the American Surveyor

JUNE 2019

Geomagnetic Declination

Simplifying Complexity
Scanning is key

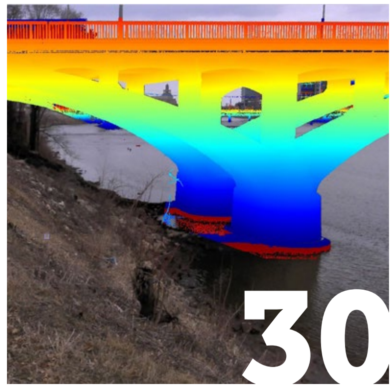
USS Surveyor
USC&GS mapping vessel

Thought Leader
The importance of records

contents

ON THE COVER

Peeling back the layers with lidar reveals something magical



features

AmeriSurv To Go!
Get the most from this magazine on your tablet or laptop.

departments

in this issue

thought leader

The Importance of Records

No doubt we are in the information age and some are saying we are entering the knowledge age. Land records are at the core of our free society. We have every opportunity in front of us to harness the digital revolution and perpetuate this foundation of liberty.

Our society is saturated with frivolous angst from the intravenous delivery of inconsequential news feeds "twenty four seven". The mindless and brain numb of the next college-educated generation may be incapable of disseminating the importance of evidence not spoon fed through social media. These same folks may also be the underachievers that show up at their government jobs for eight hours a day and adopt records policies approved by old Zuckerberg and crew over at faceplant.

Surveyors are a small but leading voice that can speak to the value and necessity of land records. We need to be extremely vocal with our elected officials when we smell bad policy from the kids down at Tammany Hall. The old adage "You don't know what you don't know" is welling up in the digital realm and I've been left with a bad taste in my mouth at both the municipal and state levels. The phenomenon I'm seeing is sort of a "disposable information" attitude. Database managers and GIS folks are having trouble digesting relevant historical information that has been superseded.

Reversionary acts seem to be especially problematic. This is a place that information can easily be lost. When a roadway is vacated it is generally assimilated with the title of the underlying land. Extinguishing the public right does not extinguish the historic proceedings affecting the chain of title. Yeah, sure remove the road from google maps to keep people off of it but develop a placeholder for the legal actions that now appear invisible. Without a placeholder for a reversionary act, future researchers are left with nothing but a null search result.

Believe it or not my state land database showed nothing for a current main county highway built by the state DOT with federal money over 50 years ago. The hiccup came when the right of way was assigned from the DOT to the county automatically under an operation of law. The DOT's new alignment was accounted for under their realignment project. The state acknowledged the old road in a simple "paper" memo to the county at the time. The wires got crossed somewhere along the line when a database manager assumed that the re-alignment documents were the "current version" and decoupled the older right of way document from the database. Poof! It's erased and the poor girl at the counter could no longer find the original documents. It took some ironing out between agencies but we resolved the issue without harm. And for the record, the state's team was in no way the cynically fictitious beasts I described earlier, in fact just the opposite and very concerned with the synapse.

They never told me in school how devastating Sherman's March through south really was to our citizens. As Decided Guidance in this issue examines a case in South Carolina we are reminded of the atrocities and undue destruction unleashed on Americans and our land cadastre. The repercussions of destroyed land records were felt many decades later and continue to this day. The heroic surveyors of Carolina were forced to cobble the fabric of society back together from seemingly thin air. Whether it's fire, or war, or apathy, we must be vigilant toward the enemies of cadastral records. The surveyor is the knight of the American land cadastre. ■

Jason Foose is a Professional Surveyor licensed in multiple jurisdictions.

the American Surveyor

amerisurv.com

June 2019 / Vol. 16 No. 6

The American Surveyor (ISSN 1548-2669) is published monthly by Cheves Media LLC. Editorial mailing address: 7820-B Wormans Mill Road, #236 • Frederick, MD 21701. Tel: (301) 620-0784.

Subscriptions prices in the U.S.: Free for qualified professionals. Canada: 1 year $56.00 US; international subscriptions $72.00 per year (Airmail), U.S. funds prepaid. Back issues (subject to sufficient stock) are available for $4.95 + S/H.

New subscription inquiries and all other address changes should be sent to *The American Surveyor*, P.O. Box 4162, Frederick, MD 21705-4162. Fax: 301-695-1538. Subscribe online @ www.amerisurv.com

JASON E. FOOSE, PS

Richardson v. Register

The Palmetto State is taste-o-graphically wedged on the continent between barbeque and boiled peanuts. That's darn near the top of my food chain. In just another decade we'll be calling South Carolina 400 years old. The cadastre of Carolina dates back just as far. In 1688 John Love wrote *Geodaesia* for Carolina as the first survey manual of instruction on the continent. This was a century before old T-Jeff started dicing up the Seven Ranges. I'll call Love's collection of standards the longest continual tradition of land surveying in America.

The court cut right to the chase on this one. "*This action resolved itself into an action to try title to nine and one-half acres, largely woodland, which lies to the south of plaintiff's admitted acreage, and to the north of the defendant. There is no question of adverse possession. It is really a dispute as to the location of the dividing line of the respective farms of the litigants. The issue was submitted to the jury which returned verdict for plaintiff and the defendant has appealed upon numerous exceptions.*"

Okay, this case is the real deal based on a genuine ambiguity in the record. However, a sideshow emerged when a flying Wallenda grabbed the trapeze instead of his plumb bob. The surveyor was hired to wingding a temporary corner at the request of his client under the pressure of a real estate closing. Bad kimchee here, folks. We set the standards of our work, not the client. In this case the parties appear to write their own standards of care and invoke risk that the surveyor is expected to mitigate. At best that was just a waste of the client's money. Worsley. Hey, since we're all bending the standards here, I'll take the liberty of warping the English language...ehhmm, worsley he's philanthropically contributing his client's money to FALF (the Feed A Lawyer Fund). So, a valuable side lesson here is that there is no such thing as half-drunk, half-pregnant, or half-surveyed. Do the whole job or nothing! This decision was affirmed without dissent so I'll take that as the court discouraging wing dingers and move on.

The first order of business is the legal descriptions. These are bounds descriptions and yes they are legal. This is what they mean when they say "*where the boundaries are is a question of fact, what are the boundaries is a question of law.*" Among those facts are a collection of sequential conveyances. Missing from the evidence kit are the numbers and linear dimensions. Good, that simplifies the problem, right? Go recover the evidence left on the ground and move on.

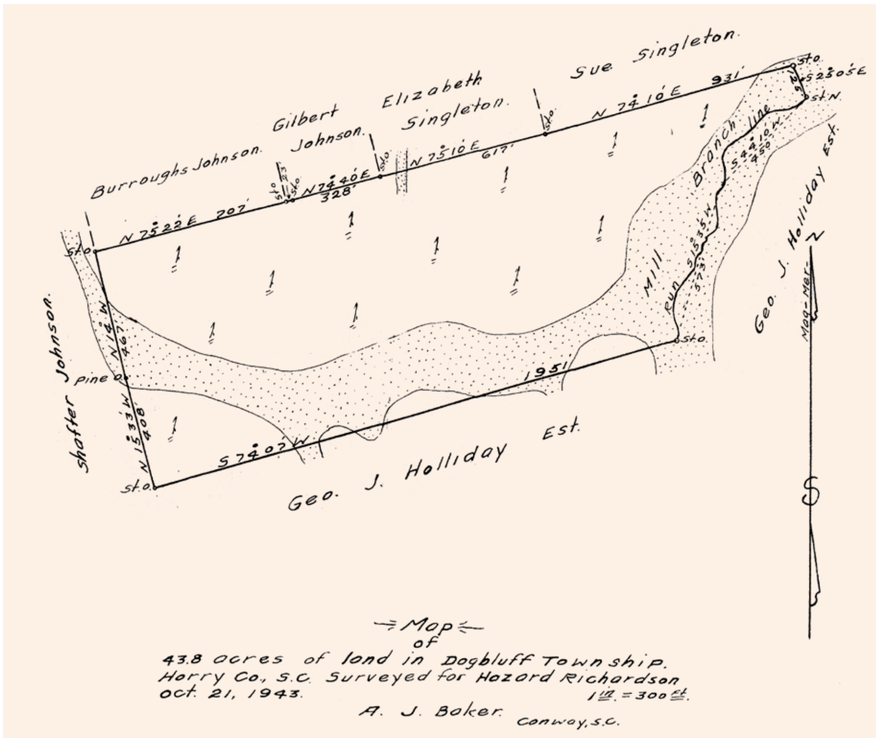
Where it gets tricky is that our evidence now includes an unresolved matter of law. Is the 1943 survey presenting the tentative boundary line reliable as notice? This raises a whole bunch of peripheral questions. How long is the discovery period for finding the true line per this agreement? What if the true line is lost and the tentative position is lost or defective? Are the subsequent owner's barred from acquiescence? Can the tentative line ripen through common report? I quote the decision "*Mr. Atkinson agreed that the corner would be located where the latter (Holliday/ defendant) thought it was, and that later, if found to be incorrect, it would be adjusted.*" This is where things got really balled up. There's an agreement about a boundary line but it's not a boundary line agreement. Hold on a minute though, there's a survey promoting the color of reliance on the line.

Despite my surveyor's angst and confusion I think the courts did a great job with this. They followed the evidence and the law. Furthermore the printed "decision" clearly expresses the integrity of the questions and basis for the decision. "*It is well established that where the dividing line between two coterminous owners is doubtful and to establish it they meet together and* *agree on a line the agreed line must be regarded in all future controversies to be the true line...the evidence here tended to show that there was no such agreement. Instead it was agreed, in effect, as has been said, that the line which was run for the purpose of the 1943 plat was tentative and subject to adjustment between the adjoining owners."*

I suspect this is Caveat Emptor, sort of. The agreement was not exclusively between the buyer and seller. It included the neighbor and don't forget the successors in title on both sides of the line. I'm going to put on my Lucas Lawyer pants for a minute and ask the court where is the successors' notice that this line is tentative? I have to believe that this agreement infringes on a future court's authority to infer that any successors met the standards of acquiescence. I'm wondering if the decision inadvertently does the same? "*Atkinson was present representing the owners of the adjoining land, who conveyed it several years later to the defendant, and no reason appears why his agreement that the location should be tentative* ***should not bind his principals and their subsequent grantee, the defendant.*** *The plaintiff, with his contract to purchase the adjoining land, was in the shoes of the Owner." <emphasis added>*. Despite the fact that "no reason appeared" in evidence, the "tentative line" notion doesn't seem to fit the livery of deed standard from the days of yore. Imagine a humorous attempt at a Turf and Twig ceremony on a windy day with a handful of hourglass sand and a pricker bush. I picture the grantor losing all the sand between his fingers before the handoff and the poor grantee dropping the twig because it pricked his finger. It just doesn't quite cut it but we give everybody an "A" for effort. I think the reason that the whole Register deal was able to fly was because everybody acted in good faith. The courts heroically respected the effect of the grant and measured the issue squarely with law. The surveyors had apparently done the best they could with what they were handed. They owners were all within the law and made a good faith attempt to disclose the uncertainty. After all, their goal is the successful completion of a land grant and the stability of the cadastre. This is a case where no survey may have been better than a tentative survey.

Other than the extrinsic evidence brought to court, I wonder how this tentative corner was memorialized? Sure there's no reason that a subsequent owner shouldn't be bound by the "tentative line" agreement if he knows about it. What is the likelihood of that? The opportunity to recover extrinsic evidence is greatly reduced after the agree-ors have faded away into the sunset. Our big lesson at this point is that a retracement survey is three dimensional in time. The subject is from the past, the concern is in the present, and the reporting is done in for the future. This case adds a fourth dimension. A promissory condition. Whether it's the owners promising to tidy up loose ends after the closing or a surveyor's statement committing to set corners after recording we know that a promise might not meet the intended standard of care down the road.

Just like the court I can only go with what's in front of me and at face value. There's not a lot to work with in this decision. I couldn't even find the parcels on the Horry County website. But don't you fret because every dog has his day. Using my plumb bob as a stylus I googled local surveyors on my smartphone. The very first one I contacted just happened to have the complete 1943 surveyor's file on the case including the maps, correspondence, and court papers. I can't express enough the importance of good record keeping and working with the local surveyors when you enter foreign turf. Now, anybody care to argue with me about respecting that longstanding tradition of land surveying in Carolina? CHAAAA-CHIIIING!!! We're gonna bring the goods and really tear into this case compliments of Tim Davis RLS and Davis Land Surveying in Loris, South Carolina. For a PDF of the case see *archive.amerisurv.com/PDF/RichardsonVersusRegister.pdf* and feel free to email me at *rls43185@gmail.com* ■



Don't be fooled by Foose's ignorance of local customs or the tentative south line on this survey. A. J. Baker's work reflects the conditions of the conveyance and holds true to the local standards of care as we'll see in the near future.

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

Bruce Carlson walks the crowd through Carlson's latest hardware offings including a host of remote sensing and scanning technologies. Users we treated to a hands on reception showcasing Carlson's growth in emerging technology markets.

CARLSON USER CONFERENCE

Grow With Us

» JASON FOOSE, PS

The trend in user conferences is to scan as many bar coded, app driven attendees then cram them all in the largest urban cubicle that can be found. Heck, I even went to one that had more indoor pyrotechnics than a Kiss concert on the 4th of July. The 2019 Carlson User Conference was a gratifying release from the current mentality of big box corporate *geovangilisim*. Carlson cleverly employs local assets and pleasantly immerses the conference among the beautiful Georgian and Federal architecture of historic Maysville, Kentucky. User sessions were interspersed throughout the flavorful architecture of this early Kentucky settlement. Every session break was a chance to indulge in the fresh spring air and enjoy a stroll through the picturesque backdrop of American history.

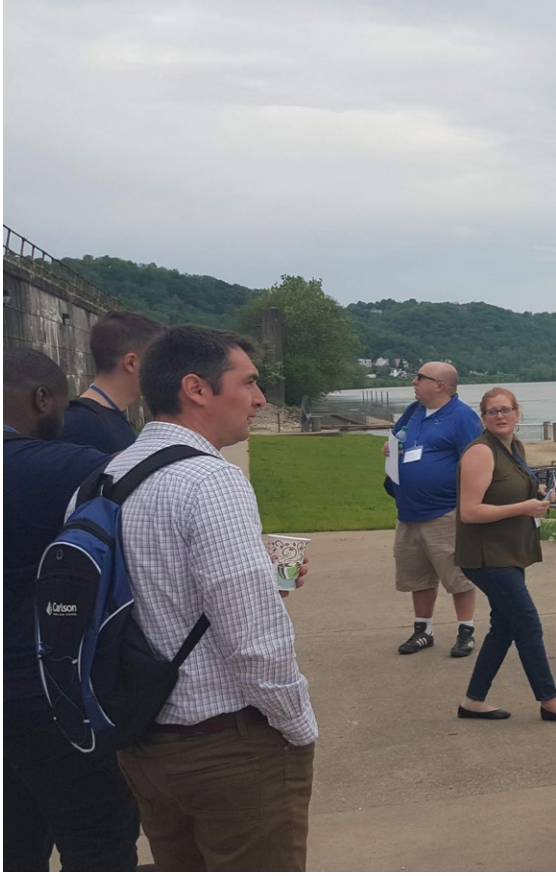
The big news at the conference was the ArcGIS-enabled version of Carlson SurvCE. True to form the Carlson team has once again transformed the software to fit our natural workflow. I watched users light up when the tech team dialed up the steam on the locomotive. Then something clicked and gap between surveying and GIS magically disappeared. SurvCE empowers the surveyor with enhanced field tools that enable control of the data at the scene of the infrastructure. Not just backdrop graphics and polylines but also real data tables and attribute updates. This includes creating attributes on the fly because in our world we are the often first responders having to quantify stuff that just don't fit on anybody's form. Remember the old slur "GIS stands for Get It Surveyed"? Well

History meets technology at this international user conference nestled on the peaceful banks of the Ohio River.

The robust scanning capabilities of the Carlson CR+Robotic Total Station were demonstrated on the historic Simon Kenton suspension bridge as traffic swayed safely across the river.

that is exactly what SurvCE does for every surveyor including those still wrestling with the antiquated notion.

SurvCE has always been as intuitive as slipping into a comfortable pair of work boots. The ArcGIS enhancements in SurvCE place the precision of CAD and the organics of GIS in the hands of the surveyor and right where they belong. The surveyor has powerful snap tools which immensely help in finding the ends, middle, and offsets of just about anything on the ground. Feature positions, attributes, and their associated linework automatically adjust when position is measured or remeasured. I don't know if the industry realizes this yet but Carlson has effectively removed a complete step in the surveying process. It's the part where an object is too flubbery to map in cad and the words just won't fit in the attribute text field so you have to burn up time with phone calls



David de Bethel, Engineering Director, Laser Measurement Devices at Carlson Software shares his knowledge of hardware production at Carlson's York, England facility.

and wasted trips. SurvCE brings all of the geo-quantification power to the scene of the incident where the surveyor can triage or better yet cure the problem on the spot. Finally, GIS is now in every surveyor's field kit.

A showcase of survey hardware featured a full boat of the latest and greatest technology. The BRx6 GNSS receiver is tight. It's a 5-½" puck that weighs 3 pounds. For god's sake I've eaten hamburgers bigger than that in my heyday. Those cardiac cakes as I now call them also didn't have the five constellation capability of the BRx6+ which includes GPS, GLONASS, BeiDou, Galileo, and QZSS. The BRx6+ also has integrated Atlas L-Band for Precise Point Positioning through a subscription service. The BRx6 is really geared up for wireless communication which includes a 4G Penta-Band LTE cellular modem, an integrated UHF transceiver, Wi-Fi, and Bluetooth. I'm not sure how you fit all that into something the size of a double Whopper with cheese but Carlson has. This connectivity is really leveraged through Carlson Listen-Listen and the Carlson RTK Network that connects the base and rover through the cellular modem.

This is a real game changer folks. Carlson has harnessed the power of Amazon's cloud delivering a low latency service to SurvCE/PC users running the BRx6 GNSS as a base station. Amazon's web service provides the muscle of unlimited processing power, speed and the bandwidth necessary to pull this off. The service eliminates base line length restrictions associated with using UHF radios. Listen-Listen runs on your single base feeding your multiple rovers. Any rover hardware can be dovetailed with the BRx6 base. There's a value added savings here by trimming the fat from rover end of the setup and having the ability to run any combination of rovers simultaneously.

The Carlson NR3 is a great example of the cost efficient dedicated rover for a Listen-Listen setup. The size of a stack of small pancakes and weighing about the same at 1.8 pounds, the tiny NR3 packs a wallop with an integrated 4G LTE cellular modem, Wi-Fi and Bluetooth for modern wireless capabilities. The NR3 uses 4 constellations to produce reliable GNSS RTK, with triple-frequency tracking on GPS, GLONASS and Galileo. The Carlson tech folks say that "The solution incorporates multipath and ionospheric detection algorithms to maintain accuracy, while exhibiting stable satellite tracking during shocks or vibration". The lightweight NR3 receiver may be used independently as a base or rover and being so light it is the ideal rig for the Hybrid+ robotic total station rover.

Carlson laid out a pair of very robust data collectors at the conference. They are both built like tanks. I think it's just a matter of keyboard preference, screen size, and options when closing the deal on either. The Surveyor 2 is for the traditionalists who prefer a tactile QWERTY keyboard and a 4.3" touch screen. It has 8GB of flash storage and 1.0 GHz processor. The long range Bluetooth will reach out to 1,500 feet when paired with class I devices and according to the brochure you will get 20 hours out of your batteries. There's an integrated camera and 3G modem all wound up in an IP68 water & dustproof, shock resistant package. The RT3 is a ruggedized tablet with a 7 inch screen and milspec tough. Battery time is 8-10 hours expandable to an additional 4-5 hours. Two cameras, long range Bluetooth, Smart Ready Wi-Fi, 4G LTE and 128GB of flash storage are configurable with the GEO CELL model. The optically-bonded capacitive touch screen is chemically-strengthened with Dragontrail™ glass for excellent impact & scratch resistance.

The whole world hasn't caught up to point cloud technology just quite yet. We're close as the stragglers marvel at a point cloud but ask "Where's my contour map and cross sections?" A really nifty thing happened at the Point Cloud software session. Interaction and dialogue opened up some really valuable lessons and techniques learned by the tech team and the users. As an aside, this wasn't particularly a "Carlson thing" but more of an industrial standard being hashed around. That's the value of a user conference and open source development. Long story short we all win from sharing industrial knowledge and that is a Carlson thing. Okay, so the session started with a multi-million point cloud file of an acre or so of vacant

The users discuss remote sensing opportunities of the robust CR+RTS while out of harm's way as the robot is hard at work scanning a live bridge deck.

> "Carlson has harnessed the power of Amazon's cloud delivering a low latency service to SurvCE/PC users running the BRx6 GNSS as a base station."

field. The session leader, Ladd Nelson of Carlson, demonstrated how to effectively parse down the data through file versioning. We ended up with a neat and efficient file to work with while keeping the original large data file on the shelf for reference.

User dialogue led the group to experiment and parse down the compact 50,000 point file version even further. The suggestion effectively was to model a sampling of points that replicated a traditional surveyor's 50' grid and breaklines. The result yielded a great looking and smooth traditional contour map with almost no noise. It was also discovered that drawing clean-up time could be greatly reduced. The realization was finding a point of diminishing returns between the "data in" and the "data out". We learned that scaling the dataset to traditional land surveying standards will yield customary results. More data is not always better; it could just be more to bog down a CPU or bandwidth in the post processing. In effect we virtually topo-ed the point cloud just like we were in the field to create a familiar and useable deliverable. In a nutshell the "thinking" part of the topo process has shifted from the field to the office because a point cloud allows us to see virtually everything. Good stuff!

The theme of the 2019 Carlson UC was "Grow with us". Having survived the 2008 depression it's invigorating to once again feel industrial optimism. Carlson is reinvesting in laser scanning and geopositioning technology. For the surveyor this means more cool tools and greater opportunities to build our client base. Carlson Boretrak is a tool currently used in the blasting industry to measure the pitch and depth of a dynamite hole. The measurements control choreographed rock blasts, keeping the neighbors safe from flying debris, and of course saving money. Boretrak resembles a set of folding tent poles that will stretch the sensor out as far as you can push it. Anybody that has designed, constructed, or as-built anything with pipe will see the immediate value of this real time sensor system. Whether you drill 2000' deep wells in arid southwest, or you're the facilities manager in the BIM realm, or a contractor in a design/build environment, I'm willing bet there's "I could have used one of those" stories for Boretrak.

C-ALS (Cavity Auto-scanning Laser System) is like a big dentist's mirror that creates georeferenced scans of inaccessible nooks and crannies. The moment I saw C-ALS I thought "I'm never going to have to dip another manhole ever again. Hallelujah!" C-ALS is currently deployed in mining applications when a conventional scanner is impractical to setup or can't see certain voids or cavities. Carlson claims it's the only borehole-deployable laser solution on the market. When queried about the "only" designation, Bruce Carlson said, "We are able to go into the smallest diameter borehole (as little as 3" diameter)—that is one of the differentiators. And we track the position to the laser head precisely using INS technology including using a precision, low-drift gyro. There are a couple competitors, but none have our precision to the laser head position through a corkscrewing and bending borehole, and none can fit under 3" that I'm aware of." Once again my mind drifts to opportunities in the built environment. Consider cities like New York or Boston where the subterranean components of construction are always a crap shoot between geology, archeology, and the international building code. Workers constantly fiddle with that delicate ecosystem which the folks at Tammany Hall refer to as infrastructure. The project intelligence gained from a tool like C-ALS is a godsend to a contractor in dollars, cents, and safety.

Carlson UC 2019 was a great experience. From the pleasant setting, to the new technology, and the education offered it truly was one of the most enjoyable conferences I've attended. The next Carlson User Conference is slated for April 20-22, 2020 in Portland, Oregon, at the Sheraton PDX and it's already penciled in my calendar. ■

Jason Foose is a Professional Surveyor licensed in multiple jurisdictions.

(1685–1910)

Geomagnetic Declination

Using Land Surveys, Lidar, and Stone Walls

My first experience with stone walls was as a young kid (6-10 years old) living in South Deerfield, NH. The family home was the site of an abandoned farmstead consisting of massive stone foundations of quarried granite and stone walls throughout the woods. Decades later while living in a rural setting outside Albany, NY, I renewed my childhood fascination by mapping about 6 miles of stone walls in the nearby woods using a handheld GPS unit. The resulting map showed a complex pattern that made no sense until a 1790 map of property boundaries in the town was located. Upon recognizing the geophysical potential of these stone walls, I mapped 726 miles of stone walls in New Hampshire (312 miles) and New York (414 miles) using old land surveys and lidar images. The results of that work have recently been accepted for publication in the *Journal of Geophysical Research: Solid Earth*. The title of the article is … *Measurements of geomagnetic declination (1685-1910) using land surveys, lidar, and stone walls* (scholarsarchive.library.albany.edu/cas_daes_scholar/5).

Lidar images with resolutions of about 3 feet are required to locate and map stone walls. The *NH Stone Wall Mapper* (granit.unh.edu/resourcelibrary/specialtopics/stonewalls/) described by Rick Chormann, State Geologist and Director of the New Hampshire Geological Survey,

» JOHN W. DELANO

Figure 1: Google Earth image showing the ground in the lidar image (Figure 2) in Henniker, NH to be obscured by the forest canopy. Width of view is 0.67 mile.

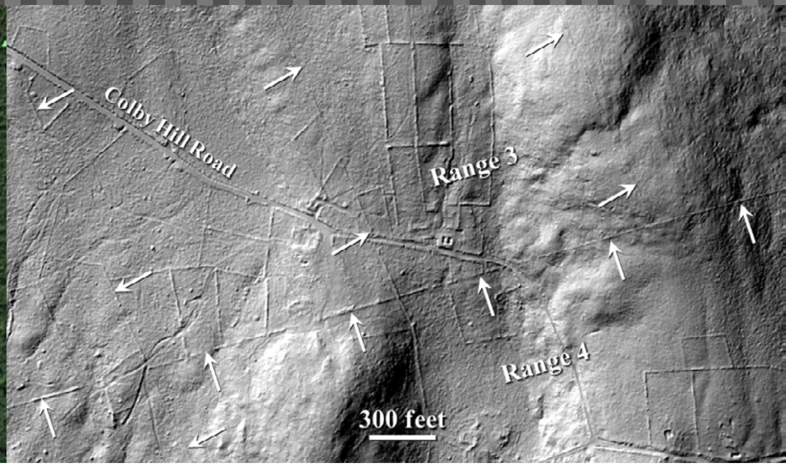


Figure 2: Lidar image from the *NH Stone Wall Mapper* showing a 0.7-mile segment of the ENE-trending, stone wall-defined boundary between Ranges 3 and 4 in a heavily wooded area (43.1887°N; 71.8789°W) near Colby Hill Road in Henniker, NH. This boundary was laid out by Matthew Patten's survey team on Thursday, October 5, 1752 using a magnetic compass-bearing of N84°E. The bearing relative to True North is N74.4°E, which yields a magnetic declination of 9.6°W in October 1752. The geomagnetic field model *gufm*1 also gives a value of 9.6°W for the magnetic declination at this location in late 1752. The NW-trending boundaries for lots # 17 and 18 had a magnetic bearing of N15°W in the original survey. Many other stone walls are also visible in this view, but were not built along the original 1752 boundaries.

in the February 2019 issue of the NHLSA Newsletter provides a complete set of processed lidar images for all of New Hampshire. This is a superb resource!

While finding stone walls on lidar images is straightforward, interpreting them is a different matter. Which walls were constructed along property boundaries? When were those property boundaries surveyed? Those two questions consumed most of my effort. Historical literature for each locality (Appendix 1 in JGR article) was needed to ultimately determine the date and magnetic bearings of the original land surveys, especially of townships. New Hampshire has an excellent compilation of that historical information (e.g., volumes by Albert Stillman Batchellor that are available on-line: *sos.nh.gov/Papers.aspx*). Those searches of the historical literature sometimes led to accounts from 18th century survey teams that had been commissioned to lay out hundreds of ~100-acre lots along range boundaries, many of which are still defined by old stone walls in New Hampshire and New York.

The diary of Matthew Patten, who was in charge of a metes-and-bounds survey in 1752-1753, described the daily challenges of rough terrain and harsh weather as his team of axmen, chainmen, and surveyors laid out hundreds of lots in 45 miles^2 of rugged wilderness in Henniker, NH (L. W. Cogswell, 1880. *History of the Town of Henniker, Merrimack County, New Hampshire, from the date of the Canada Grant by the Province of Massachusetts, in 1735, to 1880*. Republican Press Association, Concord, NH. 868pp). Using those detailed accounts, it was possible to track the paths of Patten's survey team along the range boundaries and to identify the team's location on lidar images during notably difficult times. Such accounts with the lidar images have fascinated public audiences. **Figure 1** shows stone wall-defined boundaries laid out by 1752 surveys in northeastern Henniker.

Stoddard, NH was fortunate to have a surveyor and dedicated historian, Charles L. Peirce (1874-1963), who generated a detailed map of lots and ranges (*stoddardnh.org/about-us/pages/charles-peirce-maps-stoddard*) that were laid out in the original survey in 1768-9 and are often defined by stone walls today. Although none of the stone walls are continuous from one side of the town to the other, most can be extrapolated among the current remnants to define a systematic grid. Mapping stone wall-defined boundaries along ranges and lots defined by the original survey in Stoddard, and those in nearby towns, the magnetic declinations at those locations were determined and compared

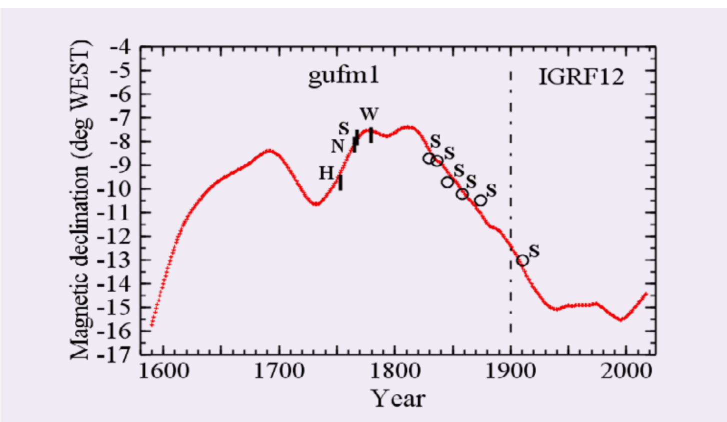


Figure 3: 233 miles of stone wall-defined boundaries in Henniker (H; 41 miles), Nelson (N; 38 miles) Stoddard (S; 141 miles), and Windsor (W; 13 miles) were mapped using lidar images to determine the magnetic declination at those locations based on land surveys conducted in the latter half of the 18th century. Those magnetic declinations are shown plotted against the gufm1 (pre-1900) and IGRF12 (post-1900) geomagnetic models (red curve). With the exception of the time-interval of 1775-1810 for surveys at other localities in New Hampshire and New York that differ from the geomagnetic models by up to 1.5-2.0° eastward, the differences between the declinations inferred from the stonewall-defined boundaries and the geomagnetic models are usually less than 0.5°.

with the current geomagnetic model, *gufm1* (*ngdc.noaa.gov/geomag-web/#declination*). **Figure 3** show excellent agreement. However, as documented in the forthcoming JGR paper, a systematic difference of 1.5-2.0° in magnetic declination (i.e., more eastward than *gufm1*) was found for surveys done in 1775-1810 at other regions of New York and New Hampshire. Local magnetic anomalies in the earth's crust are not considered the likely cause of the geographic extent, magnitude, and direction of that difference. The *gufm1* model apparently needs revision during that time-interval.

In summary, stone walls that were built by the early settlers along boundaries laid out by the original land surveys of New Hampshire townships still exist. With knowledge of the original land surveys and the use of lidar images (NH Stone Wall Mapper), those stone wall-defined boundaries can be distinguished from the myriad of other walls within a township. Although the boundary walls are often intermittent, lidar images allow the original boundaries, where stone walls are absent, to be located between existing stone wall segments by interpolation. Finally, the current geophysical model, *gufm1*, provides a good description for changes in the magnetic declination since the late 17th century, except for the interval 1775-1810 when the declination was apparently 1.5-2.0° eastward of the gufm1-derived value. ■

Note: This article appeared in the April issue of the New Hampshire Land Surveyors Association TBM and is reprinted by permission.

John earned a Ph.D. in Geology at Stony Brook University, State University of New York, in 1977. His research was competitively funded by NASA and/or the National Science Foundation (NSF) for nearly 35 years and resulted in 70 professional publications. John served on, and chaired, scientific advisory panels for NASA and NSF, and was the Associate Director of NASA's Astrobiology Institute, which was multi-institutional research consortium headquartered at Rensselaer Polytechnic Institute. He retired from his academic career at the University at Albany in 2017 at the rank of Distinguished Teaching Professor in the Dept. of Atmospheric and Environmental Sciences and Associate Dean for the College of Arts and Sciences. John and his wife, Susan, are currently residing in Williamsburg, VA.

Figure 4: Area in Sullivan and Merrimack counties of New Hampshire with some of the stone walls (pink lines) have been mapped

NH STONE WALL MAPPER: GRANIT.UNH.EDU/RESOURCELIBRARY/SPECIALTOPICS/STONEWALLS

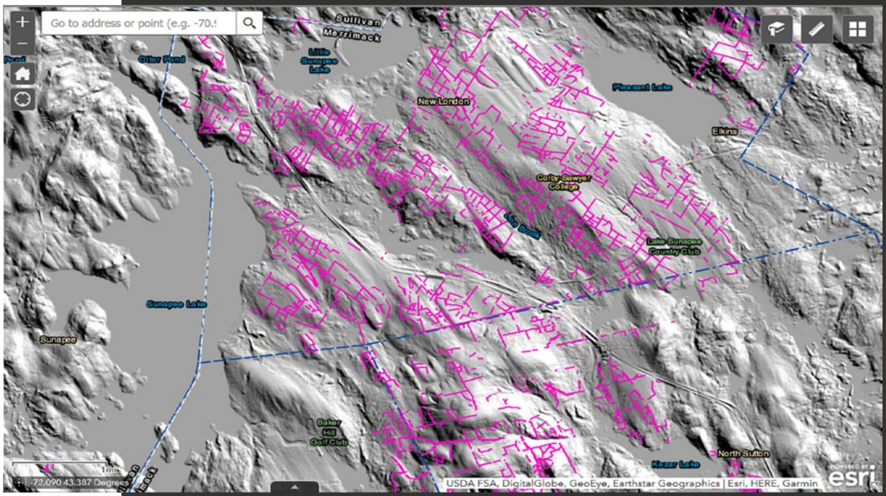


Figure 5: Lidar image of the same area shown in Figure 3 showing the abundance of stone walls. Most of these stone walls were built by 18th and 19th century farmers, many of whom subsequently left the area. The forests soon reclaimed the fields that had been bordered by stone walls.

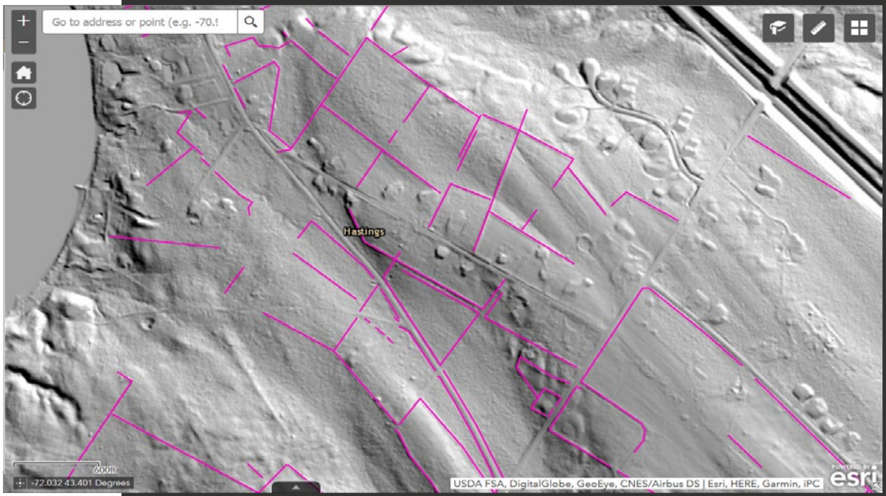


Figure 6: Lidar view of area from Figure 4 stone walls (pink lines), eastern portion of Lake Sunapee (left edge) Routes 103A (center), and US Route 89 (upper right corner). Width of view is about 1 mile.

NH STONE WALL MAPPER: GRANIT.UNH.EDU/RESOURCELIBRARY/SPECIALTOPICS/STONEWALLS

SURVEY

GEODETIC SHIP OF ALASKA (1917–1955)

In 1915, the United States Coast & Geodetic Survey (C&GS) found itself in need of upgrading and improvement in many areas. The precision field equipment was deteriorated and outdated. The Public Health Service declared the improperly lighted and overcrowded C&GS office buildings in Washington D.C. to be unsanitary. Painstakingly compiled data, maps, and charts were under constant danger of destruction while being stored in buildings with leaky roofs or in offices with no fire protection. Furthermore, the older employees' vast knowledge was continually being lost through retirement. To worsen matters, a pattern of high employee turnover had developed. New employees were being trained by C&GS who then only worked for a few years before leaving for better paying employment. Departments throughout the agency were suffering from these same symptoms with low morale taking its toll on the historically-proud agency whose beginnings trace back to 1807.

Seven shipmates of *Surveyor* pose with a life preserver in this early photo while at sea.
JERRY PENRY PHOTO

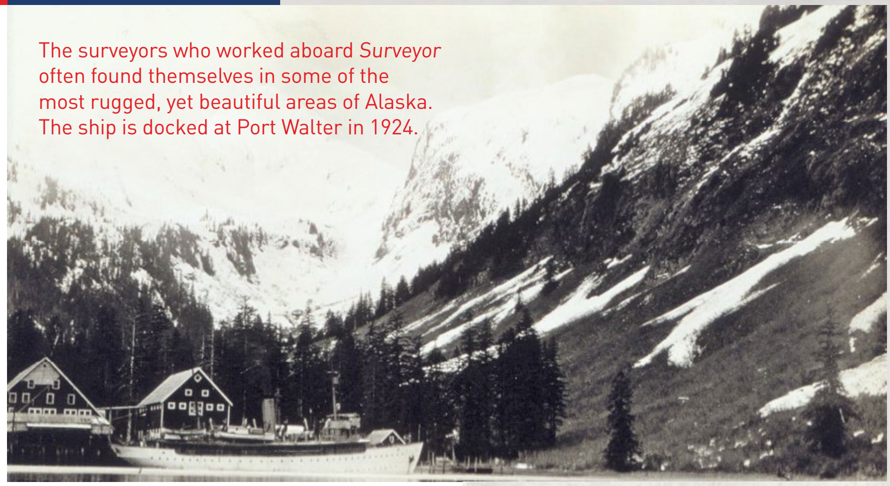
» JERRY PENRY, PS

OR

Surveyor departs its winter port of Seattle, Washington, en route to the surveying waters of Alaska in the spring of 1925.
NOAA PHOTO LIBRARY

The efficiency of the work performed on the vessels at sea was continually compromised not only due to insufficient equipment, but also due to a shortage of men. The enlisted men employed on the Pacific Coast by C&GS were paid less than any other employees whether it was government or commercial. Recruitment of Pacific sailors generally occurred in Seattle where many of the ships, particularly those working in the northern waters, were stationed during the winter months. The yearly race to recruit strong and hardy men who were willing to work the dangerous jobs was competitive due to the lumber, canning, and fishing industries also needing to hire summer employees. Those who did choose to work on the C&GS ships quickly found the work to be arduous and complicated due to the complex equipment that required a higher level of competence than other summer employment. Each year, the older employees on the ships expertly trained a new crew to operate the equipment, only to have these new employees not return the following year due to finding higher paying jobs elsewhere.

Two of the main C&GS ships that were working in the Pacific waters in 1915, the *McArthur* built in 1876, and the *Gedney* built in 1875, were so deteriorated that neither were seaworthy after forty years of continuous service. The superintendent of C&GS stated that the future existence of these ships would be a menace to human life and their further use would be without the slightest justification, so both ships were condemned and sold in 1915. The loss of these ships unfortunately coincided with a time when there was a great urgency to conduct surveys off the coasts of Washington, Oregon, California, Alaska, and Hawaii. At this time, the ship named *Patterson* was 33 years old and had been strictly confined to shoreline work. Likewise, a ship named *Explorer* showed severe structural weaknesses requiring



The surveyors who worked aboard *Surveyor* often found themselves in some of the most rugged, yet beautiful areas of Alaska. The ship is docked at Port Walter in 1924.

In order to reach the shore, special boats known as launches were used to transport the surveyors from the main ship to land. Launch 168, shown here, was associated with the ship *Surveyor*.
NOAA PHOTO LIBRARY

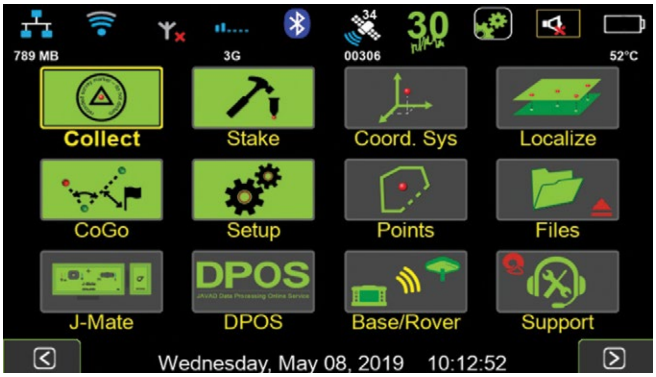
Introduction

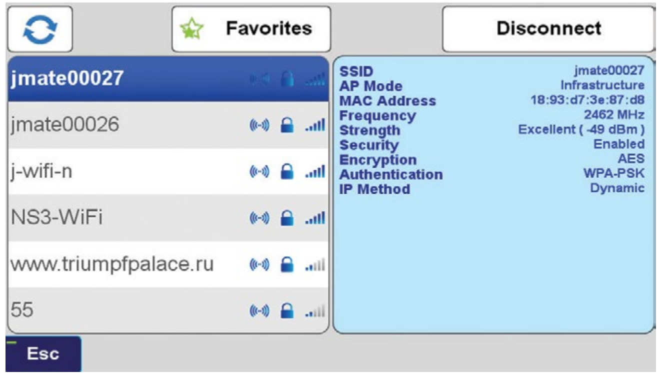
Let's set the record straight: J-Mate is not a total-station. **J-Mate and TRIUMPH-LS together** make the **"Total Solution"** which is a combination of GNSS, encoder and laser range measurements that **together do a lot more than a total station**. For long distances you use GNSS and for short distances (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.

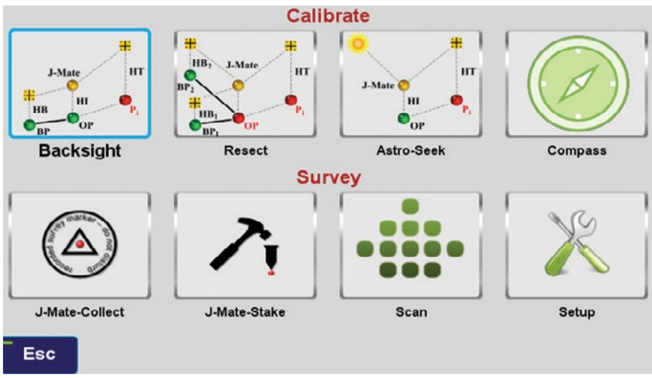
Connecting the TRIUMPH-LS to the J-Mate

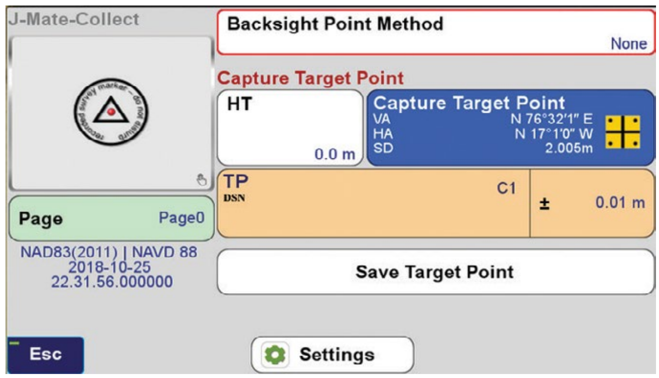
TRIUMPH-LS communicates with the J-Mate through Wi-Fi. Turn on both the TRIUMPH-LS and the J-Mate. Click the Wi-Fi icon on the TRIUMPH-LS Home screen to connect to the J-Mate, much the same way as you connect TRIUMPH-LS to your Wi-Fi access point.





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.





Main J-Mate Screen

This is the Main J-Mate Screen. Click button **"7"** in Figure 1 to switch some controls as shown above. Below are explanations of some buttons of these screens.

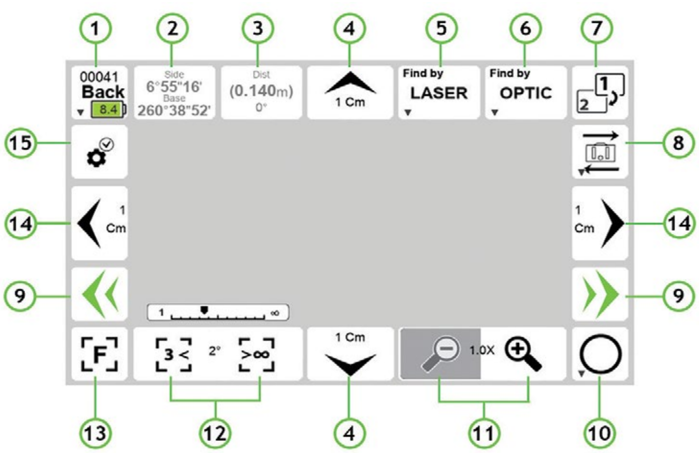
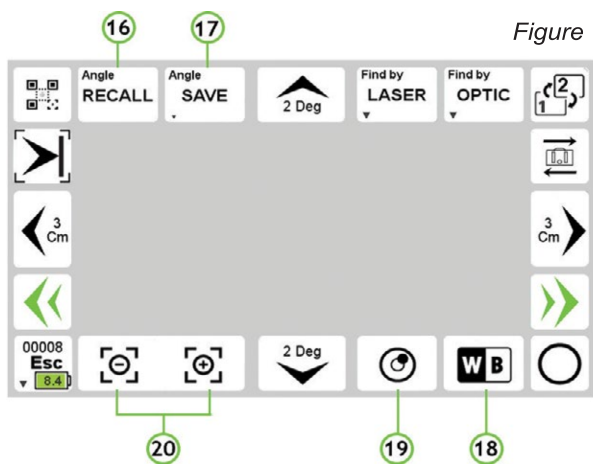


Figure 1



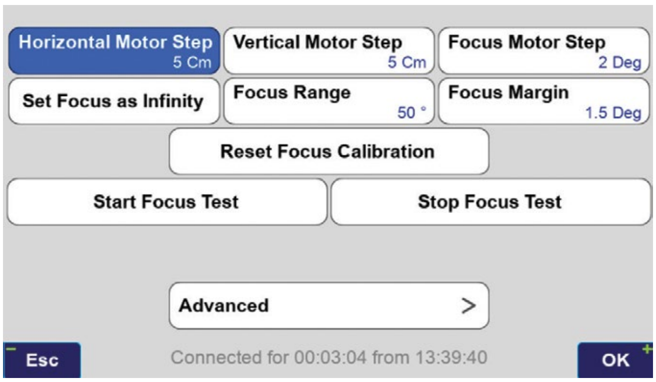
Aiming at targets manually

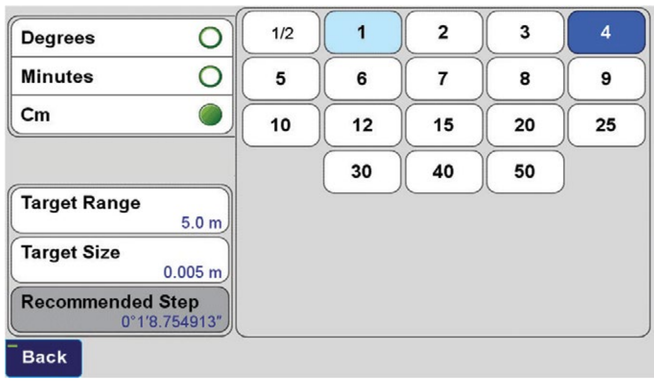
You can find targets manually or automatically.

There are five ways that you can manually aim the J-Mate towards your targets:

1. Each click of the Left/Right/Up/Down buttons around the screen (**"4"** and **"14"**) moves the J-Mate according to the value that you assign to them in the setup screen (**"15"**), as shown in Figure below (Horizontal and Vertical Motor Step).
2. While holding these buttons **"4"** and **"14"**, J-Mate rotates about 5 degrees per second.
3. Buttons **"9"** are "Fast Motion" buttons. While you hold them the J-Mate rotates about 30 degrees per second.
4. You can point J-Mate towards points by touching points on the screen and by gestures (moving finger on the screen).
5. You can also rotate the J-Mate manually while it is not moving by motors, but limit that to small rotations, not to apply backpressure to motor. Motor manufacturer does not prohibit manual motion, but we think it is better to avoid it as much as possible.

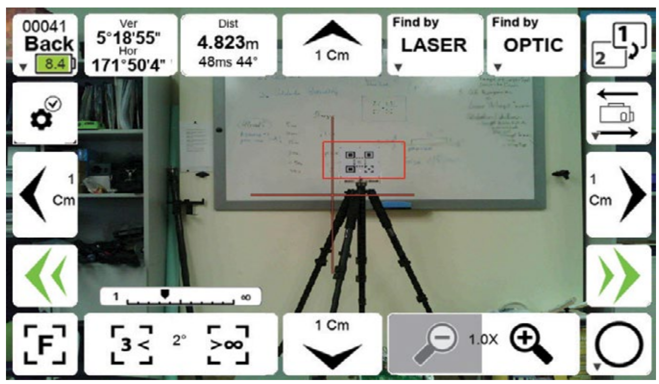
Setup screen





The two cameras

The viewing angle of the TRIUMPH-LS camera is 60 degrees wide, while that of the J-Mate is about 5 degrees. The viewing area of the J-Mate camera is represented on the TRIUMPH-LS camera by a small red rectangle. While TRIUMPH-LS is sitting on top of the J-Mate, you can view your target on the TRIUMPH-LS camera (Click Button **"8"** of Fig. 1), bring it to the rectangle by touching the target or using the navigation buttons, and then switch to the J-Mate camera.

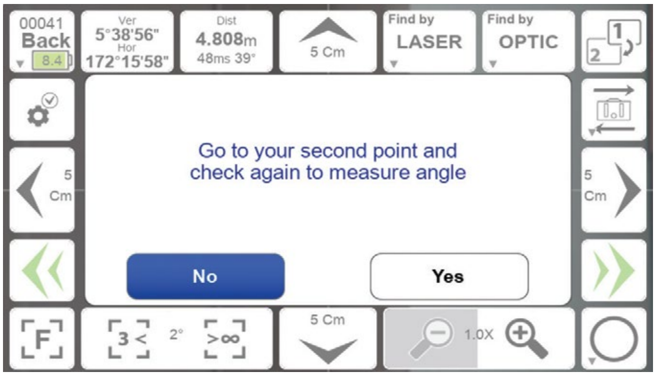


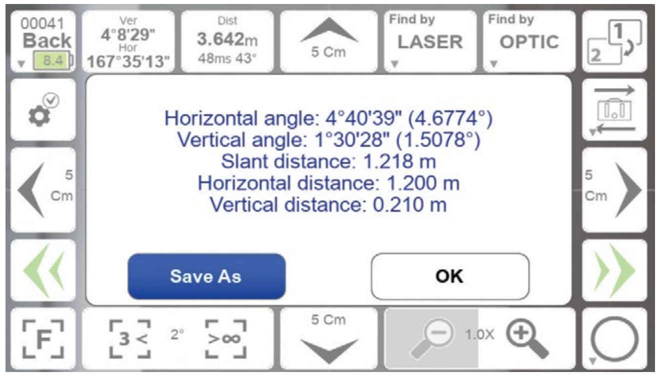
To calibrate the camera of J-Mate with the camera of the TRIUMPH-LS, while TRIUMPH-LS sitting on top of the J-Mate:

1. Click **"3"** and clear existing Horizontal and Vertical calibration offsets (if non-zero).
2. Aim J-Mate **laser** to the target.
3. Click **"2"** to set the first position of the offset angle.
4. Click **"8"** to switch to the TRIUMPH-LS camera and note the small rectangle that represents the J-Mate camera viewing area.
5. Aim the J-Mate to bring that target to the center of the rectangle.
6. Click **"2"** to finish measuring the offset angles between the laser center and the rectangle.
7. Save them to a location on the scratch pads.
8. Click **"3"** to recall the measured offsets from the scratch pad that you saved in.

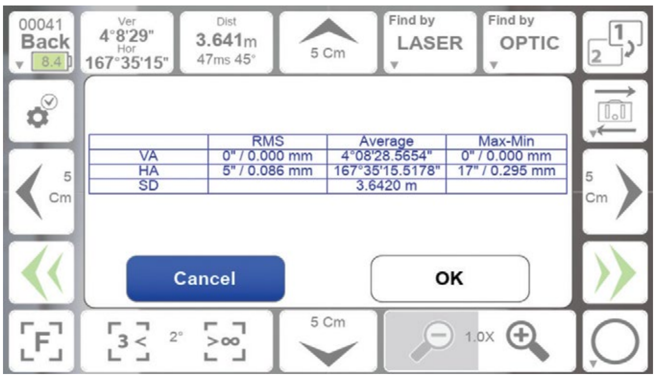
Measure angles between two points:

Aim at the first point and click button **“2”** of Fig. 1. Then Aim to the second point and click this button again. You will see the horizontal angles between the two points. You can save the measured angles in clip boards and use it elsewhere when you need.





Taking a point



Aim at your target and click **“10”**. J-Mate will take 10 readings and average them. The average, RMS and spread of the ten readings are shown. Optionally, you can specify four points around the target point to be measured too, to ensure that you have aimed at the desired target. To specify the distance of the four points around the target, hold **“10”**.

Instantaneous angular and range measurements are shown in boxes **“2”** and **“3”** in Fig. 1.

Camera operation and settings

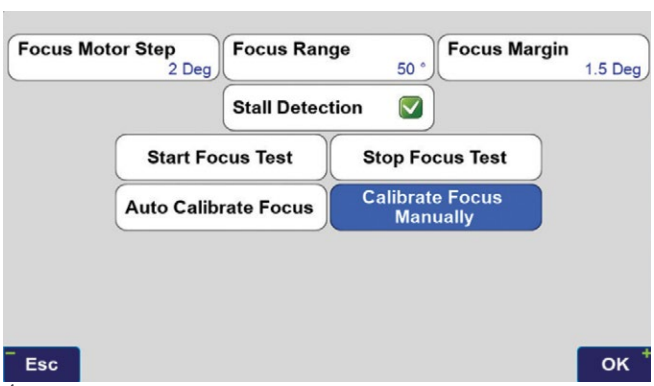
White balancing the J-Mate camera when the light setting changes: 1)Put a white paper in front of the J-Mate camera about few meters away, such that it covers at least half of the viewing angle of the camera. 2) Click **“18”** to start white balancing. It will take about 10 seconds to finish.

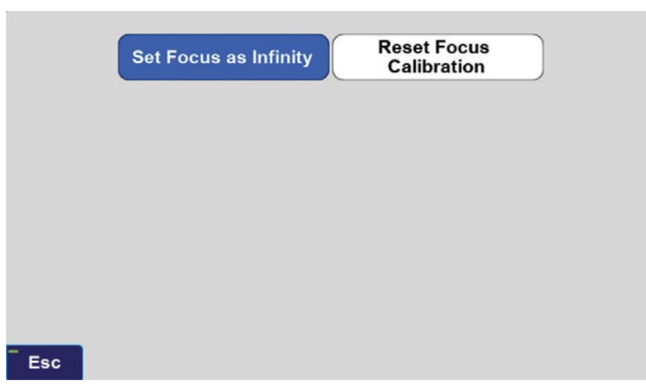
Zoom buttons: **“11”**

Contrast/Brightness buttons: **“20”**

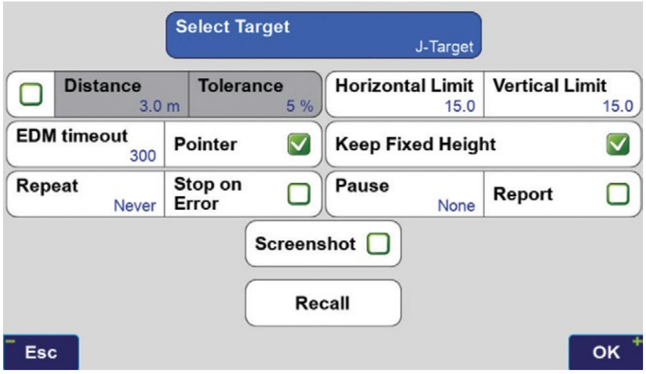
Focus: use buttons **“12”** to focus manually. Click **“13”** for autofocus on the subject.

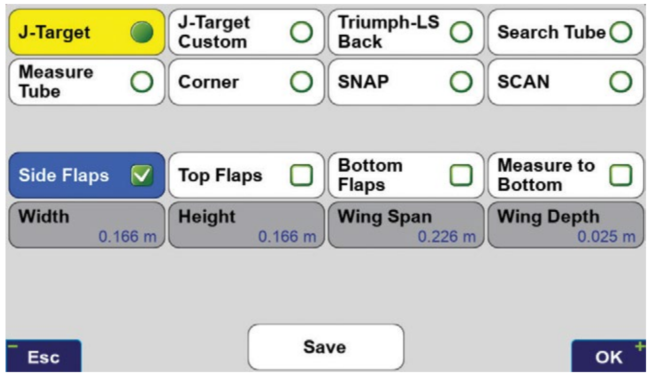
Occasionally you may need to calibrate the Focus motor. Click Setup **“15”** → “Focus” → “Auto Calibrate Focus” or “Calibrate Focus Manually”. In Manual focus, 1)click “Rest Focus Calibration”, 2) using **“12”** buttons, focus to infinity, 3) Click “Set Focus as Infinity”.





Searching and finding objects by laser and Object types





Hold the Laser button (**“5”**) to see the setup screen for laser target selection and parameters. If you know the approximate distance to the target, click the check box and enter the distance and accuracy percentage. This will help J-Mate to ignore targets that are outside the range.

Horizontal and Vertical Limits are the limits that J-Mate will search around the starting point to find targets. In this example is 15 degrees on left and right, and 5 degrees up and down.

“Keep Fixed Height” check box, scans horizontally on fixed target height. You may rarely need to use this feature. It will reduce the scanning speed by a factor of 2.

In Target Selection screen, the following targets are defined:

- **J-Target** is a printed pattern glued to 166x166 mm plywood of about 25 mm thick. It can be attached to a 226x226 mm plywood of 10 mm which provides flaps around the pattern. Select check boxes related to Sides, Top and Bottom flaps, if they exist and you want J-Mate to consider the depth of the flap (about 25 mm).
- If the J-Target is not sitting on another object and its bottom boundary is clear, then check the box Measure to Bottom. If not checked, J-Mate will measure to the top and will come down half of the height to aim at center. This feature applies to other target types too.
- In laser scanning and finding, the pattern on the J-Target has no effect.

J-Target Custom: This option allows you to build your custom J-Target type.

TRIUMPH-LS Back: searching for an object similar to the back of TRIUMPH-LS.

Search Tube: Searches to find a tube with given diameter and height. If Measure to Bottom is not checked, it will go to the top of the tube and then come down half of the specified height, irrespective of the actual height of the tube.

Measure Tube: Searches for a tube that has the given width and then it measures the tube depth.

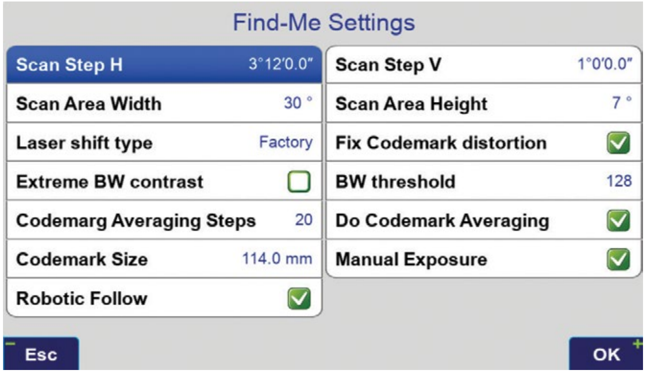
Corner identifies an abrupt change on a flat surface.

Snap: scans with the resolution given in “Step” and stops when range changes by “Edge Depth”.

Scan: Scans according with the resolution given in “Step” and saves the scanned files if the box is checked. The scanned files can be viewed in the Main screen / File icon.

Selected objects and their parameters can be saved and recalled by **“Save”** button on this and **“Recall”** button of the previous screen.

Follow me and robotic operation



J-Mate can search and find the J-Target and robotically follow it. J-Mate also measures the distance to the Target optically, and shows distance and tilt on top and the bottom of the J-Target image.

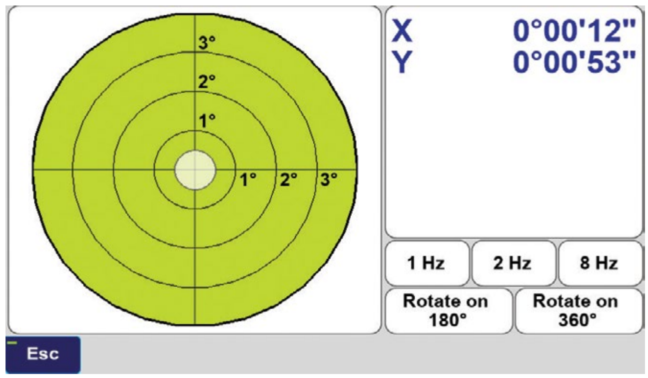
For J-Mate to follow the J-Target robotically, check the **"Follow Me"** box in the OPTIC set up (hold **6** to reach its setup).

J-Mate can also optically search and find the "Zebra Cylinder" Target. It will target the center of the Zebra Target (Half the specified height from the top). If you don't check the "Measure to bottom" box, you can make the Zebra Cylinder of any height and J-Mate will aim half of the specified "Target Height" from the top of the cylinder. The Zebra Cylinder is omnidirectional and you can hold it in any direction towards the J-Mate.

Calibrating the J-Mate laser and camera offset.

1. Select an area where range changes between 2 to 10 meters when J-Mate rotates.
2. Hold **"15"**, select "Advanced" → "Calibration" → "User Calibration" and click "Start". It will take about 10 minutes to finish calibration. This will be adjust the laser cross hair identification to where it should be.

Viewing the inclinometer



Hold button **"8"** or click button **"19"** of Figure 1 to see the embedded 0.001-degree electronic inclinometer of the J-Mate as shown in Figure 3. It updates 10 times per second.

The embedded inclinometer monitors and corrects for tilts automatically.

Saving and recalling orientation of J-Mate

Click **"17"** to save the current orientation of the J-Mate to a scratch pad.

Click **"16"** and select the scratch pad orientation that you want to orient to.

Laser time limit

The time that it takes for a laser measurement depends on the reflective surface of the target and weather conditions (dust and moisture in the air).

On a good white reflective surface and in clean air, it takes about 50 milliseconds to have a laser reading. If there is no reflective surface, or the reflective surface is black, it may take up to 4 seconds to have a laser reading.

If the surface of the object that you want to scan is a good reflective surface, limit the laser time to a fraction of a second. This will cause the laser to skip points that do not reflect enough energy in the time limit that you specified. This will significantly increase the scan speed and will ignore points that are not possibly your target and reduces the chance of identifying a wrong object.

Hold "LASER" (**"5"**) to set the laser time limit.

Option to Help J-Mate to find you

At Occupation point, click the J-Target icon (**“21”** of the Figure 1). You will be guided through the following steps for J-Mate to aim at you holding the TRIUMPH-LS with the J-Target, when going to the Backsight, for example.

1. At Occupation point, put the TRIUMPH-LS on top of J-Mate (or slightly above it, but at the same orientation as the J-Mate, to be far from the motor magnets of the J-Mate) and click Next.

This step will transfer the compass reading of the TRIUMPH-LS to the J-Mate encoders.

2. Go to your target, Put the J-Target on top of the TRIUMPH-LS and aim the TRIUMPH-LS towards the J-Mate (with the help of the TRIUMPH-LS camera) and click Next.

This will help the J-Mate to know the general direction to the target and limit its search range. You can go back to previous step to fine tune view of the J-Mate.

3. You will see the J-Mate camera view on the TRIUMPH-LS screen. You can fine tune the J-Mate view by the navigation buttons to make recognition faster.

You can also manually aim at the center of the J-Target panel and take your shot.

4. Click “Optic” if you want the J-Target panel to be searched and centered automatically.

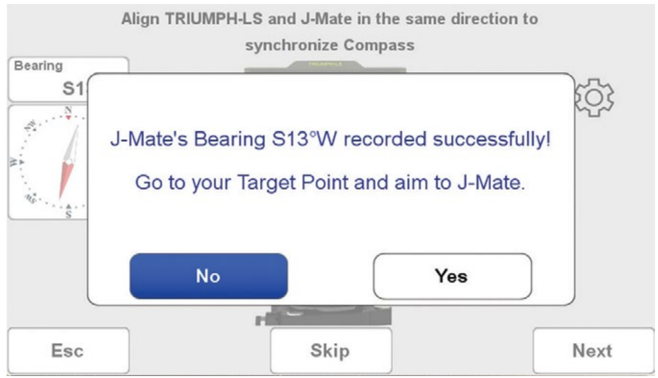
When J-Mate focuses on the center of the J-Target, you can click the “Take” button. You will be asked if you want to record the point.

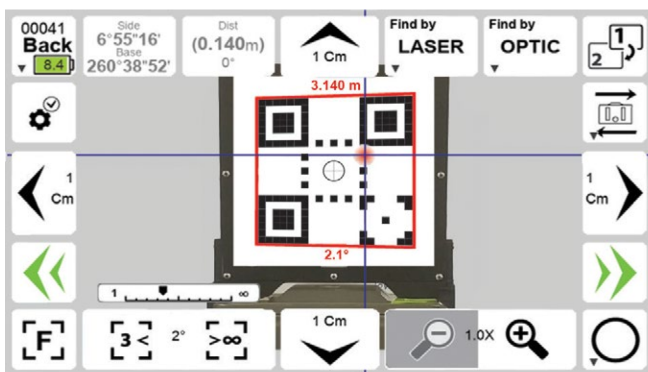
5. If you also want to find the center of the J-Target by Laser scanning, you can click the “Laser”. If Laser scan is successful, you can click the “Take” button to replace the previous measurement with the current measurement done by laser scanning.

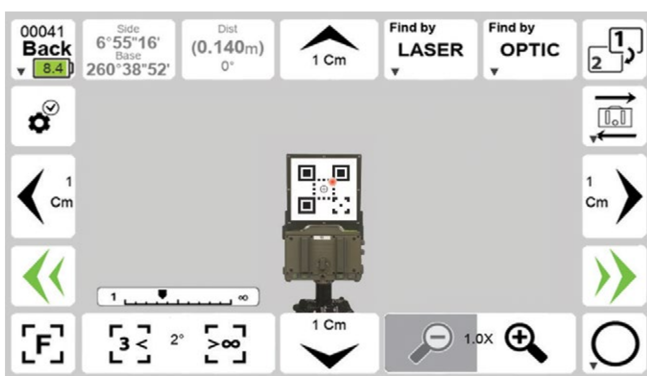
The center of the J-Target is vertically collocated with the GNSS antenna and you don’t need to be exactly perpendicular to the J-Mate path.

If light condition is such that camera cannot find the J-Target, chances are better that laser scanner can find it.

Even after the J-Target is found optically, you can continue the laser search with “On J-Mate” option to measure the J-Target and find its center more accurately by laser.



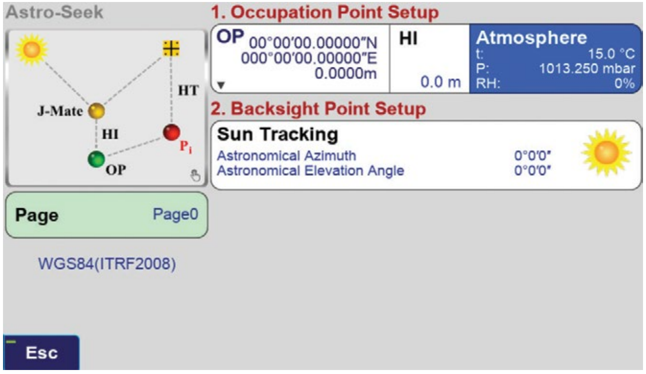




Backsight point and the Sun

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.

Four ships of the USC&GS fleet are docked together at this northern port. From left to right are *Surveyor, Pioneer, Discoverer,* and *Guide*.
NOAA PHOTO LIBRARY

The stern of *Surveyor* as seen from the ship Cosmos. It is either being towed or possibly taking part in a wire drag operation to find submerged pinnacle rocks.
NOAA PHOTO LIBRARY

costly repairs to keep it afloat. *Explorer* was confined to work only in protected waters of southeast Alaska for the safety of both the crew and the vessel. The agency therefore found itself without a vessel in the Pacific fleet capable of being exposed to the rigorous and treacherous work of the open waters. The Atlantic situation was nearly as dismal with the *Pathfinder,* at work in the Philippines, being the only ship strong enough for offshore work in that area.

Despite wanting to remain neutral, the United States came under increasing pressure to enter the First World War. The sinking of the passenger liner *Lusitania* on May 7, 1915, turned public opinion in many countries, including the United States, against Germany. During a span of fifteen minutes, the attack upon the *Lusitania* had caused the loss of over 1,200 lives, with many being young nurses. Despite a potentially expensive war looming, Congress eventually listened to the pleas of C&GS and appropriated money to purchase two new vessels for work in the Atlantic and Pacific oceans. The ship that would complement the Pacific fleet was to be christened *Surveyor* and would be assigned to specifically work the waters of Alaska. The new ship for the Atlantic was named *Isis*.

Surveyor, a steamship whose keel was laid in the winter of 1915, was completed less than two years later in 1917. The Manitowoc Shipbuilding & Dry Dock Company in Manitowoc, Wisconsin, was the low bidder at a cost of $236,000. This fifteen-year-old shipyard, located along the western shore of Lake Michigan, had developed a reputation not only for quality workmanship, but also for quick delivery, rivaling any other shipbuilder in the country. Shipbuilders not located along the coasts were often viewed as inferior, but the Manitowoc builder proved they had the expertise to compete.

Surveyor was 186 feet long, had a 1,000-ton displacement, carried 75,000 gallons of fuel, and was driven by a triple-expansion engine of 1,000 horsepower allowing it to easily achieve 12 knots with a 10.5-foot diameter propeller. Its crew consisted of 11 officers and 58 enlisted men operating the usual equipment of a surveying vessel. The equipment on this modern ship included the latest technology for sounding at all depths down to the greatest ocean bottoms and carried the latest radio equipment making communication better than ever known before on a geodetic ship. *Surveyor* was the most modern ship in the fleet and became the first oil-burning steamer for C&GS.

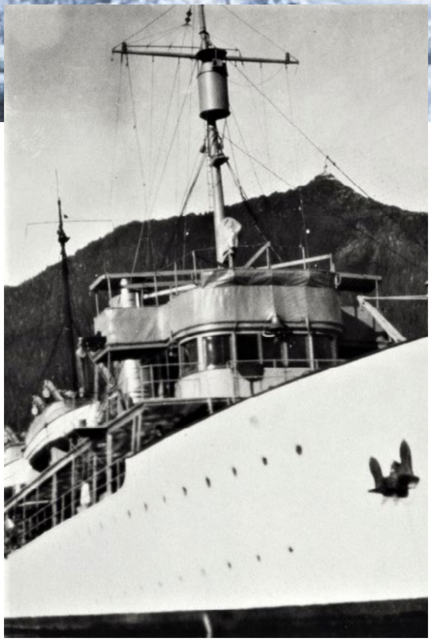
Once completed, *Surveyor* made its way through the Great Lakes on its first voyage in June of 1917. On July 1, 1917, while docked

Helicopter operations are taking place in the Bering Sea with the second ship designated *Surveyor S 132.*

NOAA PHOTO LIBRARY

at Portsmouth, NH, *Surveyor* received special launches and fittings made especially for a geodetic ship. The ship then traveled to Norfolk, VA, and to Tompkinsville, MD. On July 24, 1917, *Surveyor* arrived at Washington D.C. where it was inspected by C&GS personnel. However, its duty as a geodetic vessel would have to wait because the U. S. Navy was eying this new ship for war purposes.

As atrocities committed overseas became too great to overlook, the United States began sending troops to aid the Allies in June of 1917. On September 24, 1917, soon after the delivery of *Surveyor* to C&GS, an executive order transferred this ship and two others, *Isis* and *Bache*, to the U. S. Navy to aid the war effort. Commissioning of *Surveyor* into the wartime fleet took place on October 22, 1917 and by November of 1917, *Surveyor* was ordered to report to the historically important base for the British Armed Forces at Gibraltar. On May 16, 1918, an executive order took two more ships, the *Patterson* and *Explorer*, from C&GS for use in the war. The remaining vessels in the C&GS fleet at that time were the *Fathomer*, *Hydrographer*, *Marinduque, Matchless*, *Pathfinder, Research*, *Romblon, Taku*, and *Yukon*.



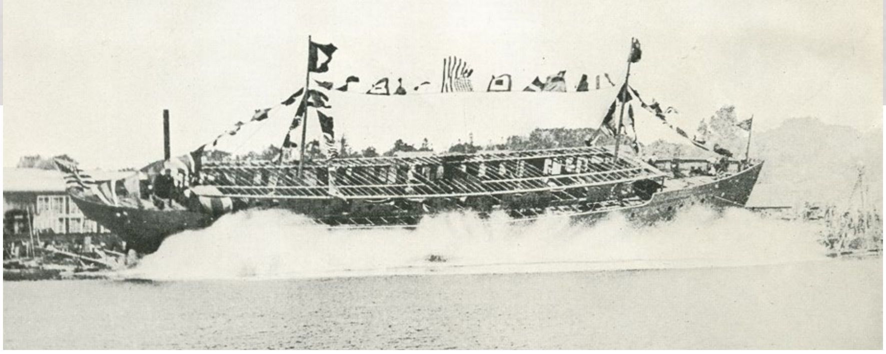
The ships of USC&GS did not bear their names on the bow like was done with other ships. *Surveyor* is shown here in 1924.

NOAA PHOTO LIBRARY

During the war, *Surveyor* mainly engaged in convoy and escort duties in both the Mediterranean Sea and the North Atlantic Ocean while at Gibraltar. During the course of service, *Surveyor* traveled over 26,000 miles, not including the many miles zig-zagging to evade German submarines. *Surveyor* participated in the escort of approximately 330 ships, of which only four were hit by enemy torpedoes and only sinking two.

Surveyor rose to heroic status during its service in the war on at least two separate occasions. The first occurred on May 11, 1918, when the German submarine *UB-52* fired a torpedo which sunk the French steamship *Susette Fraisinette*. *Surveyor*, along with other nearby ships, dropped depth charges in order to hit *UB-52*, but efforts were unsuccessful since the submarine quickly dove to avoid any damaging blows. Despite not being able to hit *UB-52*, *Surveyor* participated in rescuing thirty-four of the survivors from the French ship.

One week later on May 17, 1918, two German submarines attacked and sank the British steamship *Mavisbrook*. The same two submarines then damaged the British steamships *Sculptor* and *Elsnick Grange*. One of these submarines, *U-39*, took aim at *Surveyor* and successfully fired a torpedo. Fortunately, the aim was slightly off and the torpedo only grazed *Surveyor's* bow without inflicting serious damage. (The *U-39* was the notorious submarine that had earlier sunk the *Lusitania*.) During its participation in the war, the crew of the seemingly untouchable *U-39* had sunk 158 ships and damaged 6 others. After the near miss of the torpedo, the wake of *U-39* was quickly picked up by *Surveyor's* crew who immediately went on the offensive. The finest hour for *Surveyor* arrived when one of two depth charges dropped by the crew successfully disabled *U-39*. The submarine and its crew were subsequently interned at a neutral dock in Cartagena, Spain, thus ending its bloody rampage on the high seas.



Touching the water for the first time, *Surveyor* enters Lake Michigan from the Manitowoc Shipbuilding & Drydock facility in 1917.
NOAA PHOTO LIBRARY

After the war ended, *Surveyor* came back to the United States where its warship armament was removed during January of 1919. An executive order by Congress on February 26, 1919, authorized the Navy's return of all ships to their previous owners. *Surveyor* returned to the Department of Commerce on March 31, 1919, to begin operations for which it had originally been built with the Coast & Geodetic Survey.

Surveyor began its first official mapping operations at Shelikof Strait, Alaska, in July 1919. The main work performed was the extension of the triangulation at Kodiak Island that was already being carried northeastward from Unalaska. This provided control for the present and future surveys of the Alaskan Peninsula. One of the main mapping operations was to find obstacles that lie just below the water surface to safeguard commercial shipping.

After having worked the waters of Alaska for an entire decade, *Surveyor* continued surveys and mapping along the west coast of Kodiak Island into the 1930's. Work extended from Cape Ikolik southward through Sitkinak Strait, including surveys of Olga Bay as well as Alitak Bay and its tributaries. Despite *Surveyor* originally being outfitted with the most modern equipment, it periodically needed to be upgraded as new technology came into use. In 1938, the Dorsey Fathometer No. 3, a precision echo-sounding instrument, was placed on *Surveyor*.

By 1940, turmoil was again taking place on the European continent and many began to realize that *Surveyor* might be recalled into wartime service. That speculation was proven true when the United States entered World War II and *Surveyor* was taken over by the U. S. Navy. The ship immediately engaged in a hydrographic program in the vicinity of Port Townsend during the summer of 1942 and proceeded to the hostile areas of the Aleutian Islands for defense-related mapping operations. As in the previous war, *Surveyor* was fitted with armament that could be used for defensive purposes if needed.

By 1944, *Surveyor* undertook hydrographic surveys, along with four other ships, in the vicinity of the islands of Adak, Delarof, Amchitka, Kiska, Shemya, and Attu for the U. S. Navy. *Surveyor* also accomplished triangulation in Hood Canal and in the Puget Sound area to determine the positions of recently established navigational aids of the U. S. Coast Guard.

At the end of World War II, *Surveyor* was fortunate to have survived the world conflict after frequent proximity to some of the most intense battles of the Aleutian Islands. The guns and other armament were removed from the geodetic ship. *Surveyor* then carried on combined operations along the north and south coasts of Amchitka Island, in the Delarof Group between Tanaga and Amchitka islands in Tanaga Bay, and off the north and south coasts of Tanaga Island.

Upon reaching Seattle at the end of its thirtieth season, *Surveyor* was placed on inactive status with reduced complement due to insufficient operating funds. *Surveyor* remained docked in Seattle during the summer and fall of 1948 and all of 1949 which was the first time in its history that it had not been engaged in summer work.

After reactivation in 1950, *Surveyor* began field operations in the spring along the coast of Alaska. Tidal current surveys were made in the Aleutian Island Passes, in the Rosario Strait, and near the San Juan Islands of Washington. Age continued to take its toll on *Surveyor,* so boiler repairs had to be made at the end of the 1950 and 1951 seasons.

In April of 1955, *Surveyor* left for the familiar territory of Alaska and arrived

The second *Surveyor* ship was built in 1960 and is shown here post-1970 in Alaska after becoming part of the NOAA fleet.
NOAA PHOTO LIBRARY.

to work on hydrographic surveys in the vicinity of Shumagin Islands where the survey of a large reef-studded area between Wosnesenski and Unga islands was completed. Shore stations were established in the vicinities of Cape Seal and Bay Point and a tide station was installed in Coal Bay.

By September of 1955, *Surveyor* was deemed no longer seaworthy, so the decommissioning of the famed ship was initiated. On November 10, *Surveyor* moved alongside *Explorer* after all of its remaining heavy equipment had been removed and stored. On November 18, 1955, the Commission pennant was lowered, all flags secured, and the ship was placed on final inactive status while under the command of Captain Frank G. Johnson. To commemorate the famous ship, a bay in Alaskan waters was named “Surveyor Bay”.

A new ship with the same name, *Surveyor*, was commissioned in 1960 as *OSS-32 Surveyor*. This ship was built by the National Steel & Shipbuilding Company in San Diego. The arrival of this new ship marked the beginning of a major effort to modernize the Coast & Geodetic Survey fleet and make it capable of conducting worldwide operations. The newer ship was 292 feet long and had 127 officers and crew along with a helicopter pad. When NOAA took over USC&GS in 1970, this same ship was renamed *S-132 Surveyor*. NOAA decommissioned this ship on September 29, 1995. ■

With forward mounted gun, this painting depicts *Surveyor* while at work in Alaska during WWII. The star and chevron on the smokestack indicates this ship had previously participated in wartime operations during WWI.

JERRY PENRY IMAGE

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.

SIMPLIFYING COMPLEXITY *with Scanning*

With survey projects, there's *complex*, there's *very complex*, and then there's the Cedar River Flood Control System (CRFCS) project in Cedar Rapids, Iowa. Launched in 2015, the 20-year, $750 million project is building a combination of permanent and removable flood walls, levees and gates along 11 km of the river's banks.

As a survey consultant for the CRFCS, Cedar Rapids-based Foth Infrastructure Environment was tasked with an incredibly complex assignment: acquire railroad pier features for hydraulic modeling at one site accessible only by boat, and capture a topographic survey for flood wall design and clearance verification at a second site that would be accessible only for four hours.

Armed with advanced scanning technology and a solid plan, a small crew captured all the infrastructure elements needed and delivered more data than was initially requested. They also debunked an inaccurate assumption about the low point of a bridge, saving the city from a costly oversight.

The SX10 sits ready to capture the features of the three old railroad bridge piers in the water.

Flood waters deluged 10 square miles of Cedar Rapids, displacing 10,000 residents and swamping Iowa's second-largest city with $6 billion in damages

PHOTO BY USACE ROCK ISLAND DISTRICT

Cedar Rapids, Iowa's "Flood of 2008" was the most devastating flood in the region's history.

DON BECKER, U.S. GEOLOGICAL SURVEY.

Because Site 1 was not accessible by foot, a crew had to navigate to control and scanning points by boat. Here the SX10 is set up to capture the railroad bridge in the distance and three old pier structures in the water.

Tackling Complexity

To prepare for the project, Foth first tested traditional survey technologies. Selecting a small area of interest (AOI) they used total station and scanning equipment to capture a bridge arch along the riverbank.

"Although we acquired the data, it required extra steps to create an accurate, georeferenced point cloud," says Jody Budde, a professional land surveyor with Foth. "We needed several trips to the site to establish control and targets and scan the bridge arch. Those additional setups would add time we didn't have, and range limitations of the scanning technology wouldn't allow us to shoot across the river."

Based on the exercise, Foth determined they needed a single instrument that could integrate total station measurements with high-speed, georeferenced 3D scans. After

"We needed several trips to the site to establish control and targets and scan the bridge arch. Those additional setups would add time we didn't have."

A section of the Site 2 as-built survey project. The area highlighted in red indicates a large industrial site that is inaccessible by foot because it's lined by sheet piling walls. The long range of the SX10 enabled crews to capture that section from across the river.

A shot of the 12th Ave Bridge from the SX10 internal camera with its equivalent point cloud view. This particular bridge had a 1.5-in clearance tolerance to the bottom of the bridge requiring a team to capture a 3D point every 0.125 to 0.25 inches.

A view of the industrial site's sheet piling wall and its equivalent point cloud view.

evaluating available technology, they acquired a Trimble SX10 scanning total station. The SX10 combines surveying, imaging and scanning (up to 26,600 points per second with a range of 600m).

Based on the CRFCS project schedule, Foth began with Site One, a 2.3-km stretch of riverbank about 9.7 km north of downtown. An operational railroad bridge crosses the river and several abandoned bridge piers dot the water. Foth needed to capture railroad track locations and shape and size of the active and inactive bridge piers to within 1.5 cm.

In the fall of 2017 a two-person crew launched their motorboat carrying a Trimble R10 GNSS rover, the SX10, a Trimble Yuma 2 tablet and a Trimble TSC3 controller. Criss-crossing the 150-m-wide river, they used the R10 to establish control points in nine locations.

Next the team set up the SX10 and captured the scene from the railroad bridge all the way downstream to the old pier remnants, collecting features along and across the river at distances of nearly 300 m. By using resection, all setups were

In addition to scanning the railroad bridge piers, a team had to capture the railway track itself with the SX10.

A close-up of one of the railroad bridge piers. Defining the size of the piers on one plane was a challenge because there were vertical height discrepancies of several feet between the old piers.

georeferenced and the crew could acquire measurements to critical features from multiple locations. In total, it took two days to scan the tracks and 12 piers, collect 11.8 million 3D points and capture color photos with the SX10 built-in camera.

In the office, they used Trimble Business Center (TBC) software to integrate the GNSS and scanning data into one project. In a few hours, they created and delivered a 3D point cloud that the engineering design firm could immediately use in its own hydraulic analysis software.

Racing the clock

Foth returned to the Cedar River in spring 2018 to tackle Site Two. This 1.6-km stretch of riverbank will have a permanent floodwall and Foth needed to collect a topographic survey and as-built data of ground-level and submerged infrastructure as well as three bridges.

Collecting that information, however, required the city to close an upstream dam for the first time in its history. The dam would be closed for only four hours.

Foth dispatched two two-person crews who set ten control points with the R10 and started scanning with the SX10 while the water level was lowering. To produce the required vertical precision—one bridge had a 3.8-cm clearance tolerance to the bottom of the bridge––the crews used a Trimble DiNi digital level at each control point to ensure elevations were within the project's 3-mm specification.

In parallel with the control crew, the scanning crew used project control to capture 3D points of the infrastructure. Using four separate locations on the east side of the river, they scanned the entire length of the west bank AOI. They captured features up to 245 m away including bridges and bridge arches, flood structures and utilities. As the water level dropped, they captured submerged features like underground pipe networks. For the 12th Avenue Bridge, the structure with the tight 3.8-cm clearance requirement, the Foth team made additional scans of its underside, capturing 3D points with 3 to 6 mm spacing. By the time the dam reopened, the crews had finished the job and collected 27.6 million points.

> "Without the speed and scanning range of the SX10, we would not have been able to do this job."

"Without the speed and scanning range of the SX10, we would not have been able to do this job," says Ben Sullivan, a lead geospatial specialist with Foth. "Conventional survey technology would've required up to three times more man-hours and we would've collected only about 20 percent of the data detail we captured with the scanner." Had Foth used a dedicated scanner, they would have incurred significant additional time setting targets intervisible from the multiple setups.

Similar to Site One, they used TBC to integrate data from GNSS, total station, scanning and digital level instruments allowing them to process and validate the data into one georeferenced project. Using TBC's plane-definition and cross-section tools, the Foth team discovered a discrepancy on the 12th Avenue Bridge. Historical data indicated the lowest arch points were the lowest clearance point. The scanning data showed a support pipe under the bridge deck that was lower than the bridge arches, revealing the pipe as the true low point for vertical clearance. Had the city built the new wall based on the original assumption, it would've been a costly mistake.

With many more phases of the CRFCS ahead, it's a good bet that Foth will face its share of complexity in the future. Based on the results of its SX10's scanning debut, they're confident they have the right tools to succeed. ■

Mary Jo Wagner is a freelance writer who has covered the geospatial industry for 25 years. Email: *mj_wagner@shaw.ca*.


THE ONE THAT STARTED IT ALL
“ THE SX10 IS OPENING UP A WHOLE NEW RANGE OF POSSIBILITIES.
- Even Sellevoll, Geomatikk Survey
“ WE COULD KEEP OUR FEET ON THE GROUND AND SAFELY MEASURE REMOTE OBJECTS.
- Joel Cusick, U.S. NPS
“ WE HAVE WITNESSED BETTER RETURNS THAN ANY OTHER SYSTEM.
- Terry Nygaard, Tx RPLS
“ THE HIGHEST TECH PIECE OF EQUIPMENT I'VE EVER USED.
- Paul Biehl, Aztec
“ QUICKER ROI THAN ANY TWO INSTRUMENTS WE'VE HAD IN THE PAST.
- Matt Bryant, NTT DATA
“ ADAPTING TO THE SX10 WAS NO PROBLEM.
- Niels Balens, BAM Contractors
“ FASTER IN THE FIELD AND MUCH MORE ROBUST.
- Steve Sharron, WSP
“ WILL DEFINITELY REVIVE THE WHOLE INDUSTRY.
- Lennårt Gimring, AF Consultants
The Trimble SX10 Scanning Total Station is the single must-have piece of equipment that masters surveying, imaging, and high-speed 3D scanning in one powerful solution. Two years and thousands of customers later, the reviews are in: the SX10 remains the first and the best of its kind.
Trimble
SX10
See how others are using the SX10 at Trimble.com/SX10_Stories
(c) 2018, Trimble Inc. All rights reserved.


iG8 RTK GNSS
Network Rover: $7,605
Base / Rover Pair: $14,880
Data Collector + SurvCE + Brackets: $ 1,798
Same as cash 10% down - 24 month financing on approved credit
small, lightweight, rugged, reliable
GPS + GLONASS + Galileo + BeiDou + SBAS · Any-Mix-Fix · fully enabled · 200+ channels · tracks and uses Galileo BeiDou, L2C, L5 today
Bright sunlight readable OLED panel · keyboard for quick mode selections
Dual Batteries · hot swappable ·11-hours
Connected: 3.75 GSM · built-in hotspot · Wi-Fi · http · ftp ·Bluetooth · USB · Serial · 403-473 MHz TxRx Satel UHF
27 GB high-speed static observation memory · 8-stream · direct to RINEX logging · iGage download and OPUS submittal tool
IP68 · water and dust proof · cast magnesium case ·2.8 lbs. with batteries · 2-year iGage warranty
iGage
www.iG8g.com
+1-888-450-4922


SEILER
GEOSPATIAL DIVISION
Over 70 years of Service Excellence
SERVICE/REPAIR
• GPS
• Data Collectors
• Lasers
• Levels
• Robotic and Total Stations
Toll Free: 877-330-6303
Email: servicedept@seilerinst.com
St. Louis • Kansas City
Indianapolis • Milwaukee • Omaha
http://solutions.seilerinst.com


ALLEN
Instruments & Supplies
SIMPLY RELIABLE.
YOUR TRUSTED GEOSPATIAL PARTNER IN CALIFORNIA AND ARIZONA SINCE 1969
alleninstruments.com | 800-272-0180
SCOTTSDALE | ANAHEIM | VENTURA | ESCONDIDO
Trimble. Authorized Distribution Partner
SPECTRA GEOSPATIAL

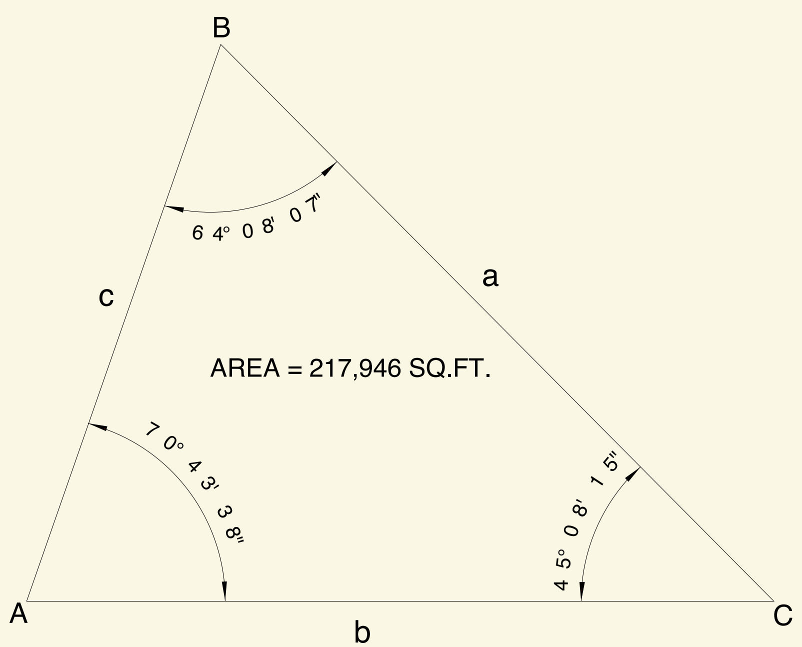
test **yourself**

Angles, areas, and...

Given the three interior angles and the area of triangle A-B-C, what are the lengths of the sides?. ■

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*.



***Lathrop,** continued from page 40*

only currently allowable form of elevation (permanent) will fail in practicality here.

What is historically significant to one may not even be of passing interest to another. What is an architectural gem to me may be dreadful, dull, or lacking distinction to you. Do the church and cemetery in Smithville, Maryland (all that is left of a former slave community) not deserve preserving because they do not meet the "integrity" standards of the state's historic preservation office? Does Little Haiti in Miami, historically significant to the community established by refugees in the 1970s, not deserve recognition by the National Historic Register merely because the minimum "50 year" standard has not been met? Who should make decisions about what and how to save our built environment?

We have lots of technical and regulatory "answers". But do we have the social ones? "Resiliency" is more than simply re-opening the grocery store and shoveling mud off the roads. Full recovery requires a sense of cohesiveness, the ability to adapt to changes together, and a firm understanding of what is most important to a community to regain the reason people want to be part of it. ■

Galveston, TX: For a visual tour of the historic recovery project 1903-1911, see *youtube.com/watch?v=6DexSKxY2Nc*

Annapolis, MD: For an overview of how one city tries to balance nature, culture, and technology, see *annapolis.gov/885/Weather-It-Together*

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.

WENDY LATHROP / PS / CFM

vantage
point

Nature versus a Sense of Place

Choosing where to settle and live is complicated, not a simple task of technical analysis and check boxes. Competing factors include affordability, convenience to work, school systems for our children, public water and sewer systems. But isn't there something about the character of a particular neighborhood that convinces us between two otherwise similar choices? Some want the close community of a small town, others prefer the liveliness of a city. Sometimes it is the physical appearance—the architecture or the presence of trees or green spaces—that attracts us.

Once we have moved in and become part of that local fabric, developmental pressures may shift the neighborhood's character away from what initially enticed us. Changes to zoning and planning are probably the most common factors altering the quality and appeal of a locale. But acts of nature play an increasingly large role in such alterations.

Back in 1900, a hurricane nearly wiped the island city of Galveston off the coast of Texas, killing thousands. Rather than move inland, the wealthy community decided to rebuild by elevating the entire island, a plan that raised the city by 8 to 17 feet, several blocks at a time, from 1903 to 1911. A new seawall added extra protection. Despite the buffer against tides and storms, however, salt water intrusion into the groundwater meant a lot of the replanted greenery did not survive.

Few areas have the dollars needed to undertake such a massive confrontation of nature. But many of our early communities are built on fill (Boston, Massachusetts; Newport, Rhode Island; Philadelphia, Pennsylvania; Annapolis, Maryland; the list goes on), encroaching into spaces water

A plaque in St. Augustine, Florida reminds us on a sunny day that not so long ago the "oldest city in the United States" was under several feet of water.

> "We have lots of technical and regulatory 'answers.' But do we have the social ones?"

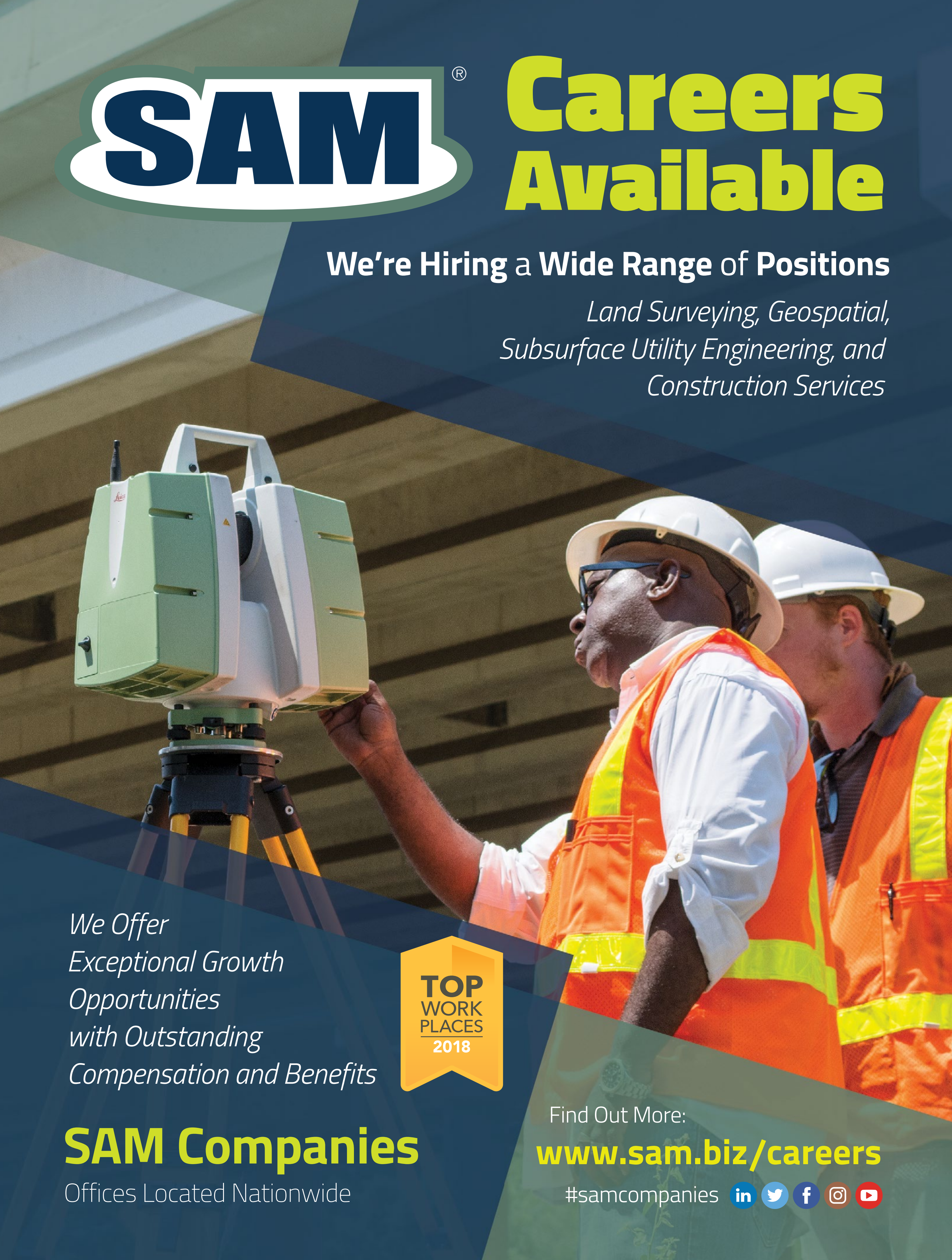
used to occupy. As we increasingly confront sea level rise, subsidence, and changes in weather patterns, it isn't just present assessments of flood risk we need to address in our mitigation plans. This is particularly important when assessing how best to protect structures we consider most valuable to protect against disasters, and often these are buildings that are historic either by their age or their role in the back story of the community. How we go about that assessment sometimes saves buildings but loses the integrity of the sense of place.

Historic preservation has generally been about keeping things (buildings and their art, fashion, or style) the same, ignoring what goes on in the streets, the people who live in the area. But people are the "why" of preservation: what makes a place important to people tips the scales in favor of rescuing one feature over another. Nature has been changing that equation.

Our laws and regulations address our built environment but don't accommodate community values. Here in the U.S., we confine ourselves to three main approaches to protecting structures from flooding: elevate, relocate, or abandon. Sometimes none of these options are particularly viable.

Consider the Pointe-aux-Chien and Isle de Jean Charles Tribes in the bayous of southern Louisiana, who have no place to go beyond their ancestral lands—subsiding land unprotected by levees, exposed by shrinking barrier islands, and subjected to increasing salinization (so no fresh water replenishes the soil) and rapid loss of solid land by erosion from marshland dredging and canals dug by oil and gas companies. Their only option is to elevate their homes, some of which have been raised as much as 13 feet. Floating structures are not insurable in the U.S., even when buoyant foundations are anchored in a way that allows them to rise with inflows and descend as water retreats. As subsidence and sea level rise continue to exact a toll on the land and threaten the roads to the mainland, eventually the

continued on page 38


SAM®
Careers Available
We're Hiring a Wide Range of Positions
Land Surveying, Geospatial, Subsurface Utility Engineering, and Construction Services
We Offer Exceptional Growth Opportunities with Outstanding Compensation and Benefits
TOP WORK PLACES 2018
SAM Companies
Offices Located Nationwide
Find Out More:
www.sam.biz/careers
#samcompanies

Introducing
NEW for
SurvCE6

Hybrid+

Survey with both
GPS & Total Station
at the **same time**

*Mix and match from the hundreds of GPS Receivers and Total Stations supported by SurvCE6

See how it works and learn the benefits at
survce.com/hybrid

Carlson Software Inc.
33 East 2nd Street ■ Maysville, KY 41056, USA
800-989-5028 ■ 606-564-5028 ■ www.carlsonsw.com

Carlson
BREAK NEW GROUND