

Spring 2026

THE

# NEBRASKA Surveyor



**In this Issue**

Honoring Surveyors Who Served .....7  
IOOF Headstone Project Starts at  
Greenwood .....9  
2026 Summer Seminar Flyer .....11  
What Are (And Aren't) Relative Error  
Ellipses? .....14  
The Duct Tape Principle .....17



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Josh Borchers, Treasurer (2025-2026)

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John Howell (2025-2026)  
Mike McNaney (2025-2026)  
Casey Sherlock - State Surveyor

## 2026 Advertising Rates

### Display Ads per Issue

**\*\* Sustaining Membership (\$500 annual dues) includes 1/4 page ad and exhibitors fees at the PSAN annual and summer conventions.**

### Professional Business Card Directory

Size of Ad	Sustaining	Reg. Rate
Quarter Page	**	\$50
Half Page	\$50	\$100
Full Page	\$100	\$150
Full Page Inside Cover	\$150	\$200

\$25/4 Issues - members only.

### Classified Ads

\$0.25 per word.

### Advertising Information

- All ads must be submitted as black & white or color in digital (PDF or JPEG) format or an additional charge will be made for set-up.
- Payment must accompany the advertisement request.
- All ads must be professional in nature.
- PSAN reserves the right to reject any advertisement of whatever nature, without cause.
- Published quarterly - Winter, Spring, Summer, Fall.

Editor: Gwen Bowers at 402-432-3444  
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# THE NEBRASKA Surveyor

## Spring 2026

### Contents

President's Letter .....	4
Summary of March 27, 2026 PSAN Board Meeting Minutes .....	5
NSPS Director's Report .....	6
Honoring Surveyors Who Served .....	7
IOOF Headstone Project Starts at Greenwood, as 100-year-old Burial Plot Will be Improved .....	9
2026 PSAN Summer Seminar Flyer.....	11
What Are (And Aren't) Relative Error Ellipses? .....	14
The Duct Tape Principle.....	17
Get Kids Into Survey Colouring Page .....	20
Sorting Signal From Noise: Enforcement Triage Through a Public Member Lens .....	21
Trimble Tech Enables cm-Accurate 3D Model of Disappearing Glaciers.....	23

### Professional Surveyors Association of Nebraska

*The Nebraska Surveyor* is the official publication of the Professional Surveyors Association of Nebraska (PSAN). It is published quarterly: Winter, Spring, Summer, and Fall. All issues are published on the PSAN website. Material published is not copyrighted and may be reprinted without written permission as long as credit is given.

Articles and columns appearing in the publication do not necessarily reflect the viewpoint of PSAN, but are published as a service to its members, the general public, and for the betterment of the surveying profession. No responsibility is assumed for errors, misquotes, or deletions as to its contents.

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***The Nebraska Surveyor***  
deadlines to submit  
content for publication:

**Winter:** February 15  
**Spring:** May 15  
**Summer:** August 15  
**Fall:** November 15

# President's Letter

June 2026

I hope all had a productive spring. More rain would have been nice. I don't remember a time when I saw so many pivots running in early May.

The summer seminar is set for June 25<sup>th</sup> in Crofton. I've personally never attended a summer seminar with an outdoor event but am planning to do so this year and I am looking forward to it. Hopefully the weather cooperates.

Enjoy your summer.

Sincerely,



Brian J. Foral  
PSAN President

The advertisement features a photograph of a surveyor in a field, wearing a yellow safety vest and a hard hat, holding a surveying instrument. The text "COMPACT DESIGN, POWERFUL PERFORMANCE" is overlaid in large, white, bold letters. Below the photograph, a red banner contains the text "The compact Leica GS05 GNSS smart antenna is loaded with advanced technology you can trust, including tilt compensation - all without weighing you down." The Leica GS05 antenna is shown in a close-up at the bottom of the banner.

**COMPACT DESIGN, POWERFUL PERFORMANCE**

The compact Leica GS05 GNSS smart antenna is loaded with advanced technology you can trust, including tilt compensation - all without weighing you down.

**Don't forget to check out the PSAN website**

— [nebraskasurveyor.com](http://nebraskasurveyor.com)

We would **LOVE** if you'd submit pictures from the field or articles to add to the website, etc.

The goal is to keep the website updated with information that's important to you! The website is also location for announcements and important information.

**Send website content to:** Administrative Secretary  
Gwen Bowers at [PSAN@nebraskasurveyor.com](mailto:PSAN@nebraskasurveyor.com)

# Summary of March 27, 2026 PSAN Board Meeting Minutes

Subject to approval by the PSAN Board of Directors

The PSAN Board of Directors Meeting on December 3, 2025, was held at the Nebraska State Surveyor's Office in Lincoln, Nebraska and began at 10:02AM CT.

The roll call was as follows:

President, Chad Marsh — Present  
President-elect, Brian Foral— Absent  
Treasurer, Josh Borchers — Present  
Secretary, Jeremy Feusner — Present  
Administrative Secretary, Gwen Bowers — Present  
Directors

Jai Andrist—Present  
Dylan Campbell — Absent  
David Forsythe—Present  
John Howell — Present  
Mike McNaney — Present  
Chris Schulte—Present  
Casey Sherlock, State Surveyor — Present  
Jon Carrell, SENLSA Affiliate — Present

Guests: Jerry Penry and Dan Martinez

Minutes from the September 17, 2025 PSAN Board of Directors meeting were read and approved.

## Officer Reports

Treasurer, Josh Borchers: The Treasurer's Report dated November 26, 2025 was approved.

## Director Reports

State Surveyor, Casey Sherlock, reported that the Board of Examiners has distributed Certificate of Authorization renewal notifications via email and that the Board of Examiners continues active enforcement of the Land Surveyor Regulation Act.

SENLSA Affiliate, Jon Carrell, reported that the SENLSA Winter Seminar will be held Dec. 13 at the Gretna Legion Hall and will include a two-hour Ethics course.

## Standing Committees

Conference

- **2026 Winter Conference:** Flyer distributed and registrations are being received.
- **2026 Summer Seminar:** To be held in Yankton, SD. Tim Gobel will host. Would like to have the seminar centered around the terminus of the 6th PM.

Education: Metro Community College is looking into the potential of creating a survey program.

GIS: Director of the state GIS was let go and the state GIS committee is trying to figure out what they're going to do.

Nominations: Struggling to get members to volunteer to hold PSAN elected offices.

## NSPS

An update was provided on recent NSPS and NCEES meetings, including revisions to ALTA Minimum Standards and ongoing licensure discussions. A survey is being developed to gather input for the FS exam. Dan has been nominated for NSPS Secretary, and contingency planning will be needed if he is elected. The organization will consider NSPS affiliate membership and establish a formal process for representative terms and selection. Chris Schulte expressed interest in serving in a representative role.

## Membership Applications

One application for Active membership and one application for associate membership were received, both were approved.

## Old Business

SCC Discussion: Sept WLT session was productive. New liaison has been good to work with. Still no instructor. Their plan is to have an instructor teach and then have the summer off.

Storage of PSAN Items: Chris Schulte described the types of items that have been received and the plan for will be destroyed and what will be kept.

## New Business

A few years ago, when dues were increase for all other levels of PSAN members, Sustaining Member dues were not increased. It was discussed, moved, and approved to increase Sustaining Member annual dues to \$500.00.

The meeting was adjourned at 12:44PM CT.

After the complete March 27, 2026 Board Meeting Minutes are approved by the PSAN Board of directors, they will be published to the PSAN website.

<https://nebraskasurveyor.com/meeting-minutes/>

May 1, 2026

## NSPS Directors Report

Spring Meeting: April 13-17, 2026 (Washington D.C.)

PSAN Members,

It was a privilege representing PSAN at the NSPS Spring Meeting. I was fortunate to have Dan Martinez as a resource. His knowledge of meeting logistics, our Day on the Hill visit, and experience serving with several incumbent directors was invaluable. With him serving as Secretary for NSPS, our state is in a unique position to have two representatives within the NSPS organization. The main event of the spring meeting is [Day on the Hill](#). NSPS lobbyist, John Byrd (JB) asked Dan and I to speak on two of the three issues NSPS was prioritizing. The priorities included Geodesy Prioritization of the 2026 Highway Bill, creating a TAP Pilot Program for 2027 NDAA, and Alpha-Gal Allergen Inclusion.

### **Geodesy Prioritization and TAP Pilot Program for 2027 NDAA**

Geodesy Prioritization in the 2026 Highway Bill focused on funding and recommended draft legislation known as “Measures for HD Mapping Act,” which places emphasis on digital roadway maps for vehicles similar to Electronic Navigational Charts vessels use, and aeronautical charts aircrafts use. Focus is on the need for geodesy experts who have understanding in GPS accuracy, and leveraging the soon to be new National Spatial Reference System (NSRS) defined by NGS as the U.S. Department of Transportation looks to make roads safer.

The Transition Assistance Program (TAP) Pilot Program brings awareness to the shortage of land surveyors across the United States and promotes a partnership with the Depart. of Defense to help military members with surveying and geospatial skills find pathways for employment in the civilian world. This was another opportunity for workforce development within the surveying industry.

Dan Martinez and I spoke with legislative assistants for Congressman Mike Flood (NE Dist. 1), Senator Pete Ricketts, and Senator Deb Fischer. Congressman Flood’s office had interest in both priorities. Senator Ricketts’ and Senator Fischer’s offices had interest in both topics, though their offices showed more interest in Geodesy Prioritization in the 2026 Highway Bill, given both are strong supporters of keeping Nebraska highways safe. However, both offices noted several issues within the highway bill that will likely cause delays and create funding issues.

### **National Spatial Reference System (NSRS)**

National Geodetic Survey (NGS) gave an overview of their processes for establishing the framework as they progress through the modernization of the National Spatial Reference System (NSRS). They are currently finalizing beta-testing of the modernized system. NGS encourages geospatial experts to visit their [website](#) so professionals know what to [expect](#) with the changes, and how they can [prepare](#). Look for more information and next steps over the next few months.

### **Young Surveyors Network**

Time was spent listening to the [Young Surveyors Network](#), and learning about the organization’s structure, operations, elections, marketing, and membership support. This was intentional to assist with promoting the industry within Nebraska’s borders. *Nebraska is one of only four states that have not established an official state chapter within YSN.* Alex Chose (Washington YSN Director) and Jon Geffre (YSN President/ South Dakota YSN Director) provided insight about establishing, growing, and sustaining a YSN committee or chapter in Nebraska, and some of the challenges to expect

(Continued on page 8)

# HONORING SURVEYORS WHO SERVED



May 22, 2026  
bernsteninternational.com

For more than 250 years, the capable hands of surveyors have played a key role in building and defending our country. From the colonial surveyors turned patriots, to the intrepid explorers of the Louisiana Purchase, surveyors were key to the founding of our nation.

As the nation grew, surveyors led the way, by surveying and mapping the frontier and planning communities. They also played a key role in the defense of the country.

Officers of the U.S. Army Corps of Topographical Engineers and the modern U.S. Army Corps of Engineers are legendary for their contributions to national infrastructure, exploration, and wartime efforts.

## A SURVEYOR OF THE WEST

[James Hervey Simpson](#) was one of the first officers transferred to the newly-created Corps of Topographical Engineers in 1838. In this role, he assisted in harbor construction on Lake Erie and later managed the port. The following year, he surveyed roads and supervised road construction in Florida, then completed lake surveys in Ohio and Wisconsin.

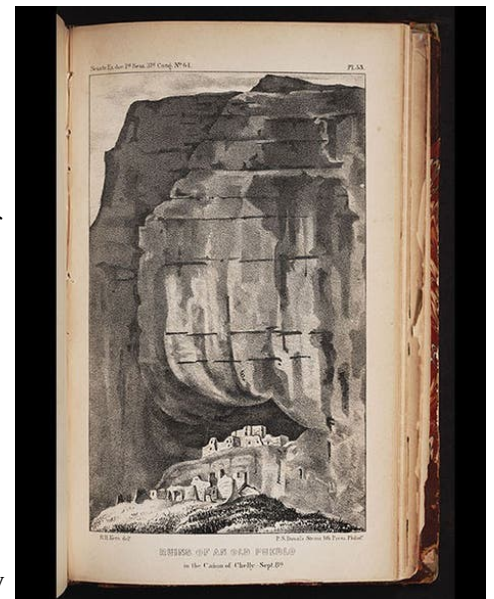


Union army colonel and bvt brigadier general James Hervey Simpson  
By Guo Tianqiao - Own work, CC0.

In 1849, Simpson was attached to an expedition to the West, surveying a road from Fort Smith, Arkansas to Santa Fe, New Mexico. With him was Richard Kern, a talented artist from Philadelphia. They encountered the living pueblo of Jemez, where Kern drew not only the Pueblo itself but some of the wall paintings in a

Jemez kiva. They later discovered the ancient cliff dwellings in the Canyon de Chelly.

When he returned, Simpson wrote and published a narrative of the expedition, *Reports of the Secretary of War, with Reconnaissances of Routes from San Antonio to El Paso ... and the Report of Lieut. J. H. Simpson of an Expedition into Navajo Country* (1850). Simpson's report is only 112 pages long, it includes 74 lithographs based on Kern's drawings.[1]



Ancient cliff dwellings in the Canyon de Chelly drawn by Richard Kern, an artist accompanying Simpson on the expedition to the southwest.

Later, Simpson surveyed the territory of Minnesota, then was ordered to Utah, where he surveyed roads for military use and led preliminary reconnaissance into the Great Salt Lake Desert. He later returned to the Salt Lake area with an extensive expedition that produced the earliest surviving photographs of features along the trail. The [Central Route](#) surveyed by Simpson played a vital role in the transportation of mail, freight, and passengers between the established eastern states and California, especially when hostilities of the Civil War closed other routes. In 1861 the Transcontinental

Telegraph was laid along the route, which only became obsolete in 1896 when transportation and telegraphy were switched to the Transcontinental Railroad, a project overseen by Simpson, now promoted to Chief Engineer of the Interior Department.

During the Civil War, Simpson served as colonel in a volunteer infantry and was captured at the [Battle of Gaines's Mill](#). He was paroled and returned, but resigned his commission of volunteers on August 24, 1862, to return to his rank of major in the Corps of Topographical Engineers. He was attached to the Department of the Ohio and was in charge of the expansion and improvements of the defenses for Cincinnati, Ohio. For his services during the war, Simpson was brevetted to the rank of brigadier general.

In 1880 he retired to St. Paul, Minnesota, and died there at the age of 70 on March 2, 1883.

The [Simpson Park Mountains](#) in central Nevada, a small range in west-central Utah and [Simpson Springs](#) Pony Express Station are named after him.

Many American landmarks are named after surveyors, including Mount Rushmore, [Mount Fremont](#), [Mount Powell](#), [Ferdinand Vanderveer Hayden](#), and so on.

## THE FINAL POINT™ PROJECT

It may be too late for today's surveyors to have mountains named after them, but the profession has its own enduring tradition of recognition. For more than two decades, Berntsen International and the National Society of Professional Surveyors Foundation have honored the lives and careers of land surveyors through the Final Point™ program.

Since 2003, Final Point monuments have been placed across the country, each one a precision-cast bronze marker engraved with the surveyor's name, license number, and the latitude and longitude of their final resting place or another location of personal significance. The monuments can be



*Henry David Thoreau's Final Point in Concord, Massachusetts.*

set in the ground with a stem mount, presented on a plaque, or installed as part of a memorial ceremony. Past dedications have honored everyone from local mentors and family members to historic figures like Henry David Thoreau, whose Final Point was placed in Concord, Massachusetts in 2017.

Every Final Point purchase contributes directly to the NSPS Foundation Scholarship Fund, supporting the next generation of surveyors entering the profession. It's a tribute that lasts, in the most literal sense, as a permanent geodetic mark, and one that gives back to the field the honoree spent their career advancing.

Footnotes: [1] <https://www.lindahall.org/about/news/scientist-of-the-day/james-hervey-simpson/>

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when establishing a committee or chapter. Additionally, Jon Geffre understands the difficulties of recruiting and generating interest in a less-populated state like Nebraska and offered to travel from Brookings to assist with establishing YSN representation.

Please use the provided weblinks throughout the report to learn more about various topics discussed at the NSPS Spring Meeting. Additionally, if you have any questions or issues with the links, don't hesitate to contact me.

Sincerely,

Chris Schulte, NE PLS #811

Nebraska NSPS Director





# IIOF Headstone Project Starts at Greenwood, as 100-year-old Burial Plot Will be Improved.

## Surveying Students Are Initial Workers in Process

Melanie Wilkinson

April 24, 2026

[www.justmelaniew.com](http://www.justmelaniew.com)

**Y**ORK – The Independent Order of Odd Fellows (IOOF) established the historic Nebraska State IOOF Home in 1910 on the south side of West Nobes Road in York. Built in 1911, the home served as a care facility for elderly individuals and as an orphanage. It served as a major institution for the Nebraska branch of the fraternity.

For many who lived there during its 60-some years of existence, it was their only home and only place of belonging.

It was October, 1912, when the Independent Order of Odd Fellows (IOOF) purchased an area on the north side of Greenwood Cemetery as a place to bury the remains of their deceased residents who did not have outside family or financial means. Many of those buried in the IOOF space were children or the very elderly.

The IOOF home in York closed in 1976 and thereby the burials stopped in the special IOOF plot at Greenwood. But hundreds of graves exist in the York cemetery – they have identical head stones, all rectangular, which lie on top of the ground in rows.

Over the years, natural erosion has caused settling of the stones and cracking of the dirt. The stones are uneven with each other and are in bad need of some work.

Well, thanks to financing from the IOOF, that project

has started. It will take several years, as the money becomes available for allocation. The plan is to do two rows at a time – the ground will be leveled, lines of cement will be poured and the cleaned/refurbished headstones will be placed with their corresponding graves, solidified by the concrete.

Greenwood Caretaker Todd Gardner said he’s pleased the IOOF organization is paying for this work, which will preserve the stones for another 100 years or more. He and Greenwood workers will be doing the physical labor – the financial responsibility is appreciated.

And he was really pleased with students and teachers from Southeast Community College (SCC) who visited the cemetery this week, to do their part as volunteers while also gaining valuable field experience in the area of surveying.

Scott Bashore, instructor in the field of land surveying/GIS/civil engineering technology at SCC in Milford, traveled to Greenwood with five students to do the preliminary work to help make sure the cement is put down in straight lines and the headstones are placed in the correct locations.

“We will do our work so they will get it all straight, the rows will be perfect, we will have it marked up for them,” Bashore said, as the students went to work with

surveying equipment, a drone and other techniques.

Bashore said as the project is done in phases, it will also allow him to return with other students so different cycles of young people will get field experience from this work.

“The experience they are getting today is valuable,” Bashore said. “Sure, if we were doing a street, let’s say, the work would be more technical. What we are doing here today is fairly basic but it is also very precise as the work we do is all about precision and accuracy.”

It was an interesting morning as students learned technical skills using today’s knowledge, to help preserve the burial place of many people who were born in the mid-1800s. And it will be equally interesting to see the end result as these rows of memorials are restored/ensured as important reminders of the people who lived here and an important part of York’s history. ■



# 2026 PSAN SUMMER SEMINAR

JUNE  
25



CORPS OF DISCOVERY EVENT CENTER  
89705 HWY. 81, CROFTON, NE 68730

JUNE 25, 2026

## AGENDA

7:30AM-5PM CT

7:30-8:30AM

Registration

8:30-8:35AM

Welcome and Announcements

8:35-10:15AM

**South Dakota v Nebraska US Supreme Court Case**  
Moderated by Tim Gobel

10:30-10:45AM

**Cedar County Surveys & Issues Along the Missouri River**  
Moderated by Tim Gobel & Gene Thomsen

10:45-12PM

**Reestablishing the Witness Corner to the Point of Terminus of the 6<sup>th</sup> Principal Meridian**  
Moderated by Gene Thomsen

12-12:30PM

Lunch

12:30-5PM

**Reestablishing the Witness Corner to the Point of Terminus of the 6<sup>th</sup> Principal Meridian**  
Work to be done in the field

### South Dakota V. Nebraska US Supreme Court Case

Moderated by Tim Gobel

In South Dakota v. Nebraska, the dispute involved the location of the boundary between South Dakota and Nebraska, specifically concerning a piece of land called Elk/Rush Island. The parties included the states of South Dakota and Nebraska, and certain intervenors who claimed an interest in the property. The conflict arose over jurisdiction and title to the island, resulting in legal actions filed in both Nebraska and South Dakota courts. To resolve the dispute, the parties agreed to a stipulation to avoid litigation and establish a Joint State Boundary Commission for future boundary determinations. The agreement recognized the land as within Nebraska's jurisdiction and acknowledged a previous Nebraska court judgment that quieted title in favor of the intervenors. South Dakota agreed to cede any claims and dismiss its pending action. The procedural history includes the filing of a stipulation and the acceptance of a Special Master's report by the U.S. Supreme Court.

### Historic surveys and issues along the Missouri River

Moderated by Tim Gobel and Gene Thomsen

This session focuses on surveys conducted by the Cedar County surveyors along the Missouri River, history of Green Island and how it was taken out by the Flood of 1881, along with the accretion issues that followed.

### History of the 6<sup>th</sup> Principal Meridian

Moderated by Gene Thomsen

In this presentation, I will be covering the history of the 6<sup>th</sup> Principal Meridian from its starting point to its terminus on the northern border of Nebraska. I will also talk about some of the interesting facts of the survey, the surveyor, and the Meridian bridge spanning the Missouri River. Many years ago, one of the founders of PSAN "Bill Rynearson" gave me his photographs on the construction of the initial point which has never been presented until now. Hopefully you will enjoy seeing how the starting and ending points of the 6<sup>th</sup> Principal Meridian were monumented.

# PRESENTER BIOS

## **Tim Gobel, PLS 759**

Tim has been in the Land Surveying field for 20 years and has participated in boundary surveys in Nebraska, South Dakota, North Dakota, Montana, Wyoming, Colorado, Iowa, and Missouri. The majority of the surveys have been along the Missouri River. Tim was first licensed in Nebraska in 2014 followed by South Dakota, Iowa, and Missouri. Since 2017, Tim has been a co-owner of Landmark Surveying, located in Bloomfield, NE, and is the County Surveyor for Cedar County and for Boyd County.

## **Gene Thomsen, PLS 397**

Gene is a life-long resident of Nebraska who grew up on a farm between Fairmont and Exeter, Nebraska. He attended Kearney State College and graduated from Southeast Community College with an Associate's Degree in Civil Engineering and Surveying. He worked in private practice before joining the Nebraska Department of Roads Design Division in 1974. Gene has been a Registered Land Surveyor in Nebraska since 1983 and became a Deputy State Surveyor in 1987. He was in charge of our land surveys for the acquisition of right of way throughout the state. Gene retired in December of 2020 but still holds his survey license as well as his interest in survey history.

**[WWW.NEBRASKASURVEYOR.COM](http://WWW.NEBRASKASURVEYOR.COM)**

# HOTEL & LODGING INFORMATION

## **Fairfield by Marriott Inn & Suites Yankton**

501 W 21<sup>st</sup> St, Yankton, SD 57078  
(605) 653-2250

When making room reservations, indicate you are attending the Professional Surveyors Association of Nebraska Conference (not just PSAN) to ensure you receive the group block rate.

A limited number of rooms have been reserved until **June 1, 2026** for attendees.

[CLICK HERE](#) to book the group rate.

## **Off Grid Lodging**

On the Nebraska side of Lewis and Clark Lake:  
Cedar Tree Cabins, 54540 897 Rd, Crofton, NE 68730  
(605) 660-4275

## **Lunch**

Lunch will be provided as part of your registration fee.

**[WWW.NEBRASKASURVEYOR.COM](http://WWW.NEBRASKASURVEYOR.COM)**

# 2026 PSAN SUMMER SEMINAR REGISTRATION FORM

JUNE 25, 2026

8 PDHS

7:30AM-5PM CT

Registrations must be received by **JUNE 15th!**  
Registrations received June 11th or later, will be assessed a \$15 late fee.

**Complete and return this form along with payment to:**  
PSAN, PO Box 83206, Lincoln, NE 68501

Make checks payable to: **PSAN**


- \$100 PSAN Member Fee
- \$150 Non-PSAN Member Fee
- Free Student - MUST still register
- \$15 Late fee if sent June 15 or later



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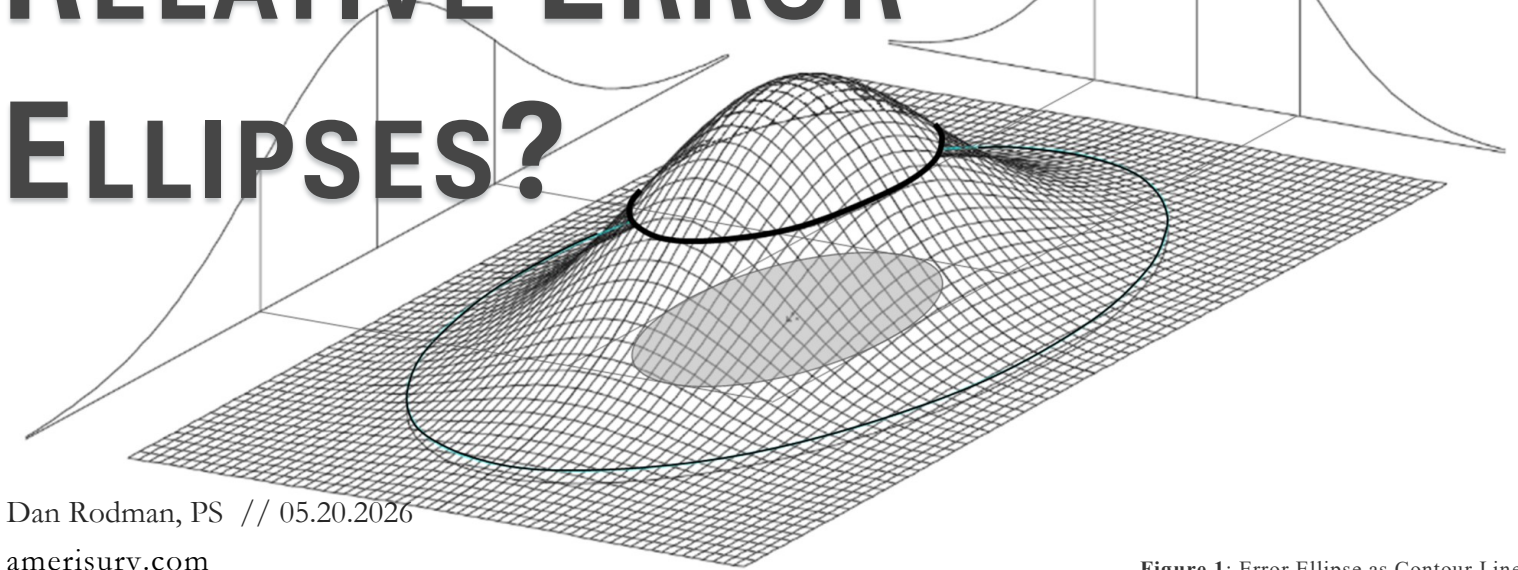
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# WHAT ARE (AND AREN'T) RELATIVE ERROR ELLIPSES?



Dan Rodman, PS // 05.20.2026

amerisurv.com

Figure 1: Error Ellipse as Contour Line

**R**elative error ellipses show the horizontal positional random error between two points, which is what's tested in some important accuracy standards for property boundary surveys, such as the Minimum Standard Detail Requirements for ALTA/NSPS Land Title Surveys, and Wis. Admin. Code A-E 7.06. The ellipses are incredibly flexible, able to describe error between points connected by any combination of measurements. The underlying math is complicated though, so there's some confusion and disagreement about how to meet such standards. The goal of this article is to explain what relative error ellipses are, and aren't, particularly at the 95% confidence level typically used in standards. Things are simplified here to keep it brief and focus on interpreting adjustment results, but some basic knowledge of random error and least squares adjustments is presumed.

## What relative error ellipses are:

**1.1.** Graphically, an error ellipse shows two-dimensional uncertainty due to random error. The true value is probably inside the ellipse (at some percent confidence), and most probably at its center. The ellipse is a contour line of equal probability on a normal distribution (bell-curved) surface.

The normal distribution surface is more complicated than the normal distribution curve that we use for one-dimensional variables (like a single coordinate, distance, or angle), so some things are different, particularly the 95% confidence multiplier (Section 1.8).

**1.2.** Relative error ellipses are different than point error ellipses.

A point error ellipse describes one point's uncertainty relative to fixed points. A relative error ellipse describes uncertainty of one point relative to another point (uncertainty of the line's coordinate differences, or its distance and azimuth).

**1.3.** Mathematically, error ellipses are computed from the variance-covariance matrix, which usually comes from a least squares adjustment. That matrix says how much random error each point's X or Y coordinate has, and also how each coordinate's error is correlated (has covariance) with every other coordinate's error. A point error ellipse is computed from one point's 3 matrix terms: X and Y error (variance); and XY covariance. A relative error ellipse is computed from two points' matrix terms, which involves 4 coordinates, so  $4+3+2+1 = 10$  pairs of error combinations, so 10 matrix terms. The math is complicated, but the number of matrix terms involved shows how a relative error ellipse is more complicated than the point error ellipses on both ends.

**1.4.** Error ellipses (point and relative) are ultimately described by 3 parameters: the semi-major axis (the "big radius") and semi-minor axis (the "small radius") describe the size; and the azimuth of the semi-major axis describes the orientation. Ellipses are also scaled a couple times (Section 1.7 & 1.8). We use the "semi" dimension (like a radius) rather than the total width (like a diameter), because we care about how far the true value could be from our most probable value (ellipse center), not what the total range of true values could be.

**1.5.** For both point and relative error ellipses, their relative sizes (each ellipse compared to all others in the network) are almost

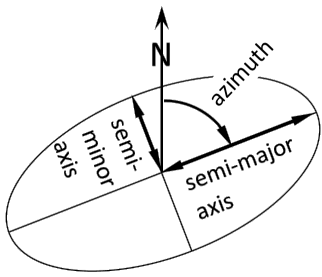


Figure 2: Ellipse Dimensions

completely determined by: 1) the approximate point locations; 2) what measurements tie them together; and 3) the user-estimated standard errors of those measurements (which weight the adjustment). The actual measured values of course affect the exact point coordinates, and the measurement residuals (how much each actual measurement changed to

agree with the others) affect the overall size of all ellipses, but only overall. This is why it's so important to be honest about the user-estimated standard errors, including instrument and target centering.

1.6. Based on the above, it's possible to compute error ellipses without any adjustment at all. Some apps (such as Microsurvey StarNet) can generate them without any redundant measurements (just side shots, or an open traverse). Most apps require some redundant measurements, but not necessarily to every point. So, the presence of an error ellipse doesn't mean that a particular point had an independent check.

Point and relative error ellipses, and other computed errors, are usually scaled twice, as described below:

1.7. First, they may be scaled by the adjustment's standard deviation of unit weight (a.k.a. reference factor, total error factor), which is basically an overall ratio of residuals (how much measurements had to change in the adjustment) divided by user-estimated standard errors (how big you expected those residuals to be). We expect that factor to be around 1. If there's nothing to adjust, the factor defaults to 1 (no scaling). Many apps scale both up (>1) and down (<1). Some apps (such as Microsurvey StarNet) only scale up, not down, the rationale being that a small factor is just luck, and doesn't mean the user-estimated standard errors are really too large. Even more complicated, some apps (such as Microsurvey StarNet) only scale up if the factor is "statistically larger" than 1 (per Chi Square test), the rationale being that a factor "slightly" larger than 1 is also just luck, and doesn't mean the user-estimated standard errors are really too small.

1.8. Second, error ellipses are also scaled up from "standard" size to 95% confidence using a factor of at least 2.45 (rounded). That's larger than the 1.96 we usually associate with 95% confidence. It's larger because an error ellipse is two-dimensional, and it must be magnified by 2.45 in order to enclose 95% of the volume under a normal distribution surface. Compare that to one-dimensional variables (a single coordinate, distance or angle), where a 1.96 multiplier encloses 95% of the area under a normal distribution curve. Figure 3 shows how that puts a lot of the 95% ellipse well outside the 95% coordinate error rectangle, which seems strange, but it is what it is. Complicating things further, some apps use even larger 95% multipliers, because they essentially assume that the user-estimated standard errors (for weighting) are just an unreliable, small set of "sample" standard errors, rather than reliable "population" standard errors. The larger multipliers depend on the degrees of freedom (number of redundant measurements) in the

adjustment. As degrees of freedom approaches infinity, the multipliers approach 1.96 (1-D) and 2.45 (2-D). Different apps use one assumption or the other, or let you choose. For example, Microsurvey StarNet and Trimble Business Center use the "population" assumption (always 1.96 & 2.45). Carlson SurvCE gives you a choice. Dr. Charles Ghilani's Adjustment Computations textbook (John Wiley & Sons) has long used the "sample" assumption.

### 95% Scaling Check in Excel

The general 95% multiplier formula in Excel is =SQRT(df1\*F.INV(0.95,df1,df2)) df1 = 1 for 1-D variables

df1 = 2 for 2-D variables (ellipses)

df2 = infinite (use 9999999) for the "population" assumption

df2 = network degrees of freedom for the "sample" assumption.

Selected 95% multipliers are listed below. Note how big they get with few degrees of freedom (df2).

df2	1-D (df1=1)	2-D (df1=2)
1	12.7062	19.9750
2	4.3027	6.1644
3	3.1824	4.3708
10	2.2281	2.8645
25	2.0595	2.6020
100	1.9840	2.4849
150	1.9759	2.4724
9999999	1.9600	2.4477

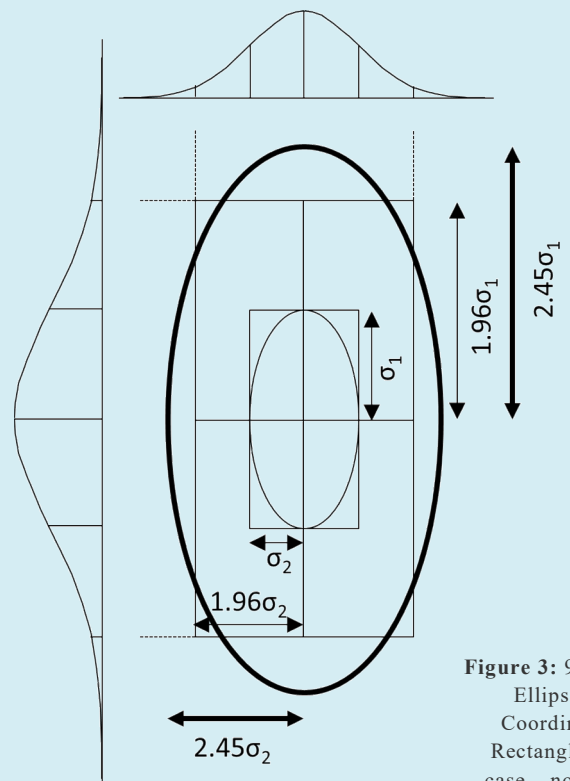


Figure 3: 95% Error Ellipse vs. 95% Coordinate Error Rectangle (simple case – no rotation)

Regarding both types of ellipse scaling, perhaps we'll all get on the same page in the future, but the differences have existed probably since we started using computers. For now at least, be aware of the different approaches, and the thinking behind them, which boils down to how much you trust the user-estimated standard errors of the measurements.

### What relative error ellipses are not

**2.1.** Relative error ellipses (uncertainty between two points) are not point error ellipses (point uncertainty relative to fixed points).

**2.2.** Relative error ellipses are not limited to two points directly connected by measurements. They can be computed between any two points in the network. For example, in Figure 5, the points are directly connected with distance and angle measurements, but in Figure 4 they are not. Figures 4 and 5 only show relative error ellipses between adjacent points, but they also exist between more distant points.

**2.3.** Relative error ellipses are not necessarily a simple function of the point ellipses on either end. A simple situation in which they are, would be two points shot independently with RTK GNSS (no covariance between points), with each point error ellipse being circular (no more X error than Y error, and no covariance between X and Y error at a point). In such a simple situation, the complicated error propagation simplifies to the “error of a sum” principle, where the relative error ellipse’s (circle’s) radius is the square root of the sum of squares of the radii of each point error circle (dashed circles in Figure 4). In more complicated situations, like when measurements tie points together locally, there can be

covariance between points, and/or covariance between one point’s coordinates. So generally, “error of a sum” does not always apply, and the true relative error ellipse must be rigorously calculated from the variance-covariance matrix.

**2.4.** Relative error ellipses are not quite the same as the computed azimuth and distance errors between points. One issue is orientation — if the ellipse axes aren’t aligned parallel / perpendicular to the line, then the semi-major axis can be larger than both the azimuth error and distance error of the line. How much larger depends on the ellipse shape and orientation. Another issue is scaling to 95% confidence — some apps assume the line’s azimuth and distance errors are separate one-dimensional errors, scaling them to 95% by 1.96 instead of 2.45 (or larger scales per “sample” vs. “population” issue in Section 1.8). Other apps assume the azimuth and distance errors work together to describe two-dimensional error, and therefore scale them by 2.45 like error ellipses are scaled.

**2.5.** Relative error ellipses are not necessarily independent of which points are held fixed. Consider a pair of points “farther” from (with weaker ties to) fixed points (Figure 5). Obviously, their point error ellipses should be larger. Their relative error ellipse could be larger too, mostly because the direction (azimuth) component of that error is relative to north, not relative to an adjacent line. Even with minimum horizontal constraints of one fixed point and one fixed azimuth, moving those fixes closer to the problem points could shrink both the point and relative error ellipses. This is the sort of change that can “juke the stats” just to

*(Continued on page 22)*

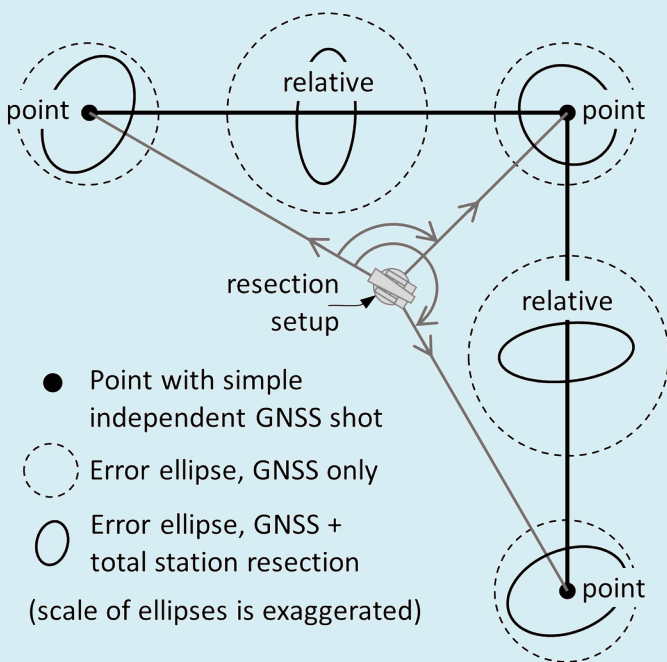


Figure 4: Relative Error Ellipses Can Be Complex

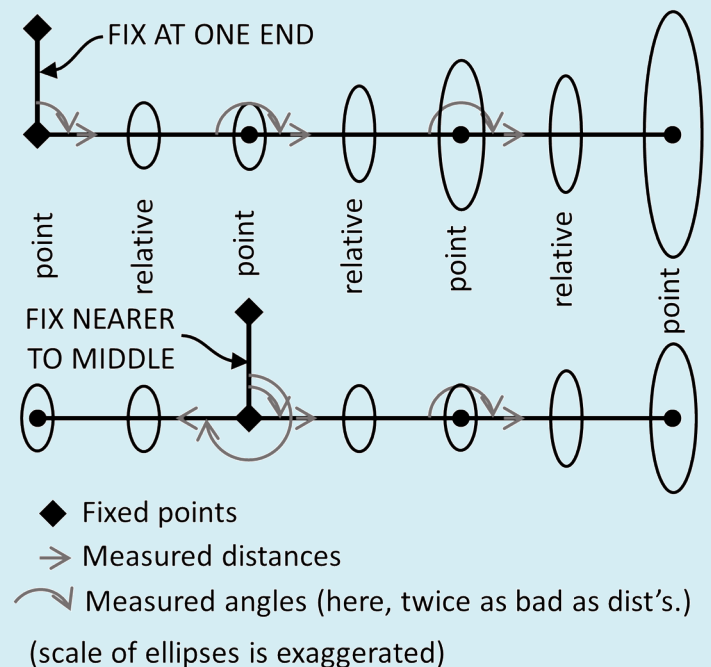


Figure 5: Changing What’s Fixed can Change Relative Error Ellipses

# The Duct Tape Principle

xyht.com

May 4, 2026

The geospatial industry has never been short on capability. That said, industry leaders have learned to look beyond the technology, to lead with problems instead of solutions. The most successful seek to find the places where people are improvising, stitching together workarounds, doing something difficult and expensive because no better option exists, and to start there.

It's a core philosophy of Philadelphia-based Exyn Technologies, a leading developer of autonomous LiDAR-based mapping systems. The company builds systems that navigate and capture data in GNSS-denied environments—underground mines, bridge substructures, confined industrial spaces—where conventional positioning solutions fail and traditional survey methods can be dangerous, slow, or impossible. When COO Ben Williams joined, the company was about five years old and had spent much of that time developing its core capability: SLAM-based autonomous navigation for aerial systems operating in GNSS denied or limited areas. Although the technology performed exceptionally well, it took a chance customer encounter to reveal where the real value lay.

A potential buyer walked past a demo, watched the drone navigate autonomously, expressed polite interest, then pointed at the point cloud the system was generating as a byproduct of figuring out where it was, and said he wanted that.

It was a small moment with large implications. The autonomy, it turned out, was the means. The data was the end. And the overall solution needed to be organized around delivering the data, with the autonomy as the mechanism that made capture possible in places no other approach could reach.

That realization hardened into a philosophy—and a way of finding the next problem worth solving. “Basically, we look for the

duct tape,” Williams explains. “We find those early adopters who have a problem that they’re trying to solve with improvised solutions.”

It became the engine behind everything Exyn has built since and the implications produced something more valuable than a better tagline: a self-reinforcing loop in which better autonomous navigation produces richer, more complete data, and richer data enables more confident autonomous navigation.

Inside Exyn, that loop sits at the heart of a broader flywheel: each improvement in reliability and data quality makes it easier to



Image: Exyn

win and serve the next customer — and to carry the same playbook into the next market.

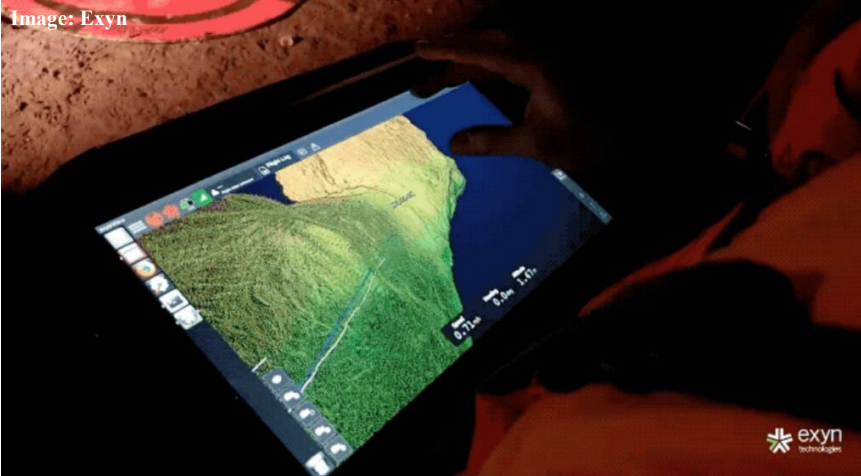
## FORGING THE FLYWHEEL

The first market where Exyn really applied its duct-tape logic was underground hard rock mining, specifically the process of tracking the geometry of mined-out voids to inform blast planning and structural safety assessment. It is a demanding environment: poor lighting, irregular geometry, significant safety concerns, no GNSS and a workforce accustomed to improvising with whatever tools are available.

It is also, Williams readily acknowledges, an extremely narrow customer base. Exyn’s longest-running customer relationship with gold miner Dundee Precious Metals has become as much an education in industrial workflows as a source of revenue.

He says, “They were very forward-looking in terms of new technologies and data-centric operations. But they were also a key reason for our strategic shift.”

Understanding how Dundee operated meant going well past the surface problem. It meant learning how a survey team descends into a mine, captures data, geo-references it, and processes results, ideally before surfacing, so that the next shift already has the information it needs before anyone goes back underground.



It meant understanding how buyers think about risk, and how to make an investment in unfamiliar technology feel like a solved problem rather than an experiment. It meant learning, as Williams puts it, to go in and say “I know I’m wrong here—tell me where” as a way of disarming defensiveness and getting to the real operational realities faster.

For Exyn, mining took four years to develop into a reliable, repeatable business. More importantly, it shaped the new playbook for the firm. Exyn now understood how to find the right early adopters, how to translate workflow insights into product features, how to build a go-to-market approach that could be documented, staffed against, and repeated.

## A HORIZONTAL PIVOT

The transition into geospatial took roughly half the time mining had required. Some of that compression was experience; some of it

was a conceptual adjustment that turned out to be as important as any technical advance.

Exyn’s initial instinct was to approach adjacent markets the way most companies do: as verticals. Construction was a vertical. Infrastructure was a vertical. Each had its own buyer profile, budget cycles, and procurement processes. The problem was that none of them had a clean line item for “autonomous mapping system” and the teams who most wanted the technology were often not the ones with authority to buy it.

“Everyone we talked to was like, ‘This is great, we definitely need this. Someone should definitely buy it,’” Williams says.

The insight that unlocked the market was reconceiving it horizontally rather than vertically. The teams actually using Exyn’s systems were not construction teams or infrastructure teams or mining teams in any rigid sense—they were data collection groups, operating wherever reliable spatial data needed to be captured: construction sites, bridge decks, maritime environments, confined industrial spaces, post-event assessments. The client’s industry was less important than the data flow. And the underlying workflow, stripped of context, looked remarkably consistent across all of them.

“Our focus really is on geospatial groups, those people who are doing the work of capturing data wherever it’s needed,” Williams says. “That’s how we have a broader portfolio of verticals, but we’re trying to serve the need of the surveyor or the data collection group in all of those areas.”

That shift in focus has quietly reshaped the kinds of partnerships Exyn pursues.

## THE SEAFLOOR SET-UP

One of the clearest expressions of that horizontal strategy—and of Exyn’s broader platform philosophy—is its partnership with Seafloor Systems, a Sacramento-based developer of unmanned surface vehicles for hydrographic survey. The collaboration tackles a persistent hard problem in infrastructure inspection: what happens to a survey when it goes underwater, under a bridge, or into any environment where GNSS disappears and the tools hydrographic surveyors have relied on for decades simply run out of answers.

One in four bridges in the United States is 75 years old or older. Many of them have never been surveyed below the waterline with anything approaching the accuracy available above it. The tools exist to complete the task in the way of multi-beam echo sounders, robotic total stations, inertial navigation, etc. But they break down in the confined, complex environments where the most critical structural questions arise. Dense pile fields defeat line-of-sight positioning. Low overhead clearance eliminates conventional vessel access. The areas that most need inspection are often the areas hardest to reach.

Seafloor had been building unmanned surface platforms since around 2010, originally for marine construction. Exyn brought SLAM. Together, they developed a workflow in which a compact unmanned surface vehicle outfitted with both a multi-beam echo

sounder and an Exyn SLAM LiDAR sensor surveys the underwater environment while the SLAM system simultaneously maps the above-water structure and generates the positioning trajectory that the sonar data requires.

The technical elegance of the solution sidesteps the GNSS problem entirely. The SLAM point cloud is registered to a geo-referenced control point cloud captured beforehand with static terrestrial scans. The transformation matrix from that registration is then applied to the SLAM-derived trajectory, converting it from an arbitrary coordinate system into a fully geo-referenced one. That trajectory feeds into standard hydrographic processing software as if it came from a conventional GNSS-inertial navigation system.

For Exyn, the partnership also illustrates the platform logic Williams describes: rather than building a full vertical solution—hardware, processing software, reporting, asset management, client delivery—Exyn exposes its core capabilities through APIs and integration pathways, enables partners like Seafloor to build on top of them, and concentrates its own energy on making the underlying system faster, more reliable, and easier to deploy.

“We always go in with software and data partners,” Williams says. “We don’t think we’re so smart that we can solve all that stuff. Why try to displace people that are already doing great work? Let’s enable them to be more successful—and it keeps the flywheel spinning.”

## **RICHER DATA, SMARTER AUTONOMY**

The flywheel concept is easy to describe and genuinely hard to build. The companies that fail to build it, Williams suggests, are usually not failing on the technology. They’re failing to go deep enough, early enough, in any single market to build the understanding that transfers.

Exyn’s rule is one new market entry at a time, never more. The process does not move to the next market until the current one is understood well enough to hire and train people against it, to institutionalize it, as Williams puts it, so that the knowledge is in the organization rather than in a few individuals’ heads.

“A startup takes a bunch of smart people, they try to figure some stuff out, and then it’s in their head. Then they document it, then they institutionalize it, and then you rinse and repeat,” he says. “That, I think, is how a company grows up.”

The same discipline extends to how Exyn thinks about AI, a topic that has become unavoidable in any geospatial conversation. Williams draws a careful distinction between what he calls LLM-type AI and the deterministic, algorithmic AI that actually runs Exyn’s systems. The core navigation and mapping are deterministic by design: consistent, trackable, auditable, and eventually, he hopes, applications certifiable for safety-of-flight.

Classification models that sit above the core system can be non-deterministic, because that’s where the flexibility pays off.

Distinguishing dust from a hanging wire—one of the cases Exyn

explicitly designs for—or flagging a change in tunnel profile or vegetation encroachment on a power corridor—are problems where trained models outperform hand-coded rules. But the boundary between the deterministic core and the probabilistic layer is drawn deliberately, not by default.

“For a tool like ours, we want deterministic solutions for the core autonomous navigation and the core mapping,” Williams says. “What gets interesting is on the classification layer on top of that.”

## **THE NEXT FRONTIER**

The biggest growth opportunity Exyn sees right now is in the broader geospatial market.

But the use cases he is most interested in are not the ones that already exist. They are the ones that only become possible when the cost and friction of capture drop far enough that teams who previously could not justify scanning suddenly can. The zero-to-one



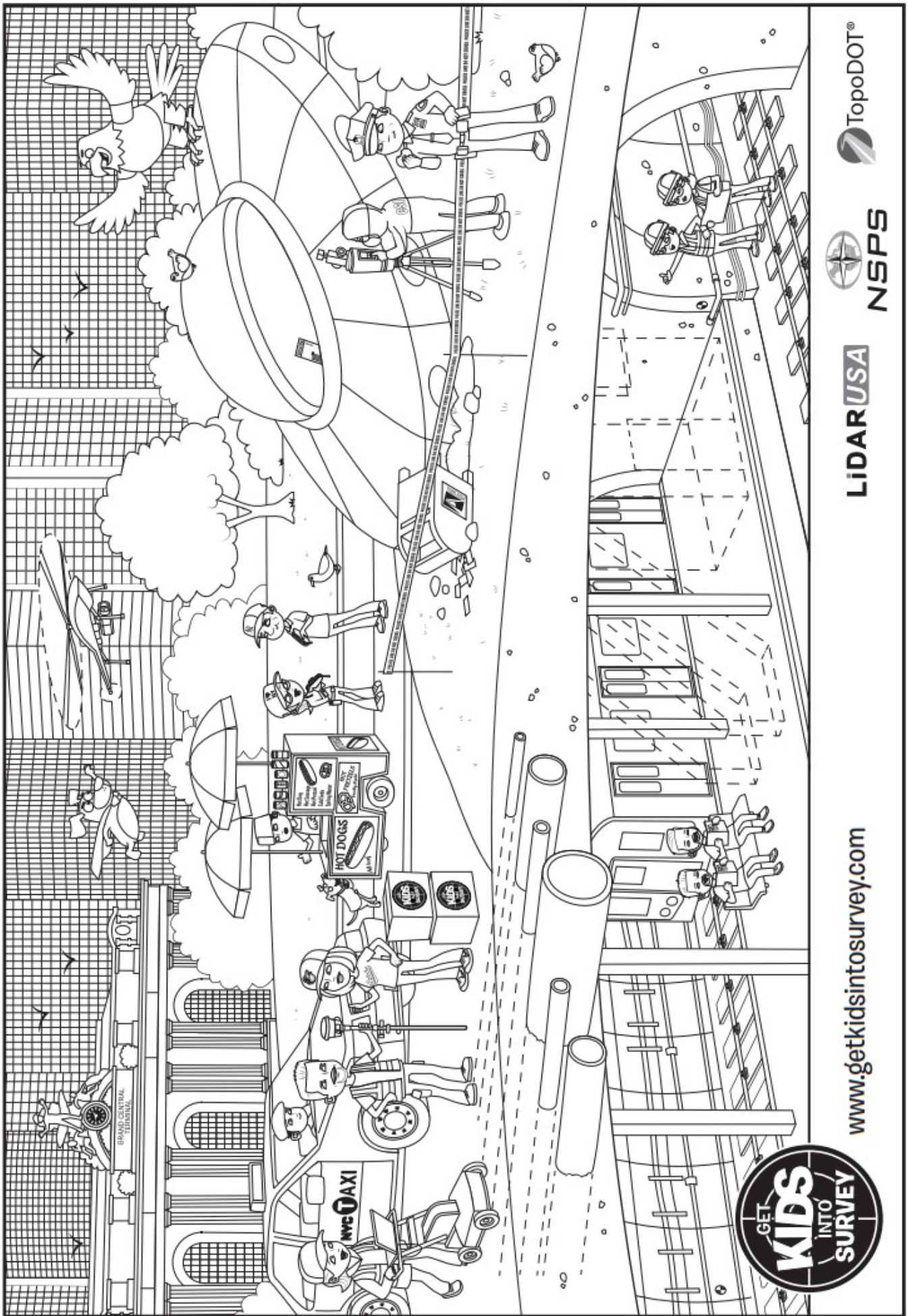
Image: Exyn

opportunity, as he frames it: not doing something more efficiently, but doing something that was not being done at all.

“If it’s too expensive and too inconvenient for someone to do something, they just won’t do it. It’s not that they’ll do it less,” Williams says. “If you then have a low-cost, high-speed scanner, all of a sudden they can go from zero to one. And it opens up whole new categories that just couldn’t exist before.”

The companies best positioned to capture that opportunity, in his view, are the ones that start from problems rather than products, that find the places where people are already improvising, already building workarounds, already duct-taping one system to another because no good solution exists yet. Those are the signals worth following. Those are the markets worth going deep on.

The geospatial industry has spent decades getting extraordinarily good at capturing the world. What comes next is about what happens after the capture—who acts on the data, what decisions change, and which problems finally get solved. For the companies that have learned to ask those questions first, the flywheel is already spinning. ■



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# Sorting Signal From Noise: Enforcement Triage Through a Public Member Lens



ncees.org  
Apr 2, 2026

**CLINTON CAMPBELL JR., PH.D.** | ARIZONA BOARD OF TECHNICAL REGISTRATION MEMBER

As a public member serving on a multidisciplinary licensing board that includes engineers and surveyors, I occupy a unique seat in the enforcement process. I am not a licensee, but I am deeply invested in the board's core mission, protecting the public. From that vantage point, one reality becomes clear very quickly: Licensing boards receive a wide range of complaints, and not all of them represent misconduct, incompetence, or public risk. The challenge for enforcement teams is sorting legitimate signal from substantial noise.

Many are surprised to learn that the Arizona State Board of Technical Registration reflects a uniquely broad regulatory structure. Unlike boards that oversee only one or two professions, Arizona regulates seven distinct professions under a single statutory framework. In addition to engineers from all branches of engineering and surveyors, the board also regulates architects, landscape architects, geologists, home inspectors, and commercial alarm agents. This multidisciplinary composition creates a broader enforcement perspective, requiring careful calibration of statutory authority, investigative focus, and public protection standards across varied professional domains.

Many complaints arrive emotionally charged. They often reflect frustration, disappointment, or financial loss rather than violations of statute or rule. In many cases, these concerns are rooted in communication breakdowns, missed expectations, unclear explanations, or inadequate documentation, rather than unsafe or unethical practice. From the public's perspective, a licensing board may appear to be a broad problem-solving body, expected to resolve disputes, correct perceived unfairness, or fix outcomes that did not meet expectations. From the board's perspective, however, enforcement is necessarily narrower, evidence based, and guided by due process.

Understanding this disconnect is critical to effective enforcement triage.

From the public seat, it becomes apparent that many complainants do not distinguish between poor communication,

contractual disagreement, and unsafe or unethical practice. A delayed project, cost overrun, or strained client relationship may feel like professional misconduct to a complainant, even when no licensing violation exists. Investigators are often tasked with unpacking these concerns while remaining focused on the statutory standard, whether the alleged conduct presents a risk to public health, safety, or welfare.

Effective triage serves multiple purposes. First, it allows boards to identify matters requiring immediate attention: cases involving unlicensed practice, failure of supervision, misuse of professional seals, or systemic competence issues. These cases represent legitimate indicators of public risk. They are aligned with the board's public protection mandate and demand careful, timely investigation.

Second, triage protects licensees from being pulled into enforcement actions driven solely by dissatisfaction rather than evidence. As a public member, I have come to appreciate how critical consistency and restraint are to maintaining trust in the regulatory system. When boards pursue every complaint with equal intensity, regardless of merit, credibility erodes, both with the public and with the profession. Several triage principles consistently emerge as effective from a public member perspective. These include jurisdictional clarity, assessment of actual public risk, reliance on verifiable evidence over emotion, recognition of patterns rather than isolated events, and consideration of the broader public impact of enforcement decisions.

In some jurisdictions, statutory frameworks now limit enforcement authority to the specific allegations raised by the complainant, even when additional concerns emerge during an investigation. While designed to define regulatory boundaries, these limitations can lead to public frustration when boards are required to dismiss matters despite apparent issues.

From the public member seat, it becomes clear that these outcomes reflect legal constraints rather than a lack of commitment to public protection. Clear communication about jurisdiction and scope is essential to preserving trust in the regulatory process.

When these principles are applied consistently, enforcement outcomes become more predictable and defensible. Even when complainants are dissatisfied with the result, transparency and fairness in process help reinforce the legitimacy of the board's role.

From the public's perspective, it is also important to recognize that restraint is not inaction. Declining to pursue a complaint that lacks jurisdiction or evidence is not a failure of enforcement; it is an affirmation of due process and professionalism. Licensing boards are most effective when they act decisively where risk exists and judiciously where it does not.

Ultimately, enforcement triage is about focus. By sorting signal from noise, boards preserve resources, protect the public, and uphold confidence in the regulatory system. From the public member seat, that balance is not only appropriate, it is essential. ■



## Everything is Somewhere Podcast

From the rope stretchers of ancient Egypt to ubiquitous satellite precision, geospatial technology has ever been the bedrock of the constructed world and of civilization itself. Your host, land surveyor and infrastructure writer Angus Stocking, engages in regular conversation with today's location experts to determine exactly where, in space and time, we find ourselves today. Location, location, location; it's not just real estate, it's everything and, Everything is Somewhere.



(Continued from page 16)

meet a standard. The right thing to do is fix what you should fix (probably the GNSS base(s), or section line), and instead improve your network, probably by adding GNSS shots in the problem area.

**2.6.** Small error ellipses (point or relative) do not by themselves guarantee that blunders or systematic errors have been removed, or even that the ellipses really show the amount of random error present. Remember that it's possible to generate error ellipses for unchecked side shots, and that the relative size of each ellipse compared to all the others is very dependent on the user-estimated standard errors of the measurements.

**2.7.** Error ellipses (point or relative) are not a good blunder detection tool. Large measurement residuals in one part of the network do not make just the nearby ellipses larger. Instead, the large residuals make the overall standard deviation of unit weight larger, which scales all ellipses. Blunder detection is best done by examining the measurement residuals themselves, understanding that a single blunder tends to cause many large residuals in that part of the network.

### Summary

If you really want to know the 95% uncertainty between any two Points A and B in your survey, do the whole survey 1,000 times, compute 1,000 pairs of  $(X_a - X_b)$  and  $(Y_a - Y_b)$  coordinate differences, plot them, and best-fit an ellipse that includes 950 of the 1,000 data points. That's impractical, so we instead use statistical theories to estimate how such repeated surveys would vary. Least squares and error ellipses are complicated, they depend heavily on user honesty, and different apps scale the final errors differently. However, these tools are universal (mix GNSS, total station and leveling in any network configuration) and also flexible (measure in any order – start topo before finishing control), which is why many modern accuracy standards are based on them. They are also showing up in more of our procedures, such as total station resection setups. They are another modern-age black box that we surveyors may never understand completely, but should still learn enough about to use them competently (particularly the different scale factors for 95% confidence).

Finally, keep least squares and error ellipses in perspective. They alone are no guarantee of a good survey, and lots of good surveys have been done without them. For property boundaries, they can't tell you whether you've done enough research and looked hard enough for the right points to measure to in the first place, nor how to reconcile that field evidence with other evidence in order to locate the boundary. The essential app for that is an experienced surveyor's professional judgement! ■

*Dan Rodman is a Wisconsin Professional Surveyor & Civil Engineering Technology instructor at Madison College, Madison WI [drodman@madisoncollege.edu](mailto:drodman@madisoncollege.edu)*



# Trimble Tech Enables cm-Accurate 3D Model of Disappearing Glaciers

Klaus Thymann uses the Trimble Catalyst DA2 GNSS system to establish location coordinates with centimeter-level precision, allowing the team to create a highly-accurate georeferenced photogrammetry model of the glacier. (Credit: Klaus Thymann)

By [Tracy Cozzens](#)  
Published May 13, 2026  
[gpsworld.com](#)

*Data provides baseline measurement for tracking change at one of Earth's last tropical ice fields in Puncak Jaya, Papua, Indonesia.*

**Trimble** is supporting Project Pressure by providing advanced GNSS positioning technology and research funding for the nonprofit organization's latest expedition to map the disappearing tropical glaciers of Puncak Jaya in Papua, Indonesia.

Project Pressure has released a centimeter-accurate, 3D model of the receding ice, created using Trimble positioning technology and drone-based photogrammetry. The model establishes a scientific baseline for calculating the rate of glacier recession and projecting the timeline of disappearance.

Puncak Jaya, the highest peak in Oceania and one of the Seven Summits, is expected to be the first of the seven continental peaks to lose its glaciers as global temperatures rise.

Puncak Jaya has the only snow in Indonesia. (Credit: Enda Kaban, CC BY-SA 4.0)

Local communities use the data to make informed choices about crop selection and prepare for expected water shortages caused by the loss of vital reservoirs.

This expedition marks the third successful outing in Project Pressure's "Melting Topics" series, which focuses on mapping equatorial glaciers. Trimble provides its GNSS mapping technology and research funding from the [Trimble Foundation Fund](#) to support Project Pressure in gathering critical data in some of the world's most remote and hostile environments.

"Mapping these glaciers before they disappear is of critical importance to establish a baseline to track the glacial regression and for the local communities to understand what is happening with their water source, allowing them to adapt to a changing climate," said Eliot Jones, senior manager, strategy and partner development at Trimble. "Through a combination of precision technology, detailed project planning and rigorous science, the models created by Project Pressure are shared for scientific study and provide a visual reference for future generations."

## Precision under pressure in hostile terrain

Mapping glaciers at altitudes exceeding 4,800 meters (15,000 feet) presents extreme logistical and environmental challenges. Near-constant cloud cover and heavy rainfall in Papua often render satellite imagery unusable, making ground-based georeferencing essential.

The expedition team installed precise geolocation reference points directly on the glacial surface at multiple locations. Using the Trimble Catalyst DA2 GNSS system and Trimble TDC600 handheld, researchers captured the exact coordinates of those points with centimeter-level accuracy. Drone imagery was then processed against the Trimble coordinates to produce a scientifically reliable 3D model of the glacier.

"Trimble makes incredibly complex technology feel simple in the field," said Klaus Thymann, scientist and lead explorer. "When you're standing on a glacier in freezing conditions, wearing thick gloves and surrounded by clouds, you don't have time to fight with equipment. With Trimble, I can capture centimeter-accurate readings and the interface is so intuitive that even someone with no prior training can help collect data. That kind of reliability and simplicity is critical when you're working in some of the most remote and challenging environments in the world."

This approach builds on methods developed during Project Pressure's [2024 expedition](#) to the Rwenzori Mountains in Uganda, which also used Trimble technology.

The lightweight Trimble Catalyst DA2 GNSS system was critical for the expedition, which required helicopter access to Basecamp, followed by a trek to the launch point. ■

Puncak Jaya has the only snow in Indonesia.  
(Background Photo Credit: Enda Kaban, CC BY-SA 4.0)



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