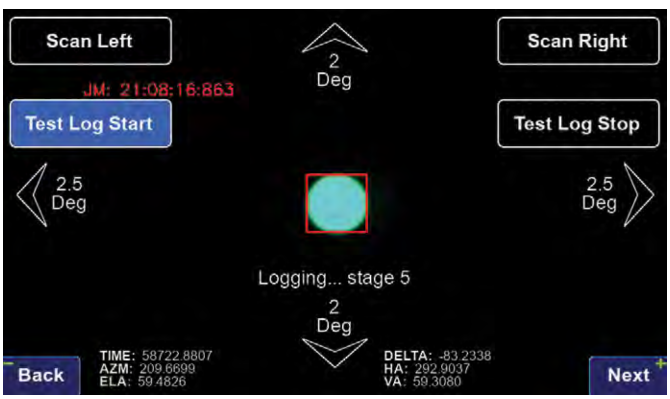
- Six parallel RTK engines to maximize solution availability.
- Automatic Engines Resets, verification and validation strategy.
- Several graphical and numerical confidence reports and documentation.
- Voice-to-text conversion for hands free operation and documentation.
- Lift & Tilt and automatic shots for hands free operation.
- Visual Stakeout (Virtual Reality).
- “DPOS it” or “Reverse Shift it” features. The most advanced RTK verification.
- Photogrammetry and angle measurements with embedded cameras.
- Automatic or manual photo documentation.
- Automatic screen shots documentation.
- Audio files for documentation.
- Automatic tilt correction.
- Scanner feature.
- Find objects by their shape, by laser or optical.
- Comprehensive HTML and PDF reports.
- Comprehensive codes, tags and drawing tools.
- Status of all GNSS signals and their quality.
- Over 3,000 Coordinate Systems.
- Automatic and free software update via Internet.

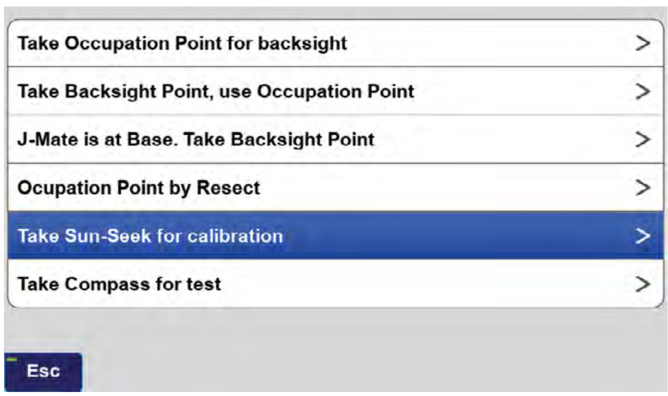
Take Backsight with a Single Shot

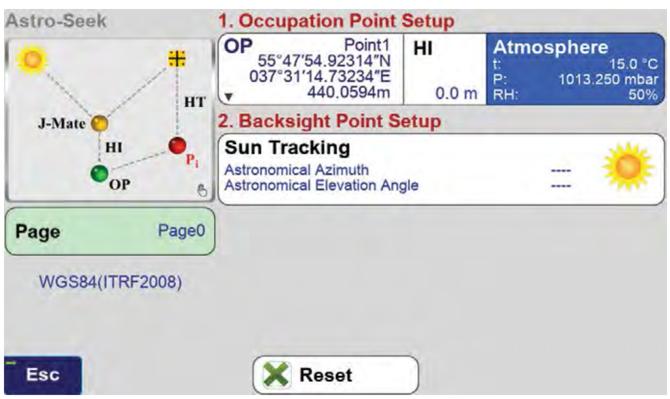
To calibrate the J-Mate, take few seconds of RTK at the Backsight point, and click “Backsight” button. There is no need to locate Occupation Point and the Backsight point, because Occupation point is the RTK Base station and one point is enough to determine the azimuth to calibrate the J-Mate angular encoders.

Backsight with Auto SunSeek

Click a button and after a few seconds Backsight will be calibrated with the Sun AUTOMATICALLY. Don't forget the Sun filter.







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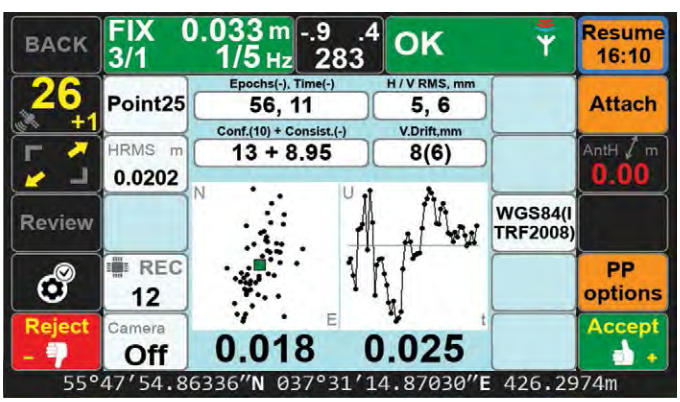
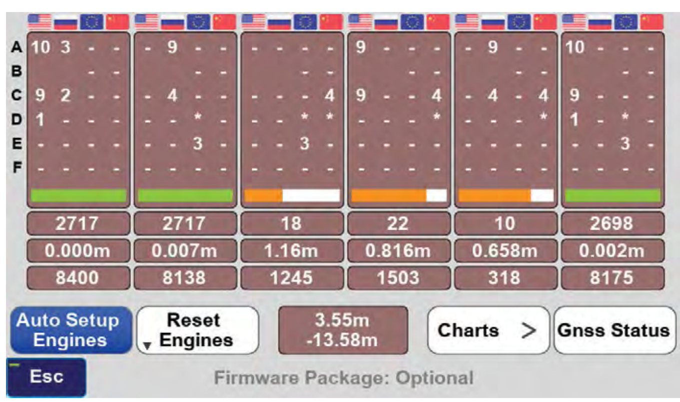
Smart assignment of satellite signals to different engines.

This vigorous, automated approach to verifying the fixed ambiguities determined by TRIUMPH-LS gives the user confidence in his results and saves considerable time compared to the methods required to obtain minimal confidence in the fixed ambiguity solutions of other RTK rovers and data collectors on the market today. The methods required by other systems are not nearly so automated, often requiring the user to manually reset the single engine of his rover, storing another point representing the original point and then manually comparing the two by inverse, all to achieve a single check on the accuracy of the fixed ambiguities. Acquiring more confidence requires manually storing and manually evaluating more points. Conversely, J-Field automatically performs this test, resetting the multiple engines, multiple times (as defined by user), provides an instant graphic display of the test results, and produces one single point upon completion.





TRIUMPH-3

The new TRIUMPH-3 receiver inherits the best features of our famous TRIUMPH-1M.

Based on our new third generation TRIUMPH chip enclosed in a rugged magnesium alloy housing.

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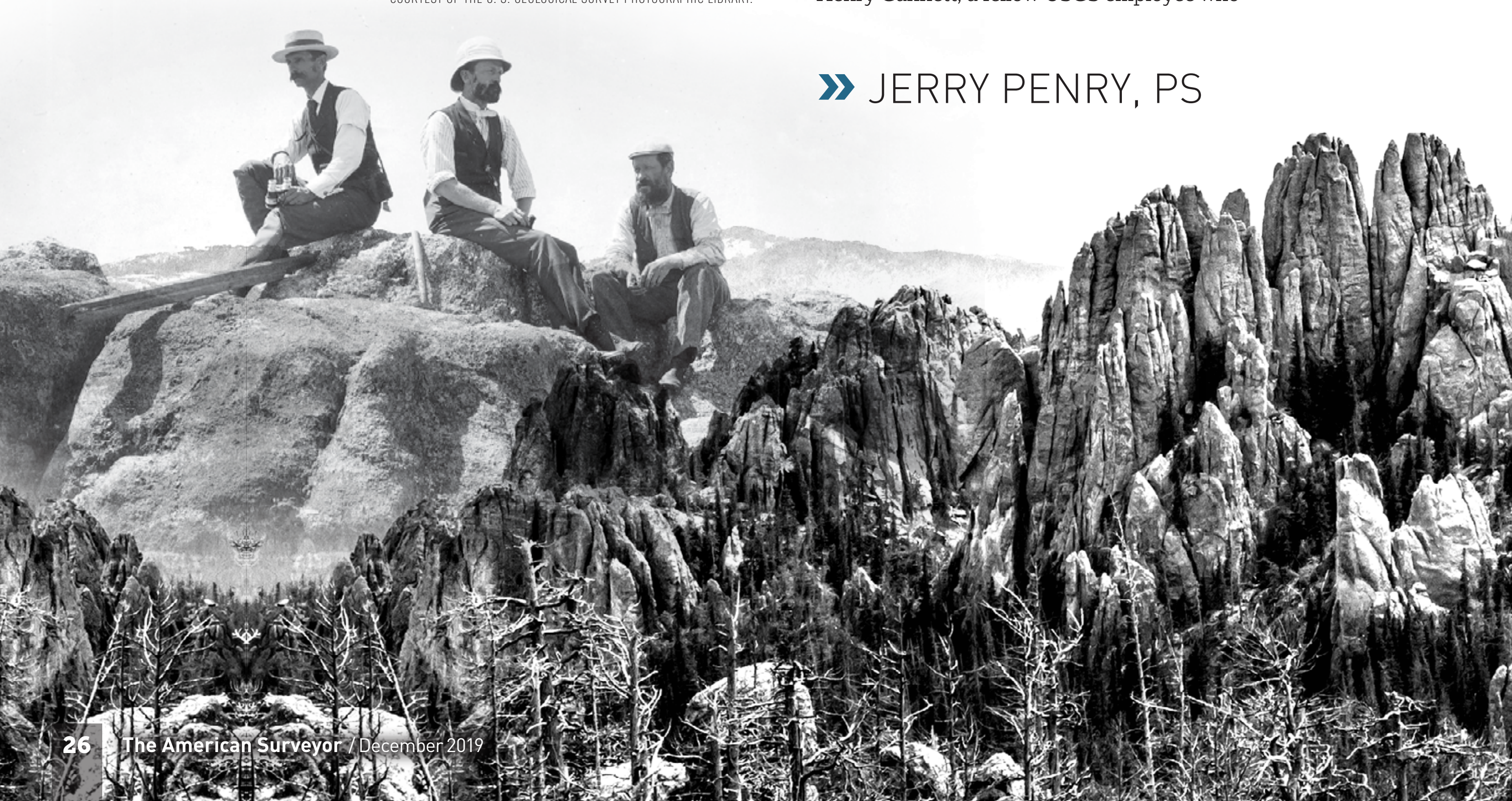
Early BLACK HILLS Triangulation

When the United States Geological Survey (USGS) became tasked with mapping the nation into one contiguous system based upon accurate latitude and longitude in the late 1800's, they chose to begin in key and often isolated areas of the country that were of national importance. One region already prospering with mining and forestry interests was the Black Hills region of southwestern South Dakota. Existing maps within the area were generally compiled from assumed or local control, so the maps were generally not spatially correct, nor could they be interconnected together.

To begin the survey of the Black Hills, 29-year-old Samuel S. Gannett arrived in the area's largest city Rapid City, during the fall of 1890. This talented geodetic surveyor was the cousin of famed Henry Gannett, a fellow USGS employee who

» JERRY PENRY, PS

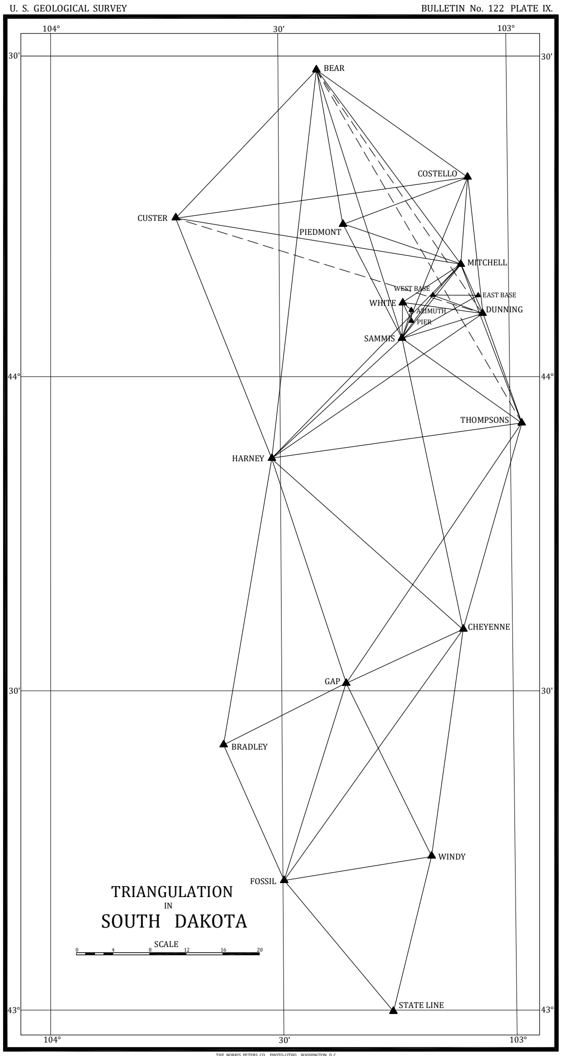


Atop the summit of Harney Peak, USGS personnel Joseph A. Holmes, Charles D. Walcott, and Henry Gannett rest upon one of the strategic points in the Black Hills triangulation network.

COURTESY OF THE U. S. GEOLOGICAL SURVEY PHOTOGRAPHIC LIBRARY.

was widely known as the father of government map making. The main objective for Gannett was to place an astronomical monument and then make the necessary observations to determine its precise latitude and longitude. With the assistance of Abner F. Dunnington, the two men constructed a brick pier in the courthouse lawn approximately 75 feet west of the southwest corner of the building. The pier was sunk 36 inches below the surface and extended 30 inches above. A dressed sandstone cap with a center point rested on top of the pier and was lettered U.S.G.S.

The work to determine the position of the astronomical pier began on October 23, 1890, by taking repeated readings on stars to determine the latitude and by telegraph time signals with St. Louis to determine the longitude. Professor Henry S. Pritchett, an astronomer and educator at Washington University in St. Louis, coordinated the signals from the observatory at that location. Pritchett had earlier been the assistant astronomer at the U. S. Naval Observatory and later became the Superintendent of the U. S. Coast & Geodetic Survey from 1897-1900. The work was completed 28 days later on November 20. Another smaller monument was placed on the true meridian north of the courthouse at a log distance of 3.3108 meters (6711.03 feet) and became known as the meridian mark. The final position of the Astronomical Pier was determined to be 44°04'45.240" North Latitude and 103°12'59.283" West Longitude and became the beginning point for the Rapid City Datum.



The initial triangulation network of the Black Hills of 1893 consisted of 20 points including an astronomical pier, meridian mark, and two baseline monuments.

The following season, 1891, USGS surveyor Charles H. Fitch came to Rapid City to establish a baseline for the upcoming triangulation network. The relatively flat area of Box Elder Creek located northeast of the city created an ideal place for the baseline, so a random location was chosen for the west end in a pasture approx. 3 ½ miles northeast of the courthouse. A natural rock outcropping was chosen for the east end of the baseline where a point was marked as the termination of the line. At both endpoints, the center points on the stones were marked with a "+" while two reference point stones were placed 25 feet perpendicular to the end points and a third reference stone was placed 25 feet on line. Each reference stone was marked "RP" along with an arrow pointing to the end points on the baseline. The locations for several of the triangulation stations were also selected in 1891 by William S. Post on prominent hills and key peaks.

South Dakota licensed land surveyors Jon Collins and Linda Foster pose with the recovered "West Base" monument of the baseline that was established in 1891. The marked stone was found moved out of its original location and placed in a nearby fence.

JERRY PENRY PHOTO

Due to commitments with similar projects in other areas of the country, no further work was done in the Black Hills during 1892. During the fall of 1893, the Rapid City Base Line was officially measured three separate times by Edward M. Douglas with a 300-foot steel tape while being supported at 50-foot intervals under a uniform tension of 20 pounds and with thermometer readings taken at both ends during each measurement. The final length of the baseline was determined to be 25,796.115 feet (4.886 miles) after making corrections for slope, temperature, and the reduction to sea level. The probable error of the three measurements was determined to be about seven-hundredths of a foot.

In addition to the astronomical pier, meridian mark, and baseline points, another sixteen monuments were placed throughout the Black Hills region. Observations were taken by single and combined directions having the entire triangulation scheme divided into blocks of five stations each and adjusted by least squares. The stations consisted of low platforms constructed of lumber with a signal pole mounted in the center above with the tripod placed below so angles could be turned from another location if a point was being occupied.

The initial triangulation network spanned a distance of about 102 miles north-south with the south end being near the Nebraska/South Dakota state line while the north end was placed upon Bear Butte located 6 miles northeast of the town of Sturgis. The width of the initial network was about 38 miles having the far west point upon Custer Peak and the easternmost point on a lone formation on the prairie known as Thompson Butte. Among the other points that were established was one upon the summit of the famed Harney Peak, the highest point in the region.

The triangulation monuments generally consisted of marked stones or iron and copper bolts drilled into rock. To test the accuracy of their latitude, USGS strategically placed their most southern point on a hill close to quartzite half-mile post 184 ½ that had been established that same year on the state line. This boundary between Nebraska and South Dakota had originally been marked with wooden stakes in 1874 and then resurveyed and remarked with the stone posts. Despite there having been several astronomical points placed along the state line to assist the contract surveyor of the General Land Office to mark the line as close to 43° North Latitude as possible in 1874, the USGS surveyors found this line to be nearly 4.5 seconds too far north.

Immediately after the triangulation network was established, and the final positions of the stations determined, the topographical mapping began of the Black Hills. In 1897, 1900, and 1904, USGS expanded their original triangulation by placing an additional 38 points that reached into Wyoming and also to the plains further north. It was not until 1912 that USC&GS entered the Black Hills to establish their own separate triangulation network. Instead of using and occupying the existing USGS monuments during their triangulation, USC&GS generally placed their own

Triangulation station "Sammis" is one of the original monuments placed in 1893. The bronze disk was likely added during the reoccupation in 1897. The letters "G. S." can be seen along the bottom edge.

JERRY PENRY PHOTO

The copper bolt along the top edge of the flat rock was placed by USGS in 1897 and was designated station "Elk". In 1912, USC&GS occupied the same peak, but placed their own bronze disk just a few feet away and also designated their monument as station "Elk".

KURT LUEBKE PHOTO

monument just a few feet away. USC&GS expanded their triangulation in the Black Hills in 1925 and again in 1950.

Time has now taken its toll on many of the original monuments of the initial USGS triangulation network in that area. The astronomical pier at the courthouse was apparently removed in 1922 when a new building was constructed with the location now situated in an asphalt parking lot. The meridian mark is likewise destroyed and is now a church parking lot. The east end of the baseline was removed around 1961 when Interstate 90 was constructed. The west end of the baseline along with two of its reference points were found lying loose in a nearby fence in May 2019 not far from where they had been originally placed. Efforts are now being made to have the scribed West Base stone placed in a local museum. Points on Harney and Custer peaks were removed very early when fire lookout towers were built at those locations. The northern point on Bear Butte has succumbed to erosion due to the brittle limestone surface on which the scribing was placed. Others, however, such as marked stones at Windy, Costello, Sammis and Cheyenne are still in place. The latter two had bronze disks placed into them during their reoccupation in subsequent surveys.

Since the original horizontal survey by USGS within the Black Hills was a stand-alone network, it was often referred to as the Rapid City Datum. The vertical aspect of the survey was also unique to the Black Hills and was referenced to a railroad bench mark at Deadwood and was known as the Deadwood Datum. (See *The American Surveyor* Vol. 9, Issue 7). The objective was to eventually cover an area bounded by 43° to 45° North Latitude by 103° to 104°-30' West Longitude. The end result of this early establishment of precise control was the publishing of eleven 30-minute (1:125000) and five 15-minute (1:62500) quad sheets showing contiguous detail never known before in that region of the country.

The National Geodetic Survey currently maintains positions and datasheets on four of the original points. The difference in positions when comparing the NAD83(1996) positions to the historical positions of the Rapid City Datum is an average of 2.15 seconds less in latitude and an average of 24.81 seconds more in longitude.

Into the early 1900's, USGS continued to maintain a visible presence in the Black Hills by surveying several key boundaries such as the extensive Black Hills National Forest boundary, the Wind Cave National Park boundary, and establishing and

Fire lookout towers were later placed on many of the same prominent peaks of the Black Hills where the triangulation stations were located. The construction of this tower on Custer Peak destroyed the 1893 monument.

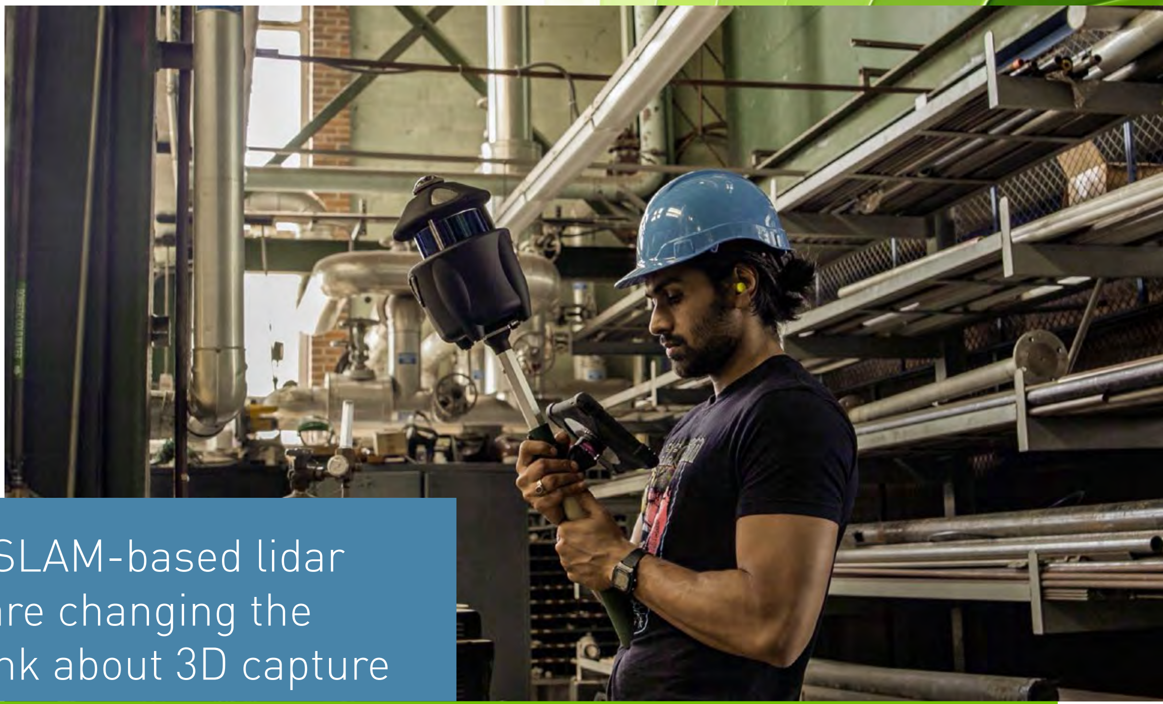
JERRY PENRY PHOTO

This boundary milepost on the NE/SD state line was placed by the GLO in 1893. USGS placed their most southern triangulation station nearby during the same year to tie into it to check the position of 43°00'00" North Latitude. The milepost monument was found to be 4.5 seconds too far north.

JERRY PENRY PHOTO

subdividing many townships while doing PLSS work within the area controlled by the Black Hills Meridian. The establishment of capped iron pipes at township corners by USGS within the Black Hills in the late 1890's was more than a decade before the GLO issued the use of iron monuments for their use in the 1909 Manual of Instructions. Widely known as primarily a mapping agency, USGS once employed some of the most competent geodetic and boundary surveyors this nation has known. ■

Jerry Penry has been surveying for 35 years and is licensed in Nebraska and South Dakota. He is an avid researcher, writer, and historian of survey-related subjects.



Handheld SLAM-based lidar scanners are changing the way we think about 3D capture

The Past and Future of Handheld 3D Scanning

In the past few years, SLAM-based handheld lidar scanners have made a big entrance into the 3D-capture market. These solutions are becoming popular not simply because of their speed, low cost, or ease of use—but because the combination of these three factors has opened up entirely new use cases for 3D capture that weren't possible with traditional methods.

Florida-based Paracosm[1] is at the forefront of this development. Its flagship product, the PX-80 handheld lidar scanner, has helped surveyors to capture large indoor and outdoor areas that would have been prohibitively slow with conventional methods, enabled AEC firms to capture building sites with a frequency that they never considered before, and allowed total beginners to capture 3D data that would have once required a team of trained professionals.

From consumer roots

Readers may not expect that Paracosm was founded to develop 3D-mapping technology for consumer applications—and that today's PX-80 enables a wide variety of use cases precisely because it developed out of those consumer tools.

Paracosm was co-founded by current president Amir Rubin, an engineer who cut his teeth at a range of startups in the surprisingly tech-friendly Florida university town of Gainesville, which gave rise to well-known companies such as WebMD and the defunct music streaming platform

[1] *https://paracosm.io/.*

» SEAN HIGGINS

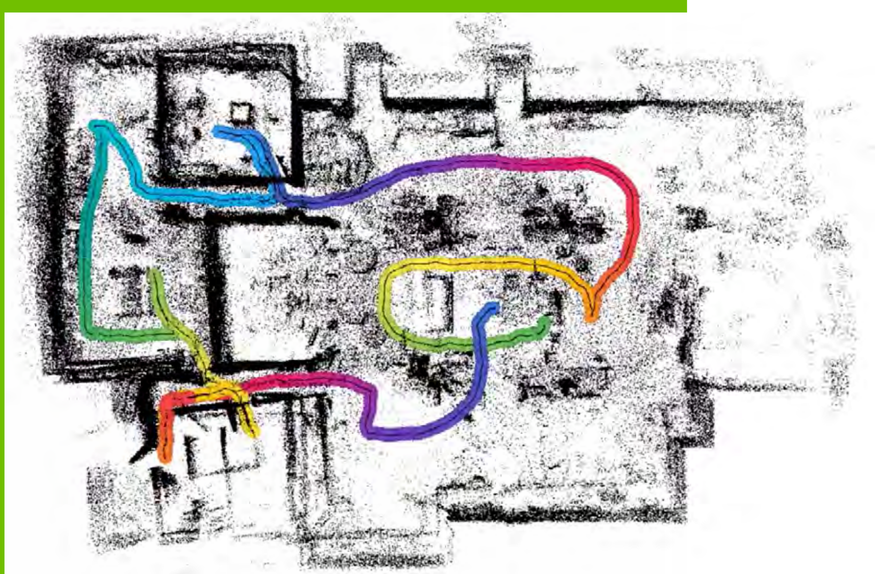
PX-80's proprietary SLAM was developed for capturing both indoor and outdoor spaces.

Grooveshark. After a decade working as an engineer and developer in other people's companies—and a short time developing a patented system for weighing livestock using only an RGB camera—Rubin gathered a team to start working toward his own vision: a product that would enable anyone to map the world in 3D.

At first, Rubin explains, that took the form of a low-cost 3D technology for collaborative mapping. This technology caught the attention of Google, which enlisted Paracosm to help on an ambitious initiative called Tango, the world's first 3D-mapping smartphone.

Amir Rubin, president and co-founder of Paracosm.

> "...handheld 3D capture brings data that would never have been seen before..."



As you walk through a space with the PX-80, the SLAM tracks your path and creates a coherent point cloud of the environment.

In 2015, Paracosm finished developing its own low-cost, consumer-grade, handheld 3D-mapping system. Though the tool attracted interest and investment from consumer robotics companies such as iRobot, it also caught the eye of a group that would prove more important to the company: engineers, contractors, and building surveyors. These forward-looking professionals saw that low-cost, SLAM-based 3D scanners had potential far beyond consumer applications.

"We started getting calls out of the blue," says Rubin. "They saw our handheld scanning system and started asking if they could use it to scan MEP[2] spaces, to do basic building survey, or to monitor their construction sites."

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[2] Mechanical, electrical and plumbing.

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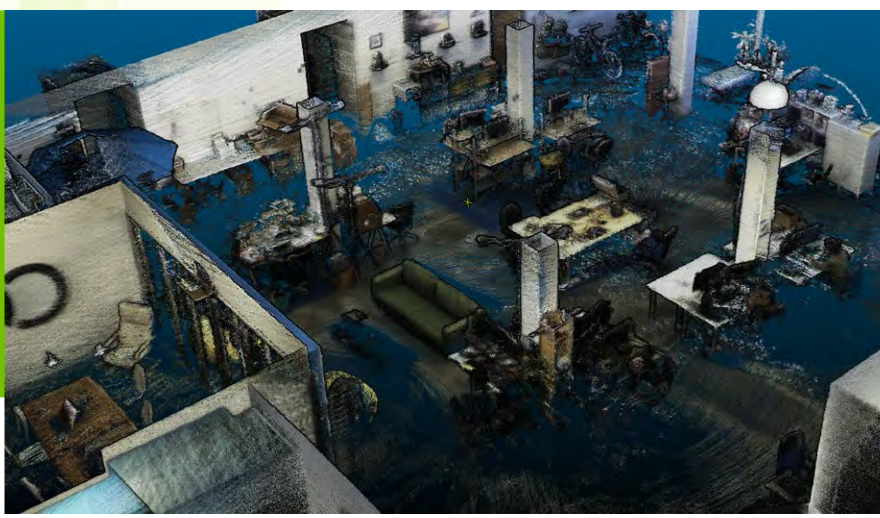
The only problem was that the system relied on 3D data from a structured light sensor, a consumer-grade 3D-capture technology that Paracosm used because it was small and inexpensive. In other words, the system was optimized for consumer use, which limited its performance in more demanding applications. Rubin explains, “That’s when we re-imagined our tech from the ground up and asked ourselves, what does a perfect, fast, handheld building scanner look like?”

The result is PX-80, a handheld, SLAM-based, lidar scanner optimized for commercial applications. It features a Velodyne VLP-16 lidar—often seen in autonomous vehicles—alongside a panoramic camera and a survey-grade inertial measurement unit (IMU), all of which it uses to produce accurate 3D point clouds and automatically colorize those point clouds while the user moves at a walking pace. Since it began shipping in 2018, PX-80 has seen use in over 15 countries, and in applications such as MEP capture, 2D floor-plan generation, mine mapping, construction monitoring, and forestry.

The system utilizes a Velodyne VLP-16 lidar sensor.

Paracosm’s handheld PX-80 fuses data from an RGB sensor, a lidar and an IMU to produce accurate and colorized point clouds as the user walks.



An automatically colorized PX-80 point cloud of the interior of the Paracosm office.

Floor-plan view of a PX-80 point cloud.

A cutting-edge technology under the hood

Paracosm's core product, however, isn't scanning hardware. The Paracosm technology that has survived the transition from consumer-grade to survey-grade mapping, and all the hardware iterations in between, is its 3D-data processing algorithm.

This algorithm is built on a technology known as SLAM, or simultaneous localization and mapping. SLAM technology has its roots in robotics, where it was developed to help machines navigate unknown environments, a devilishly complex task that requires locating the machine in a new space at the same time as it maps that space for the first time. A SLAM algorithm works by gathering data from sensors onboard the robot—such as RGB cameras, lidar sensors, and IMUs—and fusing those data together to make its sophisticated calculations.

SLAM algorithms can be optimized for mapping applications, facilitating the development of lidar scanners that don't need a tripod or GNSS to return precise, accurate results. The SLAM powering the PX-80, for example, can determine exactly where the scanner was on a job site or building when it captured each photo and each portion of the point cloud. "You can think of each position, each step that it calculates on your walking path, as a virtual tripod," says Rubin. "We use these to position the points captured by the lidar."

This means that a SLAM-based handheld scanner like the PX-80 enables users to perform a capture at a regular walking speed. Thus SLAM-based scanning is much faster to capture large indoor and outdoor environments in 3D than traditional methods and offers the bonus of real-time tablet-based feedback on the scan being captured.

SLAM's benefits do come with tradeoffs. In exchange for the greatly increased speed and lower cost of capture, SLAM generates data at a lower accuracy than traditional methods. PX-80, for instance, offers 1-3 cm global accuracy, whereas the top tier of tripod-based lidar systems perform in the millimeter range. However, many find that the reduction in overall cost and increased speed more than make up for this difference—whether that holds true for a project depends on whether the SLAM device offers good enough accuracy for the final project deliverable.

The deliverable determines the tool

When British general contractor nmcn learned about handheld 3D capture, they saw the technology's potential. Like the engineers who called Amir Rubin in Paracosm's early days, nmcn saw that handheld scanning could speed up their workflow and reduce costs, helping them to capture 3D data more regularly than traditional methods.

To test a PX-80 SLAM-based handheld lidar scanner, nmcn handed it to their head of digital transformation, Gary Ross. A mechanical engineer with no scanning experience, Ross received 15 minutes of training and set off immediately to scan a complex of derelict farm buildings. At the same time, a team from a 3D-scanning service provider captured the site using tripod-based lidar scanners. Both data sets were used to generate 2D floor plans and 3D BIM models.

An uncolorized PX-80 point cloud of the Paracosm office.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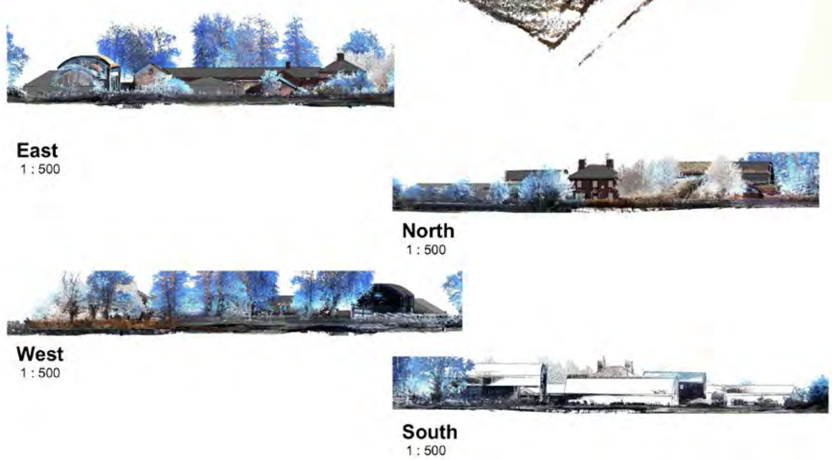
nmcn scanning for their farm refurbishment project.

nmcn converted the point cloud of the farm buildings to BIM and laid the models on top of point cloud topographic data.



In a final review, Ross argued that handheld SLAM-based scanning hit the right combination of speed, cost, ease of use and accuracy for the final deliverable they wanted. He says the PX-80 allowed him to capture the site at 1/10 the cost and 1/8 the time of traditional methods. He also notes that when nmcn generated models on top of the two point clouds, and then laid the models on top of one another, "There was 39 mm difference over the entire site, which spanned 57 m. The inaccuracies of modeling over the point cloud could have caused the 39 mm difference on either drawing, and as such the scanner technology was neither here nor there."

nmcn determined that handheld lidar scanning won't be appropriate for final deliverables that require sub-millimeter accuracy, but that hasn't stopped PX-80 from changing the way the firm thinks about 3D. "This sort of shift in cost and time and skills needed leads to a complete re-think of how and why we use laser scans," Ross says. Where, in the past, nmcn would scan a project once—at most—now, they can start to use scanning as a regular part of their process. "Certainly the scanner can now be used on every project, no matter how large or small."

As proof, Ross offers a list of potential applications for handheld SLAM-based lidar scanning that includes floor-plan generation for asset management, as well as topology capture, construction progress monitoring, as-built generation, dilapidation monitoring, and logistics/traffic management, among many others.

Ross concludes by noting that the value nmcn finds in handheld, SLAM-based 3D capture is simple: it brings his team data that they would never have seen before. "As data is central to our effectiveness and efficiency gains as we develop," he says, "this is a great leap forward in the data we can interrogate, analyze and measure—thereby improving the efficiency of our projects."

Sean Higgins is the former managing editor of 3D-scanning industry publication *SPAR3D.com*, where he provided broad coverage of innovative commercial 3D technologies for five years. Currently, he heads up content strategy at Paracosm, where he develops materials to educate new and experienced 3D professionals about SLAM-based handheld lidar solutions.

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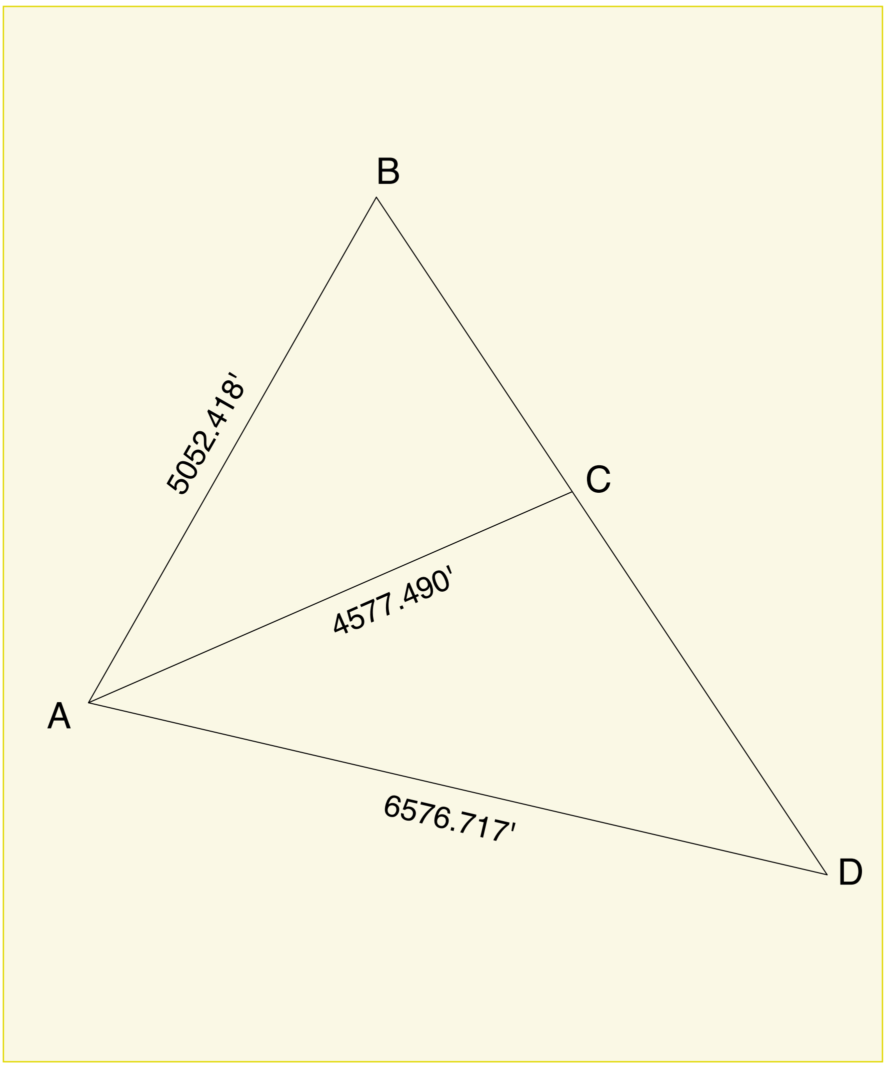
Dave Lindell, PS, retired after 36 1/2 years with the City of Los Angeles. He keeps surveying part time to stay busy and keep out of trouble. Dave can be reached at *dllindell@msn.com*.



Small(ish) Boxes, Big Ruckus

We crave fast digital access no matter where we are. We have even come to expect it to the extent that I've seen hotel reviewers slam their overnight stays solely on the basis of slow Wi-Fi. But questions arise: Where do we put the infrastructure? Who gets to control it?

5G cellular network wireless access is expected to move more data more quickly and allow more devices to connect at the same time, as is needed for sensors and smart devices. Think about driverless cars or adjusting your home's air conditioner while you are in your office miles away. Connectivity and speed are critical for our new-fangled lives.

Most new boxes for 5G are not very big compared to other utility structures, and the ones I've seen photos of are generally rectangular boxes sticking up from the top of street light poles above the arm holding the lamp or attached to the tops of utility poles. Admittedly, this adds some height to the existing facilities. But how tall is too tall? Do attempts to camouflage new large poles (if existing ones are not husky enough to bear the equipment's weight) fit in unobtrusively or look like a joke? Then there are the apartment refrigerator-sized boxes on the ground (some disguised to emulate US Postal service mailboxes): who gets to choose where they sit? Should the owner of a small residential lot have more veto power than someone with a larger lot, or should neither have a say because the public benefit of 5G access outweighs private angst?

We are re-entering a phase of utility growth last blisteringly battled during the introduction of cable television in the 1980s, before cable also figured into phone and computer connectivity and was therefore considered a frill. Back then, there were arguments about the right of cable companies to share poles with long-accepted and recognized utilities like telephone and electric services, or to be buried in general utility trenches with those other established utility facilities. Cable was not immediately accepted as a public utility that deserved the same benefits as the other established enhancers of our lives. Eventually, cable earned recognition in state statutes as bringing such public benefit to communications that it has joined the ranks of accepted utilities with privileged locations in exchange for the necessity of serving all who request its service.

The present situation is only slightly different, as 5G technology is not exactly a new utility but a change in delivery mode (like buried fiber optic cables versus above ground wires). However, some of the companies installing the infrastructure for 5G on behalf of the well-known carriers such as Verizon, Sprint, and AT&T have to apply for utility status in some states to be able to put up boxes and poles in road rights of way controlled by municipalities or counties or states. On the one hand, the companies tout healthier, safer communities through faster communications to improve medical diagnoses and emergency responses, better traffic movement and less congestion through connected sensors and transmitters for traffic control, and new opportunities to integrate new technologies into classrooms (think virtual or augmented reality) and to connect businesses. Waving the other hand vigorously we have the local governments wanting to be able to enforce their planning and zoning ordinances and fee collections. There is not a uniform fee that localities charge for each attachment to poles, which diverge by many thousands of dollars per cell node.

This range of expenses is one reason that wireless companies want the Federal Communications Commission (FCC) to set a cap for local fees, and have approached state legislatures to disallow municipal negotiations in favor of granting private wireless providers the use of public rights of way for low fees that some localities characterize as gifts or grants to those companies—an action prohibited by state constitutions. Any transfer of property or use of property by a municipality to a private company at a fraction of the fair market value of the property or its use falls into the ethical and constitutional abyss. Meanwhile, management of the public rights of way is characterized as a responsibility legislatively delegated to municipalities to protect the health, safety and welfare of the public, and the process of management entails permitting processes. Permits are issued only after considering the safety of structures, relating to construction for installation and operational safety, and site selection must consider land use related limitations.

Lawsuits are brewing across the nation. Definitely there are arguments to be made on both sides of 5G facility placement cases. Mixed in with constitutionality and aesthetics are concerns by some about deleterious effects of 5G radiation on human health; cancer, heart damage, and DNA damage are the most commonly cited. And what is the effect on property values when cell nodes are installed? The discussions are not easy, as technology, emotions, and governmental concerns compete. ■

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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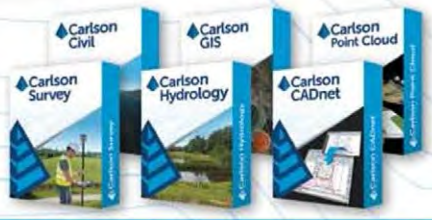

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