Surveying in Today's AEC World

Presented By:

Mark A. Smith, PS

Jerry W. Curry, PS

DGL
CONSULTING ENGINEERS

DGL Overview

Services Provided

- Transportation
- Facility & Site Development
- Land Surveying
- Traffic & Safety
- Construction Management & Contractor Support
- Parks & Recreation
- Residential Improvement

Offices Available

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2022 DBE Consultant of the Year
ODOT Division of Opportunity, Diversity & Inclusion

Professional Engineers	Professional Surveyors	Survey Technicians	Structural Engineers	Transportation Engineers
16	4	10	7	6

Presenters: Surveying in Today's AEC World

Mark A. Smith, PS

- Survey Manager
- Central Ohio
- 20+ Years of Experience

Jerry W. Curry, PS

- Survey Manager
- Northeast Ohio
- 15+ Years of Experience

Agenda

- Definition of Surveying & Historical Perspective
- Geodetic vs. Plane Surveying – Cartesian Coordinate Systems
- Evolution of Technology & the Surveyor
- Case Study
- AEC Clients – Wants vs. Needs

Surveying – Defined

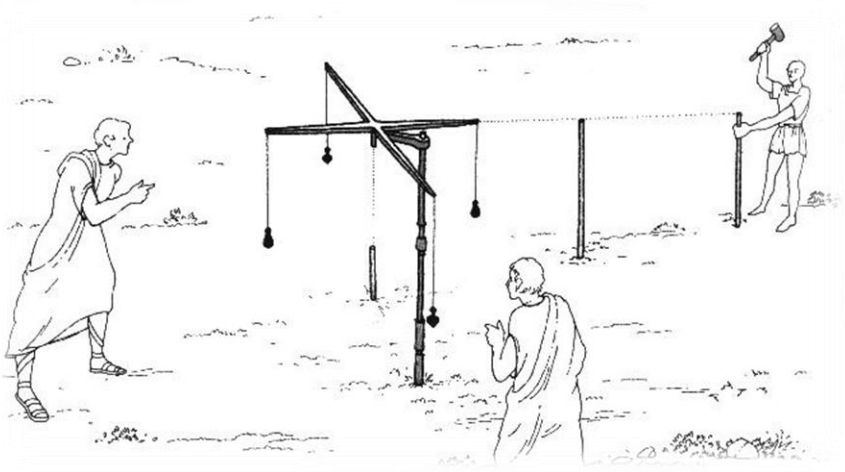
“A branch of applied mathematics that is concerned with determining the area of any portion of the earth's surface, the lengths and directions of the bounding lines, and the contour of the surface and with accurately delineating the whole on paper”

(Merriam Webster, 2022)

NSPS, 2022

Beginnings of Surveying

- One of the oldest professions in the world dating back to ~ 3,500 B.C.
- Ancient beginnings in Egypt, Rome and Greece
- Created for more accurate taxation purposes and property disputes
- Early tools started as simple ropes and sticks, eventually progressing to poles and chains
- As civilizations grew, so did the need for surveyors



Roman Groma (Picfair, 2022)

Two Umbrellas of Surveying – Geodetic

Geodetic refers to Geodesy:
Dividing the Earth (Guy Bomford, 1971)

- "Geo" – Earth or Ground
- "Desy" – Divide or Measure

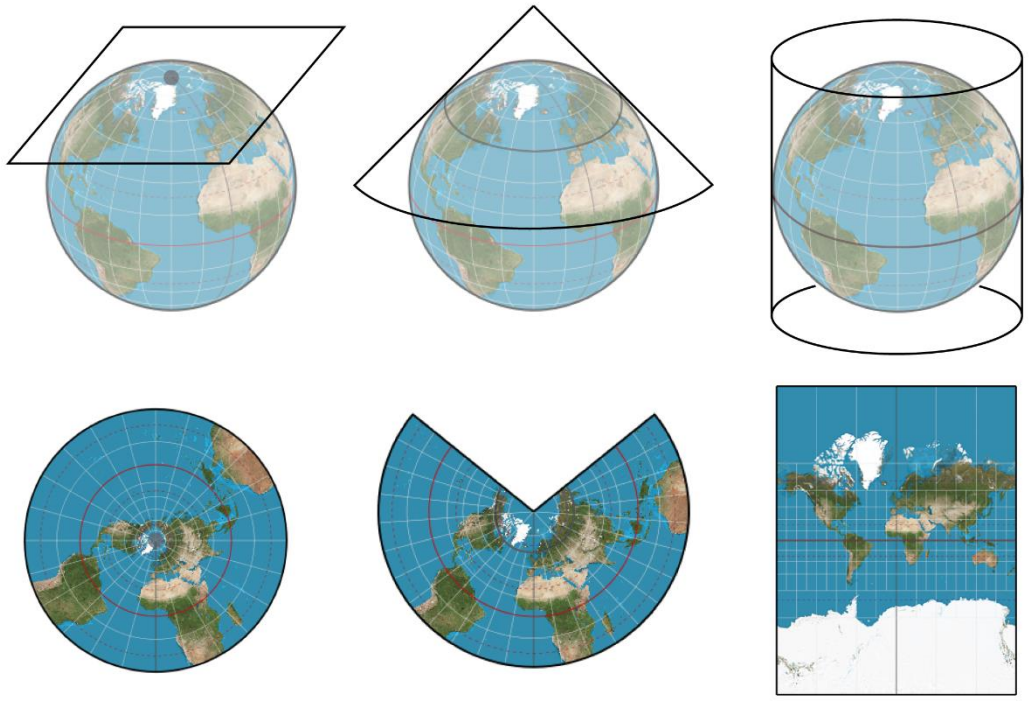
Large Scale mapping effort
– States & Counties Must Consider:

1. Map Projection Distortion
2. Meridian Convergence
3. Gravity
4. Earth's Curvature

1) Azimuthal

2) Lambert Conformal Conical

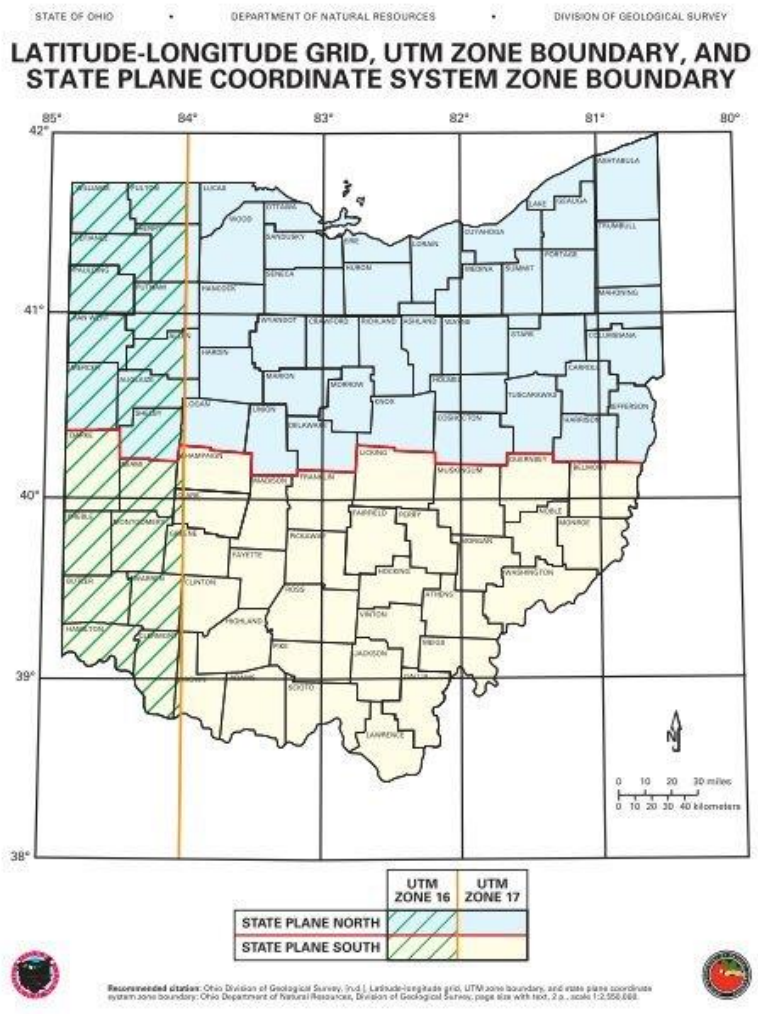
3) Transverse or Oblique Mercator



University Consortium for Geographic Information Science, 2022

Two Umbrellas of Surveying – Plane

- Attempts to create a two-dimensional map / coordinate system of a curved surface.
- Since mapping area is relatively small, geodetic elements are minimal and therefore dismissed.
- Smaller Scale mapping effort – Architecture, Engineering & Construction.
    1. Typically consists of “Northings” & “Eastings” or “X” & “Y” coordinates.
    2. North American Datum 1927 (NAD27) & North American Datum 1983 (NAD83) are commonly used horizontal plane datums.

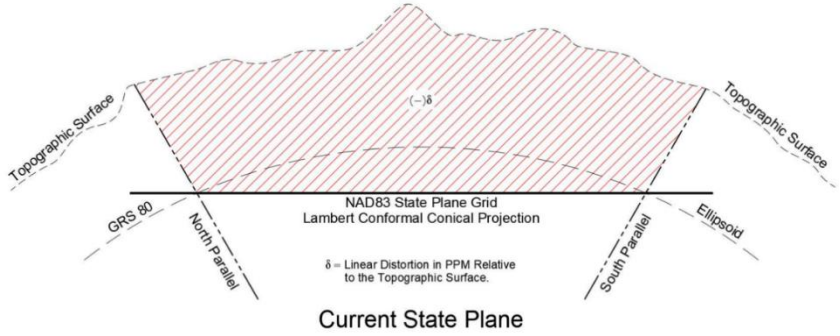


United States Geological Survey (USGS), 2022

Current State Plane vs. Future State Plane

State Plane Coordinate System 1983

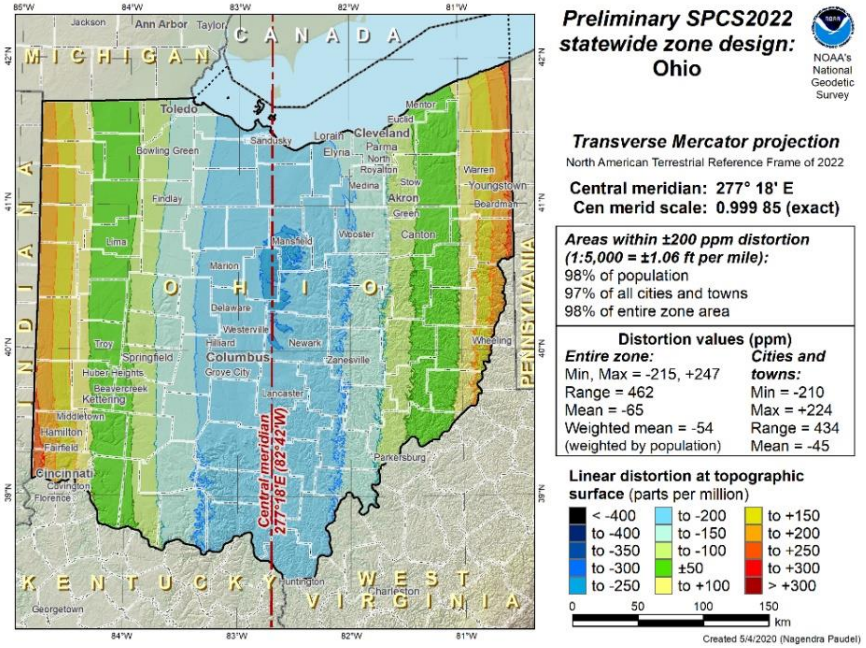
- Two Zones for the Entire State (North & South)
- Units: US Survey Feet (3.280833 feet/meter)
- More Map distortion between grid and ground distances



Colorado NGS, 2019

State Plane Coordinate System 2022

- Limited Distortion Projection (LDP), 88 zones (one zone per county)
- Units: International Survey Feet (3.280839 feet/meter)
- Less distortion between grid and ground distances



National Geodetic Survey, 2021

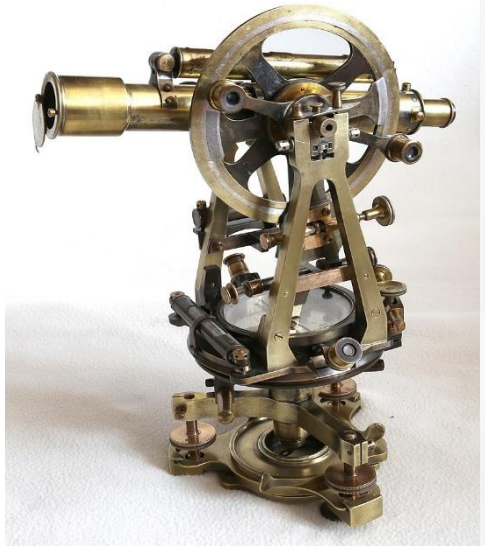
Evolution of Technology

Evolution…

- Circumferentor (Survey Compass)
- Gunter Chain – 66 feet
  - Chain pins
  - Chain person

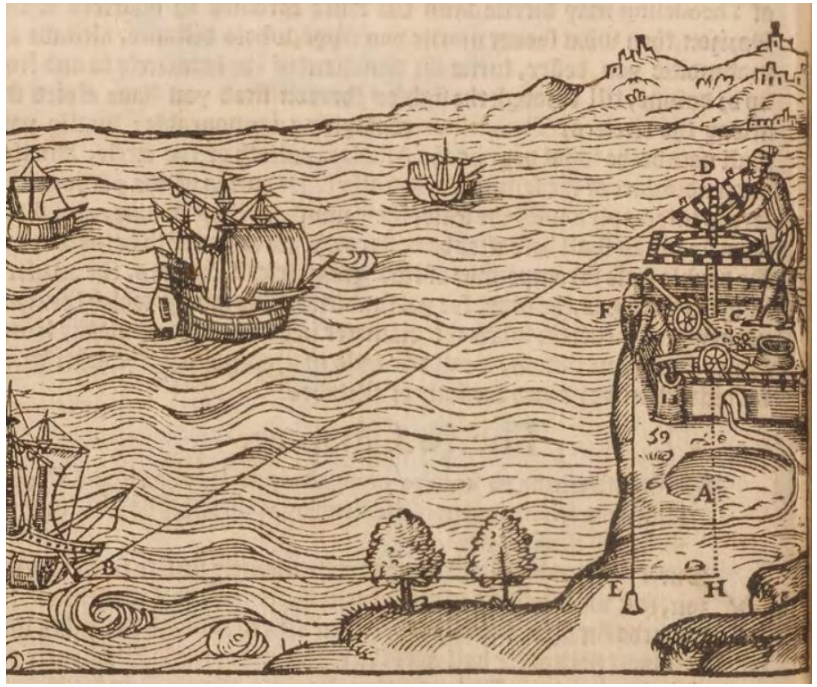
Introduction of Transit

- William Young – 1831
- Fused the compass and Monocular
- Vernier Scale / external angle readings
- Spirit level / Short scope
- American preference

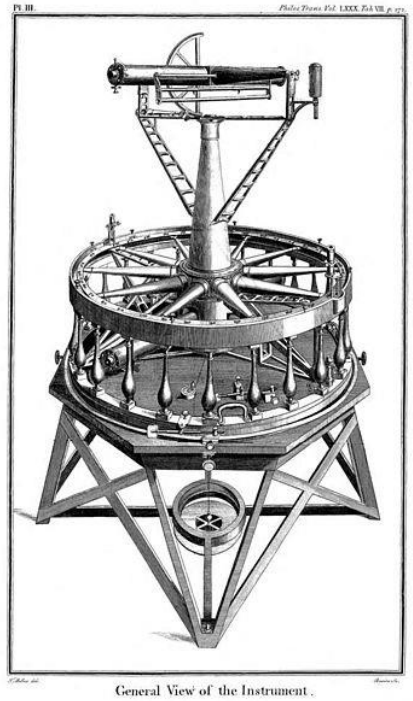


Theodolites – Optical

“a surveying instrument with a rotating telescope for measuring horizontal and vertical angles.”



Theodelitus
- 1559 (London)
- Leonard Digges
- Reflecting Telescope



Common Theodolite
- 1787 (London)
- Jesse Ramsden
- Telescope does not rotate 360°

Optical Theodolite
- 1924 (Switzerland)
- Heinrich Wild

Courtesy of The Linda Hall Library of Science, Engineering & Technology
And The Smithsonian National Museum of American History

Total Stations – Robotics

Total Stations – 1971

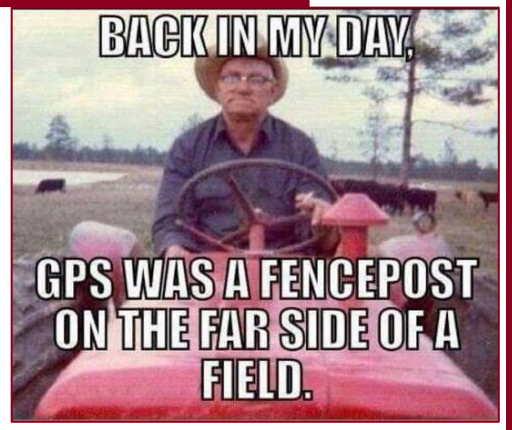
- Transit integrated with EDM
- Instrument Person – Required

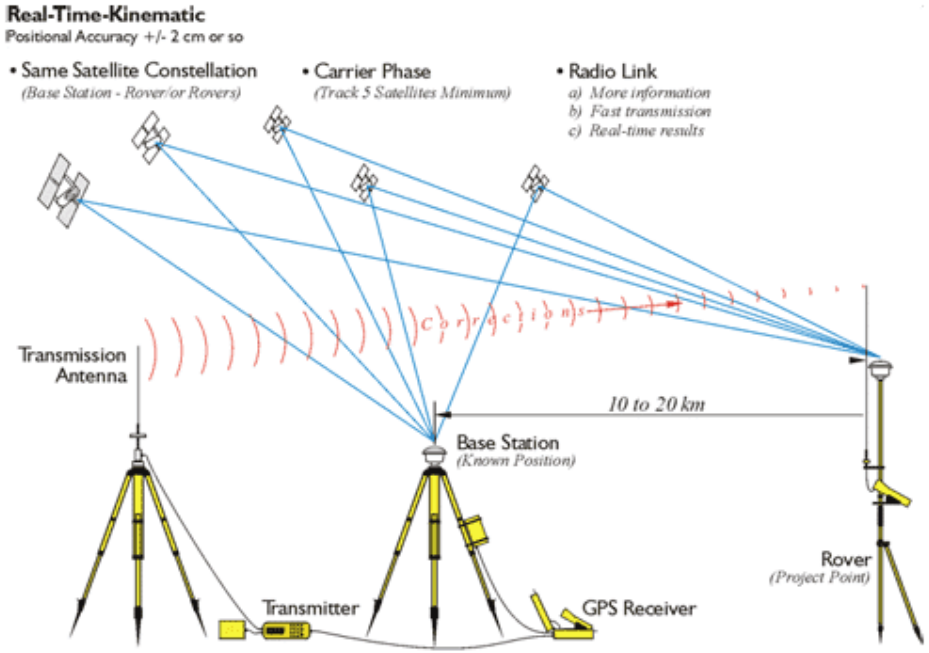
Robotic introduced Geodimeter – 1990

- Controlled remotely
- Instrument Person – Not Needed

GPS

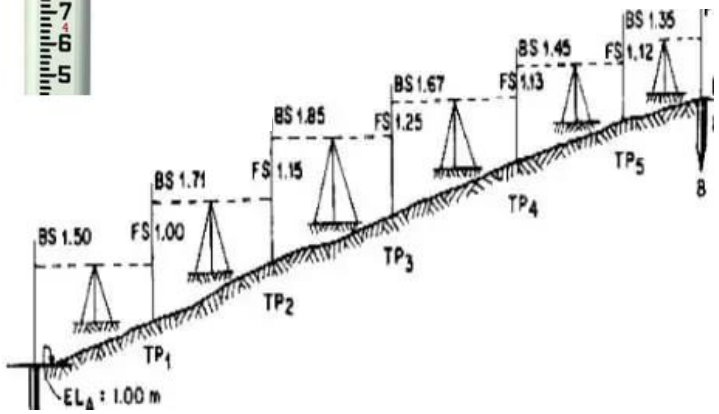
- 1957 Sputnik
  - Scientist track radio signals
  - Science behind tech started
- 1963 Aerospace Corp – Military
  - Started the system we know today
- 1989 First US Satellite



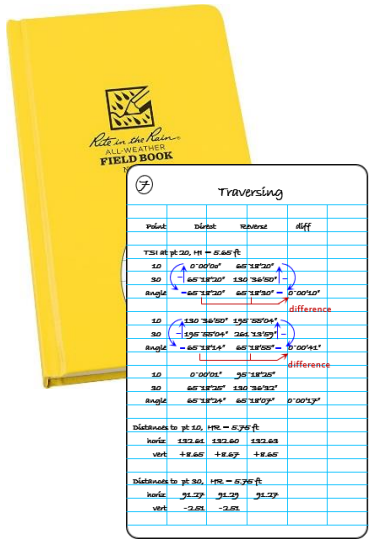


Evolution of Scanning

Evolution of the Level



Field Notes – From Paper to Digital



Surveying Toys

Old Fashioned Survey Crew to Today

Job Outlook

- Employment
  - Projected 2% growth between 2020 & 2030, slower than the average for all occupations.
  - 4,000 annual surveyor jobs are projected over the decade, despite limited growth
- Market
  - Estimated 5% growth between 2020 & 2025

Case Study

Comparative Analysis of Traditional Survey Methods, to Scanning & Drone Technology

DGL

Royalton Fire Department - Lyons, Ohio

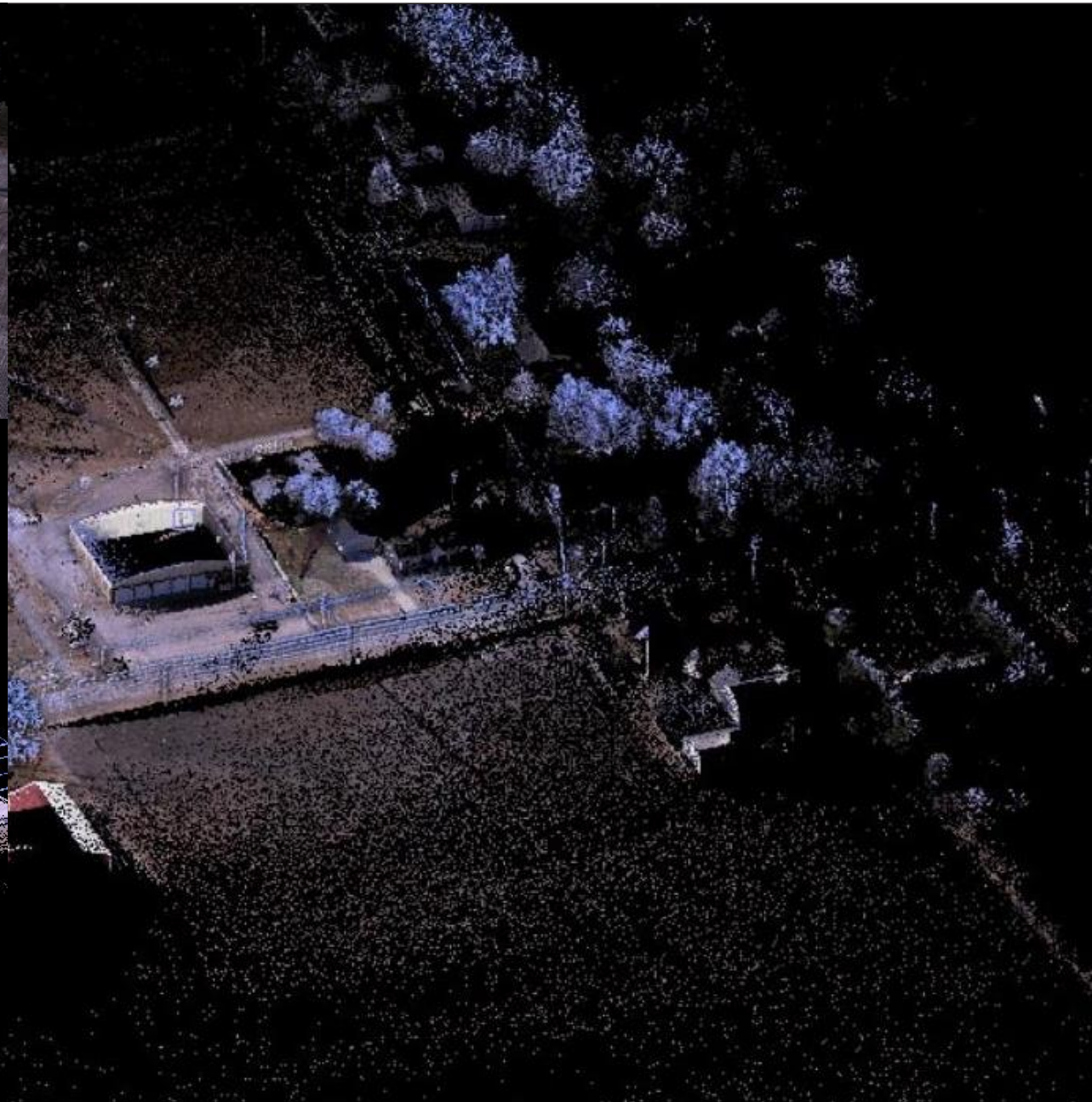
Objective: Comparison of data collection methods

- **Conventional – Trimble S7**
  - Field time: 2.5 hours
  - Office time: 1 hour
  - Points: 636
- **Scan – Trimble SX10**
  - Field time: 1 hour
  - Office time: 2 hours (surface data only)
  - Points: 7.2 Million
- **Drone**
  - Field time 0.5 hour
  - Office time: 3.5 hours
  - Points: 11.4 Million (60 ft Flight Altitude)

Excludes time for site control necessary for each.

CONVENTIONAL: Trimble SX 10

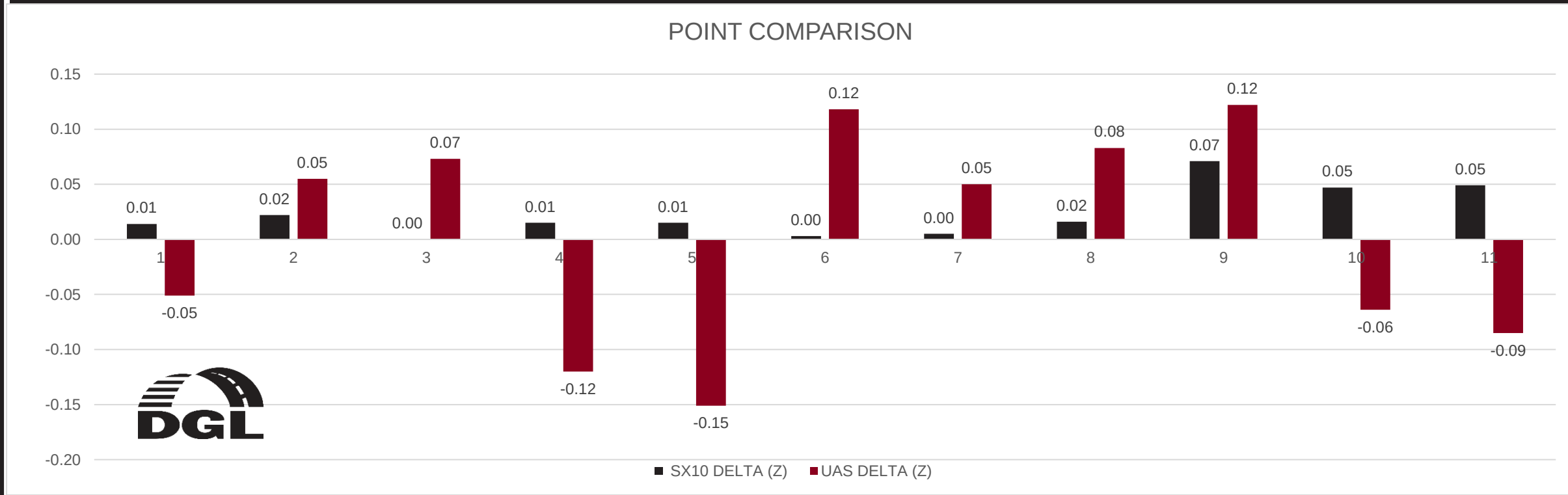
SCAN: Terrestrial (Ground) Point Cloud



DRONE: Aerial Point Cloud (Photogrammetric)

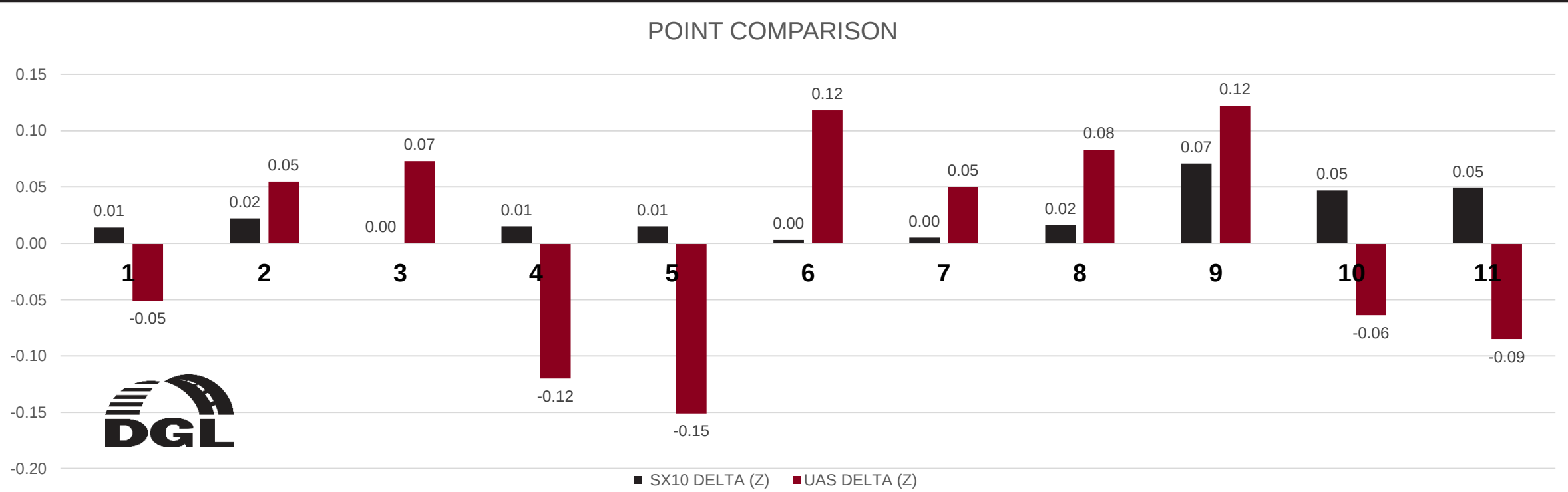
DATA RESULTS: Conventional → Scan → Drone

- Surface comparison – random spots within limits
  - Conventional – served as basis of comparison
  - Scan – spot elevations varied by 0.05 ft
  - Drone – spot elevations varied by 0.12 ft



DATA RESULTS:

1. Asphalt Parking Lot
2. Road Centerline
3. Catch basin (surrounded by asphalt)
4. Asphalt Parking Lot
5. Road Centerline
6. Edge of Pavement
7. Asphalt Parking Lot
8. Concrete
9. Gravel Parking Lot
10. Gravel Parking Lot
11. Catch basin (surrounded by grass)



SUMMARY

- Project specific dependent on conditions, safety and staff
  - Scan – defines surfaces - multip
  - Conventional – defined by grid and may miss changes in between
  - Drone – defines entire surface – elevations are inconsistent
  - All are deficient in vegetation
- Combination – best results are to combine?
- Parameters of project are dependent on site conditions
  - Choose method best for elevation
- Education – each requires training, experience and patience
- Costs – Scanning/Drone – does not reduce costs –value of additional data

AEC Solutions:

What AEC Clients Want – "A Survey"

What AEC Clients Need– "A Surveyor"

Why do we need Surveyors?

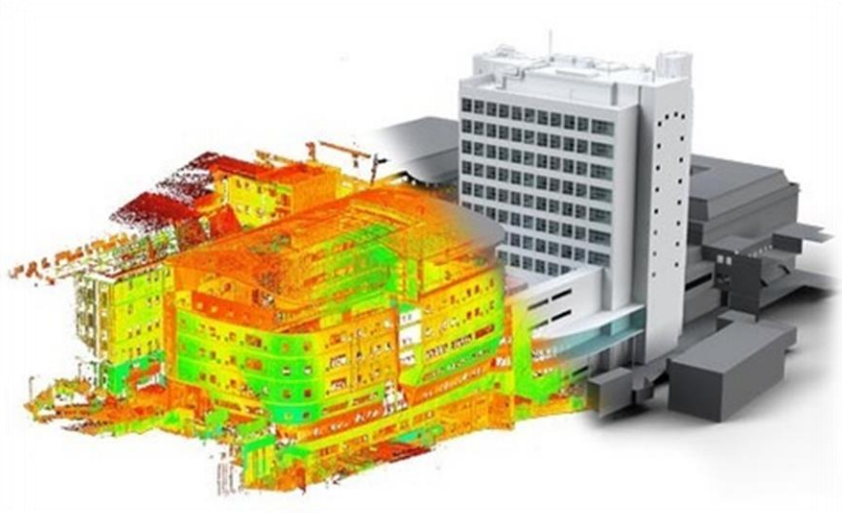
- Upcoming changes to mapping coordinate systems
- Survey is the foundation of projects and sets the tone for later phases of work
- To protect the interests of the general public
- For most scenarios, having a Professional Surveyor on the team is required by Ohio Administrative Code

Architecture

- Building refurbishment, expansions, targeted demolition and as-builts
- All generally fall under the Building Information Modeling (BIM) umbrella

- Deliverables:
  - Point clouds
  - BIM models
  - As-built sheets

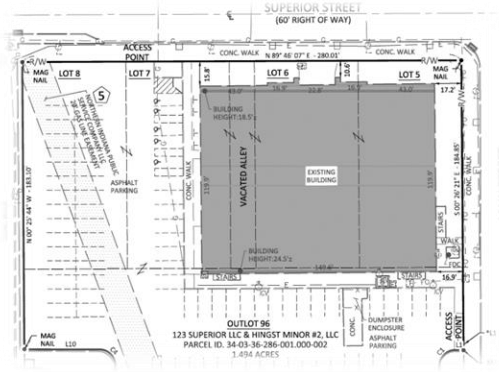
BIM Learning Center, 2022



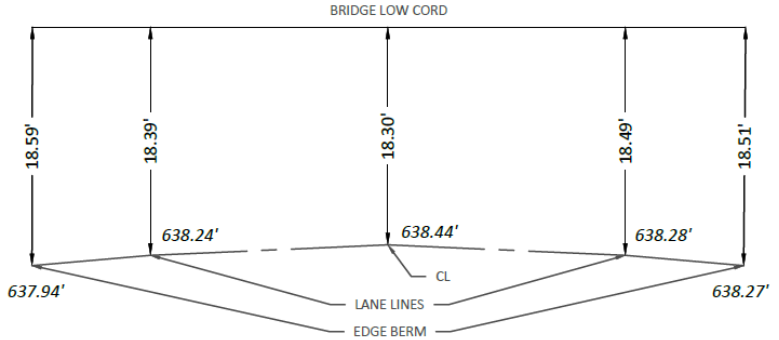
Indimart, 2022

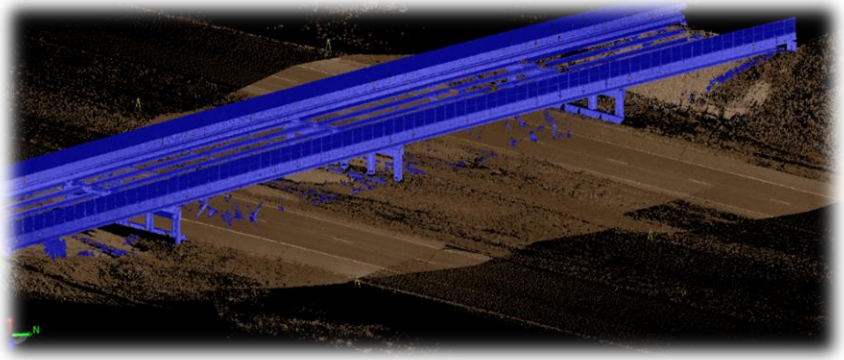
Engineering

- Existing Conditions/Topographic mapping, boundary and right-of-way resolutions, hydrographic surveys, as-built surveys, subdivision platting, and easement creation



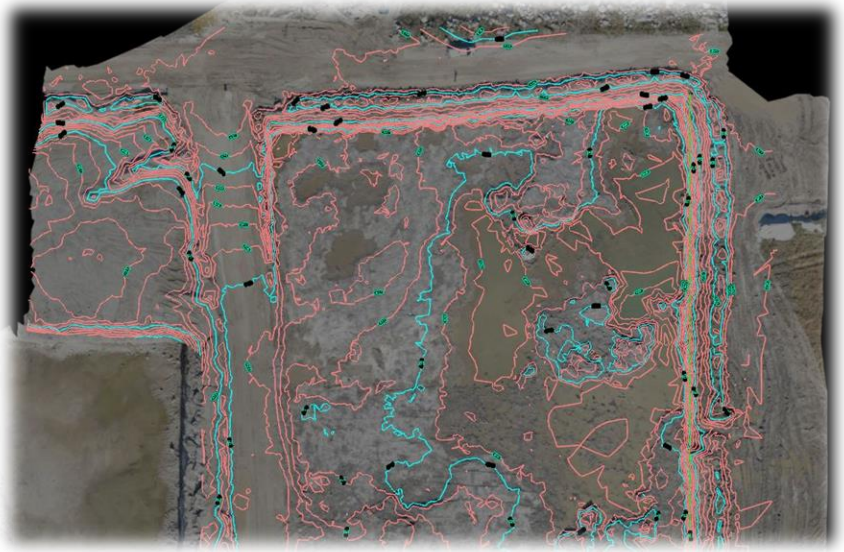
- Deliverables:
  - Signed and stamped surveys
  - Open Road Design (ORD) files
  - AutoCAD Civil 3D files
  - Land .xml files
  - Orthographic photos
  - ALTA/NSPS Survey
  - Drone/Scan Point Clouds
  - As-built Plan Sets





Construction

- Control Surveys
- Construction Layout
  - Building Foundations, Pads, & Column Lines
  - Anchor Bolt layout & As-Builts
  - Waterline, Sanitary & Storm Sewer
  - Retention Basins
  - Curb & Gutter
  - Utility Poles
  - Electric
  - Lot Corners, hold downs, & take offs
- Site Monitoring
- Volume Calculations



Conclusions

- Surveying has been in need since ancient times
- Projecting a spherical object on a two-dimensional object comes with its challenges (and distortion).
- A qualified surveyor on the team brings immense value to the project
- Development of the surveying techniques, tools, and the profession are ever-evolving to meet demand
- Case Study – using the best tool(s) and recommending the right deliverable(s) is critical to success
- The survey is the foundation of all subsequent project phases
- AEC market growth is outpacing that of the surveyor's growth
- Technology is the tool, Surveyors are the necessary Human Element
- Don't be cheap, hire a surveyor (Preferably DGL's Professional Surveyors)

Thank You

QUESTIONS?

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