MSPS "Spring Workshop" 2020

Description to Measurements; Measurements to Descriptions

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What is the Purpose of a Description?

- Describe land to be conveyed
- Make sure there are no surprises
  - Easements
  - Reservations
  - Exceptions
  - Identify resources that are part of the description

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What is a Deed?

- Instrument of conveyance
- What are the important parts of a deed?
- Does it include a description?
- What else?

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Components of a Deed

- The Heading
- The Parties
- Recitals
- Operative Provisions
- Testimonium
- Schedules
- Execution and Attestation

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Wait a Minute…

- Isn't a description part of a deed?

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Components of a Deed

- The Heading
- The Parties
- Recitals (includes description)
- Operative Provisions (obligations and rights of parties)
- Testimonium (In witness whereof…)
- Schedules
- Execution and Attestation

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A Better List Perhaps?

- Identity (of parties, where are they from, etc.)
- Consideration
- Words of conveyance
- Land description
- Signature
- Delivery and acceptance

What is a Description?

What Makes a Deed Insufficient?

By the Way

- A deed is used to confirm or convey ownership rights to real property -- physical document
- Title, however, is the legal way of saying you have property ownership. Title is not a document, but concept that says you have the rights to use the property.

Why is a Deed Called "Deed"

- Dictionary says something like… an action that is performed intentionally or consciously
- In the case of a conveyance, it is an action that used to be called the Livery of Seisin

Types of Descriptions

- Metes and bounds
- Bounds
- Metes
- All of the above tend to be used in sequential conveyances

Types of Descriptions

- Lot and Block
- USPLSS
- The above tend to be used in simultaneous conveyances

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Many Descriptions

- Can be combinations of types

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What's a Survey?

- Purpose is to delineate something?
- Measure something? What?

- My opinion: a report of an investigation of land described, including opinions on the conditions of the boundaries

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What Do Surveys Delineate?

- Generally the land described in a deed or proposed to be described in a deed
- Is it more than boundaries?
- Is it the title?
- What about the physical features of/on the land?

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Original Survey

- Demarcates a tract that didn’t exist prior to the survey

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Retracement Survey

- Retraces a prior description, hopefully a survey

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How to Lay Out Descriptions

- Get the metes
- Get the bounds
- Where do you expect to find monuments
- What about ? And ? And ?
- What if it can’t be laid out

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Missing the Calls

- They come too soon
- They come too late
- Bearing’s off
- Distance’s off
- Doesn’t match record lines
- Monument mismatch or no monument

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Point of Beginning

- Can you find it?
- Is it locatable?

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The Description Math

- Does it close?
- Can you even try to close it?
- If there's insufficient information to calculate closure, it is likely it's going to be an expensive survey
- What monuments and other evidence is used?

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Let's Start with an Easy Example

- You have all the courses (bearings and distances or equivalent)
- You can plot it on paper
- If you can find the POB you can plot it on the ground

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What Is the POB?

- Is it physical?
- What about the end of the first and subsequent courses?
- Each end and beginning of a course is a corner
- But corner ≠ monument… and we know
- Monument ≠ corner

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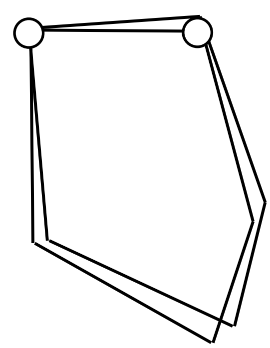
To Properly Layout a Description

- Must know how the survey was done (Methods)
- Instrumentation and mathematics applied
- Decisions made regardless of whether original or retracement survey
- THESE ARE THE FOOTSTEPS
- Without these…we are operating in a vacuum

So Easy Becomes Not So Much

- 5-sided property
- POB is yellow symbol
- First course terminates in red symbol, a found orig. mon.
- Surveyed point matches 0.8 ft (falling southerly)
- … matches 0.4 ft E-W (falling w'ly)



To Summarize

- You measured first course by turning angle using bearings at POB and then shot the 5 ch 76 lks distance with EDM to handheld prism pole
- What do you do next?

Start With Math Analysis

- Probably original surveyor used compass? Let's say accuracy is ¼ to ½ degree, assume one shot or sight
- Probably used chain? (let's assume 66 ft chain) with approx. uncertainty of ½ link per chain length
- So about 6 measurements in this gently rolling terrain
- 5.76 ch ≈ 380 ft

What Is Original Surveyor's Uncertainty?

- In N-S direction:
- $error_{N-S} = tan0.333° \times 380 = \pm 2.2ft$
- In E-W direction:
- $error_{E-W} = \sqrt{6} \times 0.33 = \pm 0.81ft$
- We got 0.8 ft N-S & 0.4 E-W

Projecting Closure

- If each course was a single sight, 5 sights total
- Let's say average length of each course is 400 ft (6 ch)
- So if this was a line prolongation with a compass and chain, we could expect uncertainty at the end of ?

Projecting Closure

- 5 compass sightings, total distance of 30 ch or 1980 ft
- $error_{N-S} = tan(\sqrt{5}\times 0.333)\times 1980 = \pm 26'$
- $error_{E\_W} = \sqrt{30}\times 0.33 = \pm 1.8'$

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OK, So Far

- If it was a linear survey (unwrapped) and just went east, we can estimate uncertainty
- You can also imagine trying to sum up in cardinal directions
- But what if the line was southeasterly, i.e. S45°E?

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Perhaps More Realistic

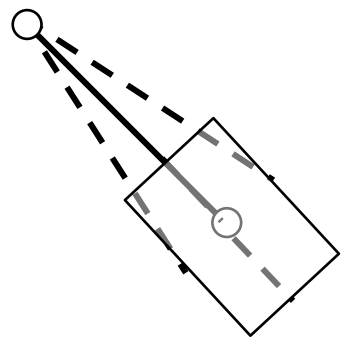
- Group E-W errors together
  - Distance errors on easterly and westerly chaining plus
  - Distance errors on northerly and southerly sightings
- Group N-S errors together
  - Similar but opposite

More Accurately

- Consider inline and normal (cross error) for every measurement

S45°E

- If we have same compass/chain uncertainty, we have this:



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But, No

- The “box” is not long in the direction of the bearing
- We calculated ±2.2 ft in direction of line and 0.81 ft normal to it for compass and chain
- …and

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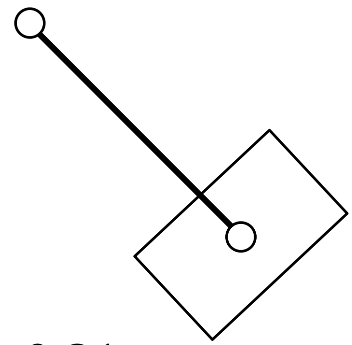
Applying the Bearing to Box

- Expanding scale
- Dimensions of box is same
- But positioning is…
- $error_{N-S} = sin45 \times 2.2 + cos45 \times 0.81 = \pm 2.12\ ft$
- $error_{E-W} = cos45 \times 2.2 + sin45 \times 0.81 = \pm\ 2.12\ ft$



So to Get Total Uncertainty

- Add some columns to your traditional traverse sheet
- Every line, for compass and chain has the same estimated error along the direction of the sight and same estimated error normal to it

Using Inline and Normal Errors…

Distance	Bearing	In-line Error	Cross Error	N-S Error	E-W Error
6 ch	N10°E	0.81	2.21	1.18	2.31
6 ch	N20°E	0.81	2.21	1.51	2.34
6 ch	N30°E	0.81	2.21	1.80	2.31
6 ch	N40°E	0.81	2.21	2.03	2.21
6 ch	N50°E	0.81	2.21	2.21	1.49
6 ch	N60°E	0.81	2.21	2.43	1.80
6 ch	N70°E	0.81	2.21	2.34	1.51
6 ch	N80°E	0.81	2.21	2.31	1.18

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Let's Re-Analyze With Modern Tech

- 5 angles and 5 distances
- Angles good to ¼ minute?
- Distances good to 0.05 feet?
- If linearly projecting…
- $error_{N-S} = tan\left(\sqrt{5}\times 0.004\right)\times 1980 = \ \pm 0.3'$
- $error_{E\_W} = \sqrt{5}\times 0.05 = \pm 0.1'$

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Etcetera!

- All of this discussion so far
- Assumes monuments at each corner
- To calculate how much is reasonable to miss
- Also reasonable error of closure
- But this is all theoretical

Not to Burden You All

- We've been probably looking at maximum error?
- So standard deviation is about 1/3 of those maximums?
- So 1/3 of 20 minutes = 6'40" call it 7 minutes
- 1/3 of 0.33 ft is 0.11 ft

Error Theory Tells Us

- Probability of standard deviation is about 68%
- We need to factor it in

So Going Back to Table

- Take 1/3 to get standard deviation table
- Then figure you'll hit those values about 2/3 of the time

So Far

- Mostly discussed compass and chain
- One example with theodolite and EDM (i.e. total station)
- To analyze for this technology, use something like…

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Total Station Accuracy

- Instrument angle spec X 1.4 if you measure angles once in F1 and F2 and take average
- So, if you have 5” instrument use ±7”
- For EDM, use the value the manufacturer gives you, like ±(2 mm + 2 ppm) and divide by square root of the number of independent measurements

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GNSS

- If RTK the theoretical standard deviation per point is ±1-2 cm PLUS 1-2 ppm
- The ppm part applies to the length of the baseline
- Sometimes there is more error in the direction of the base station, so error is not circular

GNSS

- Static?
- Your solution whether from your manufacturer or OPUS will give you error ellipse for each point

So…How Much of a Miss?

- Generally take square root of the sum of error of surveyor you are following and error of your work
- i.e. $TotalMiss = \sqrt{PrevError^2 + YourError^2}$

But All Monuments Are…

- Not found
- Not found as described
- Appear to be disturbed
- Not physical (i.e. some are record monuments)

And…

- All calls are not complete
- Uncertain distance
- Uncertain bearing
- No distance
- No bearing
- Course may not have call for monuments

Pin Cushion Corners

- Why do these happen?
- No consideration for measurement errors and mistakes

Pin Cushion Corners

- No consideration that you have errors and mistakes in YOUR measurements
- No consideration that previous surveyor has errors and mistakes too

When You Want To Set

- …that iron 0.2 ft from an existing, called for monument, don’t do it!

How Much Do I Have to Miss?

- It depends
- Remember Cooley's words:
- "…when one or more corners is extinct…, all parties have acquiesced to lines based on points that may not be trustworthy…."

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Cooley continued

- …but to bring discredit, when people concerned do not question them… "breeds trouble in the neighborhood…"
- "…often subjects the surveyor to discredit…"
- "…long acquiesced line may be better evidence of the real line that any survey made after the monuments have disappeared."

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Moving Back to the Analysis

- See the relationship to traverse computations?
- Probably best analytical tool to estimate discrepancies is to…
- What?

Rules For Analysis

- Follow the surveyor's footsteps
- By understanding procedures, instruments, mathematics applied
- If you don't know, do best guesstimate
- Least squares analysis makes the work light
- But you MUST understand error propagation!

Creating Descriptions

- Be complete
- Have permanent monuments
- What is probability of disturbance?
- If probability is high set more monuments
- Or have ties to other reliable points

Creating Descriptions

- Adjust your own surveying data so that it closes
- Use a reasonable method
- Again least squares if you understand propagation of errors
- But even Compass Rule is considered standard

In An Ideal World

- All survey plats and reports must include a narrative
- How was the survey done?
- Instruments?
- Calculations?
- Even stake out of the monuments!

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Provide

- Raw and adjustments
- Coordinates whether state plane or arbitrary
- Details such as how many times was an angle or distance measured?
- Was it a GNSS observation? Static or RTK?
- How many epochs or observation time?

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SO…

- It is your obligation to your fellow surveyors to leave footsteps
- Honor the profession, honor your work

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The Fancier It Gets, the Harder It Is

- Retracing descriptions is not a competition to see who is more accurate
- Being the original surveyor carries awesome responsibility
- Either way, DO YOUR JOB, leave your "footsteps," imagine *anyone* following you

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Thank You!

- Questions: write joepaiva@geo-learn.com

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About seminar presenter Joseph V.R. Paiva

Dr. Joseph V.R. Paiva, is principal and CEO of GeoLearn, LLC (www.geo-learn.com), an online provider of professional and technician education since February 2014. He also works as a consultant to lawyers, surveyors and engineers, and international developers, manufacturers and distributors of instrumentation and other geomatics tools, as well being a writer and speaker. One of his previous roles was COO at Gatewing NV, a Belgian manufacturer of unmanned aerial systems (UAS) for surveying and mapping during 2010-2012. Trimble acquired Gatewing in 2012. Because of this interest in drones, Joe is an FAA-licensed Remote Pilot.

Selected previous positions Joe has held includes: managing director of Spatial Data Research, Inc., a GIS data collection, compilation and software development company; senior scientist and technical advisor for Land Survey research & development, VP of the Land Survey group, and director of business development for the Engineering and Construction Division of Trimble; vice president and a founder of Sokkia Technology, Inc., guiding development of GPS- and software-based products for surveying, mapping, measurement and positioning. Other positions include senior technical management positions in The Lietz Co. and Sokkia Co. Ltd., assistant professor of civil engineering at the University of Missouri-Columbia, and partner in a surveying/civil engineering consulting firm.

Joe has continued his interest in teaching by serving as an adjunct instructor of online credit and non-credit courses at the State Technical College of Missouri, Texas A&M University-Corpus Christi and the Missouri University of Science and Technology. His key contributions in the development field are: design of software flow for the SDR2 and SDR20 series of Electronic Field Books, project manager and software design of the SDR33, and software interface design for the Trimble TTS500 total station.

He is a Registered Professional Engineer and Professional Land Surveyor, was an NSPS representative to ABET serving as a program evaluator, where he previously served as team chair, and commissioner, and has more than 30 years experience working in civil engineering, surveying and mapping. Joe writes for *POB*, *The Empire State Surveyor* and many other publications and has been a past contributor of columns to *Civil Engineering News*. He has published dozens of articles and papers and has presented over 150 seminars, workshops, papers, and talks in panel discussions, including authoring the positioning component of the Surveying Body of Knowledge published in *Surveying and Land Information Science*. Joe has B.S., M.S. and PhD degrees in Civil Engineering from the University of Missouri-Columbia. Joe's volunteer professional responsibilities include president of the Surveying and Geomatics Educators Society (SaGES) 2017-19 and various *ad hoc* and organized committees of NSPS, the Missouri Society of Professional Surveyors, ASCE and other groups.

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