# CI11338-R: Reimagining BIM for Civil Engineers – Underground Utilities

W. Curtis Smith, P.E., LEED AP

Civil Engineer / Project Manager

Innerlight Engineering Corporation – Miramar Beach, Florida

# CI11338-R:  Reimagining BIM for Civil Engineers – Underground Utilities

Co-Speakers:

**Matthew Anderson, P.E.** – Autodesk, Inc.
**Steve Hill** – Red Transit Consultants

# Class Summary

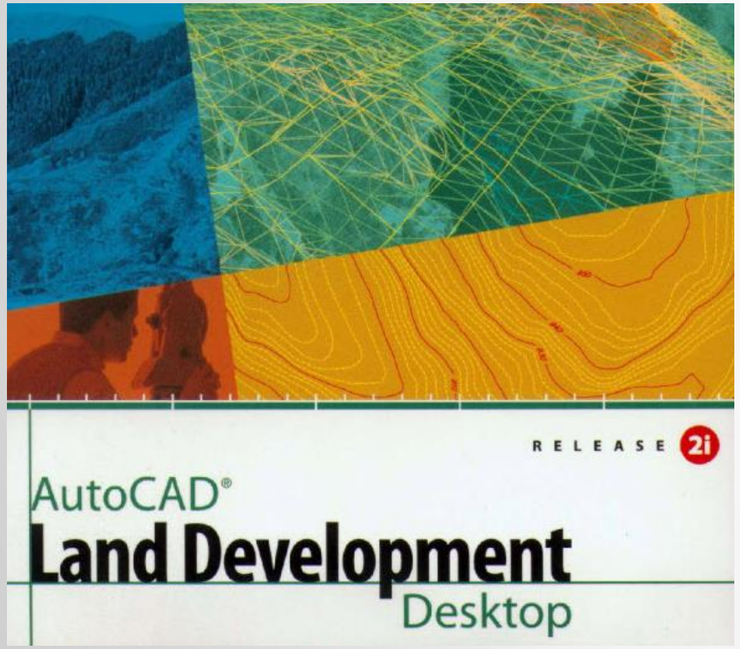
A roundtable discussion on how we might reimagine the way Building Information Modeling (BIM) for civil engineering is implemented. In this session we will focus on how underground utility piping has evolved in Autodesk, Inc., software, beginning from Land Desktop software, continuing through AutoCAD Civil 3D software, and now into InfraWorks 360 software. We will talk about what worked well through the years, what failed miserably, and what Autodesk can do in the future to improve what we call BIM for the world of civil infrastructure.

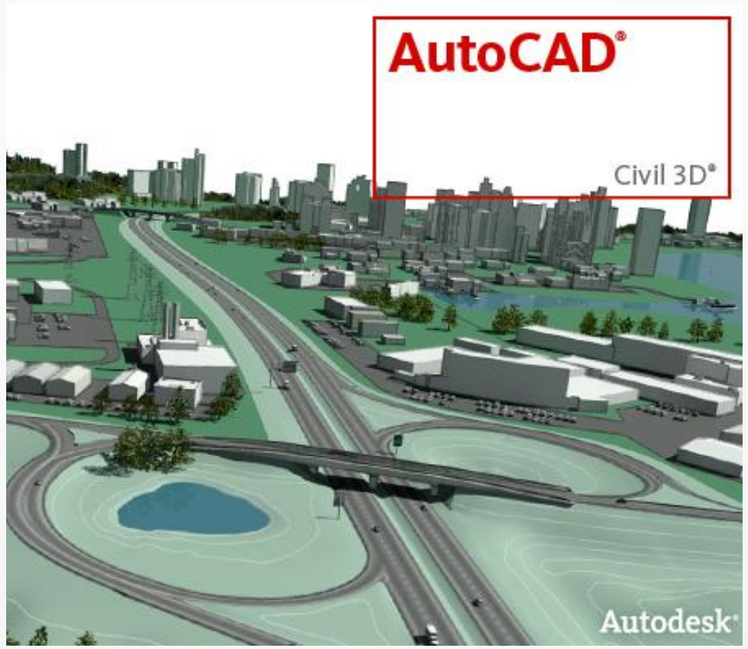
# Key learning objectives

The collaborative goal of this session is to:

- Discover the history of object modeling for underground utility infrastructure in Autodesk's software packages
- Discuss what went wrong and what went right for underground utility modeling in Autodesk's software through the years
- Discover ideas on engagement and wider adoption by both the engineering and product-manufacturing communities
- Brainstorm what can be done to improve underground utility modeling in future releases of InfraWorks and AutoCAD Civil 3D

# A Brief History of Time: The Autodesk Civil Engineering Software Underground Utilities Edition




# DCA → Softdesk → Land Development Desktop (LDD)

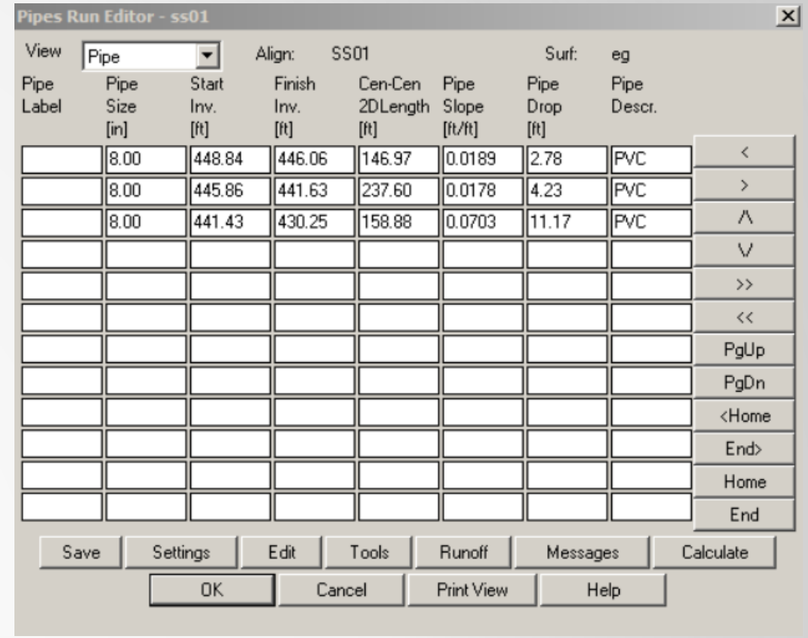
| | |
|---|---|
| Late 1980's | David C Arnold (DCA) Engineering releases a pack of AutoCAD LISP routines for Civil Engineers |
| 1994 | DCA Softdesk released for AutoCAD R13 |
| 1997 | DCA Softdesk released for AutoCAD R14 |
| 1998 | Autodesk acquired Softdesk, and Land Development Desktop was born |

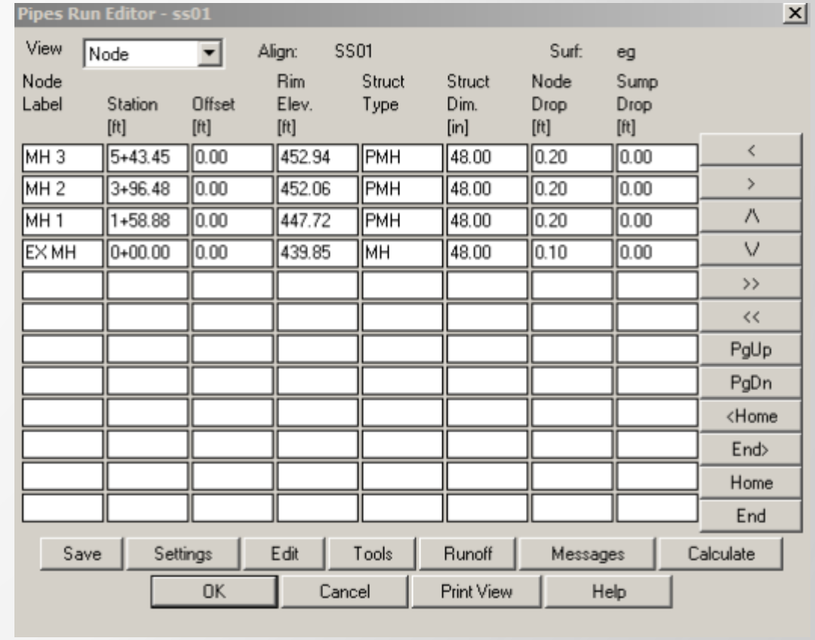
Softdesk included Pipeworks, the first Autodesk software capable of storing pipe and structure data for design and annotation.

Online historical data indicates that Pipeworks was somewhat unreliable and probably not used much in the Civil Engineering industry until LDD became widely adopted.

# LDD Pipeworks

- Pipe Runs were 2D lines with extended data used for design and annotation
- Pipes and nodes communicated with the terrain model.
- Could assign to an alignment for projection into profile views and station/offset labeling.
- Profile Views were **not** dynamic and would not react to design changes; required manually redrawing.
- **Hydraulic data such as flow rate and velocity were calculated on the fly, during design**, which some argue made this tool better than Civil 3D pipes are today.



# Land Desktop → AutoCAD Civil 3D

| | |
|---|---|
| 2003 | Civil 3D is introduced as a preview software. **Pipe Networks were not present in the software.** LD was still intended to be ran in conjunction with Civil 3D for gravity pipe design. |

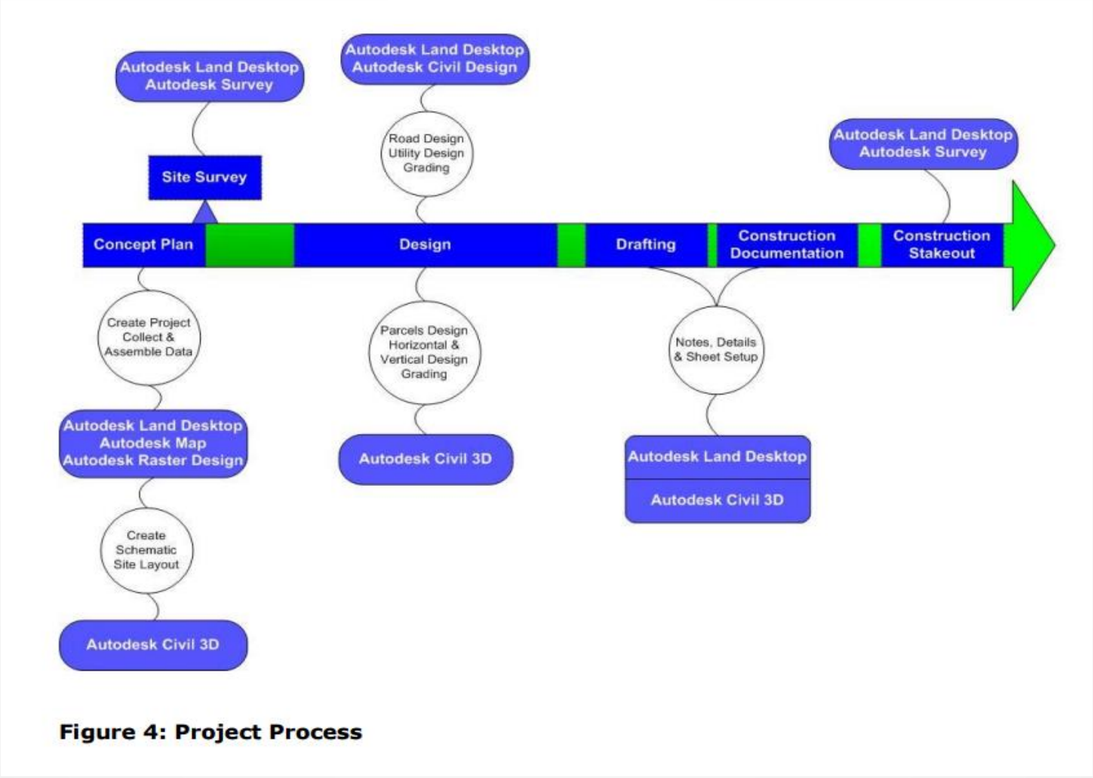


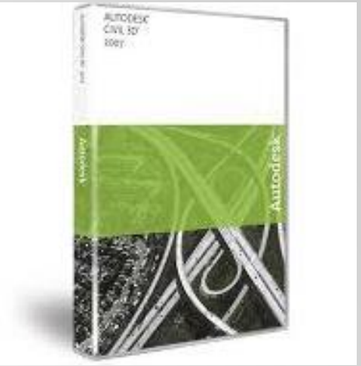

**Figure 4: Project Process**

# Land Desktop → AutoCAD Civil 3D 2006

- **Civil 3D gets its first Pipe Network functionality**
- Customizable **external catalogs**
- **Dynamic updates** between plan, profile, and section views
- Dynamic pipe and structure labeling
- **Import and export Land XML** files to transfer data to/from analysis software
- **Pipe Rules:** Slope, Cover, Pipe Length (Hasn't changed much since)
- Ability to copy pipe or structure table from Panorama and past to MS Excel

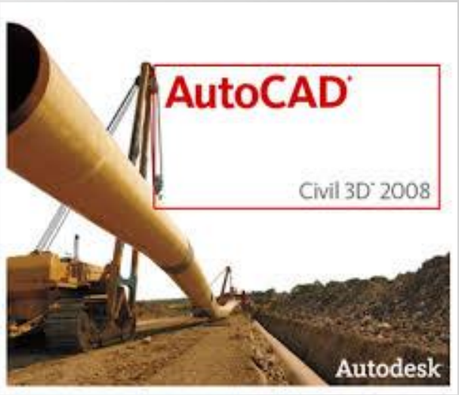
From LD to Civil 3D – Lost hydraulic and flow characteristics but gained 3D model based design, parametric parts, curved pipe capability, and truly dynamic updates

# AutoCAD Civil 3D 2007




- **Interference checks** introduced
- New profile grips to structures
- Create pipe network from objects
- Create alignment from network parts
- Change and apply new rules to existing pipe network
- Create catalog content with **Part Builder**
- **Export to Spatial Data Format (.sdf) for GIS**
- Pipe data bands in profile views
- Label pipes in section views

# AutoCAD Civil 3D 2008




- Spanning pipe labels (plan view only)
- **Dynamic Pipe and Structure Tables** introduced

| | |
|---|---|
| Late 2008 | Autodesk acquires Intelisolve, creator of Hydraflow software package |

- Hydaflow Hydrographs, Storm Sewers, and Express available to subscription customers as a standalone install
- Data can be transferred to Hydraflow Storm Sewers via Land XML files

# AutoCAD Civil 3D 2009


- Spanning pipe labels for profile view added
- Added ability to rename/renumber multiple pipes and structures
- **Hydraflow software package installs with Civil 3D**
- Enhancements to pipe-to-pipe connections “cleanup” graphics
- Improved sharing and access to part catalog libraries

# More Acquisitions

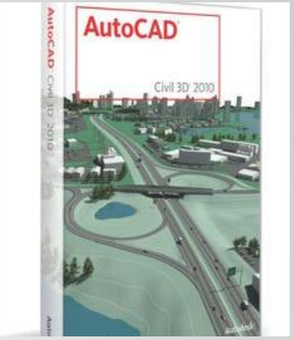
| | |
|---|---|
| 2009 | Autodesk acquires BOSS International's StormNET, RiverCAD, and WaterNET |

StormNET → Autodesk Storm and Sanitary Analysis (SSA)

RiverCAD → Civil 3D River & Flood Analysis Module

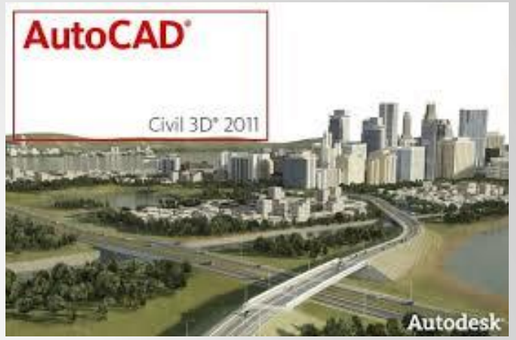
WaterNET → … ??? … lost somewhere in the space-time continuum

# AutoCAD Civil 3D 2010




- **Import or export pipe networks directly to/from Hydraflow through .stm file**
- HGL and EGL parameters added to pipes and structures.  Value can be directly input to individual parts or imported from .stm file.
- New content added to the default part catalogs, such as CMP, HDPE, and endwalls.

# AutoCAD Civil 3D 2011




- Ability to split or merge pipe networks.
- Ability to choose the vertex elevation reference when creating pipe networks from objects; i.e. Outside Top, Centerline, Invert, or Outside Bottom.
  - This enhanced the ability to model water lines with pipe networks by creating from a feature line draped on a surface and lowered the cover amount.

# Infrastructure Modeler and AutoCAD Utility Design

- Autodesk Infrastructure Modeler (AIM) 2012 was announced in mid 2011. In the 2014 release this product would become Infraworks. In its early state (and for the most part its current state) it was a conceptual planning tool to bring together all aspects of civil infrastructure.

- AutoCAD Utility Design 2012 was announced during the same period in 2011. It provided a BIM platform for electrical distribution systems. This software integrated a rules engine into the AutoCAD Map 3D environment.
  - This software delivers a much more robust 4D and 5D environment than Civil 3D or Infraworks but is limited to electrical distribution systems.

# AutoCAD Civil 3D 2012


- **SSA releases and installs alongside Civil 3D as a standalone install**
- Create a pipe network from **imported GIS data**
- Inlet location parameters added – On Sag / On Grade
- Catchment object added, providing the ability to link a drainage area to a pipe network structure
  - Catchment area, runoff coefficient, and time of concentration export to Hydraflow Storm Sewers or SSA, eliminating the need to repeat the inputs in analysis software
- Additional migration settings related to Part Families are added for transferring data to/from Hyraflow and SSA

# AutoCAD Civil 3D 2013


- **Pressure Networks are introduced**
  - Purpose built for water systems layout in plan and profile views
  - Better functionality for vertical design based on depth of cover and horizontal design based on standard fittings
- **Content Catalog Editor** introduced for authoring Pressure Network part catalogs
  - Initial catalog offered is limited.  Ductile iron material only with limited fittings and only a few appurtenances.
- Pressure Networks contain limited functionality (no section views, no crossing pipe styles, no Data Shortcuts, etc.)

# AutoCAD Civil 3D 2014


- **Pressure Network functionality is greatly increased**
- Slide and move function for editing multiple Pressure parts
- Change elevation of slope of multiple Pressure parts
- 3D plane compass settings for rotating compass plane during layout and editing of Pressure Network in model view
- Pressure parts in section views
- Crossing pipe styles for Pressure parts in profile view
- Sort Pressure parts lists by size
- **Pressure Network Data Shortcuts**
- **Dynamic Pressure Network Tables**

# Infrastructure Modeler Becomes Infraworks

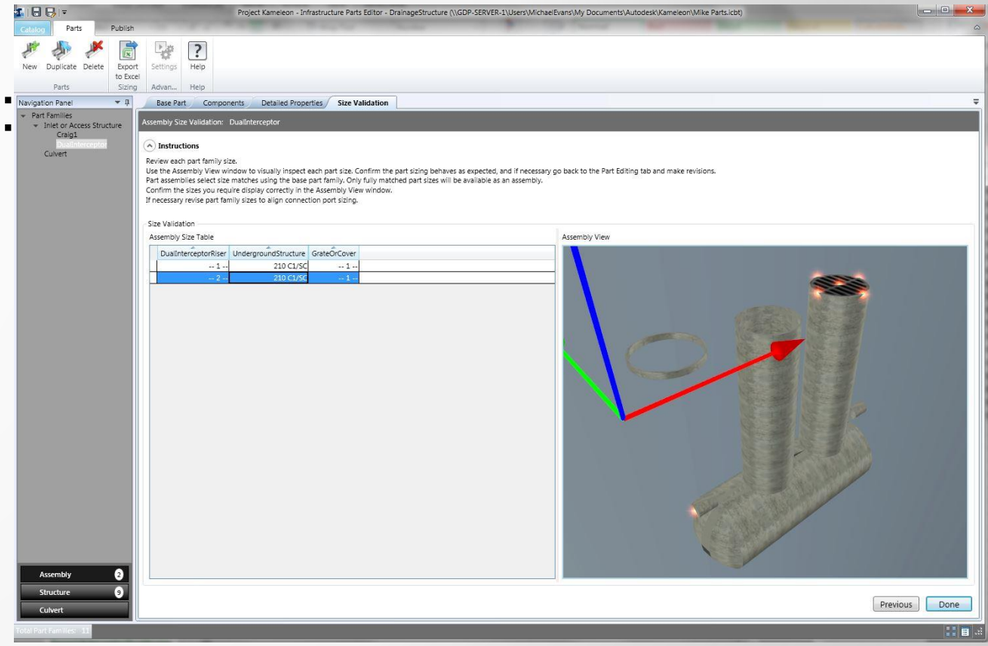

- **Infraworks 360 releases in 2013 with pipelines and pipe connectors**
- GIS data for underground utilities could now be aggregated into an Infraworks model.
- Infraworks 360 receives three updates in 2014
  - Drainage Design for Culverts
  - Pavement Drainage Design for automatically laying out drainage networks on Design Roads

# AutoCAD Civil 3D 2015


- Vault support for Pressure Networks
- Sliced solids option added for Pipe Networks in section views
- Productivity Pack 1 introduces a new Generic Drainage Catalog, which enables the transfer of drainage network content between Civil 3D and Infraworks 360.

# Project Kameleon (Autodesk Labs)

- In late 2014 Autodesk released Project Kameleon on Autodesk Labs, which seeks to replace the legacy Part Builder tool for Infrastructure content catalog authoring and provide a way to create catalogs sharable between Civil 3D and Infraworks.
- Today Kameleon contains content authoring for*:
  - Drainage Structures
  - Culvert Barrels and End Treatments
  - Pressure Pipes, Fittings, and Appurtenances
  - Bridge Structures (Piers, Abutments, Girders)




* This is pre-release software, and Autodesk provides no guarantees that the software will formally release or that it will contain the stated content when/if it does release.

# AutoCAD Civil 3D 2016


- Label Pressure Networks in section views
- Crossing pipe labels for Pipe Networks and Pressure Networks in both profile and section views.
- Generic Drainage Catalog included with install. Contains catalog content authored in Project Kameleon's Shape Modeler and Parts Editor.  This enables sharing of pipe network models between Civil 3D and Infraworks 360.

# Infraworks 360 Updates


- **Infraworks 360 gets new drainage updates throughout 2015**
  - In-place inlet analysis occurs automatically
  - Inspect Performance tool allows viewing of the HGL and EGL across a run of pipes and structures.
  - Drainage networks are adapted for automatic placement on Component Roads. Spread analysis and automatic determination of runoff coefficient for the tributary area is added.

# What Went Wrong?

Open Discussion

# What Went Right?

Open Discussion

# How Do We Drive Engagement and Adoption

Engineers

Product Manufacturers

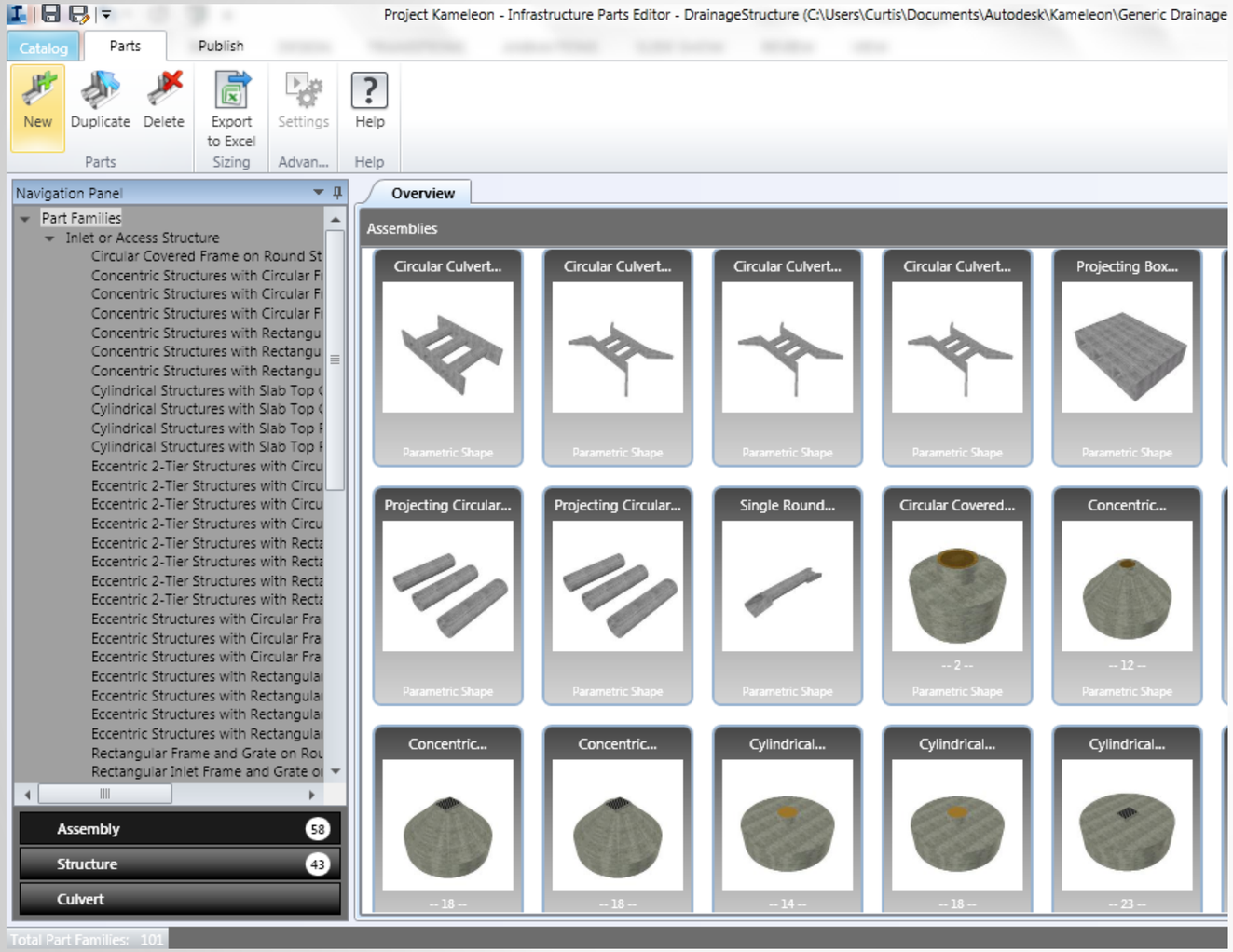
Owners / Clients / Stakeholders

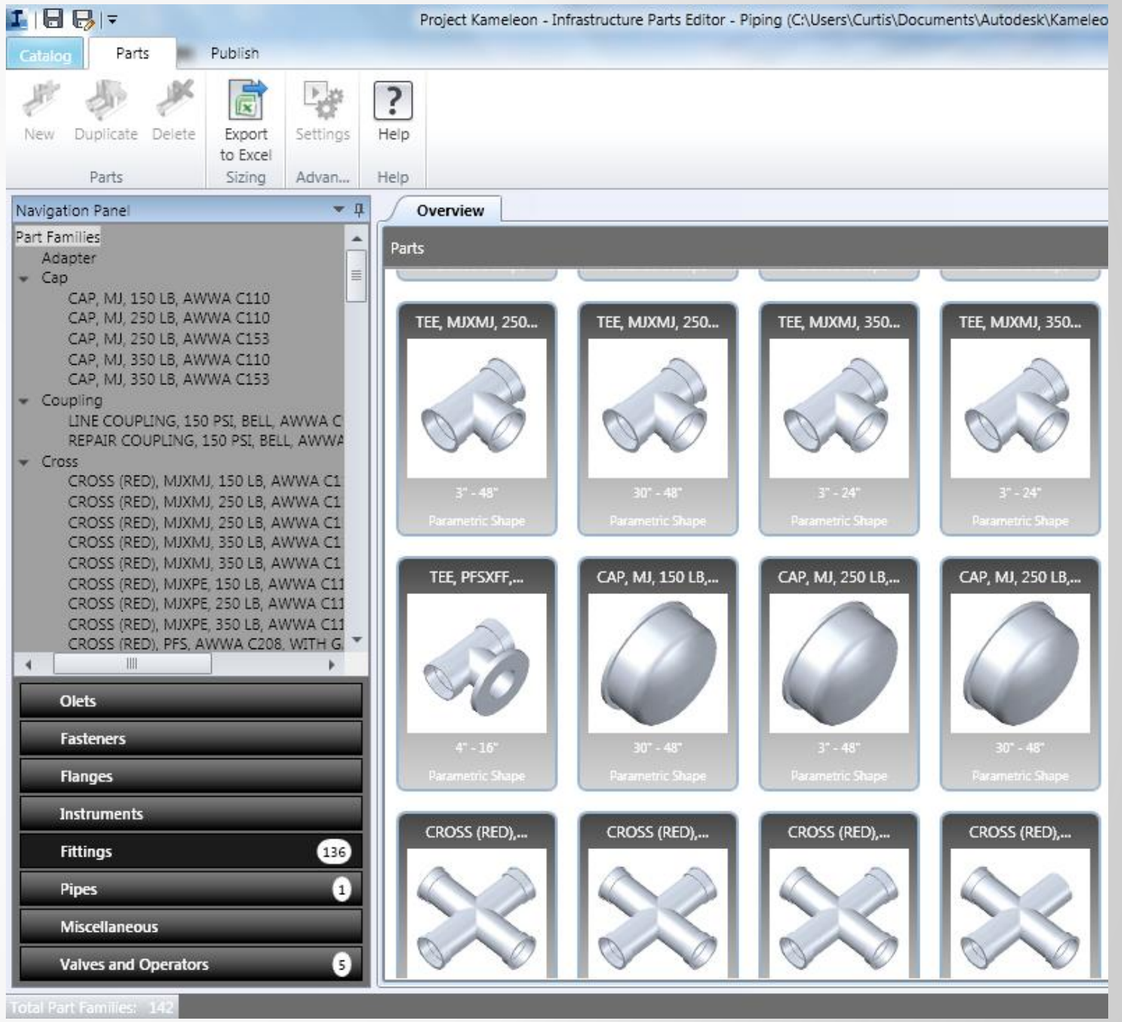
# Where Do We Go From Here?

Civil 3D

Infraworks

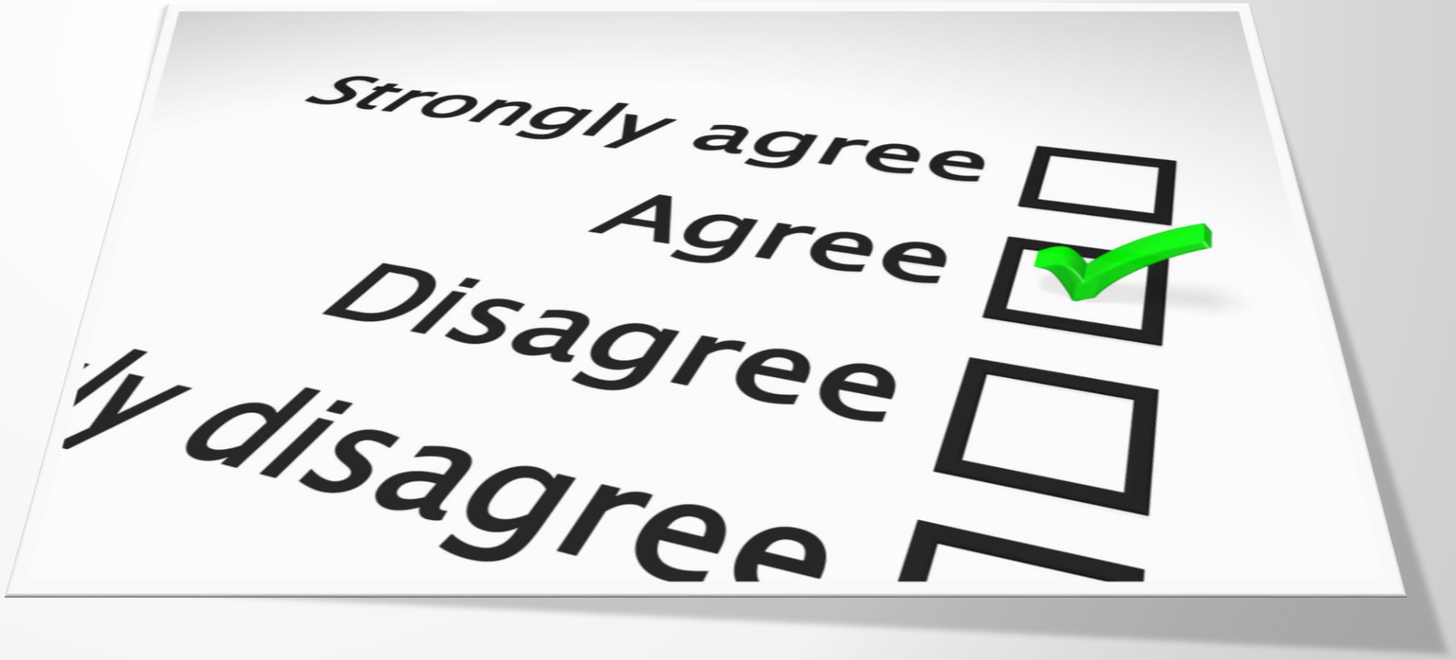
# Get Involved with Project Kameleon



# Be heard! Provide AU session feedback.

- Via the Survey Stations, email or mobile device.
- AU 2016 passes awarded daily!
- Give your feedback after each session.
- Give instructors feedback in real-time.



# Forget to take notes? No problem!

After AU visit:

**AutodeskUniversity.com**

Click on **My AU** to find:

- Class Recordings
- Presentations
- Handouts

All of your sessions will be there to enjoy again and again.