INTEGRATING TECHNOLOGIES FOR 3D UTILITY LOCATING AND MAPPING

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Lessons Learned:

The Key to Damage Prevention

1. Good decision making
2. Communication
3. Appropriate application of utility locating technologies
The SUE process will remain the same for the foreseeable future but new technologies have emerged to change the industry.
The Original Utility Investigation
We have been surveying and mapping in 2D for centuries, typical Topographic Plan
Geographic Information System
Sample of “GIS” as built by a major telecom company.

How do you relate this information to a Site Plan?
Wish List/ The Black Box
How do we build a 3 D model Above and Below ground

Integrating technologies, 3 D Laser Scanning, Survey and locating technologies
Virginia One Call System
XXXF. S 556)

Dig With C.A.R.E.
Call Miss Utility @ 811

Dig With CARE
Call Miss Utility @ 811 before you dig.

Courtesy Of Virginia One Call System
Damage Prevention vs. SUE

+ Damage Prevention
  + Focus on a toll free call to local One Call Center
  + Mark the utilities before excavation
  + Typically just days before ground breaking

+ Subsurface Utility Engineering (SUE)
  + Engineering tool used in the design phase of a project
  + mitigates the risk associated with construction projects
  + Typically months in advance of construction

OSHA Standards 29 CFR 1926.651b
The Contractors Role
Subsurface Mapping Challenges

- Existing Buried Infrastructure is dense and very complex
- Systems Buried Daily
- Other utilities are abandoned in place
Utility Location Problems

+ Despite major efforts by public and private entities, utility damage is still prevalent nationwide
+ Applying today’s guidelines and standards can prevent accidents
Walnut Creek, California- November 2004
Cause “Inadequate Line locating”

Refer to California Department Of Forestry and Fire Protection SFM Case #277
Environmental and Geotechnical Site Investigations also pose a serious risk to buried facilities.

- Virtually every major project today uses drillers to perform environmental and geotechnical investigations to identify the site characteristics in the design phase.

- These drilling operations frequently break utilities due to utility locating problems.
Even Small Construction Crews Cause the Major Utility Breaks
Why do we need 3 Dimensional data??
Subsurface Utility Locations

- We need to communicate what Level Of Accuracy is shown for underground utilities depicted on our designs
- (ASCE 38-02 Utility Quality Levels) *(Reliability of the data)*
- Designers are now working in 3 and 4 D environments.
- We face new challenges with underground utilities due to Machine Controls
Subsurface Utility Engineering
CI / ASCE 38-02 2002 Publication

+ ASCE Standard
  + Written in 2002
  + Beginning point to solving utility location problems
  + Guideline for all utility mapping project for engineers and surveyors
+ Many engineers recommend SUE to project owners to mitigate utility location problems
Review of the ASCE/CI 38-02 Standard

+ Technical portions of the standard
  + Definitions
  + Collections and Depiction Tasks and Their Assignments
  + Quality Levels for Utility data
  + Deliverables Formatting
  + Costs and Benefits
How does SUE Work?

SUE Quality Levels (ASCE)

+ **ASCE 38-02 Quality Level D**
  + *Used in for planning stage of project*
  
  + Gather all available records from public and private owners and compile a plan showing all known facilities

+ **ASCE 38-02 Quality Level C**
  + *Used in route selection stage (preliminary Design Phase)*
  
  + Survey and locate all surface utility features and compile a plan showing all known facilities while correlating all below ground facilities
SUE Quality Levels (ASCE)

+ **ASCE 38-02 Quality Level B**
  - Used in Design phase typically 15% to 25%
  - Designate the location of buried facilities using Geophysical Locating Technologies (pipe Locators, GPR, Acoustics, X ray and CCTV Technologies.

+ **ASCE 38-02 Quality Level A**
  - Used in Final Design Phase 25% to 95%
  - (Test Holes) expose, measure and record exact location of buried facilities at critical locations (X,Y and Z)
  - Pipe type, conditions assessment, soil contaminants and ground water information is also possible through Level A Vacuum Holes
Record Utility Research

+ **ASCE 38-02 Quality Level D**
  + Gather all available records from public and private owners
  + Compile various old utility plans or “As-Builts” into single composite plan

Research comes from:

- Utility Owners
- Cities
- Towns
- County records
- GIS systems
- Past construction projects

Old Schematic Phone Company Plan
Survey Locating
Beginning of Field Work

+ ASCE 38-02 Quality Level C
  + Surveying surface utility structures
  + Correlating data with the records from utility owners
Electronic Locating Systems/Utility Investigation

+ ASCE 38-02 Quality Level B
  + Applying electronic technologies to determine approximate location of buried systems

Sometimes referred to as Geophysical Investigation
Utility Designation (Line Tracing)

- ASCE 38-02 Quality Level B
  - Most utilities are traced or designated by
  - hand-held locators
  - These Systems designed to locate metallic utilities

Most utilities today are located using these types of hand held locators.
Electrical Resistivity ASCE 38-02 Quality Level B

Electrical Resistivity Side Scanning Using the AGI SuperSting Resistivity Meter

A 28-electrode AGI SuperSting Array with a 3-meter electrode spacing was oriented parallel to the bridge pier and water flow and approximately 2 meters from the pier. Modeling results indicate that adjacent subsurface structures can be mapped using electrical resistivity to image the size, depth and orientation of the target structure and surrounding earth materials.

Detection of a Sewer Pipe

Circle shows approximate size and position of the 3 m diameter sewer drain tunnel

Objective:
The objective was to detect a buried sewer pipe of 3 meter diameter. The pipe appears conductive most likely because of steel reinforcement in the concrete pipe and possibly also because of the content of the pipe

Survey date:September 18, 1998
Survey site:Le Bourget, France
Method:Dipole-dipole electrode array
Instrument:Sting/Swift, 27 electrodes at 2 meter spacing
Processing:Inversion and topographic correction using the Res2Dinv software
Units:Meter and Ohmmeter

Resistivity/Depth Cross Section

North

Reinforced Concrete Pier
Bedrock Pinnacle
Bedrock Horizon
Stormwater Drain

Limestone
Wet Fill/Weathered Rock

Distance along Profile (meters)

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Website: http://www.agiani.com

Courtesy of LRPC, Le Bourget, France

Ohmmeter
CCTV and Pipe Inspections
ASCE 38-02 Quality Level B
Pipe Line Condition Assessment Surveys

+ Sewer and drain Locations
+ Non Metallic lines can be problematic for locating technicians
+ Assets management tool
+ Equipment:
  + Robotic tractors with cameras
  + Manhole Inspection Cameras
  + Digital recording with GPS link
Ground Penetrating Radar (GPR)
Multi Array Antennas ASCE 38-02 Quality Level B

Multi Antenna Systems
Ground Penetrating Radar (GPR)
Pros and Cons, ASCE Quality Level B

+ Most widely used locating technology to trace non-metallic lines (water, gas telephone, sewer, drain and product lines) Excellent results in dry sandy soils.
+ Not suited to areas with heavy clay and/or moisture content in soils
+ Cannot always identify metallic or non-metallic lines
+ Locate lines YES, Not Always Identify—there is a difference.
GPR has numerous applications including the inspection of below ground site conditions, looking for pipes, voids and buried objects.

Runway/Roadway

Pavement Analysis.
Sample of results.

Utility Data: From 2D to 3D, Whitten Technologies
Vacuum Excavation (non destructive excavation)

**Quality Level A** (Exact X, Y and Z Data)

Exposing facilities at critical points and areas or at points of conflicts are resolved utilizing non-destructive vacuum excavation.

![Utility Locating](image-url)
Why Vacuum Excavation?

+ Air Or Hydro Excavation
  + Safe (when used properly)
  + Efficient
  + Minimum surface disruption
  + Less of an impact to traffic and pedestrians
  + Cost effective
  + Highly accurate data available
Verifying Electronic Locations

- Any interference in designation phase requires vacuum excavation
- Best method for obtaining critical depths is by utilizing the vacuuming process
- Provides the accuracy needed for final designs

Exact X, Y and Z
Vacuum Excavation
Rail Projects
Believe it or Not! This guy was locating a sewer line.
USE OF Global Positioning Systems GPS in Survey is now very common.

New Taxiway “MIKE” Project in Logan International Airport, Boston MA.

- Project team all working with the project survey control network
Surveying Services (Data Management) Utility Asset Management Systems (GIS)

+ Using a survey total station or GPS ensures all information is precise and accurate
+ Recover/establish survey horizontal and vertical control network
+ Locate all the results from the site investigation
Boston’s Logan Airport
Mapping Underground Electrical Lines
Merging the data into delivery formats
3D Laser Scanning for Route Surveys (terrestrial)
3D Laser Scanning for Route Surveys (terrestrial)
3D Laser Scanning for utility infrastructure
Modeling the 3D Data
Modeling the Data
Modeling the Data
Mobile Lidar Sample
Risk Management/ Risk Avoidance/Risk Allocation

+ **Risk Management**
+ You can only manage the risk with regard to existing utilities if you know where they are located

+ **Risk Avoidance**
+ Avoid Design conflicts that are in conflict with Existing Utilities
+ Design work clear of buried infrastructure
+ Avoid having staging areas over buried utilities
+ Avoid encountering “Differing Site Conditions”
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