James H. Anspach, P.G.
Chairman: ASCE Board Committee, Codes & Standards
Chairman: ASCE 38
Chairman: Construction Standards Council, ASCE CI
Principal Investigator, Investigator: SHRP2 R-01, R-15, R-01A, R-01B, R-01C, NCHRP 205, ACRP 509

Michael E. Harford
Vice Chair, Osceola County (FL) Commission
Certified Underground Utility Contractor (FL)
A significant component of SUE is the primary use of geophysics to locate utilities

- Relatively accurate when it works
- Non-Destructive
- Relatively comprehensive project coverage
- Correlates to records / visual features / exposures
- Leads to QLB data
Different Geophysical Tools Used For Historical QL B

- Rely on field operator to say where they’ve been
- Difficult to sweep in every direction; rely upon standard utility configurations for orientations
- Depths unreliable / no elevations possible
- Field time intensive; instrument operator training critical for good results
- Separate survey function to reference paint marks
Similar Focus On Geophysics For Geotechnical/Environmental Investigations

- Ground water studies
- Pavement studies
- Mineral deposits / Coal seams
- Contamination plumes
Technology can’t overcome poor procedures

Love Canal faux pas:
Test holes before Geophysics

- First six exploratory boreholes at Love Canal
- Geophysical map of the dump site
- ALL SIX HOLES MISSED THE TARGET!
What if we combined these technologies to find utilities and geotechnical data, at the same time?
We define SUE PLUS™ as:

- The augmentation of the practice of Subsurface Utility Engineering with geotechnical data derived from geotechnical interpretations. Such technical data may include, but not be limited to, interpretation of linear features, unknown utilities, structures, and characteristics of paving, substrate, voids, soil, rock, water, and contaminants.

- Data is typically obtained through the use of advanced surface geophysical techniques and may be integrated with records, geomorphology, lab and field testing.
The SUE PLUS Mission is:

- To marry the best of geophysics to the best of SUE
- To be very quick in and out of the field to reduce traffic impacts
- To develop data on obstructions / targets / features other than utilities during the same survey time
- To tie all geophysical measurements to above ground stationing to very high levels of confidence to show elevation of noted linear features as well as depth of cover - Topographic
- To deliver the results of the survey in both a 2D CAD, or other visual representation, as well as a digital dataset in 3D suitable for uploading into a GIS or for dataset manipulation
- To reduce the number of Quality Level “A” data points by providing accurate 3-D images of utilities and other linear features with accuracies of better than 0.5 feet Z, and 0.1 feet X,Y
Why we want to reduce # of test holes

- How many times do we really need 0.05 feet vertical accuracy?
- Costs are high
- Traffic tie-ups
- Paving repairs
- Point-source data only / can’t rely on cross-sections anywhere but at test holes
Summary of Process - Bridging the Elements

Data Acquisition ➔ Data Processing ➔ Data Interpretation ➔ Results (CAD, GIS)

Software

Handheld Tools
Radio Frequency
Pipe and Cable Locators

Digital Geophysical Mapping
GPR
EMI
Seismic

Positioning Tools
GPS
RTS

Software

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Handheld Tools
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GPS
RTS

Software

2012 AASHTO Subcommittee on Right of Way and Utilities Conference
Marriott Waterfront Hotel – Portland, Oregon
April 29 to May 3, 2012

Where Tradition and Transformation Converge
Value of Multi-Channel Data Collection / Interpretation:

• Data collection speed is at least as fast as with single channel units (“lawn mower” style)
• Collects 4 to 14 times as much data with the same effort
• 3-D imaging is superior to single channel work due to data density
• Tied to subscription grade GPS for precise X,Y, & Z
• Post Processing of datasets allows for high level QA/QC and Confidence Levels
2D and 3D GPR Representation of Utilities

This is an example of data and interpreted targets from a 3D GPR image on the M-29 Project. **Blue** is water, **magenta** is electric and **green** is sewer.

This is a 2D cross section that depicts features of interest highlighted by **yellow arrows**.
MetaVision II™ TDEMI System

- Used to augment TerraVision II™ results or stand alone in clay soils (where GPR doesn’t function well)
- Useful in areas where soils are not optimal for GPR (high clay/moisture content)
- Produces depth information via a proprietary inversion algorithm
- Essentially a metal detector on “steroids.”

TDEM results showing metal pipelines in a petroleum tank farm.
With Powerful Software & Experienced Data Analysts, Totally Different Data Sets Can Be Integrated
Overview of Integrated SUE PLUS™ Imaging Systems

- 14-channel GPR
  - Produces 3D subsurface images

- 3-channel EMI
  - Aids in most soils
  - No connection to utility

- Choice of positioning
  - Depends on needs of the job

- In-field system integration
  - GPS with GPR and EMI

- 3-D processing, visualization and interpretation
  - This piece is critical and difficult

- Final digital output
  - CAD in client’s format
  - Dataset for Machine Control and Guidance
RECAP

• Due to the vast amounts of data generated with a SUE PLUS™ survey, the data sets must be post-processed by experienced analysts using very sophisticated software.
• The deliverable provided the client is available in multiple digital formats for future use.
• SUE is proven to pay for itself; adding SUE PLUS™ provides valuable paving and geotechnical data plus better utility mapping.
• SUE PLUS™ can cut the number of test holes by a lot; it also allows a cross section to be cut anywhere.
• It’s time for utilities to catch up with technology.
Process

• Combine Early Design-Stage Utility Mapping and Some Geotechnical Mapping into Project Constructability Reports
  – Utility Report and CADD Map
  – Geotechnical Report and Map
• Then Select locations for Test Holes, Geotechnical Bores
Michael E. Harford

Perspectives from a Utility Contractor turned Project Owner
ROW Management

• Prime Consideration: Safe efficient transportation
  – Minimize lane occupancy of non-transportation activities
    • Planned project duration
    • Actual project duration
    • Future maintenance activities

• Secondary Consideration: Cost to the Public (taxpayers and ratepayers)
What keeps me up at night?

- Safety Issues
- Cost overruns
- Closures of businesses (planned and unplanned)
- Maintenance of Traffic
- Bad Tourist Impressions
Situations Where SUE PLUS Can Help

Milling Snafus
– buried covers
Situations Where SUE PLUS Can Help

Undercuts to pavement

- GPR on relatively thin pavement over base material
- Quick and easy measurements
Situations Where SUE PLUS Can Help

Buried Manhole Covers
Situations Where SUE PLUS Can Help

Buried / Paved-over Vault Structure
Situations Where SUE PLUS Can Help

Unknown function Trench
Situations Where SUE PLUS Can Help

Tree Roots
Situations Where SUE PLUS Can Help

Multiple Material Layers

Good GPR data showing pavement layers
Situations Where SUE PLUS Can Help

Voids under rebar

GPR signal has negative amplitude (noted as black space) because it doesn’t have anything to bounce off of (namely air).
Situations Where SUE PLUS Can Help

Voids under rebar
Situations Where SUE PLUS Can Help

Cemetery / Grave limits

- The black rectangles represent visual grave stones.
- Green and white areas are TDEMI anomalies interpreted to be gravesites.
Situations Where SUE PLUS Can Help

Bedrock

Interpreted Top of Bedrock

Soil Layering
Situations Where SUE PLUS Can Help

Underground abandoned storage tank and piping
Situations Where SUE PLUS Can Help

RR Ties (tracks removed)
Situations Where SUE PLUS Can Help

Remnant Buried Foundation Supports
(Plus a variety of other linear targets)
Osceola County Data: Pavement Layering; Multiple Utilities

- From Narcosee & Rummel Intersection
Osceola County Perspective

- Developing utility relocation plans,
- Getting better info to bidders,
- Reducing differing site condition change orders and contingencies,
- Targeted test holes based on reliable utility data without excavation,
- Traffic impacts/merchant impacts due to shorter construction times
- Regulations…