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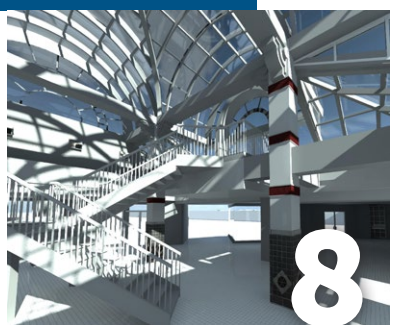

The National Landing project has provided much work for surveyors.

features

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departments

in this issue

editorial

Got Help?

We live in crazy times! Invented by the Japanese, our economy has shifted to the just in time model for supply. It's smart because it eliminates the need to warehouse parts needed for manufacture. But when something like the pandemic interrupts the supply line, havoc results. We have a worldwide shortage of a certain microchip used in car manufacturing. As a result, the big car manufacturers expect to produce several hundred thousand less units this year. Other shortages are rippling through our economy, and some things you take for granted are simply on backorder.

Likewise, the news tells us that there are several million available jobs that are going unfilled. We are hearing survey companies are unable to find employees. The latest issue of the *Nevada Traverse* contains several good articles, but one in particular, by Carl C.de Baca, PS, and titled "Poachers", caught my eye. The article is primarily addressed to companies who are angry because their employees are being lured away, but Carl makes an excellent point: *"We can debate the causes of this predicament all day, but the conclusion is always the same: we were bad boys and girls through the Nineties and Noughties. We focused on the bottom line when we should have been laying the foundation for the next generation. We were shooting ourselves in the feet back when we were too busy to pay attention to little things like training technicians or reaching out to the youth in our schools. We got busy and skipped a whole generation."*

We have agonized over this for decades, but Carl's right: any company that doesn't keep an eye on the future is in for trouble. And we're not talking about staying up with the latest technology. We're talking about investing in human capital. I'm thankful that I worked for a man early in my career who understood the need and value of training and education. He eagerly paid for me to attend seminars, knowing that, because I treated his business like it was my business, I would diligently attempt to apply what I had learned to the bottom line.

Through our partnership with NSPS and CST, we have been supporting training for years. As a magazine editor, and even though I rejected a college degree myself, I have supported the four and two-year degree requirement for nearly 25 years. Understanding some aspects of our technologies demands a degree, but we all know that advanced training will suffice for much of what we do. So, the question remains: what are you doing to ensure a steady stream of employees, both now and in the future?

In this issue

I have always shied away from theme issues because I don't want to risk having a segment of our readers find nothing they are interested in. But this issue might as well be called the GNSS issue: We continue with our series on the history of RTK, the game-changing technique we now take for granted. Frontier Precision provides the state-of-the-art in satellite-based GNSS augmentation systems. And I provide an article about where JAVAD GNSS is at after the passing of company founder Javad Ashjaee one year ago. Rounding out the issue are the contributions of our expert columnists, as well as an application article and Part 2 of how one family served the GLO. I hope you enjoy, but most of all I hope you have sufficient work and a sufficient number of employees. ■

the American Surveyor

amerisurv.com

May/June 2021 / Vol. 18 No. 3

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

Subscription prices per year, six issues: U.S. $25; Canada $50; International $75 (Airmail). Visit the website to pay online. Back issues (subject to sufficient stock) $5 plus S&H.

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JOHN PALATIELLO

the business of surveying

A Surveyor's Retirement:

Creating an Ownership Transition Plan (Last in a Series)

Too often, surveyors who own their firms wait until their 60s or 70s to begin thinking of retirement and ownership transition. Retiring and turning one's firm over to another is one of life's most important decisions. It is one that should not be made in haste or without proper planning.

It is also too frequent that surveyors fail to have an identified successor and end up simply closing the doors and liquidating assets.

For a surveyor who has spent years building a practice, creating a good reputation, and making a good living, there is more value in his or her firm than just the assets. To such a surveyor, an ownership transition plan is as important, if not more important, than a business plan, marketing plan, or strategic plan.

Here's a few facts to keep in mind—

- Nearly 40 percent of all business ventures end in liquidation;
- Up to 80 percent of a business owner's net worth can be tied up in their business; and
- Liquidation usually results in the owner getting less than 100 percent of a business's value and fails to provide a return on your investment in "good will", reputation, and client base over a period of years.

Charles Pecchio, a consultant on ownership transition and seminar instructor for several surveying organizations, believes a few basic steps are critical to the successful transfer of a firm. They include starting transition planning early (5-10 years before your planned retirement or sale), formalizing a succession plan as part of a larger business plan, and developing a written business succession plan with an implementation timetable. If you plan to implement an internal sale, to employees, a leadership development plan must be designed and implemented.

To whom you will sell your business depends on a number of factors, particularly the legal structure of your firm. If you are the sole owner the transition will be different than if you have partners, shareholders, investors, or even other licensed surveyors on staff. There is no one-size-fits-all answer to selling your business.

Many states have laws governing ownership of a surveying firm, beyond laws governing licensure as an individual surveyor. These requirements must be kept in mind when planning the sale of a firm. If you have a younger family member who is a licensed surveyor and the heir apparent, the transition can be relatively easy. If you have partners, each partner and part owner need to be part of your exit strategy, as well as their own. If you sell outside of your current employees, the sale is more complex.

There are different types of sales, but they all have financial, tax, retirement lifestyle, and family implications.

An owner can sell and get out, leaving the firm upon the sale, sell and stay on for a few years, or sell with the intent of staying for a longer term to run the firm for the new owners.

In any case, discussing your strategy with your spouse and family, accountant, attorney, business partners, and financial adviser is an important first step.

Here are a few things to keep in mind when executing a transition:

- Keep things confidential, or closely held, for as long as possible. Word of the sale of the firm could demoralize

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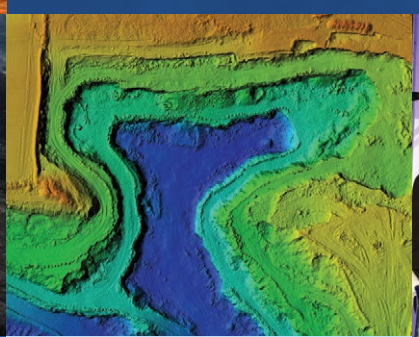

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"Thanks, But No Thanks"

The process of presenting a residential development to a local governing body doesn't often follow a smooth trajectory from proposal to approval. Sometimes even when it does seem to be on a sure course toward success, odd things can pop up to throw the developer off track.

The image accompanying this article depicts a proposal to tear down one unremarkable 1970s house and build six new homes on a two-lot site not far from my part of the same township. The preliminary plans looked good to the planning commission, especially with the open space preserved in the layout schematic. But there is one hitch: the developer wants the cul-de-sac road to be public while the township wants it to be private. There are big outcome consequences to both sides in trying to resolve the current impasse.

The proposed development is according to code and the open space is commendable, but the municipality's refusal to accept the street could sink this plan.

It is a well-known and long-established bit of real property legal lore that ownership of property runs to the centerline of abutting streets unless there is specific language to the contrary in the conveyancing documents. That is true whether a street is public or private. Then matters get a little more complex.

When the street is public, ownership still extends to the center of the street (assuming title runs that way) but it is subject to an easement for the public to use the road. And if a street is public, then not only does the public at large have the right to use it (whether the public uses it or not) but there is also a public (governmental) responsibility to maintain the road.

When a street is private, then ownership extends to wherever the title extends and there is no public right to use the street except as agreed and allowed by the owners. And maintenance is the responsibility of those private owners.

What are the implications for each side of the current situation? If the road is public, then the municipality is charged with paving, trash and snow removal, and signage. If the road is private, then the owners must fulfill and pay for these services. They will also need to negotiate with utilities as to where facilities are to be installed and then pay for the installations. Forming a homeowner's association is the usual approach to these kinds of shared responsibilities. Do they agree to share the expense of maintaining a main water line in the street with connecting laterals to be at private cost? Will they form a snow shoveling brigade or hire someone to clear the street? Should they contract with the municipality for trash removal or hire a private firm? How do they make sure everyone pays their fair share of costs? It isn't as though non-paying owners could easily be prohibited from using the road.

The developer's plan calls for the road to be built to municipal public street standards. But dead end streets are notoriously difficult creatures. Most notably, they make emergency access more difficult due to having only one way in and out, with limited turnaround space. While that point supports the municipality's refusal to accept the road, the developer's unanswered question was whether all cul-de-sacs in the municipality should be made private. I can see that translating to a claim of unequal treatment under the law and opening the possibility of litigation.

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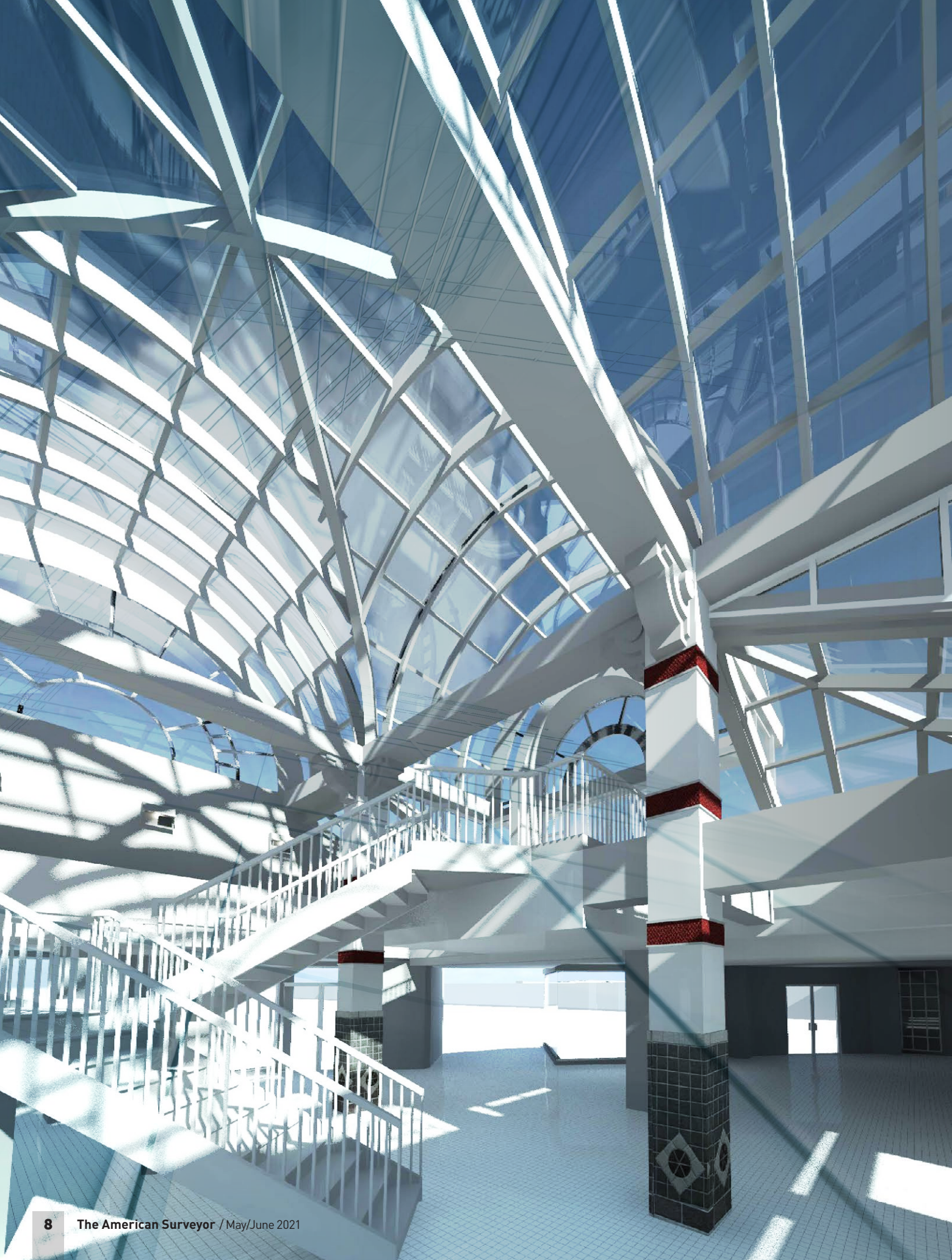


BOWMAN Spearheads Survey and Engineering Efforts on National Landing Redevelopment

The Washington D.C. area, known for its landmarks and bustling urban life, is also a hub of activity for engineers and surveyors. These experts are engaged in development and redevelopment—often at the same time.

The Crystal City area of Arlington County, Virginia is named in a nod to a prominent crystal chandelier in the lobby of the first building built in the community. It is an urban area with a dense network of commercial buildings connected by a labyrinth of underground tunnels. Since the tunnels were finished in 1976, they have been in continuous use with little change, but aboveground, the city, along with surrounding areas, is being revitalized as part of the National Landing redevelopment plan transforming Virginia's Arlington County.

A public-private initiative led by Maryland-based real estate development firm JBG Smith, National Landing is on track to be the region's premier mixed-use urban community and the largest walkable downtown in Virginia. Encompassing Crystal City and portions of Pentagon City and Potomac Yard, National Landing is a vibrant, transit-rich location overlooking our nation's capital with over 17M sq. ft. of existing commercial space and more than 150 acres of developable land. The redevelopment connects these urban districts with three Washington Metro stations, provides diverse housing options, 60+ acres of parks and green space, 150 restaurants and shops, and supports an aggressive plan for continued growth.

Bowman is a leading consultant on the project, providing full engineering design and surveying services on approximately a dozen different sites throughout the Arlington, Virginia area. The project sites include asset repositioning, complete redevelopment, and open space delivery, including green infrastructure, transit,

» OBADYAH FOORD, LS

Laser scanning is an integral part of many Bowman survey projects. With a variety of instruments in our inventory we can deploy the right scanner for any project.

In addition to scanning the pedestrian tunnels at Crystal City, Bowman has scanned and modeled over 1M Square feet of underground parking garages, building facades, landscaping and roadway corridors.

3D modeling was used to support 3D design. Revit model renderings are an excellent way to share snapshots of the 3D models.

mixed-use, and walkability components. Bowman's broad scope of work benefits the many aspects of the overall project and surrounding areas. The community will realize the many benefits associated with these projects, including conveyance of the land for future parks, committing to sustainability in construction and operation, constructing new connector roads and protected bike lanes, allocating space for dedicated transit lanes, major intersection improvements, and enhancement of streetscape and open spaces. There will also be increased access to space for businesses, driving additional jobs.

These projects provide incremental realization and fulfillment of the client's vision for a more vibrant, sustainable urban village with a better mix of offices, retail businesses, homes, and public open space, as well as improvements to the system for all modes of transportation.

"This project and Bowman's services will bring many benefits to the local community here in National Landing," said Scott Delgado, Vice President at Bowman. "Knowing that our work brings their vision to reality is motivating."

When asked how Bowman is poised to tackle a project of this magnitude, Mike Bruen, Chief Operating Officer at Bowman, credits the diversity of services and expertise of their dedicated staff. "Bowman's multi-disciplinary service offerings are supported by incredible teams of industry-leading talent who seamlessly collaborate to deliver innovative and solution-driven results without compromising on quality," Bruen shared. "With roots in the DC area, it is exciting to be part of this large-scale revitalization effort and make a difference on a project that is in our own backyard."

The Bowman team recently provided surveying and 3D scanning services for the pedestrian tunnels and much of the existing underground parking garage network, and performed significant site surveying, utility locations, and as-builts for the civil and architectural design.

Bowman developed a highly accurate GNSS and conventional survey control network to support surveying efforts including detailed field run and LiDAR topographic surveys, boundary and ALTA/NSPS Land Title Surveys, utility as-builts, construction staking, construction as-builts, and platting. For the pedestrian tunnel project, Bowman

Pandeli Stoja, PhD, A Bowman surveyor running the laser scanning field operations. Safety is paramount and woven into the Bowman culture, even within climate-controlled spaces such as these pedestrian tunnels.

> "What an honor to work alongside the respected professionals with JBG Smith to support development around Amazon's new headquarters. Our collaboration allows both firms to leverage the perfect skills and talent for success on such a large-scale project."

is surveying approximately one mile of tunnels from 12th Street through 23rd Street utilizing laser scanning (LiDAR) technology. A combination of traversing with a total station, running digital differential level loops, and collecting static LiDAR was performed to produce an as-built 3-dimensional model of the general tunnel layout below the city.

The project mapped out the precise location of the tunnels to within 1.5" and assisted with development plans for the area. The scans were done in segments, with surveyors strategically placing removable targets along the route. Bowman surveyors started their work above ground on one side of the project and worked along the tunnel corridors until an entry/exit point was reached. At every entry and exit point, surveyors "daylighted" with the field operation and tied into known control points. A methodic and planned field operation moved through the pedestrian tunnel system along the maze of tunnels. This intricate network of data collection was processed and adjusted into a seamless and accurate LiDAR point cloud. The LiDAR data was uploaded into Leica Geosystems' Jet Stream point cloud environment where multiple 3D modeling technicians could work with the data set efficiently. Bowman 3D modeling experts then commenced to generate a 3-dimensional Revit model of the tunnel system. The main general elements were drafted and included walls, floors, ceilings, columns, stairs and staircases, shop and restaurant entrances, glass partitions including mullions, and skylights.

Above ground, Bowman's survey team created design quality base maps for multiple city blocks. These efforts started a few years ago and grew to include 35 parcels with associated easements and mapping. Traditional survey methods were used in developing these design quality maps. Title reports and county courthouse records were thoroughly reviewed with the designers and land use attorneys. Then, careful effort was put into the computation and location of property corners to help define the urban parcels. Traditional instruments, robotic total stations, and GPS were all used in combination to locate physical features and create 3D maps showing major grade breaks and critical elevations. Ultimately, office and field data were melded together to create maps showing the above ground features, building footprints, easements, and elevations, all of which are certified per state code and sealed by licensed professionals.

The land surveying portion of these projects did come with challenges the Bowman team had to overcome. One of the challenges was a flight restriction zone for drone mapping. National Landing is located between the Pentagon and Washington's National Airport. Drones have become a go-to tool for larger scale mapping, but in this area are not permitted due to security concerns from the federal government. The flight restrictions effectively grounded any plans to perform survey data collection from UAV platforms.

Another obstacle overcome was defining and mapping the dense urban property system over a large area spanning several blocks. Due to decorative brick sidewalks and other hardscape features, this area is not monumented in the ground with traditional iron rods as is typical in most other places. Cross cuts, or chiseled cuts in tops of curbs are the primary places for survey ground control points or property offsets to be set and found. Due to spot utility installations or maintenance, portions of these urban curbs were replaced over time, losing this information. The solution involves conventional locations of buildings and comparison against record information, along with other found physical evidence that confirms record parcel limits.

The Crystal City pedestrian tunnels provided a great place to survey during the winter months and with low foot traffic volumes due to COVID-19.

"What an honor to work alongside the respected professionals with JBG Smith to support development around Amazon's new headquarters. Our collaboration allows both firms to leverage the perfect skills and talent for success on such a large-scale project," said Obadyah Foord, Regional Survey Director for Bowman. "We are excited to be a part of this redevelopment project that is helping to create a thriving, easy to navigate urban community."

Bowman's breadth of experience makes any challenges easier to navigate. The tunnels are open to the public and are in a high-traffic location. This can cause problems for surveyors because the laser scanning equipment needs a clear line of sight to its targets to accurately capture the data. The pedestrian tunnels were open during their field operations and many targets were knocked over or moved by patrons of the tunnels. Bowman surveyors also navigated the challenges of inclement winter weather that brought several snowfall events. Other planned area-wide events impacted the field operations, the more notable of such events was the 2021 Presidential Inauguration.

"Luckily, with the tunnel portion of the project, we can continue through the climate and poor weather conditions that caused others to shut down their sites," said Charles Powell, Vice President of Bowman. "We take the time up front to predict and think through the resolution of any potential challenges. Despite the few challenges we face, our progress has streamlined, and we are working efficiently to get this project completed on the estimated deadline date."

The tunnels are of sentimental value to many who grew up with them. Some of Bowman's employees, including Powell, recall spending time at tunnel shops and the theater as a teenager. "I grew up in Arlington and spent much of my high school years and after high school years, during the mid to late 70's, in Crystal City patronizing the underground shops and restaurants. It was a great place to hang out," said Powell. "It is surreal to know what they were then, and I am excited to now provide my expertise for renovating the tunnels."

In a massive project like this, the surveying challenges are just the beginning; the base information developed is the basis of design or starting point for Bowman's engineering teams. Accurate surveys of the underground facilities, including tunnels,

garages, and utilities, within National Landing are paramount to the success of the engineering design. Since the underground tunnel and garages extend under and across the streets of National Landing, a primary engineering challenge is connecting utilities along the street grid to ensure system redundancy when these underground elements may prevent connectivity. Buildings situated where the tunnels and garages prevent direct routes for the installation of utility services require alternative strategies and extensive planning to ensure that all elements work cohesively.

Headquartered just a few miles from National Landing in Reston, Virginia, Bowman is a leading multi-disciplinary consulting firm offering a broad range of real estate, energy, infrastructure, and environmental management solutions to both public and private clients across the country. Their more than 780 total employees work together in over 30 offices nationwide, and with clients in nearly every industry.

The thoughtful work of careful surveyors and engineers, like those at Bowman, are integral to the maintenance and creation of great American cities.

While Bowman has an extensive list of projects involving land surveying and engineering services, their breadth of expertise makes them a top service provider for complex projects like the National Landing project. Their design services encompass site design, intersection and roadway design, large utility relocation design, maintenance of traffic, pedestrian and ADA facility design, and dedicated transit lane design. Bowman teams also perform cycle track design, 5G infrastructure design, SWM, green roof and bio-retention design, topographic and boundary surveys, GNSS control surveys, UAV and terrestrial LiDAR services, full 3D and 2D plan development, ROW and easement plat development, FAA plat development, arborist services, landscape design, water network design, streetscape development, and full construction administration services. Their services also include surveying, civil engineering, MEP engineering, subsurface utility engineering, land planning, environmental consulting, construction engineering and management, landscape architecture, and right-of-way acquisition. ■

Bowman takes quality assurance and control seriously. This image is an example of verifying the inverse between control points and comparing them to the conventionally surveyed values.

Obadyah Foord, Regional Survey Director at Bowman, is a surveying team lead on this project. His areas of focus at Bowman include LiDAR and Surveying Technology. He is a licensed surveyor and is a certified mapping scientist with ASPRS.

Palatiello, *continued from page 4*

employees and discourage clients from continuing to do business with you. Never advertise or publicize that your firm is for sale and never let your name or the name of your firm be known. Use a broker or consultant to assist with your transition and insist that they require any interested party to sign a nondisclosure agreement before providing the identity of your firm or any proprietary information.

- Think of potential buyers. Are there employees who can assume the firm? Are there friendly competitors or fellow surveyors you know through your state surveyors society who have similar cultures, ethics, business approaches, or you believe would be a good fit, with whom you can discuss a deal in confidence?
- Begin developing or updating essential information about your firm—financial information, client lists, major on-going contracts and projects, an inventory of equipment and other assets, staff resumes, etc.
- Work with your accountant and bring in a consultant who knows how to do a valuation of a professional service surveying firm.

If you don't know what EBITDA is, start studying. It stands for Earnings Before Interest, Taxes, Depreciation, and Amortization and is a metric used to evaluate a company's operating performance. Some view it as a substitute for a cash flow analysis. In finance, EBITDA is used to describe the overall operating profitability of a business over a given time period. Optimally, the firm should have cash on hand and no debt when entering a sale.

While it is important that you take care of yourself in the transition, focus on the longer-term well-being of your employees and clients as well.

Finally, don't let ego get in your way. You're not indispensable. With the right successor, your firm can fly to new heights. That should be your goal. As Jim Collins pointed out in his best-selling business book *Good to Great,* a great leader is one who has enough self-confidence to set up their successors for success. ■

John Palatiello is Executive Director of Virginia Association of Surveyors, Pennsylvania Society of Land Surveyors, and Maryland Society of Surveyors, as well as national government relations advisor the National Society of Professional Surveyors (NSPS). With more than 35 years of experience assisting design firms, he is a partner in Miller/Wenhold Capitol Strategies, LLC, a public affairs consulting firm based in Fairfax, VA, providing government relations, public relations, association management, strategic planning, event planning, and management and marketing consulting services to private firms, associations, and government agencies with an emphasis on the architecture and engineering; geospatial, mapping and GIS; information technology; construction; transportation and infrastructure, and land use sectors. He has advised numerous surveying and mapping firms on transitions.

MAKING THINGS RIGHT

MISSION PLANNING AT JAVAD GNSS

Following the passing of industry icon and JAVAD GNSS founder Dr. Javad Ashjaee last year, many are wondering about the future of his namesake endeavor and some of the more recent technologies developed over the arc of his 40+ year career. From the beginning, Javad's passion consumed every aspect of the organization. It's not a stretch to draw parallels to Apple and the late Steve Jobs—a boundary-pushing multi-decade relationship between a brand and technology mastermind, beset by an untimely passing—leaving many to question whether the firm could continue innovating in the absence of its visionary founder.

In either case, the potential for derailment had far reaching consequences. Both firms held a wide array of patents and other developments in various stages; in Javad's case, products of a restless mind bent on wringing every last bit of computable precision and accuracy out of the global navigation satellite system. Still, the question remains whether the company can navigate such a juncture—what to do without Javad?

» MARC CHEVES, PS

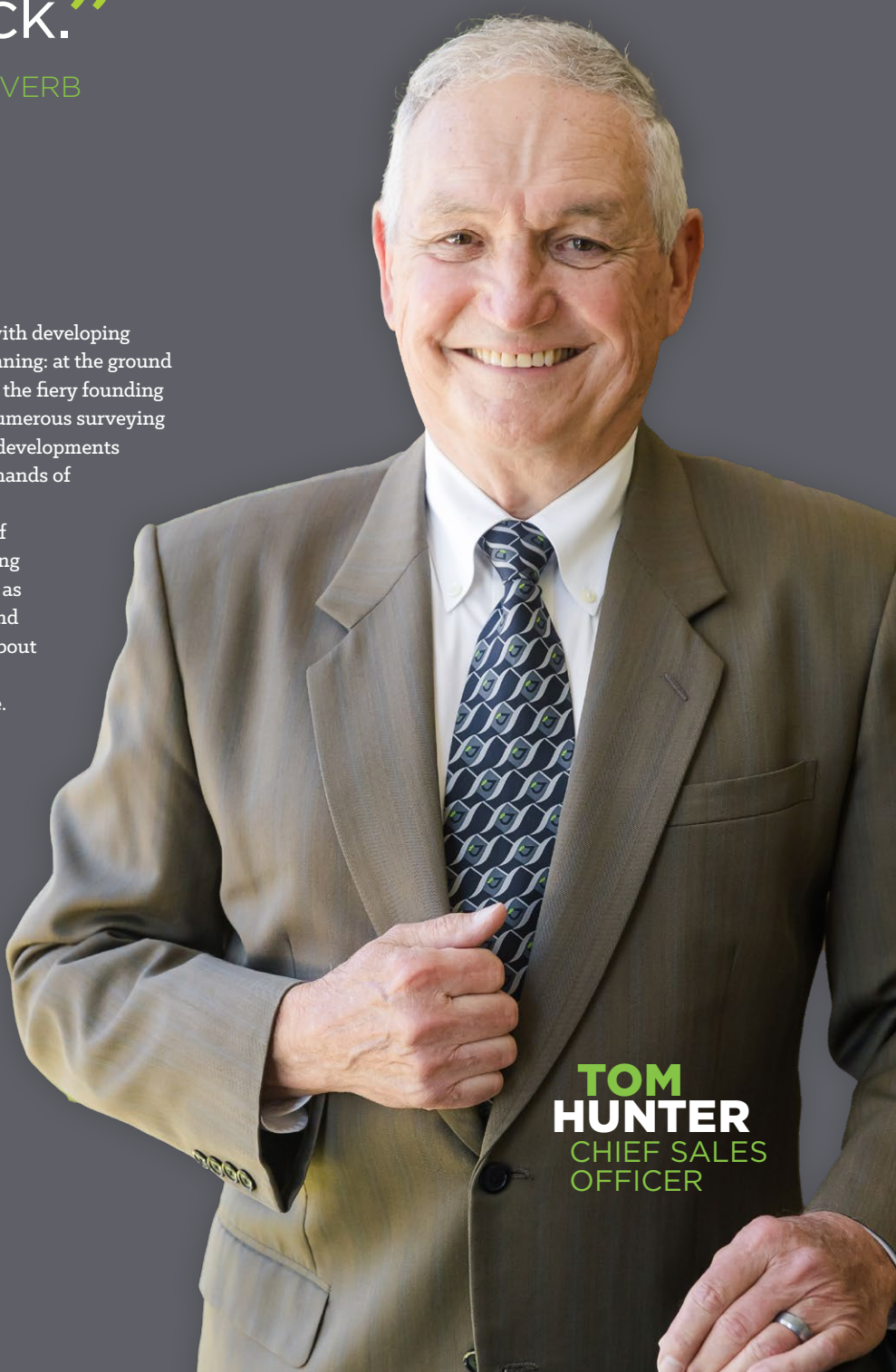
> “If you can see the path ahead of you, you’re likely treading someone else’s track.”
>
> —AMERICAN PROVERB

Succession Planning

As we’ve detailed before[1], Javad was involved with developing GPS for surveying and mapping from the beginning: at the ground level with Charlie Trimble in the 1980s, on into the fiery founding of his first namesake firm, Ashtech, charting numerous surveying industry firsts, and laying the groundwork for developments that would eventually place his designs in the hands of surveyors around the world.

Over the years Javad retained a close circle of confidants and talented lieutenants, chief among them daughter Nedda, who has taken the reins as CEO. Through multiple phone conversations and Zoom sessions we learned much from Nedda about the company’s forward plans that affect more than 200 employees in offices around the globe.

After burying her father, one of Nedda’s first action items was to put product development on a brief pause. With a 100+ person engineering operation—many personally mentored by Javad—this was important as some time had passed since the company had formally revisited its company roadmap. Of equal importance was a review of the many standing contracts and agreements. “Previously, we rarely went after anyone,” Nedda explained, speaking of potential infringements on contracts common to a global enterprise. “Good agreements prevent problems, they shouldn’t create them.”



900 Rock Avenue, home to JAVAD GNSS operations in the USA. In the heart of California's Silicon Valley, the company headquarters contains vast manufacturing facilities that run 24/7.

> "My father's curiosity was endless, something he instilled in all of us... there's always something we can enhance or do better."
>
> —NEDDA ASHJAEE

Nedda has held various roles in the JAVAD group of companies for more than 30 years (since Ashtech) and is familiar to all who conduct business with the firm. For a brief period, she departed to UCLA to acquire a Bachelor of Science degree in Biology, returned to Javad's side full-time in 1999, and subsequently acquired an MBA at Santa Clara University. By 2009 the firm had expanded in both Russia and San Jose. At the time Javad announced that "Silicon Valley was back to build," unveiling impressive OEM/board manufacturing lines, rare for a stateside operation, that have since quadrupled production.

As CEO and a proud mother of her two boys Nedda, who was born in Iowa, confided, "My father's curiosity was endless, something he instilled in all of us; that and the refusal to be satisfied with current development because there's always something we can enhance or do better."

Mission Planning

A key component of this year's restructuring involved the hire of long-time lieutenant Tom Hunter, who returned to the firm as Chief Sales Officer in January 2021. Prior to a short retirement to care for his aging parents, Tom's history with Javad goes back to December 1987 as one of seven members of the founding team at Ashtech and continuing through all three companies. Prior to joining Ashtech, Tom had an illustrious career in the aerospace and mapping industries. His company, Hunter Systems, subcontracted with Rockwell Collins, one of the first GPS satellite and equipment manufacturers.

"After a couple years," said Tom, "I realized that retirement is not all that it's cracked up to be—Nedda's offer of joining a newly built J-CORE team was too good to pass up." Nedda added, "Tom is key to our operations. I am looking forward to re-igniting this group of companies and continuing our four-decade tradition of bold innovation. Who better to do this with than the person who helped my father build the original company in the first place?" Tom will oversee sales channel development in support of an all-new market-driven roadmap developed by J-CORE.

The J-CORE team has spent the last 12 months restructuring the business plan. According to Nedda the emphasis has been on technology and innovation. A large library of patents has been generated, GNSS development has continued, and the company has an engineering team that was personally mentored by Javad.

In a virtual gathering of global JAVAD dealers, technicians, and other personnel, Nedda mentioned Walter Isaacson's biography of Einstein, one of Javad's heroes. Isaacson reveals that innovators aren't necessarily extra smart or powerful, but rather that they have endless curiosity. Javad's unique Cinderella Program that allows a user to satisfy their own curiosity by trying out a feature before purchasing it has been successful. The majority of users who try it end up buying the product.

Javad's enduring goal was to make his gear the "iPhone of GNSS." With that in mind, he once told us that he believed in the power of online sales. We argued (fancy that, for those of you who knew him) that most surveyors wanted in-person demos, questions answered and general handholding, at least when it came to robust survey systems. Javad argued that while this may have been the case 20 years ago, his vision with the Triumph-LS^2 was many years ahead, modeled in tribute of the touchscreens so many of us have come to utilize. The interface Javad developed for the Triumph was in itself unprecedented, opening a world of previously hidden commands, features, even the act of surveying itself, to any surveyor willing to make the leap. The system could be purchased directly, via the website, same as an iPhone.

The company is poised to compete in the new economy. They are signing up new dealers, the latest being in Taiwan. Virtual workshops are held the last Thursday of every month and are developing all the online tools today's customers demand. From Javad's tireless efforts to make GLONASS an everyday tool to a receiver that will do everything a surveyor wants to do, he left the company in excellent shape, ready to face the future.

"If you're a surveyor or other positioning professional working with GNSS, you owe a debt of gratitude to Javad,"

Dr. Javad Ashjaee, 1941-2020

"Those who speak of GNSS maturation show the limits of their imagination."

—JAVAD ASHJAEE

San Jose (California)-based production continues for a wide range of OEM applications, prime for strategic partnerships and private labeling.

> "If you're a surveyor or other positioning professional working with GNSS, you owe a debt of gratitude to Javad."
>
> —TOM HUNTER

said Tom. "The man dedicated his life to developing GNSS for the high precision marketplace. You can see his hand in nearly every major GNSS survey system on the market today."

He went on to say, "As we continue to develop and introduce new products in support of the surveying and reference station markets, we will use our exceptional technology and our US-based world-class manufacturing facility to focus on new OEM applications and opportunities including strategic partnerships and private labeling." Tom added, "We will expand our dealer distribution network for more global presence and establish a US distribution channel with qualified businesses."

The (unwritten) rules of the market

Those that knew Javad quickly developed a sense of his complexity, a duality born of considerable struggle and once-in-a-generation ability. Geomatics professionals are fortunate that he opted to focus his considerable talents on precision GNSS. Javad once remarked "Those who speak of GNSS maturation show the limits of their imagination." From the beginning, it was about the challenge. The world has lost a remarkable innovator although his designs live on, unencumbered and supported by a team with an intuitive understanding of the marketplace, poised to support those that utilize them. ■

Triumph-LS, Javad's 864 channel RTK surveying masterwork, the culmination of 40+ years of precision GNSS innovation.

Marc Cheves is editor emeritus of the magazine.

[1] https://archive.amerisurv.com/PDF/Professional_Surveyor_Magazine_Javad_Interview.pdf

[2] https://archive.amerisurv.com/PDF/TheAmericanSurveyor_Garner-TriumphLSReview_August2017.pdf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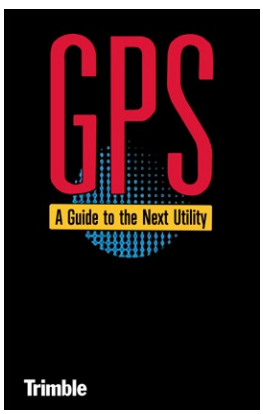
Are Satellite-Based Correction Services

the "Next Utility" for Surveyors and Measurement Professionals?



"GPS: A Guide to the Next Utility," by Jeff Hurn, published by Trimble in 1989.

GPS: The Original "Next Utility"

In the summer of 1978, I worked as a rodman/chainman for Boston Survey Consultant (now the BSC Group). My crew partnered with the engineering staff to conduct soil percolation tests for septic system design. At one point, our boss informed us he had just attended a meeting at our corporate office in Boston on the status of the GPS satellite constellation. Little was known about this technology as the first GPS satellite (NAVSTAR 1) had only been launched months earlier. He told us that within a few years you would be able to put a "magic black box" on the surface of the earth and obtain XYZ coordinates. As an 18-year-old kid, it was impossible for me to comprehend as we were in the process of locating the percolation test holes with a turn of the century K&E transit, a handheld magnifying glass to read the vernier, a Philly stadia rod for distance interpolation, and a machete for cutting line. As I reflect on this story, I realize how lucky I am to have witnessed all these measurement technology enhancements over the last four decades.

Entrepreneurs and innovators like Charlie Trimble, Javad Ashjaee and Dr. Benjamin Remondi (the father of GPS kinematic principals) capitalized on this technology. The cost for one GPS receiver when they hit the market in the late 1980s was about $100,000. Three GPS receivers, software and state-of-the-art computers were needed since most of the survey applications required GPS static survey methodology, creating a half million-dollar investment on equipment alone and resulting in only a handful of companies adopting this emerging technology. But those who did became pioneers and industry leaders.

» ROBERT L. GREEN, PLS

Illustration of RTN/VRS technology, a precursor to Trimble RTX.

Game Changer #1—Real Time Kinematic (RTK)

On December 8, 1993, GPS Initial Operational Capability (IOC) was announced by a joint venture between the Department of Defense and the Department of Transportation. On April 27, 1995, GPS Full Operational Capability (FOC) was announced by the U.S. Air Force Space Command. This event reassured both public and private stakeholders of the validity of GPS. Real Time Kinematic systems started "trickling" into the profession.

My employer at that time was Mangini and Associates in Pueblo, Colo. Having worked for the progressive thinking BSC Group, I was versed enough in GPS technology to talk company management into buying an RTK system. I felt like a spaceman with my backpack, Trimble 4000 GPS receiver, GPS antenna, whip radio antenna, extension poles, heavy camcorder batteries and cables. Early RTK receiver technology suffered from limitations. The most notable was range or distance from base station to rover. Most manufacturers RTK systems specified positioning performance as 1 cm + 1 ppm RMS HZ x 2 cm +2 ppm RMS VT. The parts per million (PPM) component plays an important role later in this article.

Game Changer #2—Real Time Networks (RTNs) and Virtual Reference Station (VRS) Technology

Around the year 2000, my company was a sub-consultant on a Colorado DOT project in Grand Junction, Colo. The CDOT Project Manager told us that Mesa County had several UHF broadcasting base stations in the area. Having used RTK since its infancy, I understood the language he gave, but the workflow was foreign to me. All my RTK experience involved utilizing my base station and my rover. How was I to trust a third-party source of correction data? After observing multiple project control points with my RTK rover via corrections from one of the local Mesa County stations, I was sold! These local stations became the foundation for the Mesa County Real Time Virtual Reference Network (RTVRN)—one of the longest operational VRNs in the country. As robust as GNSS network solutions have become with enhancements of correction data via internet protocol, they all have limitations. For one, they cover a specific geographic location that is typically geo-fenced—whether that be city, county, states or larger. Another limitation to RTN solutions is cellular coverage, no cell = no data! Yes, RTK "bridge" technology exists that incorporates cellular boosters that rebroadcast the internet-based correction via UHF. However, this requires another piece of hardware, cables, and in most cases, a designated ISP data account.

Are Satellite Based Correction Services the "Next Utility" for the 21st Century?

On several occasions during the mid to late 1990s I had the opportunity to collaborate with GIS professionals on creating survey grade GIS databases and schemas. The consultants utilized Trimble MGIS/resource-grade backpack mounted receivers and antennas with a handheld data collector. I was told that these units were OmniSTAR compliant and could receive satellite corrections from this fee structured Satellite-based Augmentation System (SBAS). Upon arrival, I would setup my RTK system and get to work. The GIS team, on the other hand, would assemble their system and then wait for almost an hour to receive OmniSTAR "convergence." Meanwhile, I had already collected a fair amount of RTK data. When we compared observed coordinate values, at best, they were within a meter or so of my centimeter RTK value.

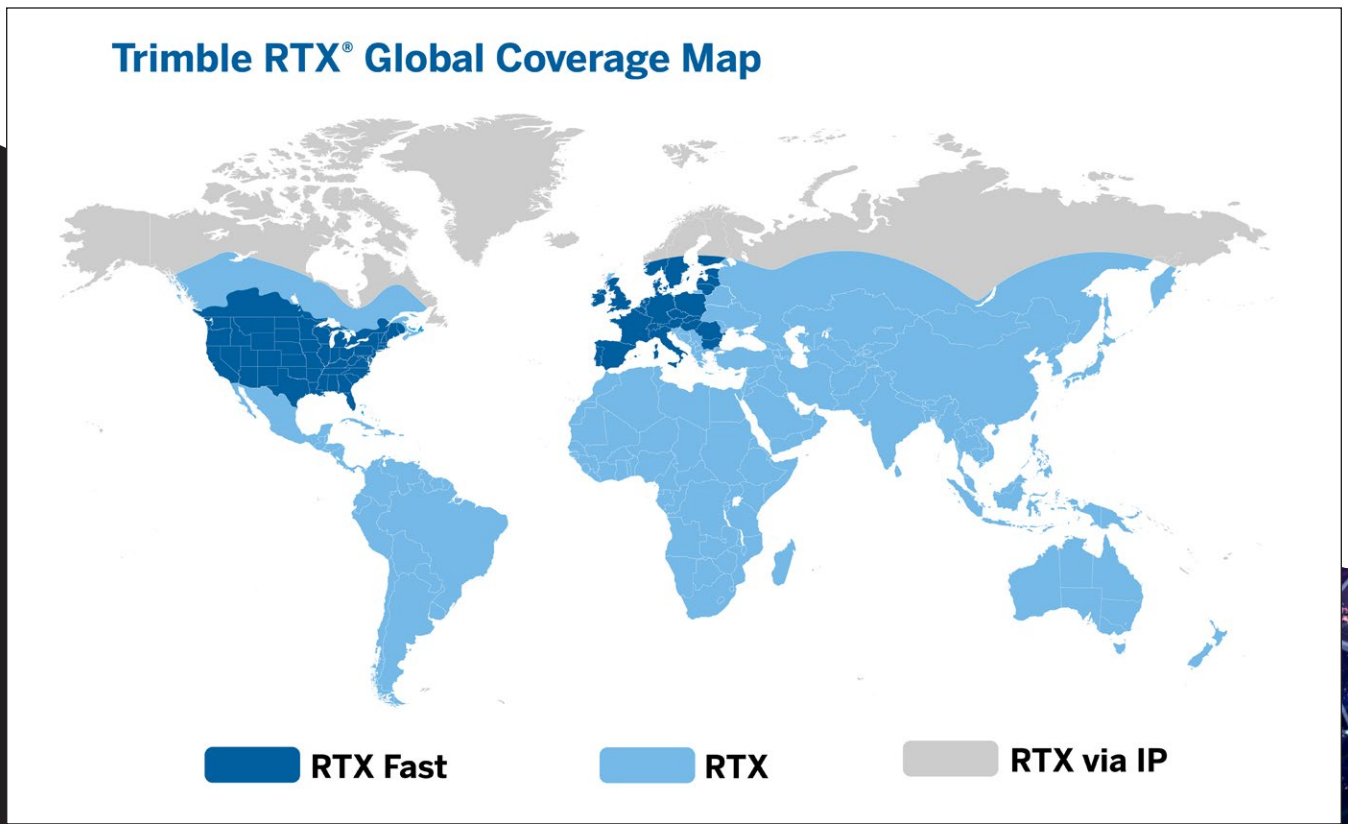
Now, fast forward to March of 2011 when Trimble Navigation acquired certain assets from OmniSTAR. This initiated a campaign of "disruptive innovation" not totally realized until May 5, 2020.

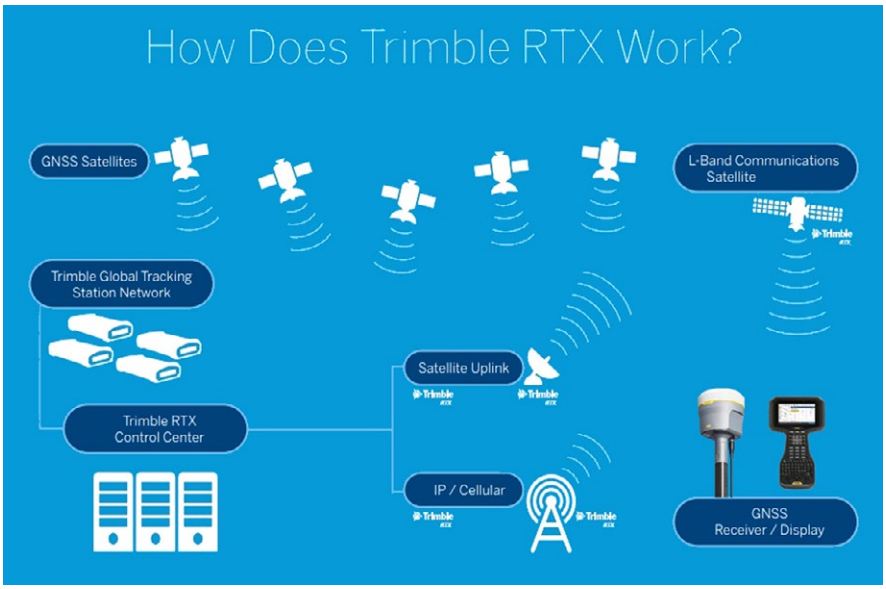
There exists a series of privately owned SBAS solutions from a variety of manufacturers (Novatel/TerraStar, EOS/Atlas, Trimble/RTX). Also, publicly available SBAS systems encompass the globe—WAAS (Wide Area Augmentation System), EGNOS (European Geostationary Navigation Overlay Service), GAGAN (GPS-aided GEO Augmented Navigation) and MSAS (MTSAT Satellite Augmentation System). Although beneficial, these publicly available SBAS solutions yield 1-2-meter accuracies at best. Trimble CenterPoint RTX (Real Time Extended) yields 2 cm (RMS) horizontal and 5cm (RMS) vertical accurate solutions in less than 1 minute. Automated transformations from global ITRF (2014) current values to NAD 83 (2011) are now performed real time in Trimble Access (TA) 2020. Additional enhancements are included in the December 2020 release of TA 2020.20. Most notably is the inclusion of plate motion deformation models. See: white paper "Deformation Models in Trimble Access 2020.20 and Trimble Business Center 5.40" at https://frontierprecision.com/wp-content/uploads/Trimble-Def-Models.pdf. In the U.S., (NAD83 2011) the Horizontal Time Dependent Positioning utility (HTDP v3.2.9) was incorporated. These new features resolve RTX to NAD83 (2011) legacy offset issues that required localization routines to remedy.

Briefly mentioned earlier in the article, on May 5, 2020, Trimble announced coast-to-coast coverage of CenterPoint RTX Fast service (less than 1 minute to convergence). All of this has happened since Q2 of 2020, which now makes RTX a "utility" that is much more than a game changer. Imagine being a large survey engineering firm with projects scattered around the U.S. or, for that matter, around the globe. All crews, regardless of location, could simultaneously work from the same correction source on the same geodetic datum with real time corrected data, all with the same accuracies! Mind blowing isn't it? This is just the beginning of an avalanche of GNSS rendered enhancements I predict will happen over the next 5 years (or less)!

How does Trimble CenterPoint RTX work?

Trimble owns and operates a network of terrestrial tracking stations strategically placed around the globe. These stations receive data broadcast by all GNSS satellites (GPS, GLONASS, Galileo, BeiDou, QZSS) and are the basis for a precise global modeling





campaign including GNSS satellite orbit, clock, and atmospheric errors. This data is then sent to the RTX control center and processed. The RTX control center transmits the processed data to two entities. One: IP/cellular. Two: the processed data is also uplinked to geostationary L-band satellites. The L-band satellite then broadcasts correction data to the end user in the field providing real-time cm level positioning without the need for a base station, UHF radio, VRS/RTN connection nor internet connectivity.

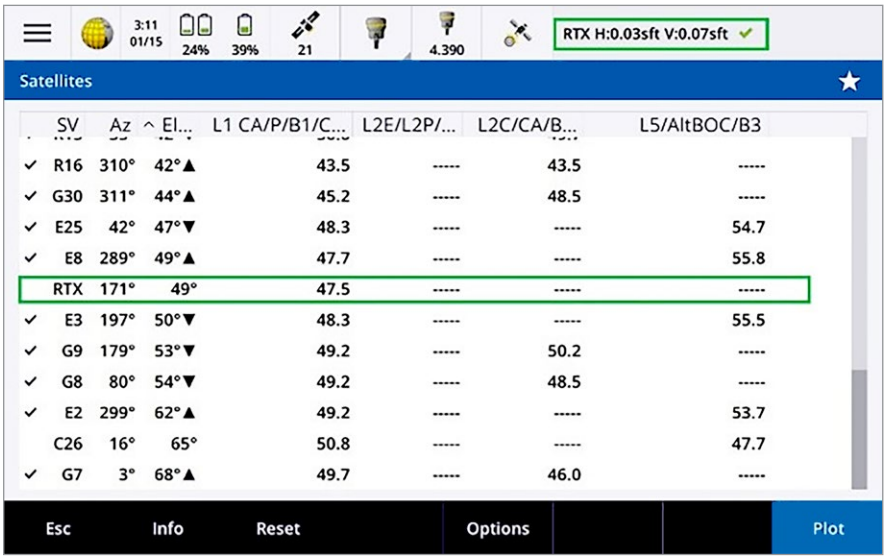
Over the past decade, as Trimble's network of tracking stations has densified, convergence/initialization times have been reduced dramatically. On May 5, 2020, the densification of these ground-based GNSS tracking stations was sufficient for Trimble to release RTX Fast service for the U.S. and parts of Southern Canada. RTX Fast service boasts less than 1 minute to converge at 2 cm (RMS) HZ. With that said, I independently tested these specifications utilizing Trimble's R10 Model 2 GNSS receiver and TSC7, Trimble Access and no cellular connection or local base. The result of using this technology in different environments, in different states and at varying times of the day was eye opening. Trimble CenterPoint RTX converged in less than a minute and met specifications. However, for even better results, I wait on average 5-7 minutes to obtain precisions of 0.03'/1cm HZ (DRMS) x 0.08'/2.5cm VT (1sigma). I chose these settings since DRMS (not RMS as in the specifications) has been the defaulted precision display in both legacy Trimble Survey Controller and Trimble Access for almost 25 years. Access 2020 gives users the option to select the job precision displays of legacy DRMS, 1 Sigma, 95% or 99% reporting. This enhancement integrates Trimble Access settings with those in Trimble Business Center as DRMS has been added to Trimble Business Center as well.

So, what's in it for me?

Trimble CenterPoint RTX yields centimeter accurate positioning. However, not all applications require these accuracies. Trimble RTX offers a complete portfolio of solutions based on accuracy specifications (to see the range of RTX performance levels offered, visit positioningservices.trimble.com/services/rtx). Regardless of the tier being used, all data collected from multiple disciplines would be rendered on the same global datum. For national, state, county and city entities, this could be huge. For the private sector surveyor, the benefits are significant considering the time saved not having to setup and breakdown a RTK base station, not counting the liability of leaving the station unattended. To validate the concept that a Trimble CenterPoint RTX solution will yield similar results to other legacy correction sources, I conducted a very basic test on one point. Prior to the December 2020 release of Trimble Access 2020.20, I utilized ITRF 2014 (2010) values in my testing. Since the recent incorporation of displacement models in Trimble Access (previously mentioned in this article), the test was conducted in NAD 83 (2011). Another point worth mentioning, as with RTK, RTX observed data renders not only HZ and VT precisions values but a full covariance matrix as well (QC2 in Trimble Access settings).

The test data consists of 4 solutions as shown in the penny diagram in this article. Point "1_NA" was calculated through a least-squares network adjustment and tied to the national CORS network to create a "standard." Point "1_RTX" is the result of a 180-epoch real time "observed control point" observation in Trimble Access with converged Trimble CenterPoint RTX. Point "1_VRS" was generated from the local Colorado-based Trimble VRS Now RTN. Point "1_OPUS" is the coordinate rendering via NGS's OPUS RS Service incorporating a 1-hour data set. As shown, all is centimeter accurate (distances are horizontal in meters). Simply amazing, all falling within the diameter of a penny!

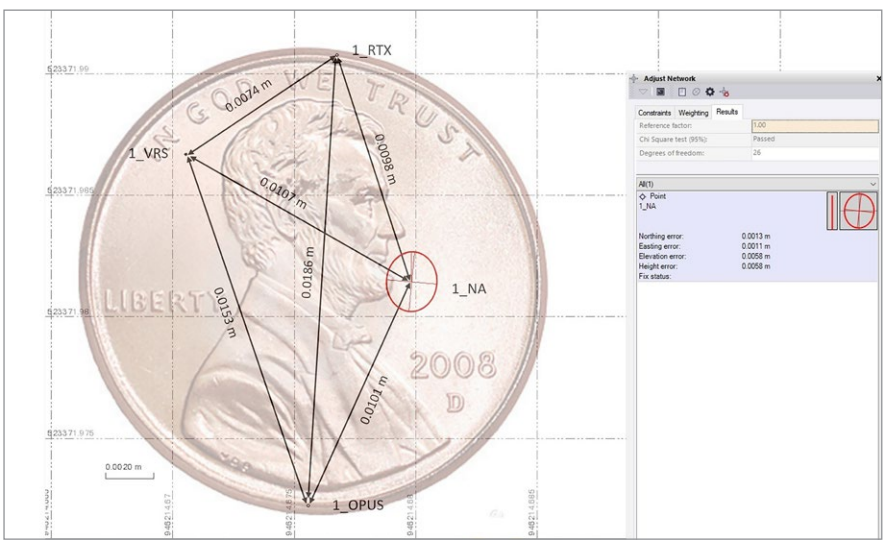
Another benefit to Trimble CenterPoint RTX as compared to traditional RTK—there is no compounding parts per million components. Depending on the specifications of the RTX receiver being used, my yearlong testing reveals that somewhere around the 3-mile mark (RTK base station to RTK rover) a threshold is met where RTX accuracies



GNSS data collection displayed from all available constellations coupled with the RTX satellite. The top right corner displays the resulting RTX accuracies.

surpass that of traditional RTK. I do realize that Trimble VRS (Virtual Reference Station) solutions minimize ppm error by localizing a correction packet, but this is not the case with RTK. For long linear jobs (pipelines, powerlines, railroads) the benefit of this technology is substantial and worth investigating.

My preferred linear project workflow would be a least squares network adjusted "static" survey of primary control, then supplemented with RTK secondary control. Unfortunately, due to time constraints, budgets and other variables, many companies opt for an OPUS and/or RTK "traverse" survey. Both options are riddled with potential problems. I witnessed a situation where a surveyor was hired to survey around 70 miles of pipeline. He chose to "leapfrog" or traverse the line with RTK, continuously compiling both RTK and PPM error. Unfortunately for him, the pipeline had minimal design grade.



Multiple geodetic solutions calculated within the diameter of a penny.

Trimble CenterPoint RTX solves most of these problems, bringing seamless accurate and repeatable geodetic control to all crews throughout the continental United States and Southern Canada. Naturally, if tight vertical control is required, a combination of RTX and RTK or differential level analysis could be incorporated as part of the project workflow and Standard Operating Procedures.

In closing, the title of this paper is a question: Are satellite-based correction services the "next utility" for surveyors and measurement professionals? After reading this article, I hope you will agree the answer is yes! This technology will continue to improve with enhancements to not only the geodesic sphere of GNSS, but also global terrestrial tracking networks, precise modeling of the atmosphere, and satellite clock and orbit algorithms. GNSS receiver and data collection hardware and firmware will continue to evolve, capture our imagination, increase productivity and so much more. Consider all your positioning solution options and remember "Measurement is a science, not the press of a button." #HowYouMeasureMatters ■

Bob Green, PLS, is a multi -generation land surveyor with more than 42 years of experience. For the past 17 years, he has provided sales, support and training for Trimble Navigation GNSS receivers, robotic total stations, 3D scanners, and lidar and survey software. Bob has been a positioning consultant to numerous government agencies including the U.S. Air Force Space Command, U.S. Marine Corps/Department of Defense, U.S. Border Patrol, Army Corps of Engineers, Homeland Security (FLETC) and NASA. Bob is employed by Frontier Precision and is a well-known public speaker and measurement technology advocate. Bob is currently working on several research and development endeavors to streamline and improve functionality to legacy geospatial workflows.

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HISTORY OF RTK—PART 2

RTK ROOTS RUN DEEP

Predecessor technologies and research breakthroughs lay foundation for precise GPS positioning

» STACEY HARTMANN

A Texas Instruments 4100, or TI 4100, which was used in early GPS surveying experiments.
SOURCE: NOAA

Left: Charles R. Trimble signs a gift agreement for Trimble's first production GPS receiver at the Smithsonian Museum, Washington, in late 1985 or early 1986.
SOURCE: TRIMBLE

When it comes to Real Time Kinematic (RTK), full appreciation of its development trajectory means never forgetting its roots, especially the predecessor technologies and research steppingstones that advanced the use of the Global Positioning System (GPS) for static and kinematic surveying.

In this second article exploring the history of RTK, we focus mostly on the 1980s to look at what confirmed or inspired further exploration of GPS for land and marine surveying and foreshadowed an intense period of development (to come in Part 3) in the first half of the 1990s as geodesists, scientists and engineers tried to build the perfect system.

Cornerstone: Using extraterrestrial systems for centimeter-level accuracy

The development of satellite geodesy would rest on the foundation of using phase differencing for high-accuracy baseline determination, such as was used with Very Long Baseline Interferometry (VLBI). GPS, which launched its first satellite in 1978, was designed to use code-based signals for real time accuracies of 3-to-5 meters horizontal and 10-to-15 meters vertical, but there was so much more potential.

Clever scientists determined they could use GPS satellites in a similar way, using two receivers to interpret its non-code signals, called carrier-phase signals, for precise measurement to the accuracy of centimeters. This was known as carrier-phase differential GPS positioning, and a host of individuals started developing software algorithms for extracting and processing that data, as well as developing techniques to improve GPS surveying capabilities.

One of those individuals was Dr. Benjamin W. Remondi, a GPS technologist for the National Geodetic Survey (NGS) who in the early 1980s began a long, productive career in static and kinematic positioning based primarily on GPS observations. His body of work over several decades included more than 50 technical papers on methods still in use today, such as the triple differencing method, the antenna exchange method, and the kinematic survey method. Researchers in the field would come to refer to him as "the father of Real Time Kinematic survey."

A USACE survey crew sets up a Raydist base station around 1980.
SOURCE: STEVE DELOACH

Dr. Clyde Goad (right) conducting a kinematic survey with another USACE employee. Goad published the results in "Kinematic Survey of Clinton Lake Dam", ASCE journal of Surveying Engineering, Feb 1989.
SOURCE: STEVE DELOACH

Meter-level positioning at sea

Prior to Remondi's research, there were also technologies that routinely used broadcast radio waves for meter-level positioning of marine vessels performing engineering and construction work in the world's ports and harbors.

One was Raydist, a marine navigation system that relied on carrier signals broadcast from land-based shore stations. In the 1940s, engineer Charles Hastings developed a method to measure the phase shift of a signal superimposed on radio waves transmitted between aircraft and a ground station. This led to the Raydist radio wave system for accurately measuring distance through continuous wave phase comparison.

Raydist was in use for hydrographic positioning and dredging when Steve DeLoach, a civil engineer and land surveyor, began working for the U.S. Army Corps of Engineers (USACE). "We had to run geodetic control along all the nation's bays, rivers and harbors to establish stations to locate the Raydist towers and had to set 'spar buoys' along the shipping channels as known points, and locate these geodetically, with multiple angle resections from shore," said DeLoach, now retired. "These spar buoys were often many miles offshore bobbing about. The boat would pull alongside, and the captain would yell 'mark' so the Raydist operator could enter the correct number of cycles from the two base stations."

As a young engineer DeLoach was dumbfounded at the Raydist system's mass of paper tape, whirling analog dials, massive ships' power systems (fire hazards), and no vertical positioning. "All vertical information was from a tide station that was miles away, therefore in significant error."

But those issues aside, Raydist represented the same type of solution as GPS ambiguity resolution, making GPS carrier-phase positioning worth pursuing for hydrographic surveying. "The method of using a known static point to 'resolve integers' is exactly what the old 1960s Raydist system did in the marine environment," DeLoach said.

Comparing Raydist and other marine navigation systems was a way to prove that GPS could actually work and provide compatible results, and those results also helped DeLoach make his case with USACE for funding in the late 1980s for a major project to develop a GPS carrier-phase positioning system for hydrographic surveying and dredging that would lead to RTK development.

"Raydist counts lanes of phase difference, and that is exactly what geodetic GPS does," DeLoach said. "It's the same basic math problems—just complicated by satellites orbiting versus base stations on the ground."

Remondi would join the dredging project team in 1989 as one of its key problem-solvers, but before that phase of development could begin, other steppingstones on the way to RTK needed to be found.

Centimeter GPS positioning on land

The Macrometer was another predecessor technology demonstrating centimeter-level accuracy in GPS positioning. In the 1980s, Charles Counselman, a physicist at the Massachusetts Institute of Technology (MIT), led the development of the Macrometer V-1000. According to a 2010 article on Counselman by MIT Technology Review, a NASA scientist labeled Counselman's invention as "snake oil" but would soon be proven wrong as it represented a new way to harness GPS by combining expertise in radio and astronomy.

Counselman proved his technology in a series of demonstrations in the early 1980s and was subsequently granted 36 patents. But while the Macrometer demonstrated extraordinary accuracy, it had downsides for everyday civilian surveying uses. It was expensive, heavy, took two people to carry, and had to be transported in a utility vehicle. Even so, it would play an important role in research on the way to more streamlined and nimble commercial GPS systems.

"Today, GPS receivers embodying Chuck's technologies are portable, inexpensive, and ubiquitous," noted a 2008 article when Counselman received the Charles A. Whitten Medal from the American Geophysical Union. "Look under the hood and you'll find many of his basic patents inside."

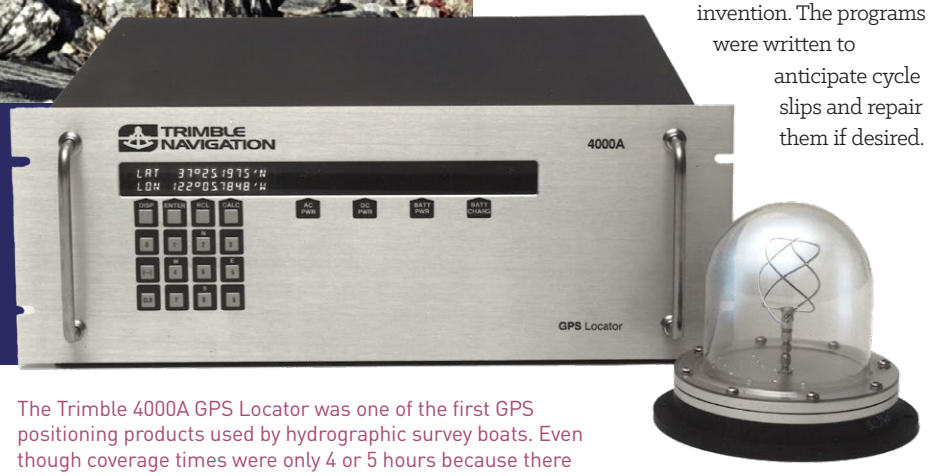
The TI 4100 in use in Alaska in 1984 (approximately).
SOURCE: NOAA

GPS data simulation for precise carrier phase data

After earlier work in orbital mechanics and software development (see Part 1), Remondi was hired in 1981 by Admiral John Bossler and Dr. Clyde Goad to work at the NGS to solve "a most important problem"—using GPS for surveying at centimeter-level accuracy.

At the time, there was no carrier data, so Remondi's first activity was to write a GPS data simulator for precise carrier phase data. During that time, Remondi recalls being given tremendous freedom as a researcher, including use of the lab's minicomputer. The combination made developing software at NGS "amazing," he said. "I had been programming by that time probably 20 years of my life, and it was always a burden. Sometimes I had to wait two or three days in the early days for a response to a program, and another two to three days to get feedback. Now, it was instantaneous. I could do two lines of code and ask it to compile and run two more lines of code. This was just unbelievable. This just super-charged me like you can't believe."

With this new computing power, Remondi wrote two software programs that could process his simulated data. One used an interferometric search method he learned from Counselman and Sergei A. Gourevitch (Miniature Interferometer Terminals for Earth Surveying: Ambiguity And Multipath with Global Positioning System, October, 1981), while the other was a triple-difference program of his own invention. The programs were written to anticipate cycle slips and repair them if desired.



The Trimble 4000A GPS Locator was one of the first GPS positioning products used by hydrographic survey boats. Even though coverage times were only 4 or 5 hours because there were only a few GPS satellites in orbit at the time, the receiver paid for itself quickly by saving time and resources.
SOURCE: TRIMBLE

There was an obsession with cycle slips, and the interferometric methods Remondi got from Gourevitch and Counselman enabled him to develop advanced computer methods to speed up the time for processing by a factor of 100,000. The triple-difference method, while considered naïve on the theory that there would be too little signal, was faster in processing, detected cycle slips and worked fine.

Collaboration and data familiarity advance RTK methods

Also, to support Remondi's initial work, Bossler approved the purchase of two Macrometers at $250,000 apiece. "They are usually $300,000 but we got them for a Sunday Special," Remondi recalled. The receivers tracked six GPS satellites, were codeless, and had weak signals, but with a small dataset provided by MIT, "miraculously, my programs worked."

Meanwhile, NGS was working with four sister government agencies to partner with Texas Instruments to develop the TI 4100, one of the first commercial GPS receivers and antennas. The TI 4100 team included excellent engineers writing simulation software, Remondi said, and he contributed timing software to their efforts. "They liked my contribution, and good relations were established."

After receiving the Macrometers, the NGS team put them to work surveying the nation. It was no small logistical and physical effort, because the receivers were heavy, required large batteries and had to be time-synced. The team had to generate orbital data in the home office and send it to the field.

"I became extremely cozy with the data," Remondi said. "I noticed that a tracking channel could get confused and switch satellites when the doppler signal was the same. The receiver would then report the wrong satellite. This was easy to fix, but it pointed to how close I was watching the data. MIT was unaware of this sympathetic tracking behavior."

Goad and Remondi shared the results of this work in 1984 in "Initial Relative Positioning Results Using the Global Positioning System."

Initialization without sitting still for hours

Also, in the 1983-84 timeframe and as part of the Macrometer testing, Larry D. Hothem, a geodesist with the United States Geological Survey, set up a test network in California with survey marks near each other. At the time, it was taking three hours at each monument to establish a position, and Remondi thought there had to be a more efficient way. He realized the long stays at each monument were to give time for the satellites to move and wondered if they should stay a couple of minutes at each site and return several times. "I did not experiment with this method right then," he said, "but I did later."

> "The antenna swap was greeted with a big 'wow' and without skepticism," Remondi said, "meaning my work was beginning to be taken seriously."

The jumping from site to site made him wonder: Could the antenna be moved from a known site to an unknown site while maintaining carrier tracking? "While I believed the Macrometers could not do this, I thought if I rotated the antenna very slowly, I could prove the point. I asked Professor Counselman if such tracking could be done. He said, no, but if there was an application, they would consider it."

By the spring of 1984, Remondi—inspired by a paper by Dr. Alan G. Evans at the Naval Surface Warfare Center (NSWC) that proved carrier tracking could be done while moving—set up a kinematic (or motion geometry) test, but it didn't work.

He learned from Texas Instruments engineers that, with an increase in bandwidth, the TI 4100 could track the carrier when the antenna was in motion. Next, he asked his colleagues at NSWC to modify the receiver's software to widen the bandwidth to 8 Hz. With this change, Remondi repeated his experiment, with field personnel carrying an antenna around a roughly square path and sending the data to him.

Antenna swapping—an awkward dance

The experiment was successful. With that proof, Remondi designed more interesting experiments to travel between known survey marks using RTK. "Those tests were not in real time yet, so we called the method 'kinematic' and not 'RTK,'" he said. "One of those experiments added the technique of swapping antennas."

It looked like an awkward dance. Picture two tripods, each with a GPS antenna, and two guys lifting the antennas carefully up over their heads so they don't interfere with the signal and then walking around each other to set the antennas down on the other tripod, and not tangling the cords in the process. "They looked silly while doing it," said DeLoach, and at some point, the antenna swap started being referred to as "the Remondi Foxtrot."

The article "Performing Centimeter-Level Surveys in Seconds with GPS Carrier Phase: Initial Results" (NAVIGATION, Journal of The Institute of Navigation, Winter 1985-1986), describes the initial tests: "The results of this experiment show that centimeter-level relative surveys can be performed in seconds. A priori geodetic coordinates of the initial location of the 'roving' antenna are not required since they, too, can be determined within seconds."

Surveying with kinematic GPS—stopping only for a few seconds—seemed preposterous to many of Remondi's colleagues. Until it didn't. One scientist eventually apologized for his skepticism, and receiver manufacturers started asking for the capability. "The antenna swap was greeted with a big 'wow' and without skepticism," Remondi said, "meaning my work was beginning to be taken seriously."

Hydrographers use the Raydist system in the Gulf of Mexico.
SOURCE: NOAA'S PHOTO LIBRARY, 1958

GPS commercial development: What can we do to keep the company going?

Alongside the scientific work of GPS technologists like Remondi were efforts by commercial GPS pioneers, including Charles R. Trimble, who founded the company in 1978 to initially focus on Loran-C, a hyperbolic radio navigation system, but in 1982 began developing receivers using GPS signals.

Unlike scientists at NGS or the Department of Defense who had access to the computer systems that tracked the GPS satellites and could develop the ephemeris data for their calculations, surveyors needed receivers that could download and understand the ephemeris, or orbital data.

In 1984, Trimble introduced one of the first GPS positioning products, called the 4000A GPS Locator, a C/A code receiver intended to replace Loran. The main users for the 4000A were hydrographic survey boats locating previously drilled holes over which to build oil platforms.

Then, on Jan. 28, 1986, the Space Shuttle Challenger was engulfed in flames 73 seconds into flight, killing all seven crew members aboard. Also lost in the explosion was a satellite to enhance coverage worldwide. It would be two more years before additional GPS satellites could be launched.

Unlike other GPS manufacturers that were able to shift to other areas of production, Trimble was invested almost exclusively in GPS. "Here was Charlie with a commercial company, and all of a sudden, the whole GPS program came to a halt because they could no longer launch satellites," said Mark Nichols, general manager at Trimble and one of the company's early RTK development leaders. "So, he turned to Ron Hyatt, who also came out of HP, and said, 'What can we do with GPS to keep the company going when there aren't enough satellites in the sky?'"

They shifted the company's focus to time transfer because it was possible to get atomic clock accuracy timing out of a GPS receiver with only one or two satellites, and also to the development of GPS static carrier-phase differential positioning for geodetic surveying.

"GPS entered into the surveying industry by virtue of Trimble looking for a commercial application after the Space Shuttle disaster," Nichols added. "And it was used initially for doing control surveys over long distances." ■

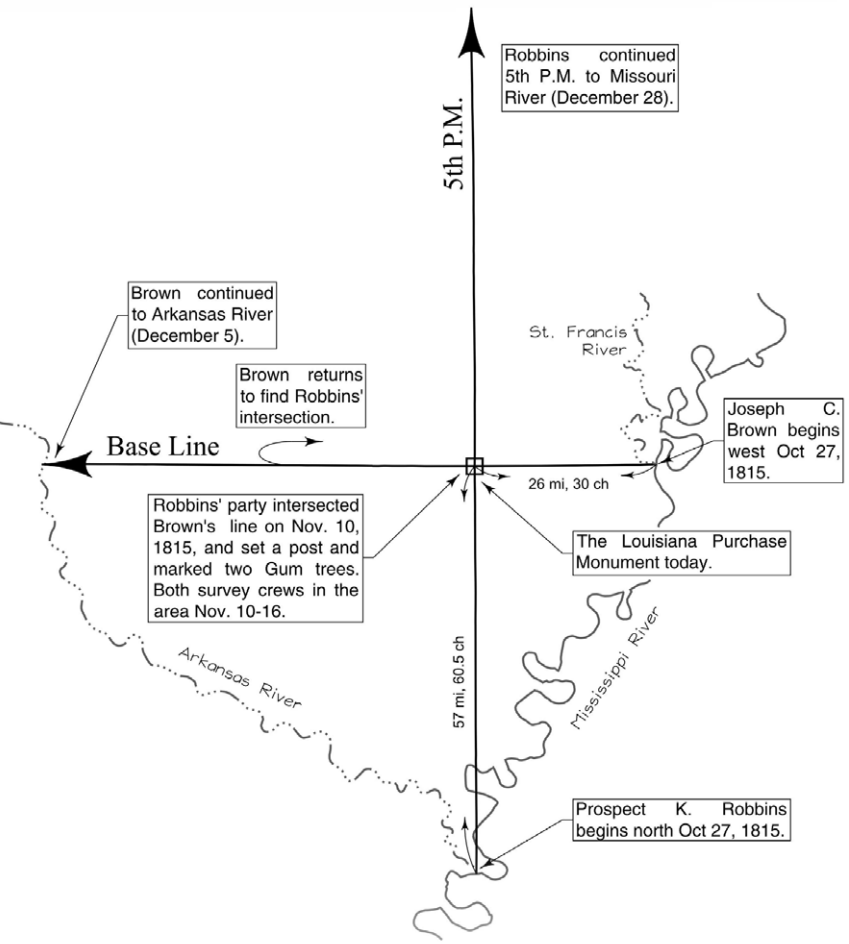
Check out our next issue for History of *RTK—Part 3*

Link to part 1: *https://amerisurv.com/2021/04/18/history-of-rtk-part-1-a-really-tough-problem-to-solve/*

Stacey Hartmann writes about surveying and geospatial topics for Trimble's Geospatial division.

SELLING AMERICA PART II

The General Land Office and the Rector—Conway Family Surveying Dynasty

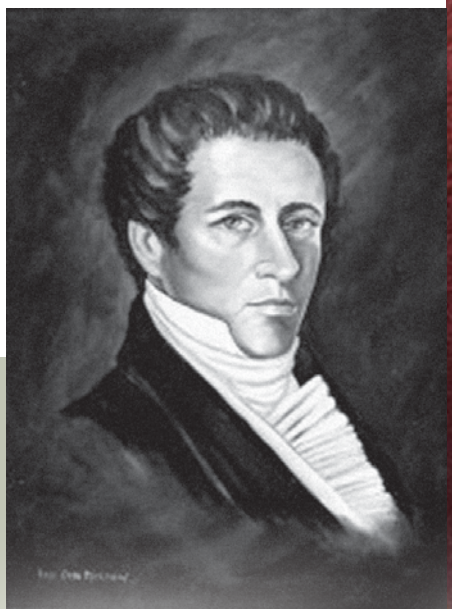


The Initial Point, being the crossing point of the north-south and the east-west survey lines of the 5th Principal Meridian.
COURTESY OF ELGIN, *THE U.S. PUBLIC LAND SURVEY SYSTEM FOR MISSOURI (2016).*

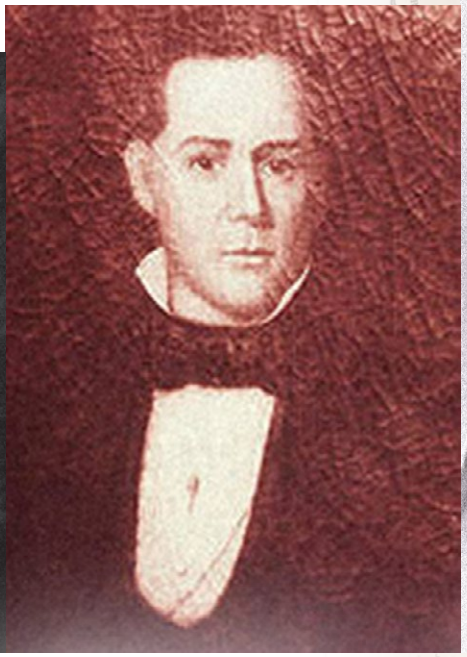
In 1816, Rector was appointed Surveyor General of the Illinois, Missouri, and Arkansas Territories when the Arkansas Territory was carved out of the Missouri Territory. Rector's position was second in importance only to the Commissioner of the General Land Office in Washington, D.C. Most of the 3.5 million acres of surveyed Bounty land in Illinois were overseen by the Rector brothers. Weather conditions and the delayed finalization of an Indian treaty prevented any surveying until late summer of 1816, but the Illinois Bounty survey was finished in 1817. In the same year, a former clerk in the General Land Office in Washington, D.C., Nicholas Biddle Van Zandt, published a booklet entitled *A Full Description of the Soil, Water, Timber, and Prairies … Between the Mississippi and Illinois Rivers.*[1] In this booklet are comments such as "rich farming land", "spoon River… beautiful stream, navigable for larger boats", "very rough, broken land", "not fit for cultivation."

All of these comments were meant to guide the War of 1812 veterans to the best land. Van Zandt's booklet goes on to describe the other remaining Illinois lands that had been surveyed. John Gardiner, Chief Clerk in the General Land Office headquarters in Washington, D.C., self-published in 1817 a map of the Illinois Bounty land surveys supervised by William Rector. It is safe to say that the Rector family were responsible for the surveys of most of Illinois by the time Illinois became a state in 1818. Their names appear on hundreds of township plats.

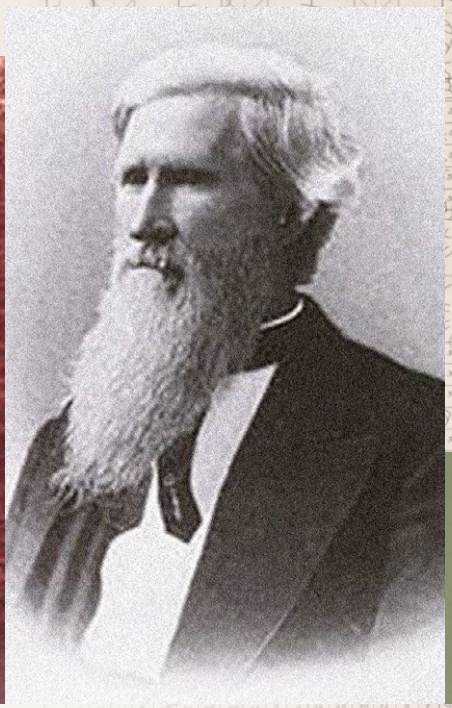
» LARRY CALDWELL



James Sevier Conway, First Arkansas Governor (1836-1840).
CREDIT: WIKIPEDIA.



Elias Nelson Conway, Fifth Arkansas Governor (1852-1860).
CREDIT: WIKIPEDIA.



Henry Massie Rector, Sixth Arkansas Governor (1860-1862).
CREDIT: WIKIPEDIA.

William relocated to his new headquarters in St. Louis after the Illinois work was essentially completed. Brothers Elias, Wharton, Nelson, Thomas, and Stephen also relocated to the Missouri Territory. The Fifth Principal Meridian was in place, and surveys began. Problems arose in Missouri because of the prior land ownership claims of French settlers in these Louisiana Purchase lands. A second problem was the massive earthquake of 1812 at New Madrid, Missouri; new lands were set aside for those settlers whose land had become unusable. The surveys of 2.5 million acres of Missouri Bounty land and new land to replace the land lost in the earthquake were completed in 1818, but it took three years to clear titles and confirm earthquake losses. The surveys of the 6 million acres of Military Bounty Land directed by Congress were now completed. Also, in 1818, William Rector's survey work was incorporated in a map of the western United States compiled by Isaac Roberdeau of the office of the U.S. Topographical Engineers. The map was signed by Josiah Meigs, Commissioner of the General Land Office. Although never published in its original 1818 format, Rector's map was cited in reduced format in Gouverneur K. Warren's 1859 *Memoir*. This report was published at the conclusion of the Pacific Railroad surveys and included a brief account of various exploring expeditions and maps that contributed data for Warren's landmark map of the West.[2]

In late 1818, the major surveying efforts were now focused on the southeastern portion of the Missouri Territory. Josiah Meigs, Commissioner of the General Land Office, wrote to William Rector:

> "The Secretary of the Treasury is desirous of having lands prepared for sale in the county of Arkansas [part of the Missouri Territory]. You will, therefore, please to cause to be surveyed about 60 townships, and subdivided as usual. If this quantity of saleable lands cannot be found in one body, the subdivided townships may be connected, by surveying the intermediate lands into townships only."[3]

Of the Rector brothers, only Elias, Wharton, Stephen, and Thomas were still active Deputy Surveyors. The next generation of Rectors and other related kin had begun to enter the survey business: Wharton Rector's sons Wharton Rector, Elias Rector, and William Vance Rector; Elias's son Henry Massie Rector and brother-in-law Lucius Thruston; Stephen Rector's son Thomas Rector; Nancy Ann Rector Conway's sons Frederick Rector Conway, James Sevier Conway, Elias Nelson Conway, Thomas B. Conway, and Henry Wharton Conway; other Rector sisters' male in-laws: Kimber W. Barton, Charles Lockhart, and Enock Steen. There were also family relatives with the names Pelham, Shields, and Sheppard. By year end 1819, 60 townships, equal to nearly 1.4 million acres of land were designated and then surveyed. Between 1816 and 1823, William Rector had hired 62 Deputy Surveyors, 12 of whom were Rector relatives. According to the Missouri Society of Professional Land Surveyors, these particular Rector contracts covered more than 5 million acres.[4] A number of the Rector Deputy Surveyors worked along the line of the important Fifth Principal Meridian, the lengthy north-south line that was established before any other surveying could begin.

In the summer of 1818, the Bank of the United States changed monetary policy.

Map showing part of the boundary between the United States and the Republic of Texas as surveyed by John R. Conway.

CREDIT: *PART OF THE BOUNDARY OF THE UNITED STATES AND TEXAS*. 27TH CONGRESS, 2ND SESSION, SERIAL 397, SENATE DOC. 199, MAP 2 (WASHINGTON, DC, 1841). COURTESY OF GEOGRAPHY AND MAP DIVISION, LIBRARY OF CONGRESS.

They demanded payment of all outstanding land notes and refused to issue new loans. Congress now demanded cash sales on all lands sold. Many persons who had purchased land on credit could not pay when their loans became due. Notes submitted by state and local banks, normally cashed by the U.S. bank, were refused. The entire banking system ground to a halt. President Monroe re-appointed William as Principal Surveyor General in 1819.

Apparently, Rector was not advised of the need to slow the surveying program. From 1816-1823, he presided over the largest surveying organization ever put together under one man, using it to survey most of Illinois, Missouri, and Arkansas during his short tenure. In Missouri alone, William issued 98 surveying contracts, 19 to family relatives. In 1821, he proposed to survey 559 Townships at a cost of $120,000. By the time the General Land Office Commissioner became aware of the program, it was too far along to stop. From 1818-1822, Rector oversaw the survey of more than 98,000-line miles. Three other Land Office Districts combined had surveyed only 123,000-line miles during the same period. In 1822, he surveyed the location of the city of Chicago. At the time, the population was fewer than 100 people. In addition to his surveying responsibilities, he was elected a director of a prominent local bank in St. Louis in 1817 and was a delegate to Missouri's constitutional convention in 1820.

General Land Office Establishes More Regulations

William Rector was due to be reappointed to his position again in 1823. Missouri Senator David Barton, who chaired the Senate Committee of Public Lands and whose family were political rivals of the Rectors, brought charges against William for hiring so many relatives and personal friends. He also charged William with not managing the contracts closely. It was a lucrative system for certain senior surveyors, and no rules prevented it. During the 1816-1823 period, Surveyor General Rector would secure a project budget from the General Land Office. He would then hire his Deputy Surveyor family members and friends with a lesser budget, and the Deputy Surveyors would hire the crews with an even lower budget. Surveyors were traditionally paid by the number of acres surveyed. There were clearly some instances of shoddy work, but few complaints were lodged. The practice of hiring friends and family continued, and the dynasty continued to thrive and expand. The Rector-Conway families produced a total of 22 Deputy Surveyors who worked

in Arkansas starting in 1815. There were almost certainly more family surveyors participating in the surveys of Missouri. President Monroe re-appointed William Rector to his Surveyor General position. But while William was still in Washington, D.C. defending himself, St. Louis newspapers began printing slanderous articles about the Rector dynasty. William's brother Thomas determined that Senator Barton's brother was the source for these articles. Thomas challenged him to a duel on Bloody Island in the Mississippi River off St. Louis and killed him. The St. Louis population was horrified. In early 1824, President Monroe then revoked William Rector's position. William's dismissal was probably part politics, part jealousy, and part oversight failures. The practice of subcontracting was ended. Rector retired and died a year later.

Missouri, Arkansas, And New Mexico Territories: The Dynasty Ends

Four more family members rose to senior survey positions after William's passing. Second-generation Frederick Rector Conway began his working career as a Deputy Surveyor. He left the General Land Office organization to pursue other interests. Later on, he became Recorder of French and Spanish land claims in Missouri, Arkansas, and Louisiana. In this capacity, he was one of three Commissioners who arbitrated these claims. But he returned to surveying when appointed Surveyor General of Illinois and Missouri from 1845-1849, a senior position in the General Land Office. James Sevier Conway, brother of Frederick Rector Conway, began his career as a Deputy Surveyor, then advanced to Surveyor General of Arkansas from 1832-1836. He was then elected the first Governor of Arkansas in 1836. Henry Massie Rector, a first cousin of brothers Frederick, James, and Elias (See Elias below.), served as a U.S. Marshall, then Arkansas State Senator 1848-51, Surveyor General of Arkansas 1853-1857, Arkansas Supreme Court Justice 1858-59, and sixth Governor of Arkansas in 1860. William Pelham, brother-in-law of Fredrick Rector Conway, served as Surveyor General of Arkansas from 1841-1849. He became Surveyor General of New Mexico from 1854-1860. Conway, Arkansas, a city of 750,000 people, was named for James Sevier Conway.

Other Rectors and Conways held survey positions early in their careers, but most moved on to pursue other careers and political offices. The importance of surveyors made new careers and political offices possible for those eager to assume them. Elias Nelson Conway, brother of Frederick Rector Conway, also began his career as a Deputy Surveyor, moved on to Arkansas State Auditor and became the fifth Governor of Arkansas in 1852. Henry W. Conway was a Territorial Congressman, Postmaster of St. Louis, and General Land Office Receiver of Public Money. William B. Conway became an Arkansas Supreme Court justice. Ambrose Sevier, another first cousin of the Rectors and Conways, became a U.S. Senator from Arkansas and oversaw the General Land Office Register. Of course, not all family members leaving the surveying business achieved high office.

Final Observations

Americans were eager to move beyond the Appalachian Mountains to the lands of the Northwest Territory and the Louisiana Purchase. Americans were dedicated to making a better life for themselves and their families on the frontier. Surveying was a well-respected occupation in the 18th and 19th centuries because of its technical nature and the demand for new land as a new beginning for American families.

There was no doubt that the operations of the local Land Offices were manipulated for the benefit of insiders as well as providing land for the general population. Insiders included not only the employees of the Land Offices, but also local politicians. They identified the best lands, and they had the ability to buy these lands. They also had the ability to purchase defaulted notes from the original landowners at bargain prices. Some senior surveyors used their surveyor status to obtain high political office, securing influence and status. But, the Dynasty accomplished much. The states of Illinois, Missouri, and Arkansas comprise nearly 120 million acres. The Dynasty surveyors probably oversaw the surveys of as many as 30 million of those acres. The sheer manpower brought to the task of surveying these millions of acres was daunting. Its members helped to complete this task, but anti-nepotism rules were later imposed on the Surveyors General as the land survey system matured. The Dynasty phenomenon was not likely to be duplicated in any case.

Author's note: *Larry Caldwell is a collector of maps showing the progression of the settlement of America. Several years ago while researching his family roots, he came across the Rectors and Conways. His great-great grandmother married Frederick Rector Conway in 1859. A longer version of this article was published in the 109 Winter Issue of* The Portolan—Journal of the Washington Map Society. ■

Larry Caldwell is a collector of maps showing the progression of the settlement of America. Several years ago while researching his family roots, he came across the Rectors and Conways. His great-great grandmother was married to Surveyor General Frederick Rector Conway.

Endnotes

1 Nicholas Biddle Van Zandt, *A Full Description of the Soil, Water, Timber, and Prairies of Each Lot or Quarter Section of the Military Lands Between the Mississippi and Illinois Rivers* (Washington, D.C.: Printed by P. Force, 1818), passim.

2 Gouverneur K. Warren, *Memoir to Accompany the Map of the Territory of the United States from the Mississippi River to the Pacific Ocean: Giving a Brief Account of Each of the Exploring Expeditions since A.D. 1800, with a Detailed Description of the Method Adopted in Compiling the General Map* (Washington, D.C.: 1859), p. 23 and plate 2.

3 Letter from Josiah Meigs to William Rector, July 20, 1818, reproduced in Carter, vol. 15, p. 417.

4 Steven Edward Weible, "GLO Subcontractors, Sub-Deputies, and Assistant Surveyors," posted December 2016, on *Etienne Hayseed*. http://atnhayseed.blogspot.com/2016/. Accessed July 14, 2020.

Lathrop, *continued from page 6*

The concept of "offer and acceptance" for the dedication of roads sometimes gets sticky when we surveyors look at recorded subdivision plans that show streets. Mere depiction of a platted road generally does not mean that it has been formally dedicated (unless jurisdictional law says it does). Not only must there be an offer, but there must be an acceptance on the part of the entity on which the responsibility is to be bestowed. So merely showing this developer's proposed dead end street on a recorded map is not an option.

On the other hand, once an offer is made and actions by the intended recipient indicate acceptance, whether a deed is filed or not, dedication *has* occurred. A 2019 case (*Prout v. Dept. of Transportation*, Docket Number C076812) addressed such a situation, in which landowner Loren Prout lost his claim of inverse condemnation against the California Department of Transportation (Caltrans) for its use of a strip of land along a state highway without compensating him. The Court of Appeals pointed out that Prout had obtained an encroachment permit for his development in exchange for an agreement to dedicate the now-disputed strip to Caltrans.

Prout had, in fact, shown this area on his subdivision map as "In the Process of Being Deeded to Caltrans For Highway Purposes" to comply with the permit requirements—but no deed was ever signed or recorded. Caltrans eventually acted on the platted offer of dedication by physically occupying the strip for highway improvements (the time it took between platted "offer" and Caltrans' action was one of Prout's arguments against dedication). The combination of Prout's platted offer to dedicate with actions by Caltrans that amounted to "implied acceptance" (as opposed to "express acceptance" in a recorded document) convinced both the lower and upper courts to prevent revocation of the offer. The moral of that story Is that getting both sides of the dedication transaction committed to writing – and in the public record—keeps things clear and out of court. ■

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.

DAVE LINDELL / PS

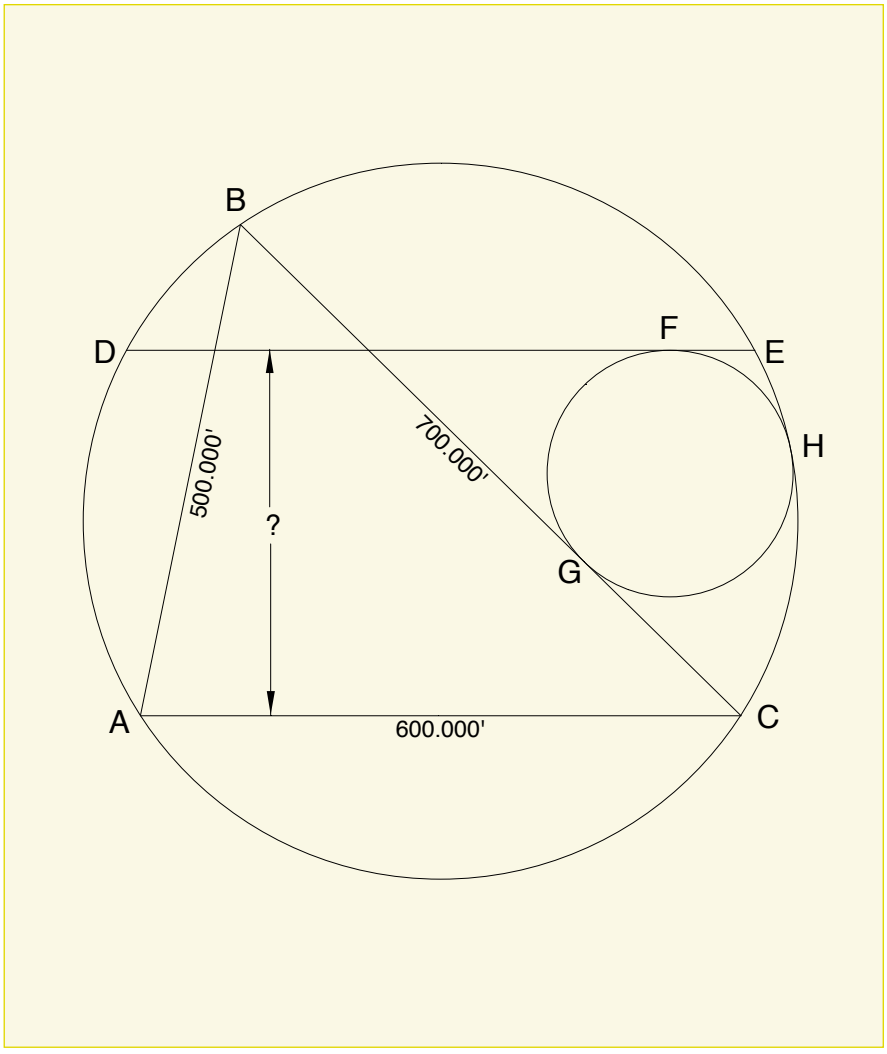
test yourself

XYZ

The small circle of radius 123.000' is tangent to the inscribed triangle ABC at G, the circumcircle at H, and line DE, which is parallel with AC, at F. How far apart are lines AC and DE?. ■

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*.



Demma, *continued from page 40*

including stories about unresolved personal disputes between family members, the names and purported addresses of at least 85 members of the Wrightfield and Jones families could be ascertained.

It was a given that not all of the members of the Wrightfield and Jones families were known, or whether they all were even living or dead, and then there is always the possibility of illegitimate children, whom no one wanted to acknowledge. Many known family members were scattered around the country, and were found to be located in various Maryland counties and cities, but also in the District of Columbia, Florida, Michigan, Nevada and Texas.

Except for a couple of small estates having been opened for a few deceased family members, solely for the purpose of transferring automobile titles as required by the state motor vehicle administration, no regular estates had been opened, thus making it next to impossible to completely and actually determine the genealogy of the respective families.

By modern day inheritance laws, each one of the 85 known members of the Wrightfield and Jones families, and all those unknown who could possibly trace their respective ancestry back to either Molly or Agnes, would legally own a small real property interest in the Wrightfield Cemetery were named in the complaint as defendants—that would, of course, include grandchildren, great-grandchildren, "long-lost" nephews, nieces, and cousins, *etc*. It was a certainty that there were many unknown descendants of Molly and Agnes who could not be identified, and therefore the number of persons who may have had some remote real property interest in the Jamaica Cemetery was certainly far greater than 85.

As a result of a boundary survey of the Jamaica Cemetery, 40 grave sites were identified, with not all of them being marked by monuments, and with many of the inscriptions being worn out by age and therefore were incapable of being read; and by observable ground depressions, it was obvious that there were other grave sites which were unmarked.

After the collection of the available evidence, a complaint to quiet the title to the Jamaica Cemetery was filed in the local circuit court, requesting that the fee simple title be ordered and decreed to be vested in Gordon Wrightfield, by the common law doctrine of adverse possession. Included as attachments to the complaint were verified releases which were obtained from a few of those members of the Wrightfield and Jones families who were willing to quitclaim to Gordon any and all of their respective interest in the Wrightfield Cemetery which they may have acquired by the laws of inheritance.

As required by various rules and statutes, service of process was achieved on all of the known defendants by personally serving upon them a copy of the complaint, along with a summons; or by certified mail, return receipt requested, when an address was known; and on the unknown defendants by posting a court ordered notice on the courthouse bulletin board, and by publishing the notice for three (3) consecutive weeks in a newspaper of general circulation, and by posting the same notice on trees in conspicuous places on both "Molly's Parcel" and "The Jones Burying Ground."

> "Much of the evidence [of adverse possession] concerned... picking up beer cans and condoms..."

The named defendants in the complaint included all of the known persons who had been identified by research in the public records, and their addresses derived from the families' oral histories; and included in the complaint were all of the unknown heirs, legatee, devisees, spouses, estates, personal representatives, testate and intestate successors of Molly and Agnes, and **all other persons who may be claiming any interest in the subject properties**.

During the litigation Gordon died and his widow was appointed as the personal representative of his estate, and thereafter she was substituted as the plaintiff in this case. Default judgments were entered by the court against all of those persons who had not responded to the complaint which had been served upon them in the manners as described above, and judgments were also entered against those defendants who had been personally served and had responded, but who did not appear in court on the day of the trial.

For all of the many persons who had been identified in the complaint as defendants, and who may have had some real interest in the subject properties, only two (2) appeared on the day of trial!

Much of the evidence concerned the manner in which Gordon and his father had taken care of the properties as if they were their own, by paying all the expenditures for the upkeep of the Wrightfield Cemetery, shoving snow, cutting the grass, racking leaves, removing fallen tree branches, cutting back the shrubby, getting rid of nesting bees, chasing off trespassers, picking up beer cans and condoms left after late night partying in the cemetery, paying the real estate taxes each year, cleaning up the grave sites and the funerary objects, setting a fire to burn down a dilapidated structure on the property, repairing the boundary fences, and giving permission to certain family members to have the remains of their deceased relatives buried in the Jamaica Cemetery, *inter alia*.

During the one (1) day trial, nine (9) witnesses testified as to their personal knowledge of the Jamaica Cemetery, including how and by whom it had been maintained; and as to their knowledge of the relationships between the members of both the Wrightfield and Jones families, The court's opinion and order was entered four (4) months later, declaring that Gordon's widow, as his personal representative, possessed the absolute title and ownership, **in fee simple**, to the Wrightfield Cemetery, which included both Molly's Parcel and the Jones Burying Ground.

Thus, after many decades of uncertainty as to who actually owned this small piece of real estate, with its ownership being somewhat in limbo, the title had been cleared by an action to quiet title with a final court order declaring that Gordon's widow was the legal owner—such an action being a very useful remedy to be used when one is in doubt as to the true owner of real property.

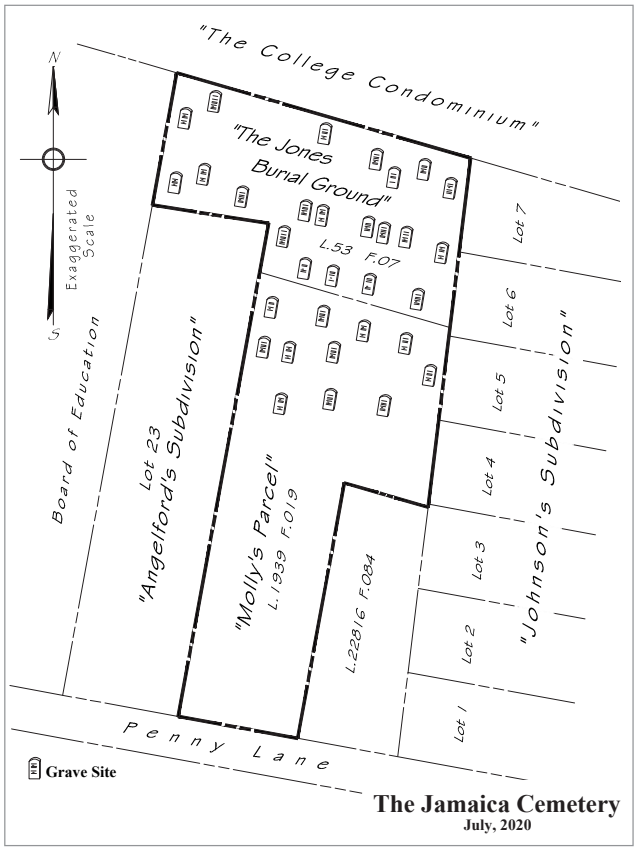
If any of the readers of *The American Surveyor* have any questions or comments about how the title to real estate can be made more certain, please do not hesitate to contact me at jdemma@milesstockbridge.com ■

Jim Demma is a Maryland licensed professional land surveyor and has practiced law in both the State of Maryland and the District of Columbia for more than 30 years. His extensive practice has included land use & development, real estate contracts and titles, condominiums, easements, land patents, boundary disputes, and all matters that touch and concern the land.

surveyors & law

Actions to Quiet Title

After my long hiatus from writing for *The American Surveyor*, its publisher, Marc Cheves, has persuaded me to again start contributing articles to this fine magazine. I put a lot of thought into what subject I should start out with, and I thought that the topic of quieting title to real estate—otherwise known as "an action to quiet title," should capture the interest of many of its readers, and especially the land surveyors.



The process known as "quieting title" is necessary when the ownership of a parcel of land is in doubt. Sometimes attorneys, title examiners and surveyors often find that the title to a parcel of land is not clear and confusing from an examination of the public records, and therefore the ownership may be in dispute; and when such a doubt exist the law provides a judicial remedy for property owners to have determined the true ownership of the real property at issue.

Suits to quiet title are the traditional remedy to clear titles of certain defects; however such suits are likely to be complicated, time-consuming and expensive, especially when notices by publication and posting are necessary, and they can seldom be conducted to a conclusion in time to satisfy an impatient client.

In addition to curing title defects, by way of examples: unreleased mortgages, abandoned roadways and forged instruments in the chain of title, a quiet title action can be utilized to endorse a claim of adverse possession, providing that all of the elements can be met.

Without spilling a lot of ink on the pages of this article with legal quotes and citations from pertinent cases, I thought that the best and easiest way to describe the process by which disputed titles can be cleared of its "clouds" is to review the legal process of one actual case, without giving public exposure to all of the facts and the actual identity of the people involved.

That one such case arose when a certain Gordon Wrightfield approached his attorney seeking help to acquire a "deed" in his own name for an area of land which he and the community considered to be his family cemetery, and which Gordon alleged that he and his father before him had been maintaining it as their own for more than eighty (80) years, although the "record title" was in the names of others.

The cemetery, known as the "Jamaica Cemetery," actually consisted of two (2) adjacent parcels of land, the total area of which being approximately one (1) acre. One of the parcels was owned ***of record*** by Gordon's grandmother, Molly Wrightfield, who had acquired that parcel in 1939, and who died *circa* 1961; and the other parcel was owned ***of record*** by an Agnes Jones, who had acquired the property in 1887, and who died *circa 1923*.

Both Molly and Agnes died intestate—meaning that they had each died without leaving a last will and testament to be probated; and Molly's parcel was simply referred to in the neighborhood as "Molly's Parcel," and Agnes' parcel was simply referred to as "The Jones Burying Ground."

All of the available public records were examined by the attorney, *i.e.*, those records maintained by the land and wills offices, the law and equity filings, the taxing authorities, the plat records, and the state archives; and with many interviews being conducted with certain family members, all of whom had ancestors buried in the Jamaica Cemetery going back into the early part of the 19th Century

After listening to many antidotal stories about family relationships, lore and tales,

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GNSS AND RADIO/MODEM SOLUTIONS

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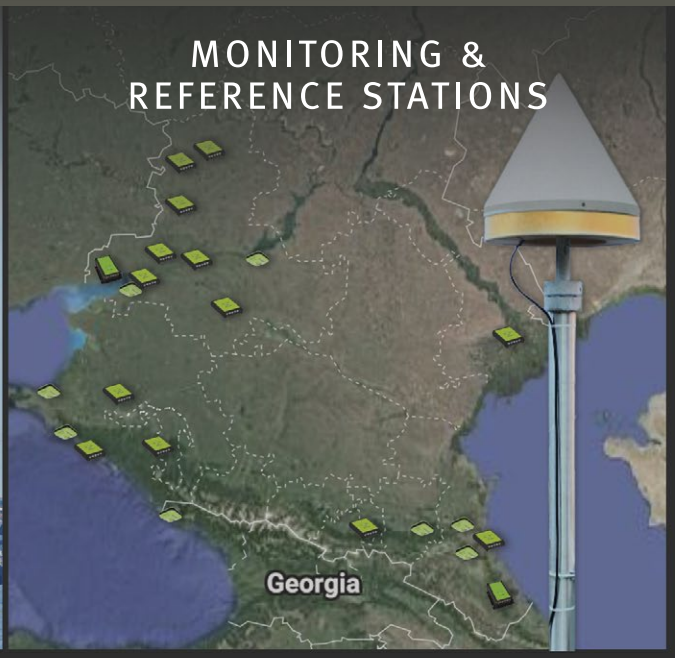

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