Municipal infrastructure engineering projects like mass rapid transit, improved sewers, and water mains have been booming over the last few years due to population growth and a focus on better urban planning to do more with existing city-owned property and road networks. For every project, Subsurface Utility Engineering (SUE) is required to do a full investigation of existing underground assets before the design is complete and certainly before shovels hit the ground. In this session we will first look at various best practices using AutoCAD Civil 3D software to build intelligence into SUE data sets and Navisworks software for performing clash analysis between existing utility objects and design objects. We will then end the session using InfraWorks 360 software to present our combined model to others in the Project Team. Using InfraWorks 360-Collaboration software, the session will show some inventive mobile field capability for viewing, photo, and data capture that you can post to the model.
CI11646 - Subsurface Utility Engineering Meets Innovative 3D Technology

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Key learning objectives

At the end of this class, you will be able to:

- Learning Objective 1 - Learn how subsurface utility engineering can benefit from 3D modeling
- Learning Objective 2 - Learn the workflows required to perform clash detection between utility and design data sets
- Learning Objective 3 - Learn the workflows required to build the enhanced model using InfraWorks 360
- Learning Objective 4 - Learn about mobile technology for viewing and augmenting the model with photos and data capture
Integrated Products used in SUE Workflows

- Autodesk Infrastructure Design Suite Ultimate
  - AutoCAD Civil 3D
  - AutoCAD Map 3D
  - Autodesk InfraWorks 360
  - Autodesk Navisworks Manage
Autodesk Navisworks NWC Export Utility

- Converts AutoCAD Civil 3D Drawing .DWG AECC Objects to Autodesk Navisworks Manage .NWC files directly
Dataset Review for SUE Analysis
Critical Civil 3D Datasets used for SUE

- Existing and Design Terrain Surfaces can be stylized and exported to NWC format
- Pipe Networks and Existing Underground Utilities can be Exported Directly to NWC format
- Road Corridor can be converted to AutoCAD Solids and Layered based on Station Range and Material Code
Overview of SUE Model Data Extraction

**Base Topo**
- Includes: Existing Ground Surface from InfraWorks 360/Surveyor

**Base Corridor Design**
- Includes:
  - Site Parkway, Streets and Curb and Gutter Alignments, Profiles
  - Site Parkway Corridor
  - Site Parkway TOP and DATUM Surfaces

**Base Pipes Design**
- Includes:
  - Pipe Network
  - Pipe Trench Surface
  - Excavation Surface (Datum + Trench)
  - SWM Pond Surface

**Base Utility**
- Includes:
  - Sanitary Pipe Network
  - 2D Utilities for GAS, POWER

**Construction Datasets**
- **Corridor Solids** (Layered by Construction Zone, Region Station and Shape Code) (DWG Format)
- **Storm Pipe Network and SWM Pond** (Parts Layered for Construction Zone) (NWC Format)
- **Excavation Surface** (Layered by Construction Zone) (DWG Format)
- **Existing Sanitary Pipe Network and 3D Utility** (assumed depth) (NWC Format)
Base Topo from Survey

- Provides the Base Existing Elevation Model for Utility Projection
- Must be accurate for accurate interpolation of Utility Depth
Base Corridor Design

- Provides accurate TOP Surface for Proposed Utility Design in Profile
- Provides accurate DATUM Surface and Assembly Solids for Navisworks Clash with shallow Utilities
Base Pipes – Existing and Design

- Pipe Networks for both Existing and proposed
Creating the Interpolated 3D Utility Model
What is the Interpolated Utility Surface?

EXISTING SURVEY SURFACE

INTERPOLATED UTILITY SURFACE
(Net volume surface between utility surface and existing survey surface)

UTILITY DEPTH SURFACE

UTILITY DEPTH FROM TESTPITS

0.5  0.7  0.2  0.5  1.0  1.2
What we need to Build the Interpolated Utility Surface?

- Existing Topo Survey and Surface Model
- GIS converted to CAD Mapping – 2D Polylines representing the Utility Conduit
- Actual Testpit or Pothole Data with Depth to TOP of Utility
- More Testpit Info like Size, Shape and Type
Testpit Depth Import - XYZD

1. Using the Testpit Datasets collected in the field
2. Create Point File from Excel with only PNED columns
3. Import Points using a Comma Delimited XYZD format,
4. Where “D”escription is the Utility Type
5. Create Point Groups for EACH utility type
6. Create a “Default” Point Group of points defining the common limits of the site (we need this later 😊)
For EACH Point Group, create a Surface called “TP-XXXX” which represents the Testpit Depth Surface

Add the Default perimeter points for common limits and better TIN

Edit the TIN using breaklines if required
Interpolated Utility Surface based on Dynamic Differential Net Volume Surface

1. For Each Utility Create a New Drawing with Data Shortcuts to both Existing and TestPit Surface
2. Create a Net Volume Surface using,
   - Base = TP-XXXX
   - Comparison = Existing Survey
3. The Resultant Surface IS the Interpolated Utility Surface
4. It’s DYNAMIC! Changes to Survey or more Testpits will change this surface automatically
- Import 2D Polylines into UTIL-XXXX Drawing
- Using Featureline Modify Tools,
- ADD Pis to Featureline every 1m
- Set Elevations on Pis using UTIL-XXXX Interpolated Surface
- Split and Relayer as needed for Shape, Size and Type (we may need this for Infraworks)
- Done!

Ready to Project 2D to 3D…
Navisworks Configuration
For Navisworks, We need Solids...

- NWC Export,
  - Pipe Network for Existing and Proposed
  - Surfaces (for Context Only)
- DWG Solids
  - Design Road Corridor
  - Existing Utility Conduits
  - TestPits
Export NWC for Pipes

- Isolate the Pipe Network and Export to NWC using “NWCOUT” command
3D Solids for Road Corridor

- Select Corridor
- Context Ribbon Menu Option “Extract Corridor Solids”
- Add all regions
- Export to New Drawing
- HINT: Make sure Units is correct in the resulting Drawing
Using our 3D Polyline in the UTIL-XXXX drawing, we first MAKE A COPY of the 3D utility Polyline. Then use the SWEEP command to create our 3D Utility Object. Warning: Depending on the size of the Utility, you may have to drop the 3D Polyline to accommodate the TOP Elevation.
Creating a Swept Path Solid
Adding Testpits.dwg to Navisworks using AutoCAD Automation

- Using a Standard 3D Block with Attributes
- Display Options showing Attributes
Clash Detection Analysis between Design Pipes and Existing Underground Features

- Proposed Storm Design vs Existing Sanitary Trunk
- Proposed Storm Design vs Existing Utilities
- Proposed Pipe Trench vs Utilities
- Reporting and Output
Infraworks Configuration
AutoCAD Map 3D to the Rescue

- Create a Class for Utility Definition
- Before we get started, Users need to “Login”. Select “Map Setup” Panel, Select “Login” to Map 3D as a “SUPERUSER”. The Password is “SUPERUSER”. Note: All Uppercase…
- Define a Class
- Set Object Properties
- Set Custom Properties
- Classify Selected Objects
Classify Utility using Map 3D
Infraworks Configuration using SDF Properties

- Map Export to SDF
- Configure Data source using SDF Properties
Import using VBA – Map Export to SDF
AEC Inspect Configuration
AEC Inspect Form Configuration for Data Collection

- Custom Mobile Field Data Entry Form
- Data Direct to Excel
- Photo Direct to PDF
- Direct to AutoCAD Blocks using VBA
GCX2 Receiver connect to AEC Inspect App

- Smallest and lightest GNSS integrated receiver
- Innovative and ergonomic shape
- Compact, rugged, and cable free design
- Wireless multi-channel Long-Range Bluetooth Technology RTK corrections
- All day operational with rechargeable batteries
- RTK performance with cm level
- Low cost
Our TestPits Mobile Form

- Project Select
- General Details
- Custom Details
- Photos
Add Testpit Data to Infraworks using same AutoCAD Automation

- Download Bundle from AEC Inspect Portal
- PDF Photo Report
- CSV Excel with Records
Adding AEC Inspect Data to Navisworks via AutoCAD

- Configure Navisworks Options to display Attributes
Adding AEC Inspect Data to Infraworks via AutoCAD

- Export Blocks using Map Export
- Add Attributes to SDF
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