The “Realities” of Today’s Plant Design Projects

John Bunn & Isabel Suarez

FARO Technologies, Inc.

Class summary

This class will examine the latest uses of reality capture data for plant design within the Autodesk 2016 suite of products as well as recommend workflows for making efficient use of capture hardware and software in order to achieve typically needed plant design deliverables.

Key learning objectives

In this class you will:

- Learn how to adopt point-cloud workflows within the 2016 Plant Design Suite software
- Gain insight from user experiences regarding what to expect with new Autodesk technology
- Understand the recommended steps for preparing laser scan projects within your Autodesk design package
- Discover how to extract typically needed plant deliverables from point clouds, such as intelligent models, tie-ins, and more

Reality Computing: Capture, Compute, Create

- **Capturing** real-world object in order to view them in a digital
- **Computing** and converting those objects into a useful form
- **Creating** new physical objects, models, and drawings

CAPTURE for Plant

"Collecting existing field conditions via surveying devices"

- Terrestrial scanners
- Hand-held scanners
- Total Station
- Digital Camera

Total Station

Digital Camera

Laser scanner FARO Focus X330

reddot award 2015 winner

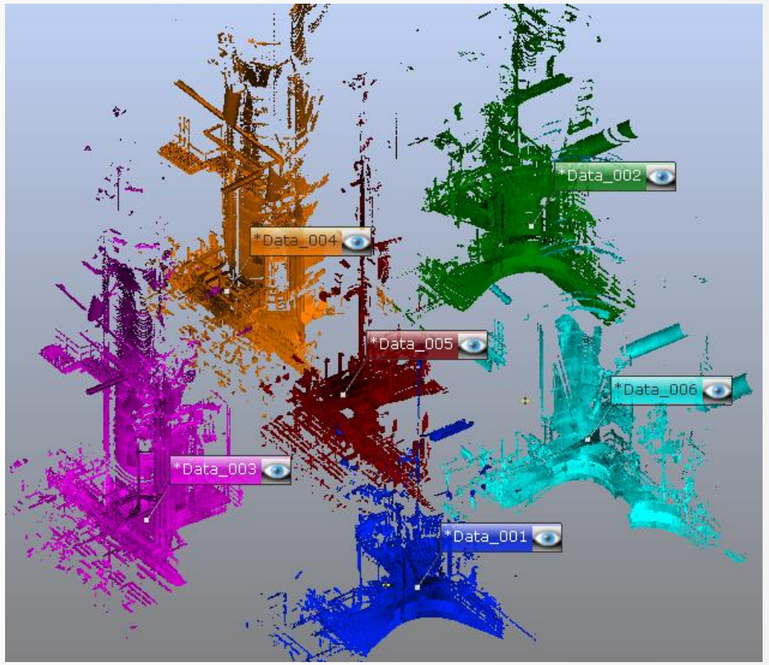
FARO Freestyle 3D X Handheld Laser Scanner

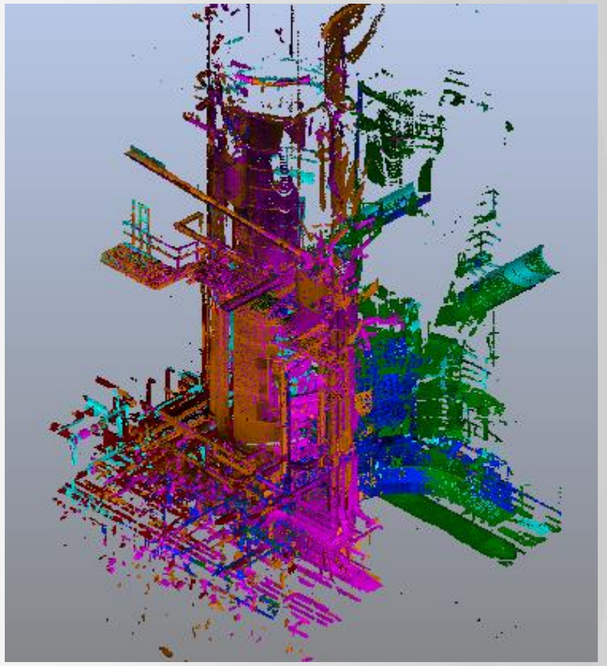
COMPUTE for Plant

“Processing captured data into a useful form”

Pre processing:

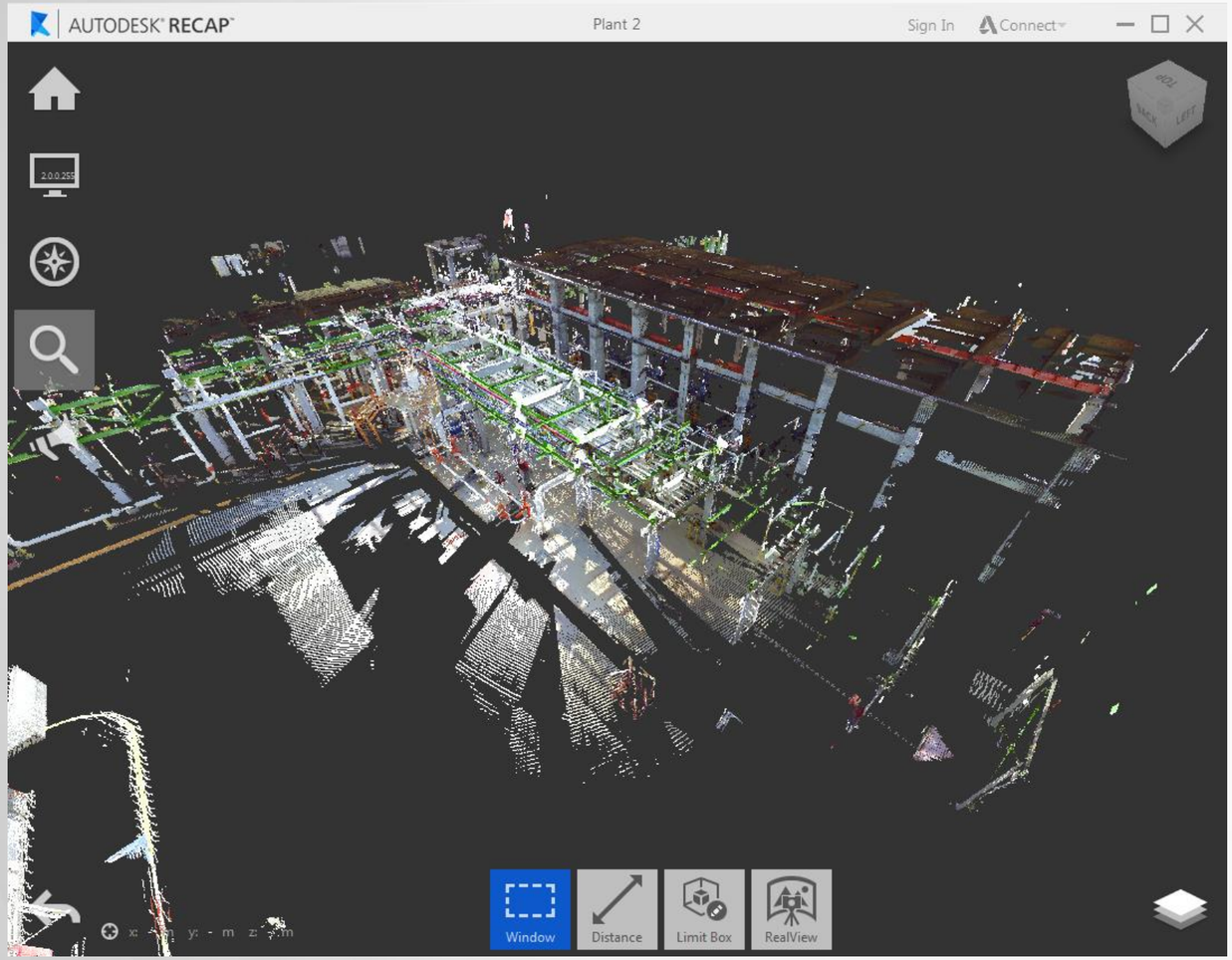
- Registration
  - Determining relationship between scan positions to create a scan coordinate system
- Transformation
  - Convert scan coordinate system to overall coordinate system
- Cleaning/filtering noise





COMPUTE for Plant

“Processing captured data into a useful form”



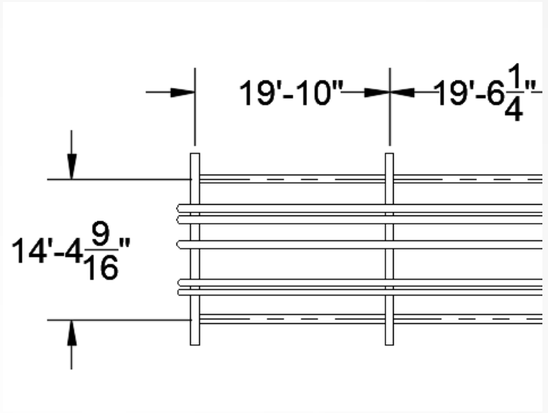
Post-Processing

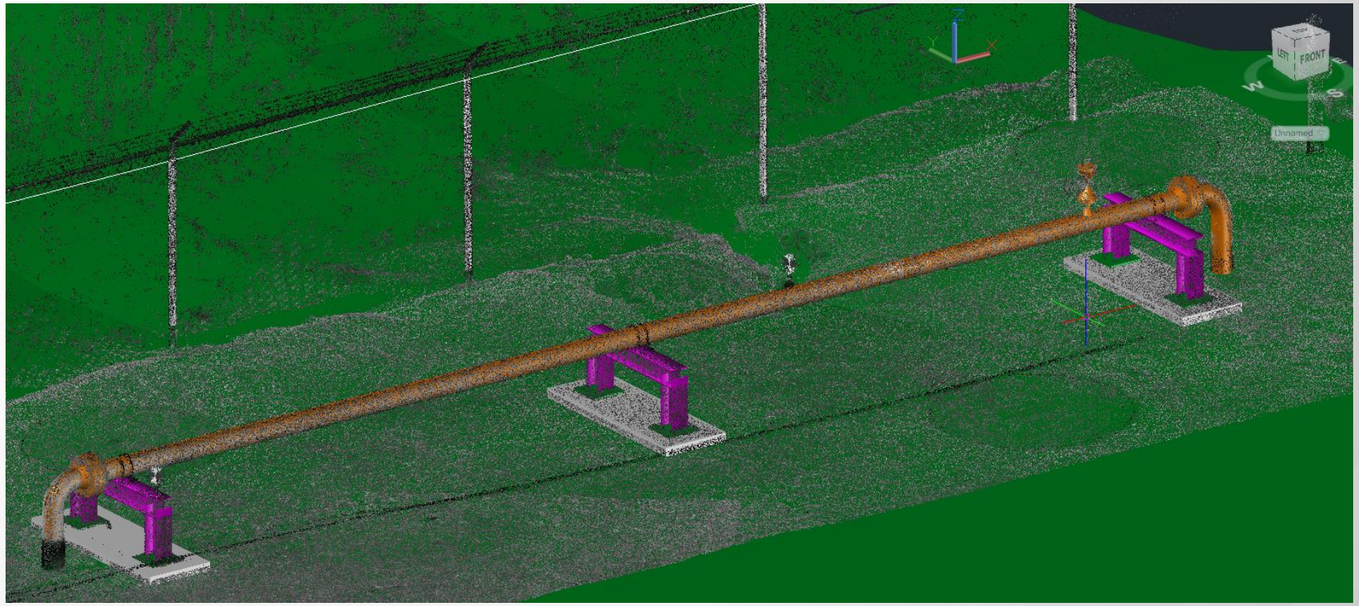
- Creating a point cloud in Recap for use in:
  - AutoCAD & Verticals
  - Revit
  - Navisworks
  - Inventor
- Attaching point cloud into drawing or project

CREATE for Plant

“Creating deliverables for internal and external customers”

- Accurate 2D Drawings
- Intelligent 3D Models
- Isometrics
- Fabrication Drawings
- Site Plans
- Lifting Plans





From Field to CAD

Field to AutoCAD 2016

Register in manufacturer's software or ReCap Ultimate

Import to Autodesk ReCap
(RCS per scan position, RCP project file)

Attach RCP i CAD or Revit

Scan in field

What's New in 3D Data Capture

What's New in Software

2015:

- Turn scans on/off
- Larger point clouds at higher density
- Higher point max (25 million)
- Clipping or isolating scans improves view quality

2016:

- Recap 360 Ultimate - Auto Registration
- Additional reporting tools
- Clipping no longer slows down point cloud
- Smart Snapping to find edges and centers
- Masked data is visible to developers

What's New in Hardware

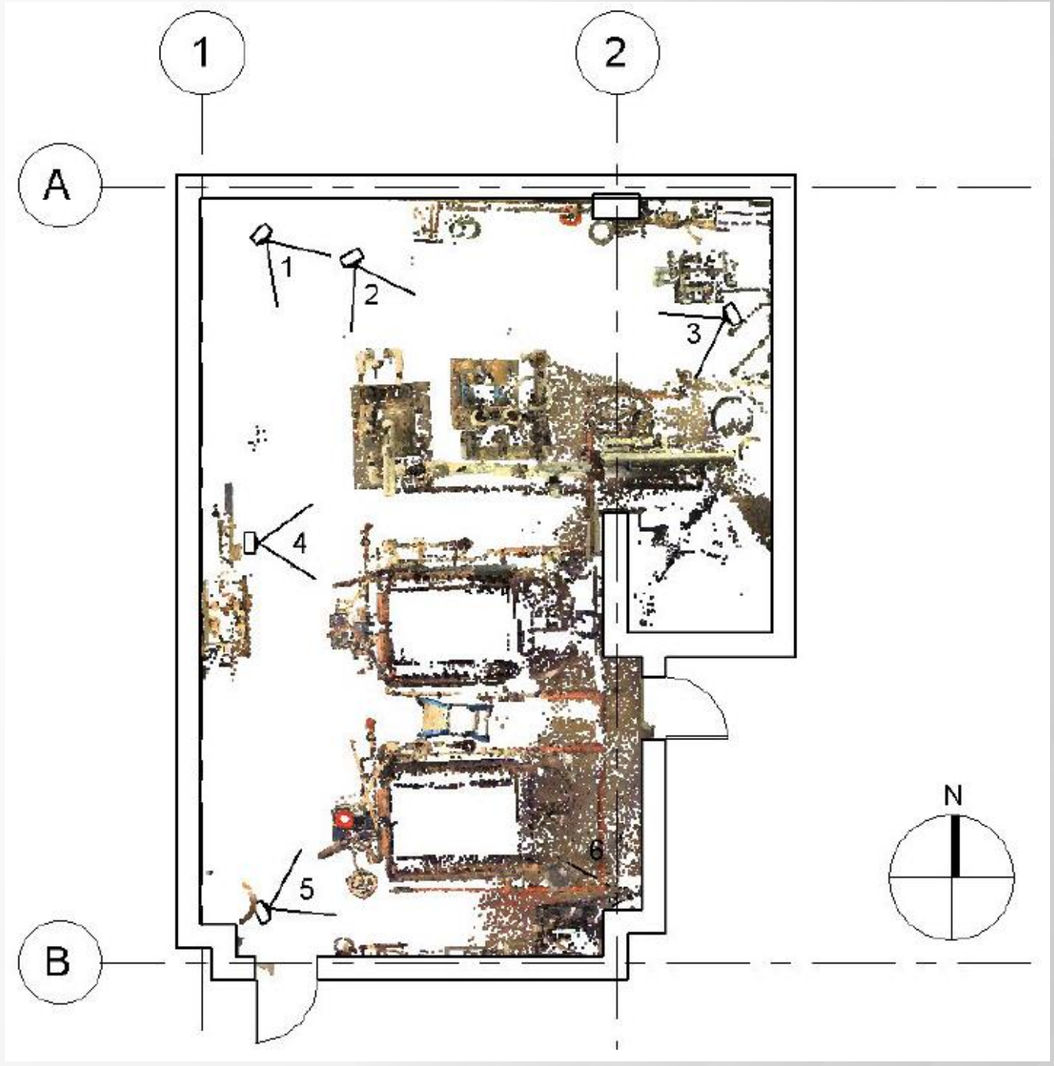
- Handheld scanners being used for more for creating as-builts
  - Access to confined spaces
  - Improved 3D point accuracy: ≤ 1mm
  - Affordable alternative
- Traditional scanners
  - Job specific – range based
  - Entry level pricing on new models

FARO Freestyle Case Study
Boiler Room
Courtesy of Jacobs
(Pennsylvania)

Scope of Area

“FARO Freestyle Boiler Room Case Study by Jacobs”

- BOILER ROOM
- 37’L x 28W’ x 11’H (Approx.)
- 915 SQF (Approx.)



JACOBS®

Jacobs | Global Buildings | www.jacobs.com

DICARLO
PRECISION INSTRUMENT INCORPORATED
Surveying Equipment and Supplies • 3D Laser Scanners • Robotics
Large Format Technical/Graphic Plotters and Scanners
MFP Solutions • RTK Network • GPS & GIS Mapping
Desktop Software • CAD & Drafting Supplies
www.dicarlo1.com

Scanning in the Field

“FARO Freestyle Boiler Room Case Study by Jacobs”

- Total Scanning Time: 2 hours
- 11 Scans, Average 1300 FPS
- Total Data: 24.7 GB

Processing Scans

“FARO Freestyle Boiler Room Case Study by Jacobs”

- 11 Scans Total: 9HRS
- Steps:
  - Copy scans from tablet to desktop computer
  - Open scans and process, Total 6 1/2hrs or Approximately 35min per scan
  - Register scans, Total 1hr
  - Final Process with ReCap, Total 1 hr
  - Link into Revit

Completed Scans

“FARO Freestyle Boiler Room Case Study by Jacobs”

- 11 Fully processed Scans: Total Data = 1.05GB
- 1 Registered Point Cloud linked into Revit

Additional Views

“FARO Freestyle Boiler Room Case Study by Jacobs”

Comparison of Results

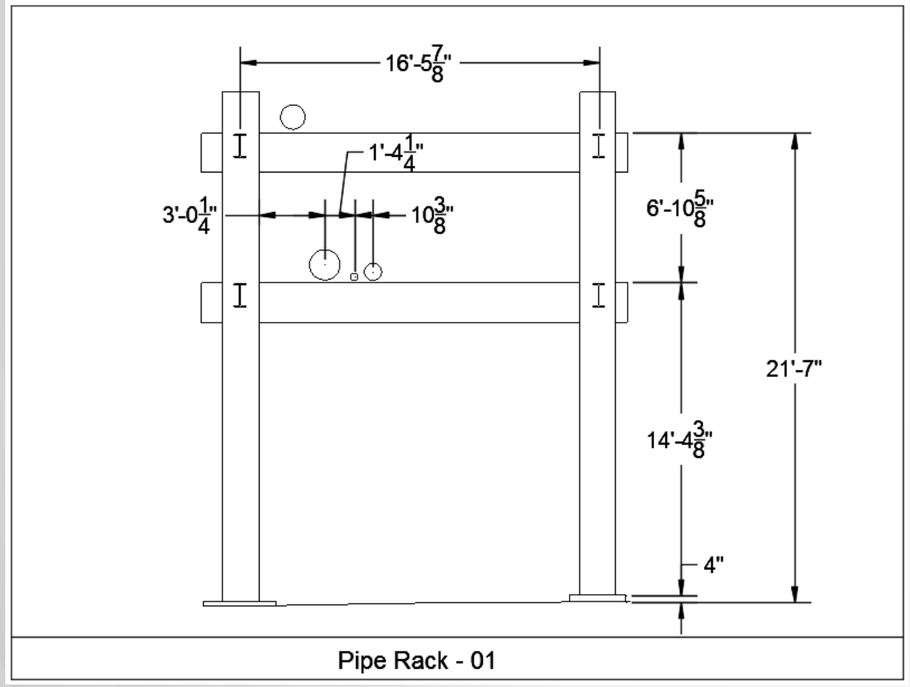
“Handheld Scanning vs Terrestrial Scanning”

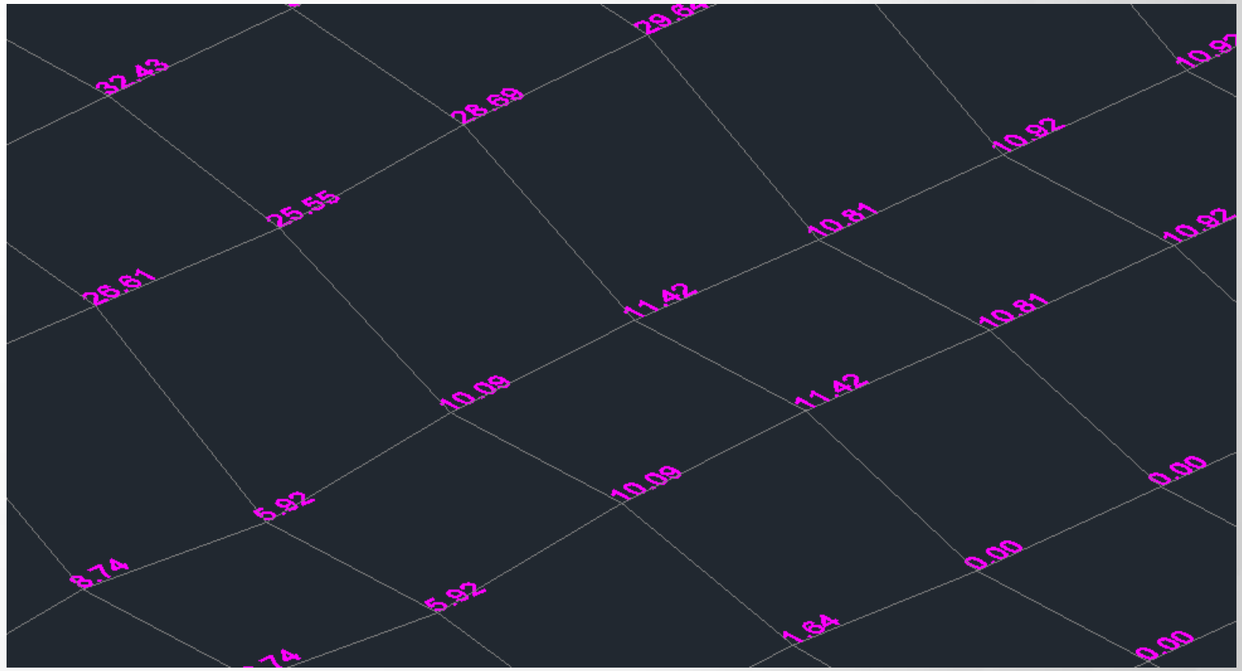
	Handheld	Terrestrial
Scan Time		
Registration Time		
Price of Scanner		
Accuracy		

Extracting Value From Point Clouds

Purpose of Point Cloud based Modeling

- As-built Modeling
  - To create as-built documentation
- Analysis
  - To analyze real world conditions in comparison to design or ideal





As-built Modeling

Asset Management

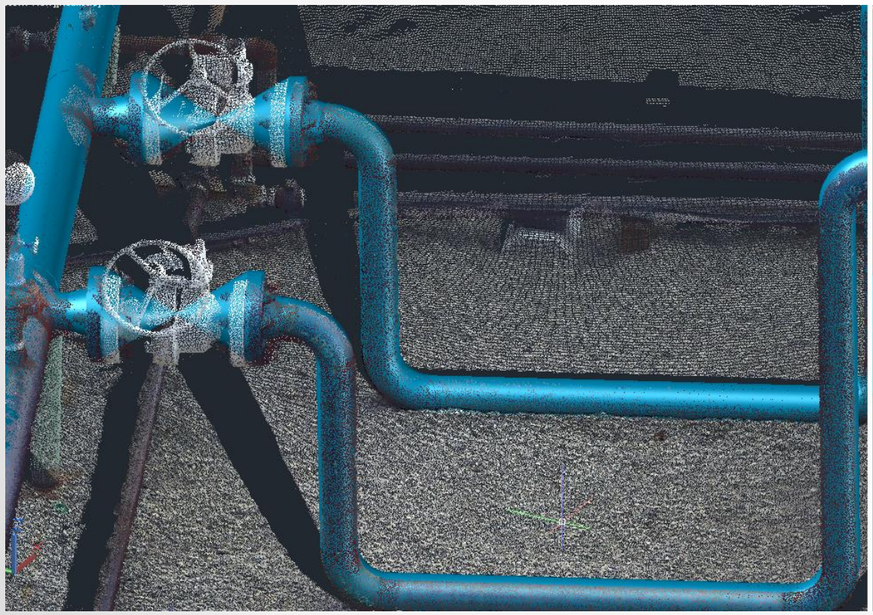
“What assets do we have in the facility?”

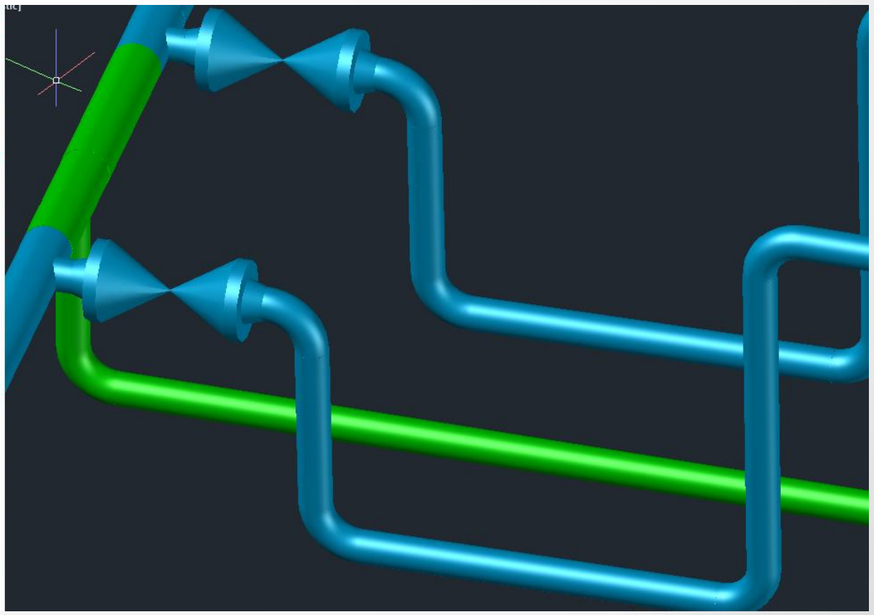
- Piping Systems
- Structural Components
- Equipment
- Power Components
- Tanks

Fabrication

“We modelled existing and now we create new design.”

- Additional Structure
- Piping Systems

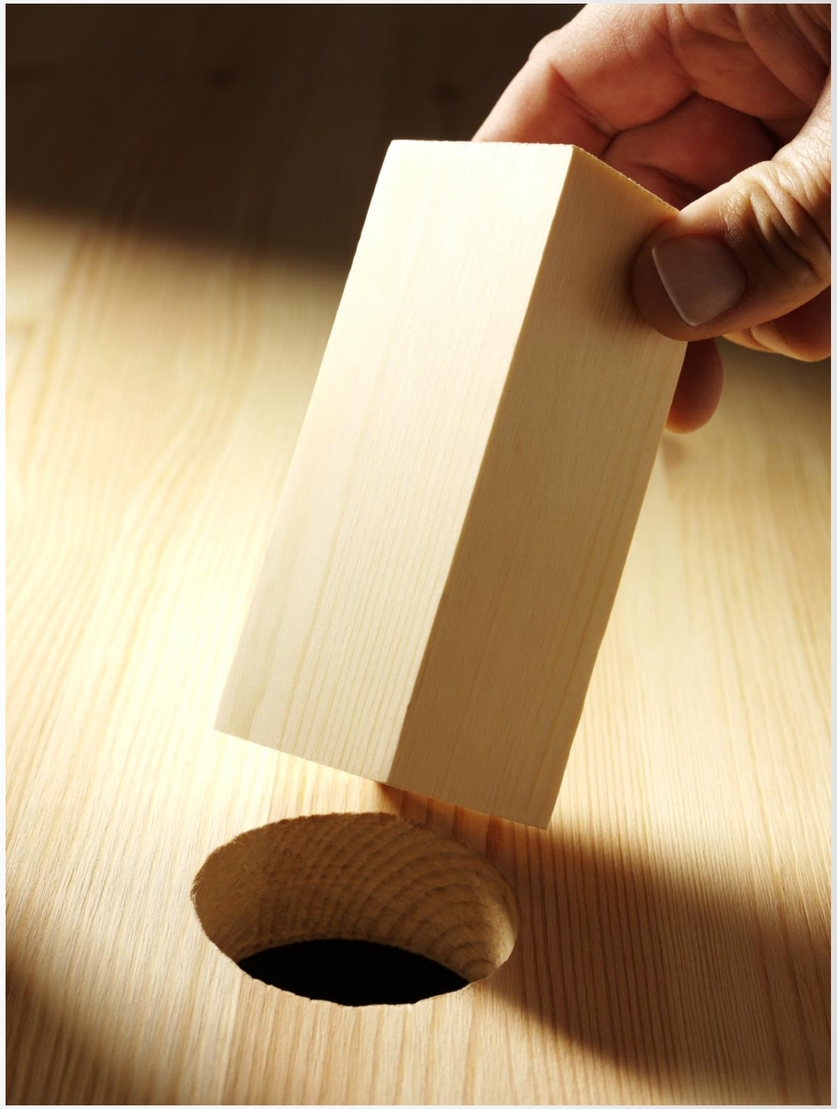




Clash Detection

“We designed it, now will it fit?”

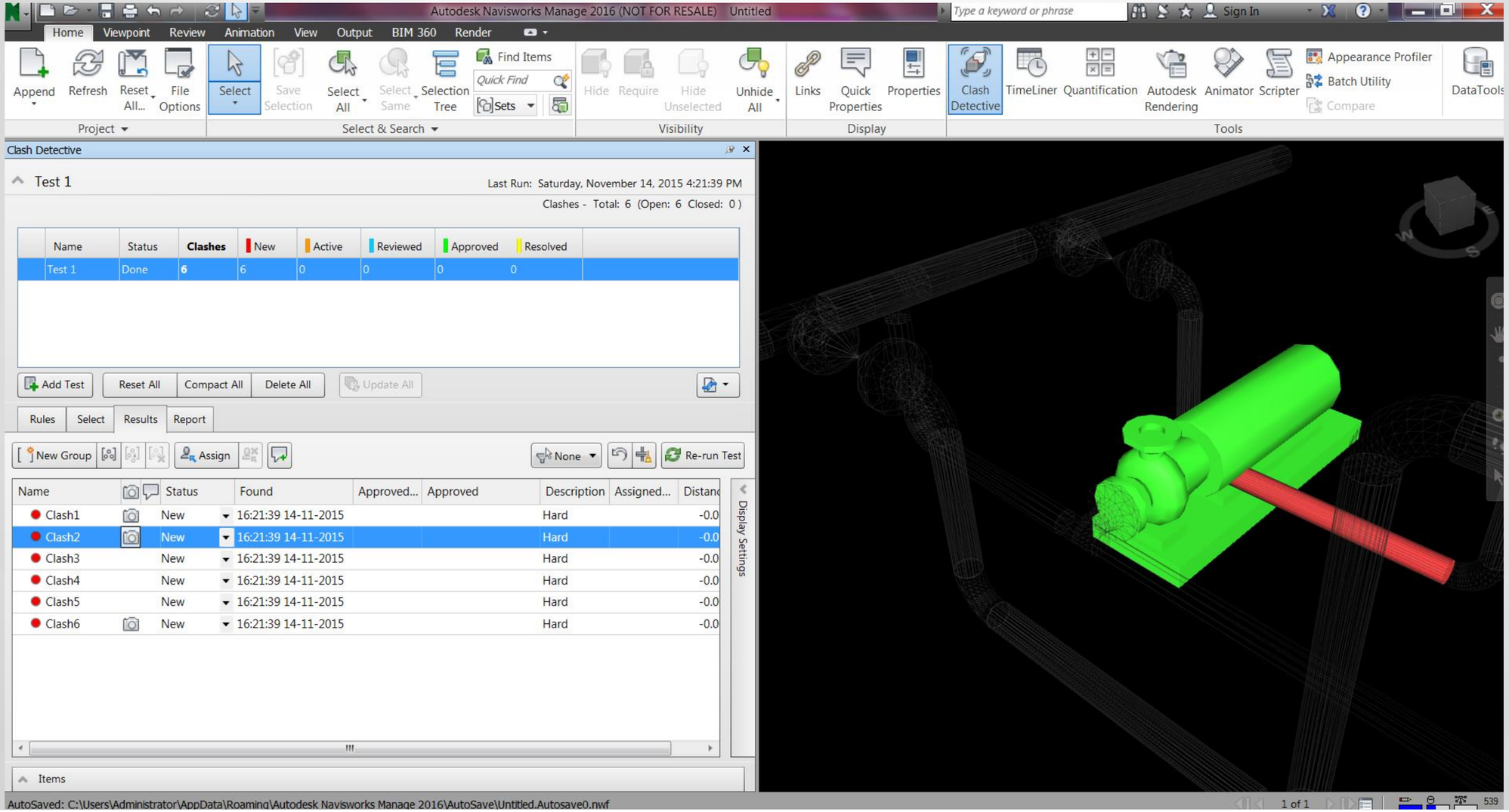
- Running clash detection between fabricated component and as-built
- Identify clashes with existing equipment
- Early identification of logistical challenges



Analysis

Clash Detection

“Does the equipment, surface, or component meet the standard?”



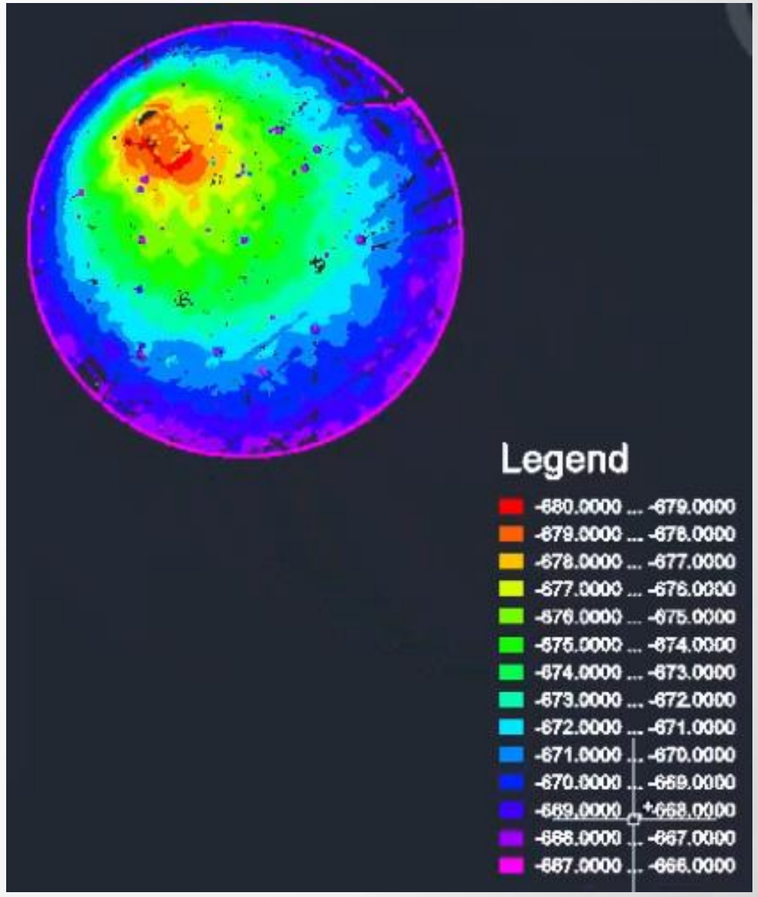
Quality Control & Verification

“Does the equipment, surface, or component meet the standard?”

- Cylindrical Analysis

5	circumference	slice volume	total volume	deadwood slice volume	reduced slice volume	reduced total volume
5	392.444072	18379.71815	18379.71815	8.82702492	18370.89113	18370.89113
5	392.444072	36759.31442	55139.03257	8.73207552	36750.58234	55121.47347
6	392.4425258	36759.5161	91898.54867	4.521402483	36754.9947	91876.46817
1	392.446108	36763.80074	128662.3494	4.521402483	36759.27934	128635.7475
7	392.4905844	36763.68867	165426.0381	4.521402483	36759.16727	165394.9148
4	392.4514074	36770.4242	202196.4623	4.521402483	36765.90279	202160.8176
8	392.5681799	36786.99101	238983.4533	4.521402483	36782.4696	238943.2872
3	392.6290161	36785.28937	275768.7427	4.521402483	36780.76797	275724.0551
8	392.5561507	36772.29541	312541.0381	4.521402483	36767.774	312491.8291
1	392.503155	36772.84845	349313.8865	4.521402483	36768.32705	349260.1562
3	392.5684008	36776.25463	386090.1411	4.521402483	36771.73323	386031.8894
1	392.5477894	36768.80307	422858.9442	4.521402483	36764.28167	422796.1711
7	392.4999788	36770.00769	459628.9519	4.521402483	36765.48629	459561.6574
1	392.565038	36774.42117	496403.3731	4.521402483	36769.89977	496331.5571
6	392.5498065	37597.99644	534001.3695	4.623919683	37593.37252	533924.9297

- Planar Analysis

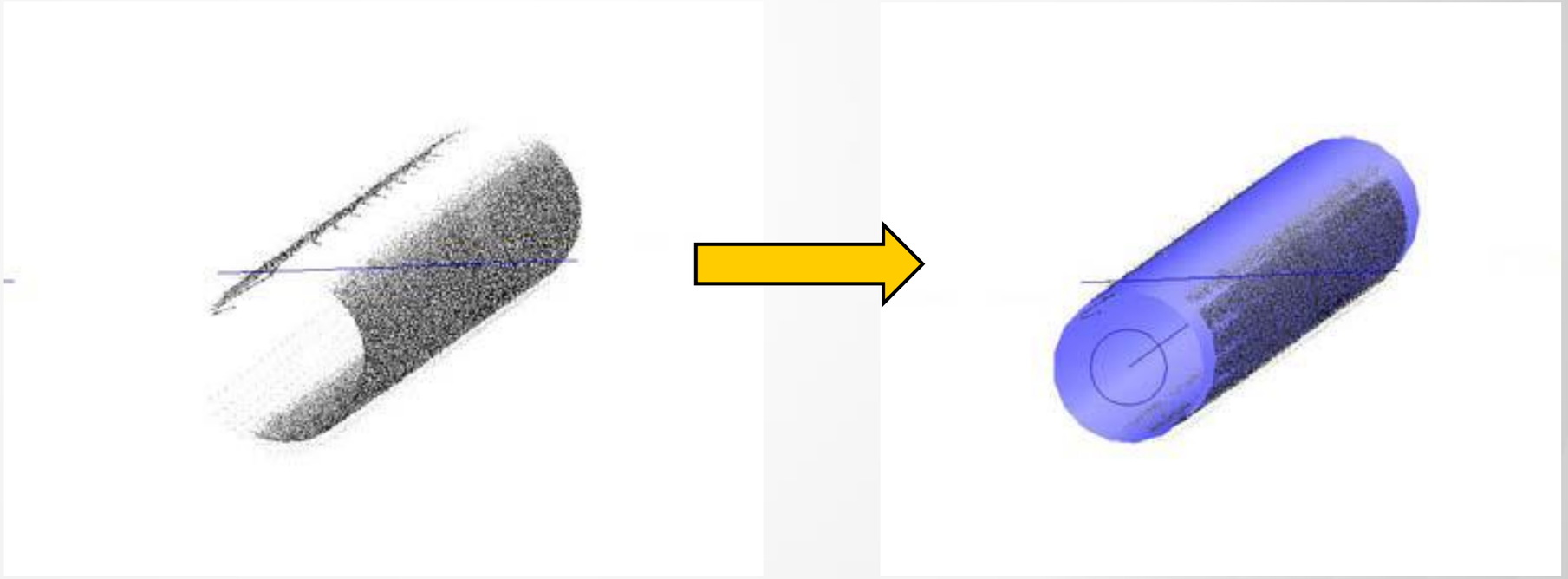


As-Built Piping & Tie-Ins

From Basic to Intelligent

“Matching Generic Shapes With Intelligent Parts”

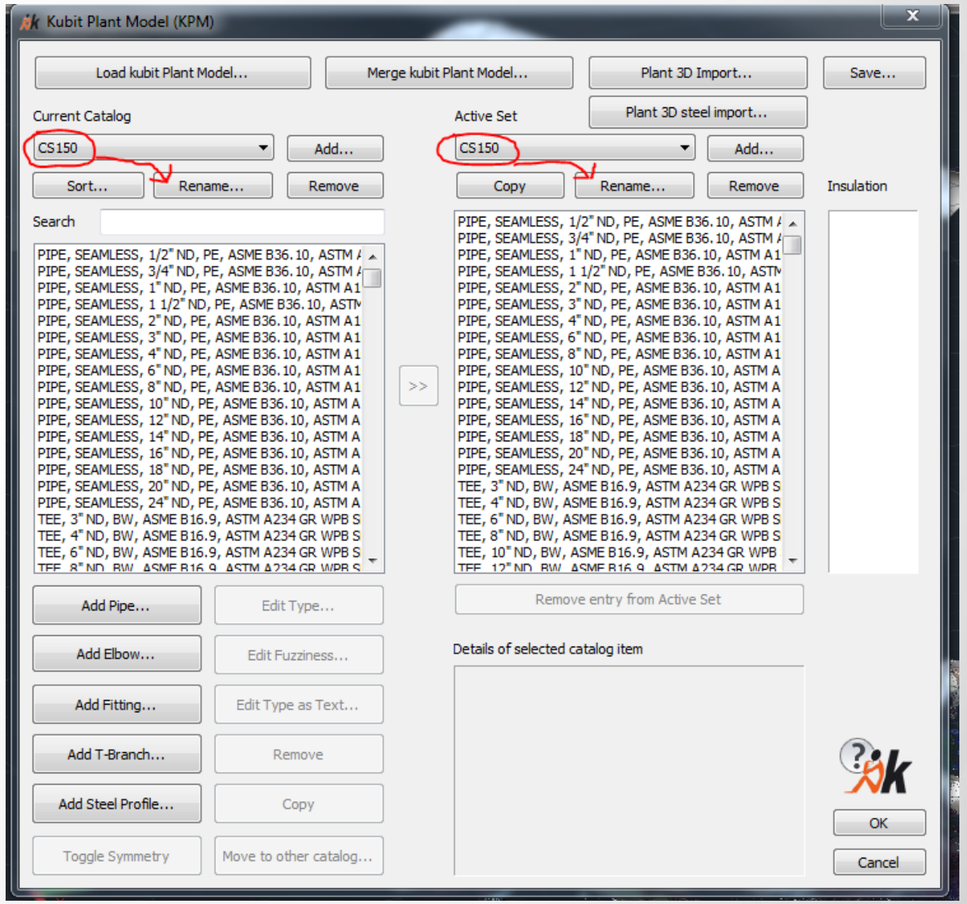
- Find generic shapes in point cloud data
  - Cylinder
  - Torus
  - Cone



From Basic to Intelligent

“Matching Generic Shapes With Intelligent Parts”

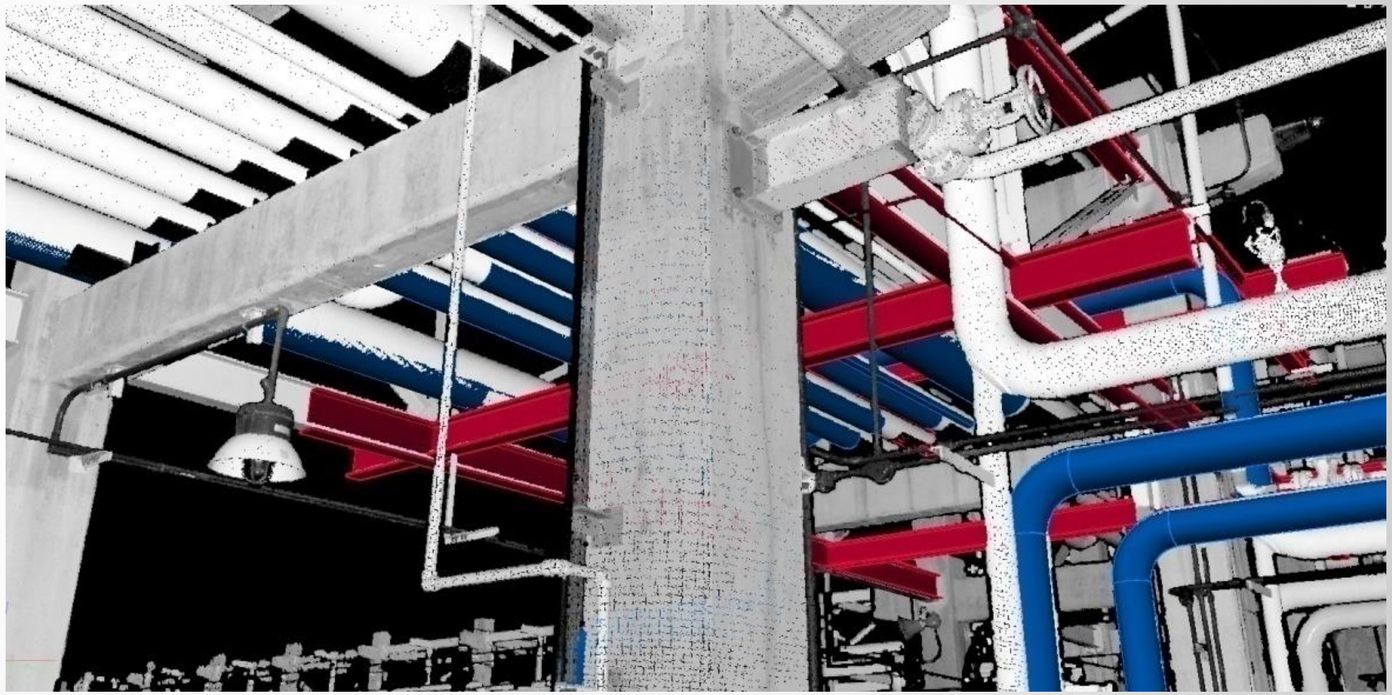
- Match generic shapes with catalog-specific piping components
  - Cylinder = Pipe
  - Torus = Elbow
  - Cone = Reducer



From Basic to Intelligent

“Matching Generic Shapes With Intelligent Parts”

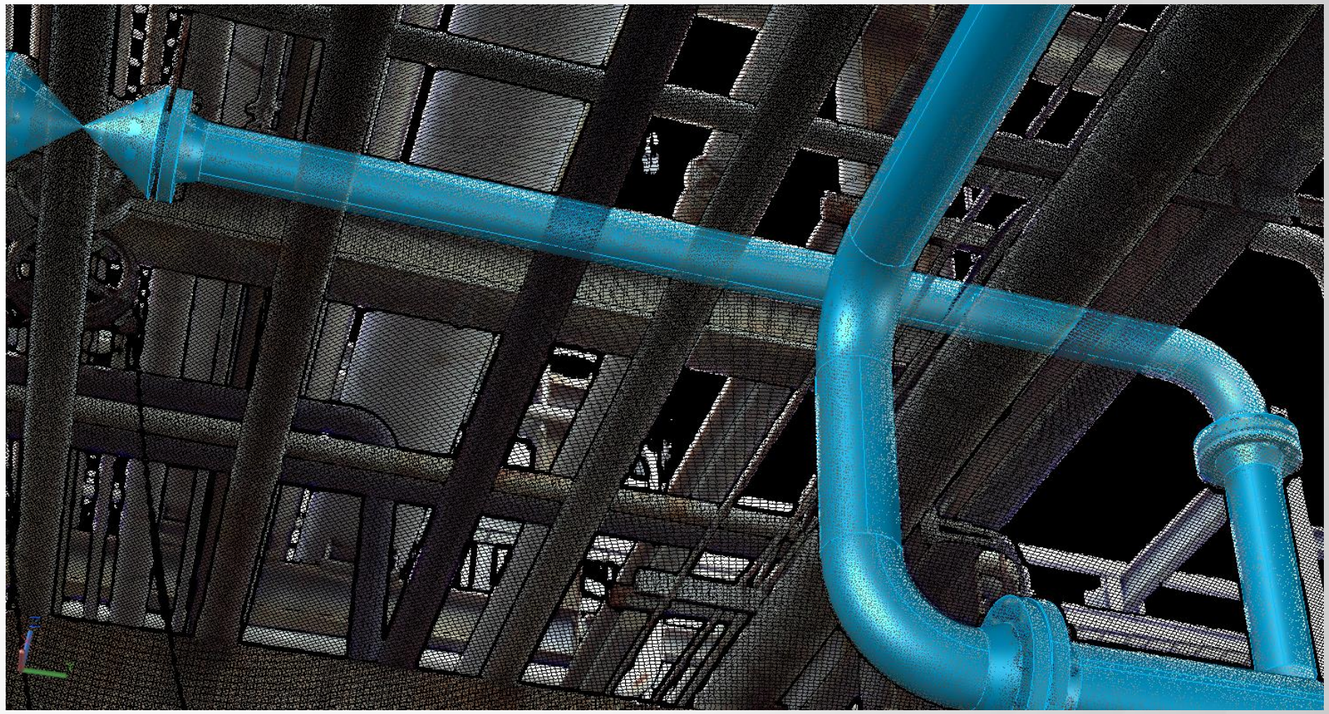
- Verify connections and govern engineering limitations
  - Match flange ratings, schedules, specs, etc.
  - Eliminate options that can’t physically occur in the real world



Semi-Automatic Pattern Recognition

“Verifying results as you go”

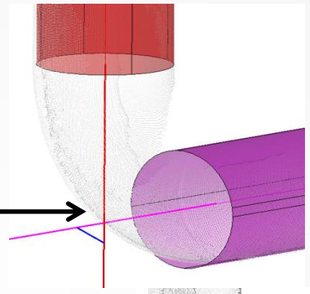
- Semi-Automated pattern recognition of plant objects
- Intelligent fittings from specs and catalogs
- Additional methods to insert fittings, including 3+ points around a circle
- Now utilizing saved cylinders in the background to greatly increase detection speed

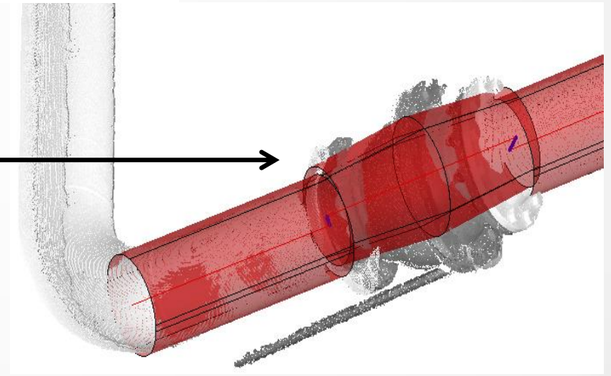


Applying Constraints for Design Software

“Converting real world geometry to design”

- Fixes lines automatically
- Either align fittings to data or force fittings to comply with design constraints
- Allows user to perform initial modeling faster with less focus on accuracy

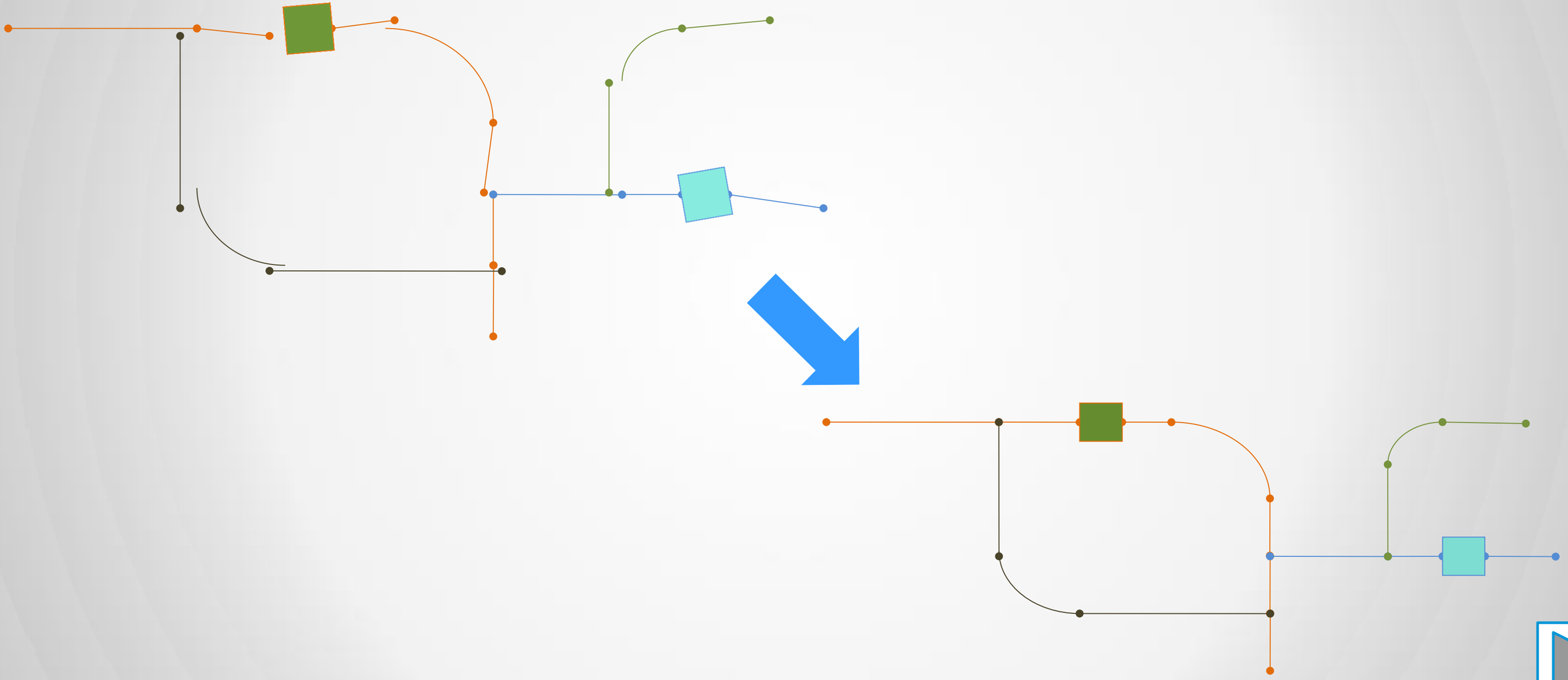


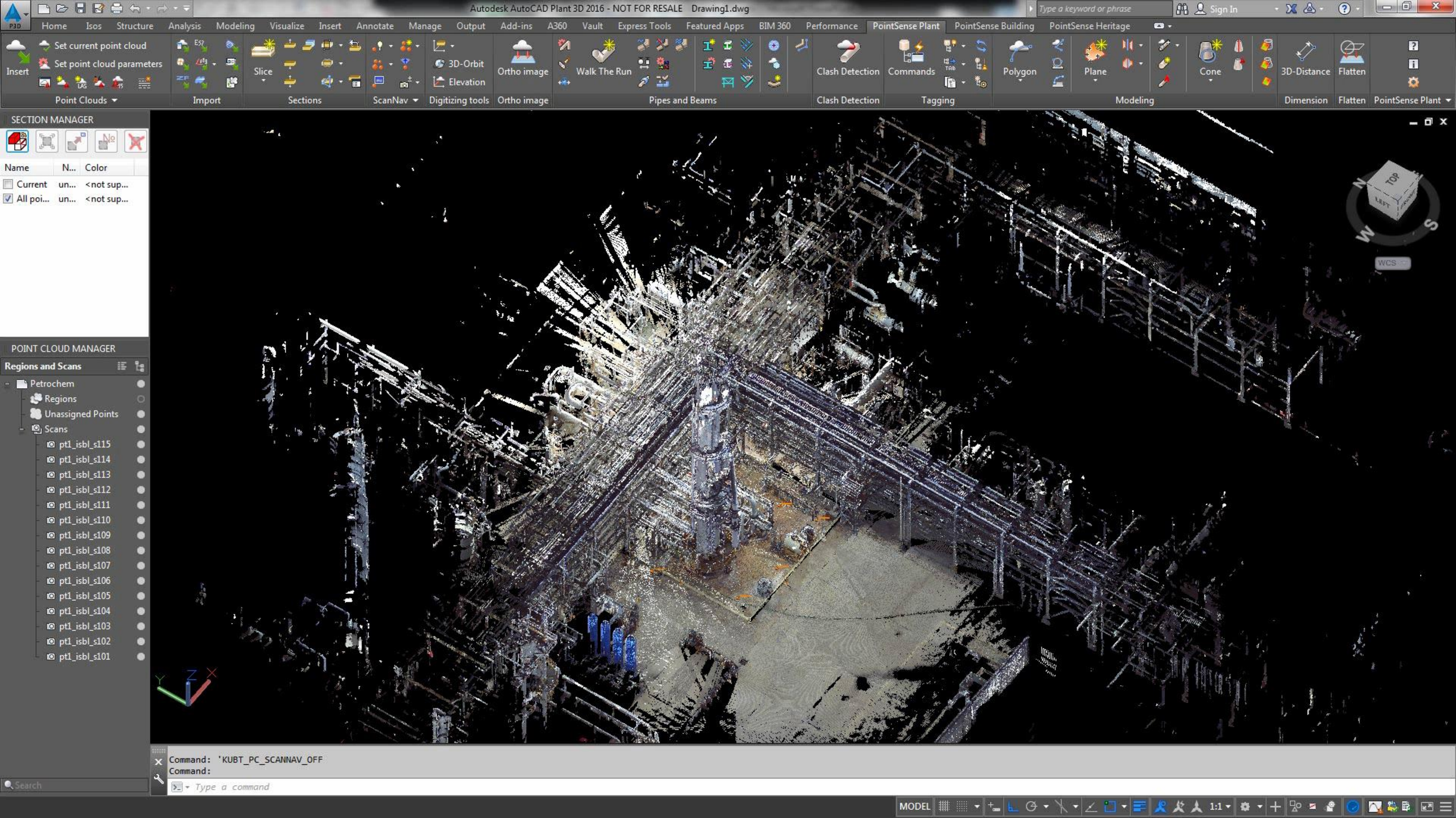


↳ Global Optimization is needed

Applying Constraints for Design Software

“Converting real world geometry to design”

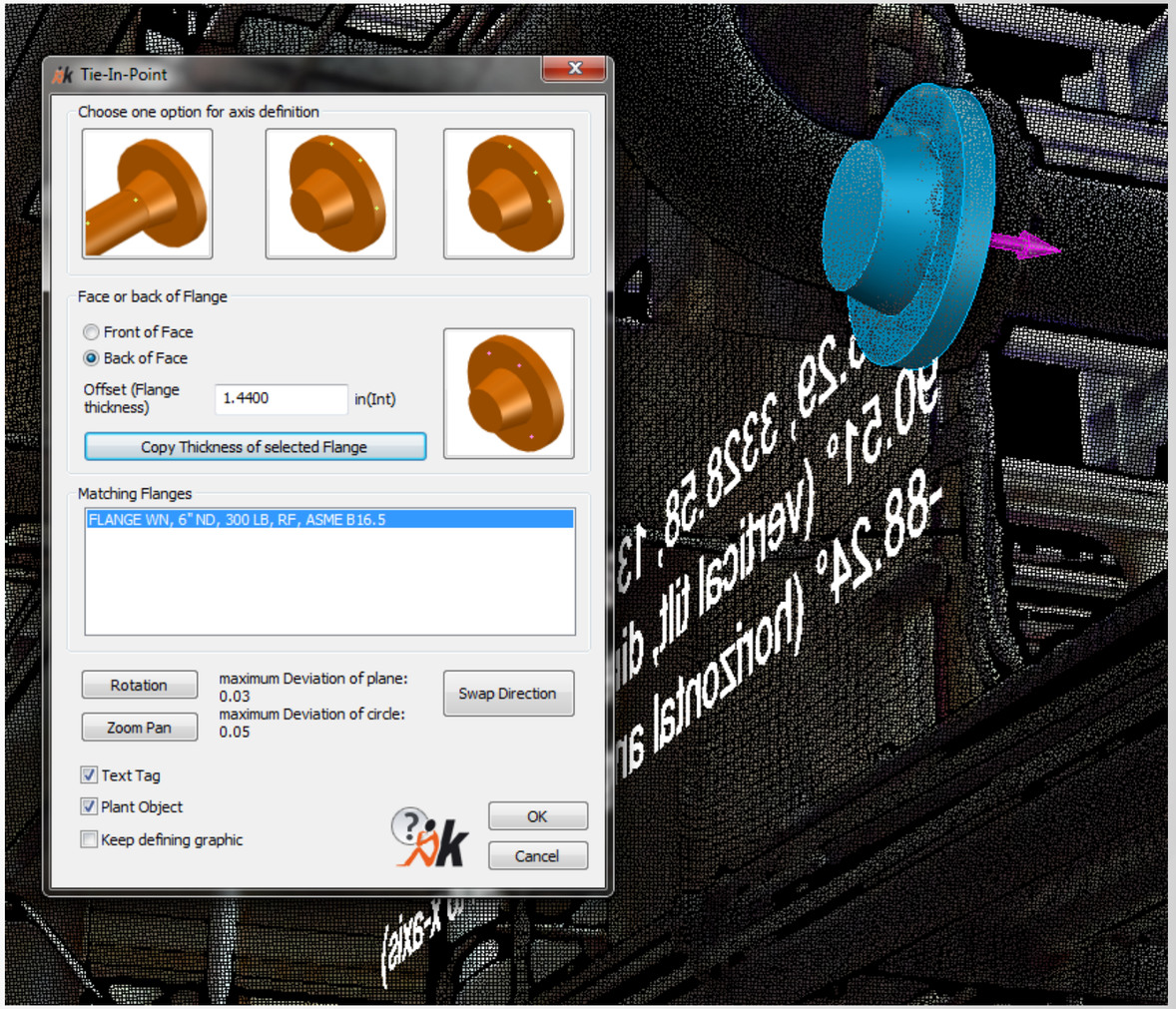


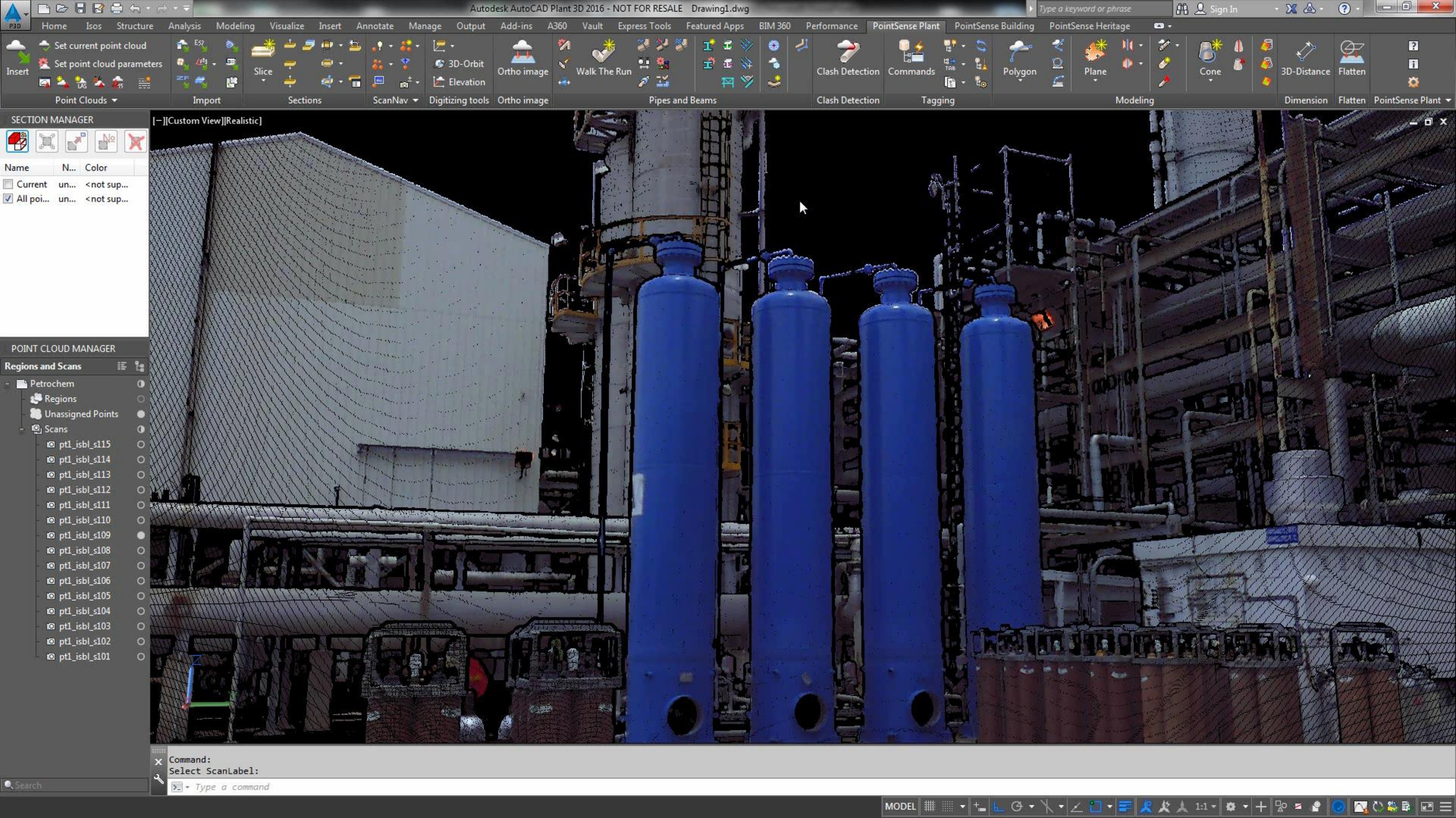

Autodesk AutoCAD Plant 3D 2016 - NOT FOR RESALE Drawing1.dwg
Home Isos Structure Analysis Modeling Visualize Insert Annotate Manage Output Add-ins A360 Vault Express Tools Featured Apps BIM 360 Performance PointSense Plant PointSense Building PointSense Heritage
Insert
Set current point cloud
Set point cloud parameters
Point Clouds
Import
Slice
Sections
ScanNav
3D-Orbit
Elevation
Digitizing tools
Ortho image
Ortho image
Walk The Run
Pipes and Beams
Clash Detection
Clash Detection
Commands
Tagging
Polygon
Plane
Cone
Modeling
3D-Distance
Dimension
Flatten
Flatten
PointSense Plant
SECTION MANAGER
Name N... Color
Current un... <not sup...
All poi... un... <not sup...
POINT CLOUD MANAGER
Regions and Scans
Petrochem
Regions
Unassigned Points
Scans
pt1_isbl_s115
pt1_isbl_s114
pt1_isbl_s113
pt1_isbl_s112
pt1_isbl_s111
pt1_isbl_s110
pt1_isbl_s109
pt1_isbl_s108
pt1_isbl_s107
pt1_isbl_s106
pt1_isbl_s105
pt1_isbl_s104
pt1_isbl_s103
pt1_isbl_s102
pt1_isbl_s101
Search
TOP
LEFT
WCS
Command: 'KUBT_PC_SCANNAV_OFF
Command:
Type a command
MODEL
1:1

Extracting Tie-Ins

“Why model everything when you don’t need it?”

- Multiple insertion options, including Back of Face, Front of Face, etc.
- Intelligent modeling with true roll, tilt, and coordinate information
- Use to continue new design from



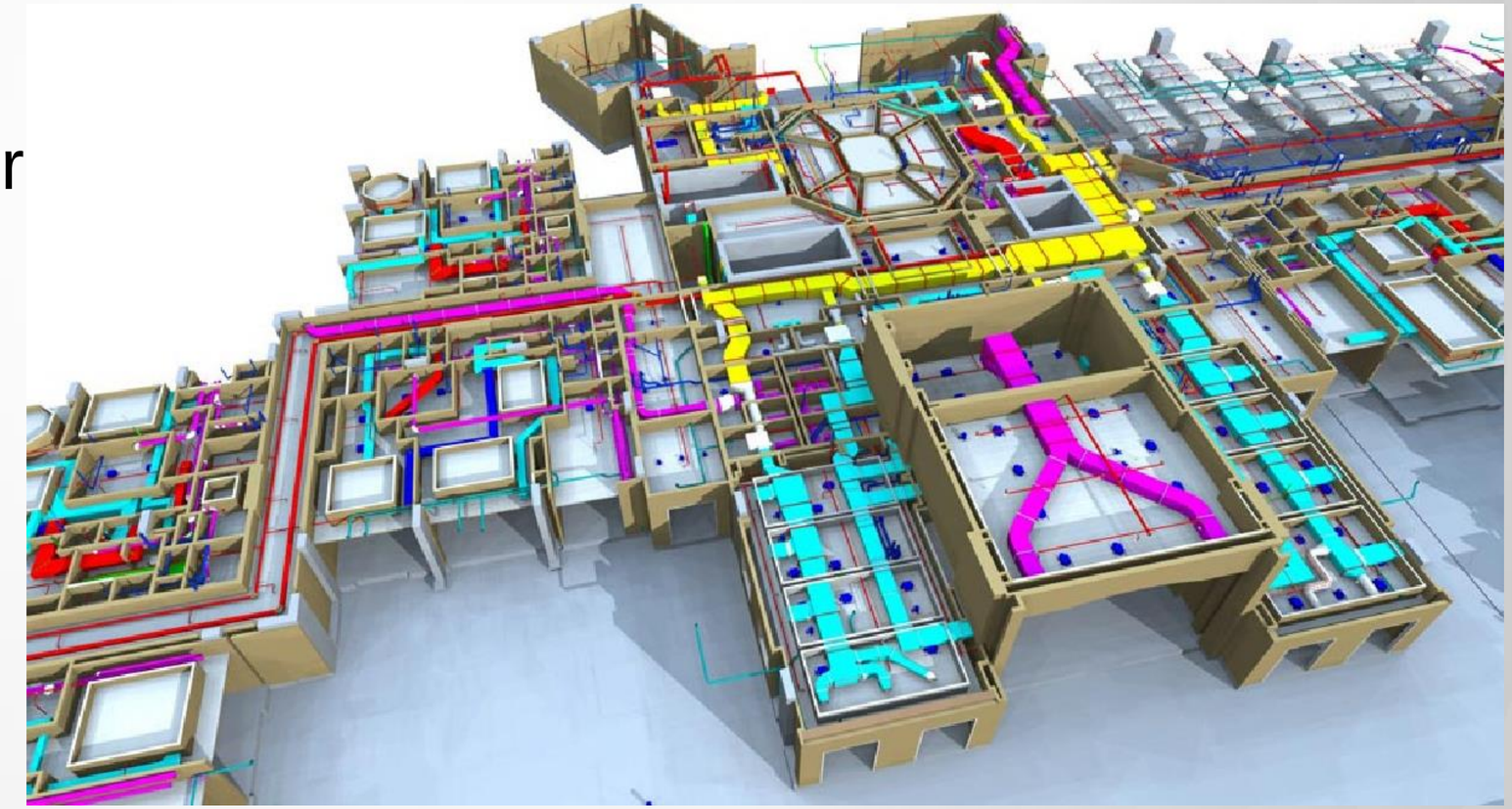

Autodesk AutoCAD Plant 3D 2016 - NOT FOR RESALE Drawing1.dwg
Home Isos Structure Analysis Modeling Visualize Insert Annotate Manage Output Add-ins A360 Vault Express Tools Featured Apps BIM 360 Performance PointSense Plant PointSense Building PointSense Heritage
Insert
Set current point cloud
Set point cloud parameters
Point Clouds
Import
Slice
Sections
ScanNav
3D-Orbit
Elevation
Digitizing tools
Ortho image
Walk The Run
Pipes and Beams
Clash Detection
Commands
Tagging
Polygon
Plane
Cone
Modeling
3D-Distance
Dimension
Flatten
PointSense Plant
SECTION MANAGER
Name N... Color
Current un... <not sup...
All poi... un... <not sup...
POINT CLOUD MANAGER
Regions and Scans
Petrochem
Regions
Unassigned Points
Scans
pt1_isbl_s115
pt1_isbl_s114
pt1_isbl_s113
pt1_isbl_s112
pt1_isbl_s111
pt1_isbl_s110
pt1_isbl_s109
pt1_isbl_s108
pt1_isbl_s107
pt1_isbl_s106
pt1_isbl_s105
pt1_isbl_s104
pt1_isbl_s103
pt1_isbl_s102
pt1_isbl_s101
[−][Custom View][Realistic]
Command:
Select ScanLabel:
Type a command
MODEL

Exporting and Getting Deliverables

Intelligent Objects and Deliverables

“Creating necessary results for production”

- Create objects directly for major Autodesk packages
  - Plant 3D
  - Revit MEP
- Alternate exports for other packages and uses
  - Centerlines
  - Databases
  - 3D Solids



Intelligent Objects and Deliverables

“Creating necessary results for production”

- Automatically create intelligent Plant3D objects
- Generate isometrics, bill of materials, orthographics, etc.
- Additional exports of intelligent centerlines available for other design tools

Autodesk AutoCAD Plant 3D 2016 - NOT FOR RESALE Drawing1.dwg

Type a keyword or phrase Sign In

Home | Isos | Structure | Analysis | Modeling | Visualize | Insert | Annotate | Manage | Output | Add-ins | A360 | Vault | Express Tools | Featured Apps | BIM 360 | Performance | PointSense Plant | PointSense Building | PointSense Heritage

Insert | Set current point cloud | Set point cloud parameters — Point Clouds

Import

Slice — Sections

ScanNav

3D-Orbit | Elevation — Digitizing tools

Ortho image — Ortho image

Walk The Run — Pipes and Beams

Clash Detection — Clash Detection

Commands — Tagging

Polygon | Plane | Cone — Modeling

3D-Distance — Dimension

Flatten — Flatten

PointSense Plant

SECTION MANAGER

Name	N...	Color
Current	un...	<not sup...
All poi...	un...	<not sup...

POINT CLOUD MANAGER

Regions and Scans

- Petrochem
  - Regions
  - Unassigned Points
  - Scans
    - pt1_isbl_s115
    - pt1_isbl_s114
    - pt1_isbl_s113
    - pt1_isbl_s112
    - pt1_isbl_s111
    - pt1_isbl_s110
    - pt1_isbl_s109
    - pt1_isbl_s108
    - pt1_isbl_s107
    - pt1_isbl_s106
    - pt1_isbl_s105
    - pt1_isbl_s104
    - pt1_isbl_s103
    - pt1_isbl_s102
    - pt1_isbl_s101

Command: _u
Command: PCEX GROUP
Type a command

MODEL

Point Clouds & Structural Design

An Autodesk Trainer Perspective

Introduction

- Irene Radcliffe, Technical Consultant
  - Certified trainer for Plant Design Suite
  - 25 years in the Oil & Gas business.
  - Joined Cansel Survey in 2013 as an oil & gas industry consultant. Being surrounded by Cansel's very strong scanning/survey team, quickly realized the benefits that an integrated point cloud workflow would bring to my Plant & Structural clients.
  - Began developing workflows for plant/structural clients on field to Autodesk deliverable workflows

Cansel
Improving field to finish productivity

Structural Design Trends

- Customer Trends in structural design
  - Revit Structure
  - ProSteel/ProStructure
  - Cadworx Steel
  - Tekla
- Customer trends using Autodesk point clouds
  - Increased customer awareness of the technology.
  - Requests for information and product demonstrations has tripled in the last year.

Structural Design Trends

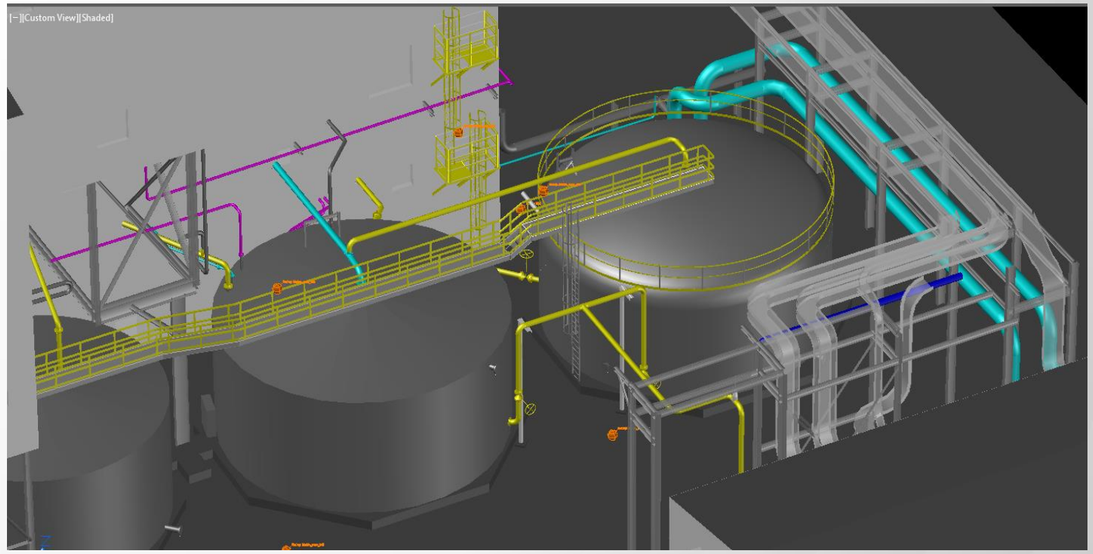
- Customer needs and challenges
  - Clients need to have accurate site data in order to execute successful projects.
  - Budget restraints make it cost prohibitive to send personnel to site to take as-built field measurements.
  - Shrinking schedules do not allow time for site visits for design verification.
  - Working in congested, elevated areas makes it difficult to get accurate measurements, and poses safety risk.

Structural Design Trends

- Customer requests
  - Clients looking for cost effective solution, easy to use, and integrated with their existing software and hardware.
  - With point cloud technology being adopted quickly in field-based engineering, clients are seeking a solution that is portable, and can be used to it’s full potential on a laptop or tablet.
  - Request for scanning now coming from many non-oil & gas related industries, including aquaculture, ship building/refitting, pharma, food, paper and residential

As-Built Structural

- Why do customers need as-built structural models?
  - Asset management
  - Fabrication
  - Inspection
  - Clash detection
  - QA/QC model against as-built data

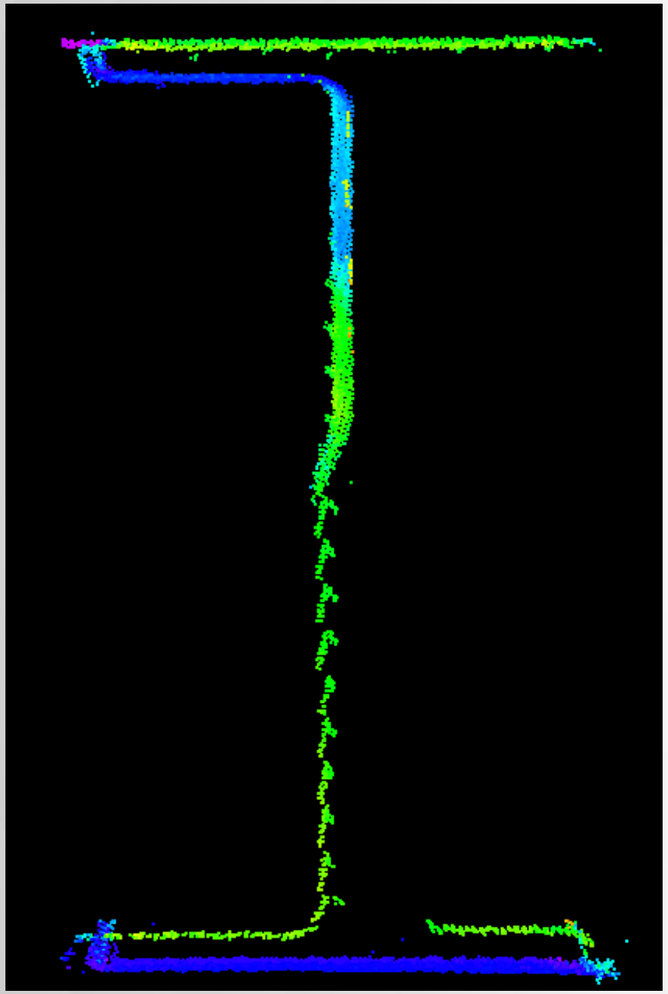


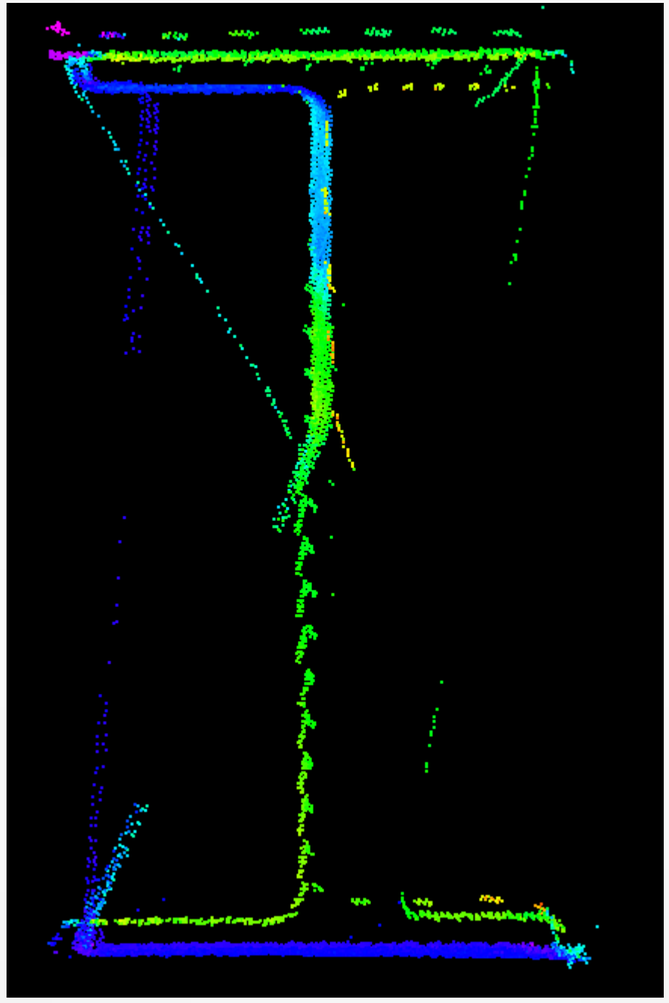
Extracting Structural

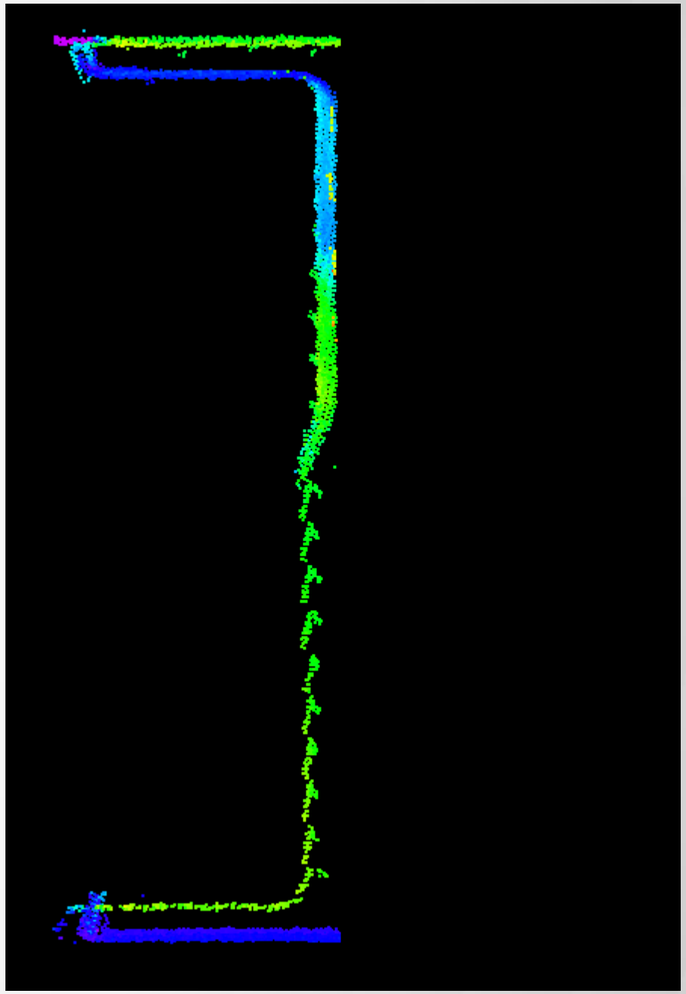
- Manually
  - Time consuming and missing data makes tracing profiles difficult.
- Using pattern recognition software
  - Helps designer in determining precise size/shape.
  - Makes assumptions for user where data is missing.
- Tying shapes to intelligence
  - Solids are useful for clash detection.
  - Intelligence is needed for asset management.

Structural Profiles

Good software, Good hardware, Good communication

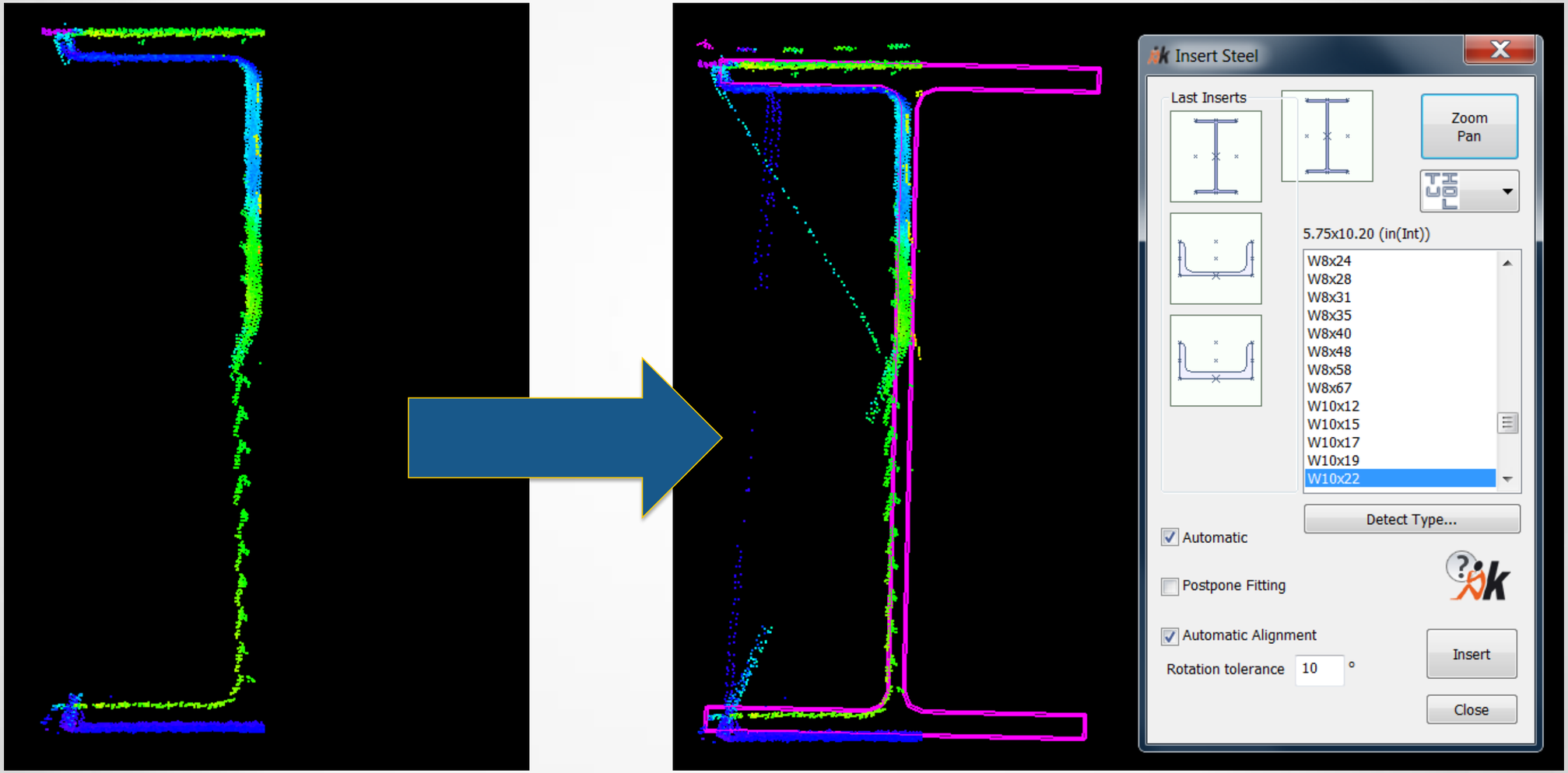






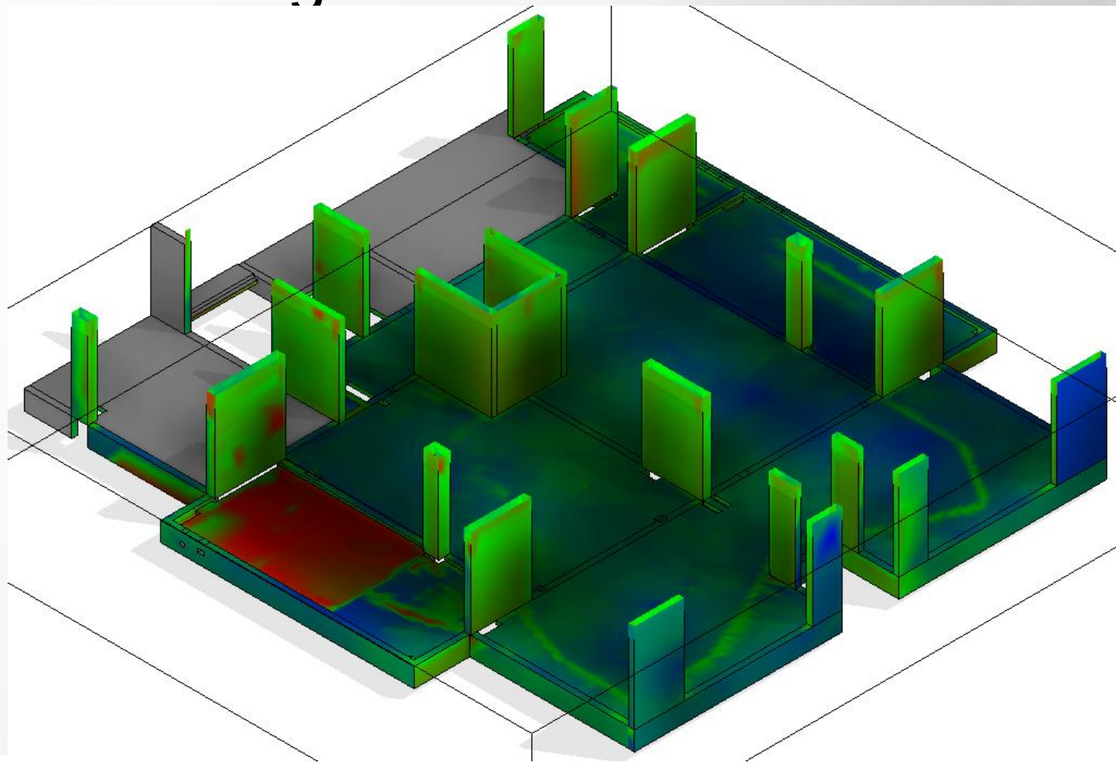
Structural Profiles

Good software, Good hardware, Good communication



Quality Control

- Challenge:
  - Extraction software applies perfect shapes to as-built data.
  - Users often need true assessment of existing conditions
- Solution:
  - Deformation Analysis tools
    - PointSense Plant
    - PointSense for Revit
    - Cloud Compare

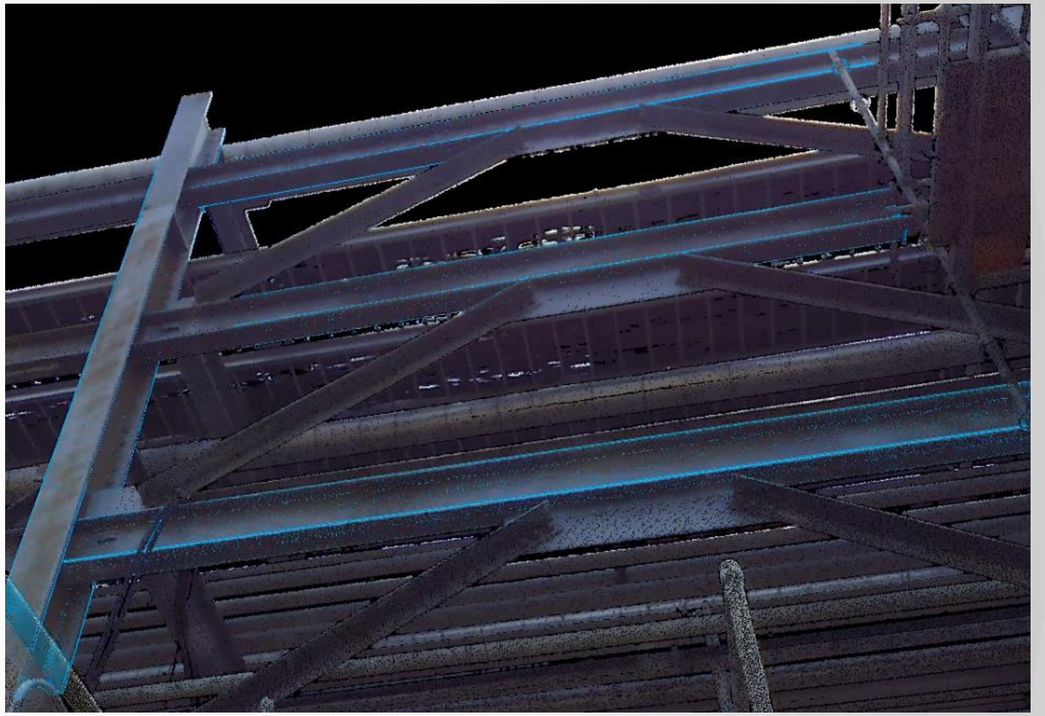


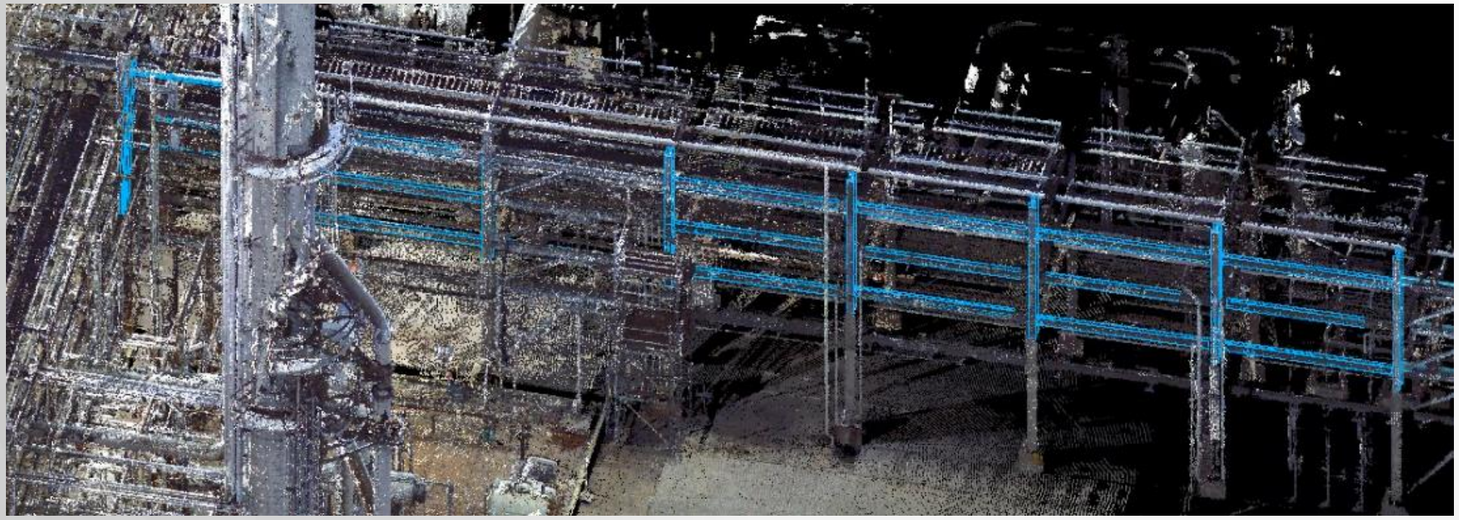
Point Clouds for Structural Design

Structural Extraction

“Modeling and exporting structural components”

- Pattern Recognition of steel members
- AISC, CISC, DIN, etc
- Create custom profiles for extraction
- Multiple options to adjust/edit beams
- “Copied Steel” fit option

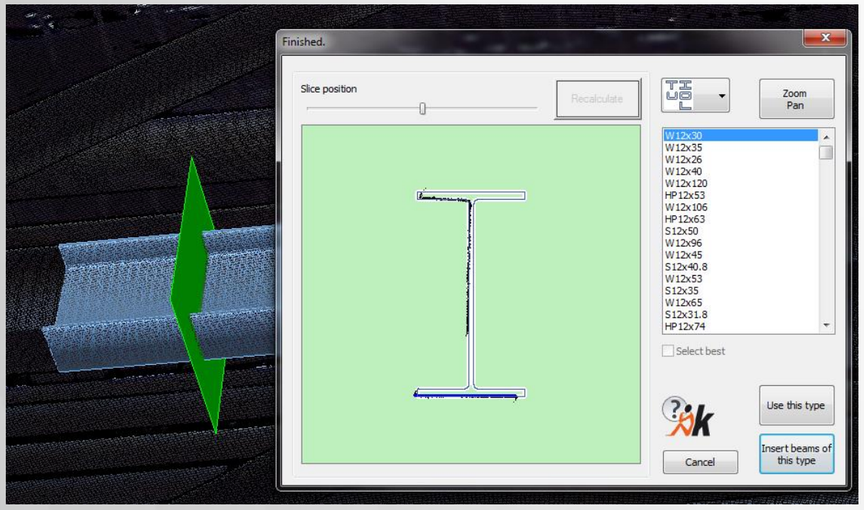


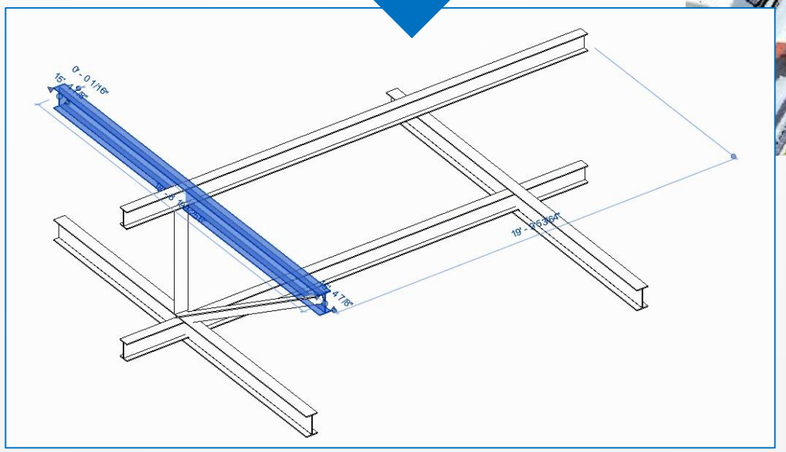


Structural Extraction

“Modeling and exporting structural components”

- Automatic Type Detection
  - Multiple tools needed to improve recognition in noisy areas
  - Beam-type filtering
  - “Eraser” tool to remove unwanted data

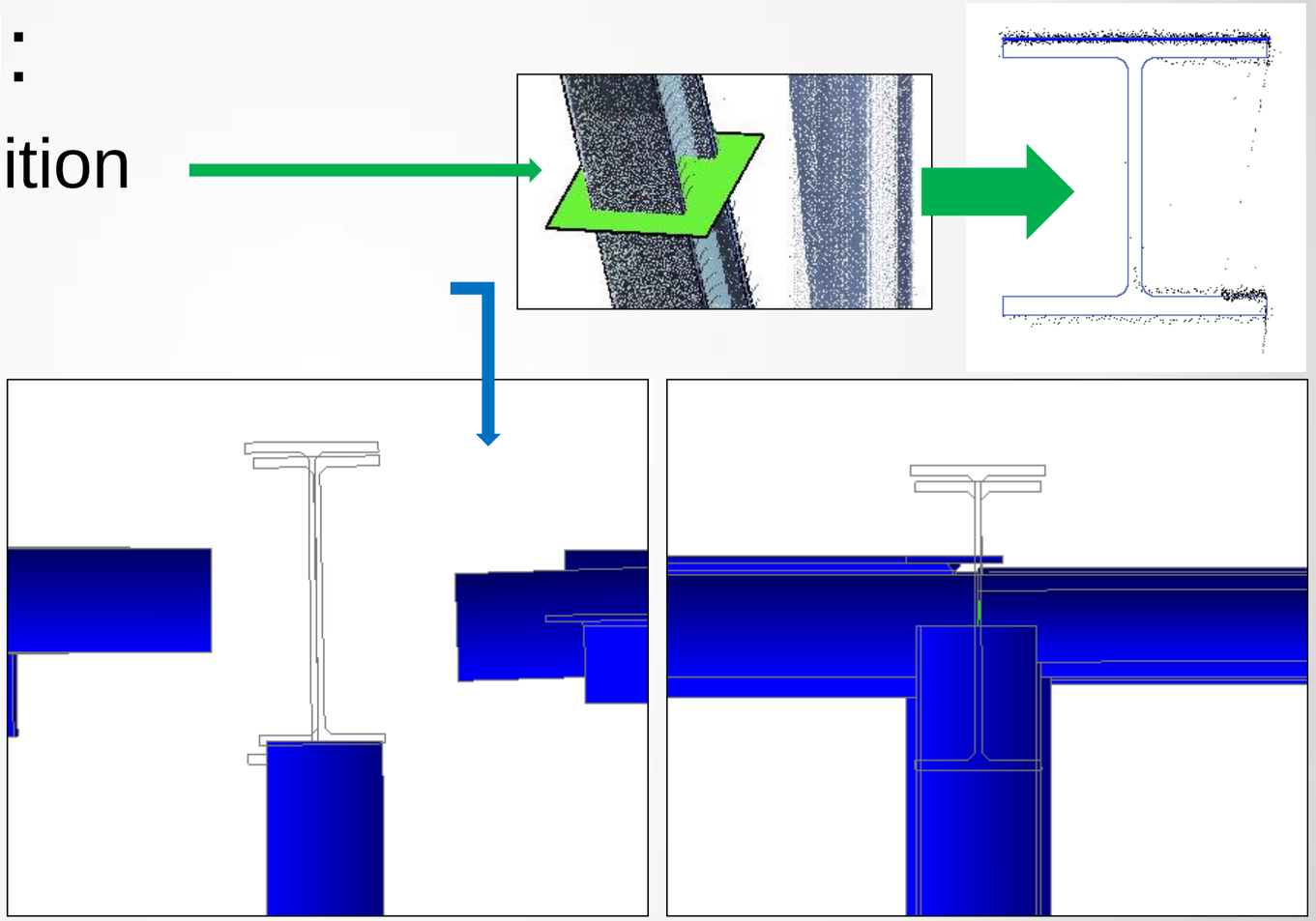




Structural Extraction

“Modeling and exporting structural components”

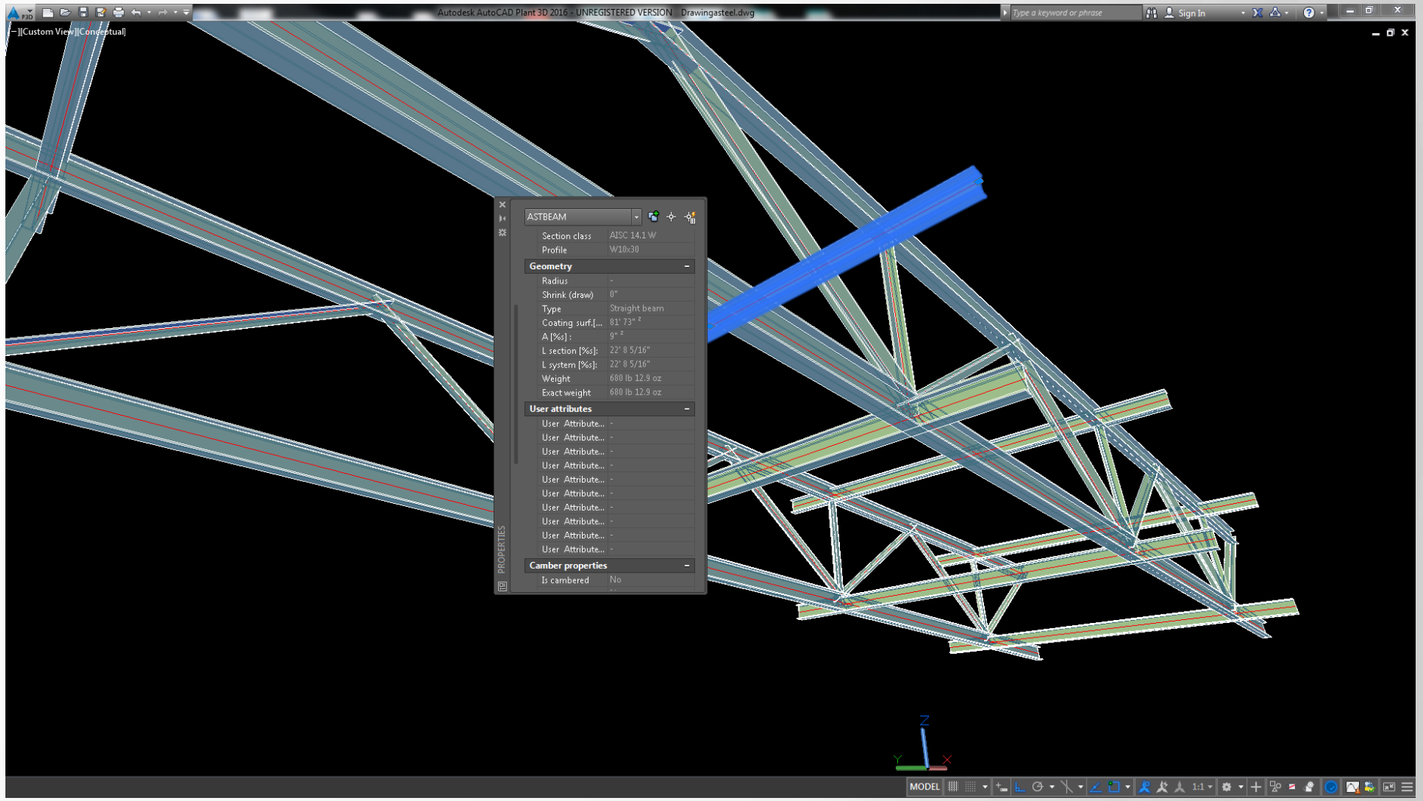
- Two steps needed:
  - Local Pattern Recognition
  - Apply Constraints

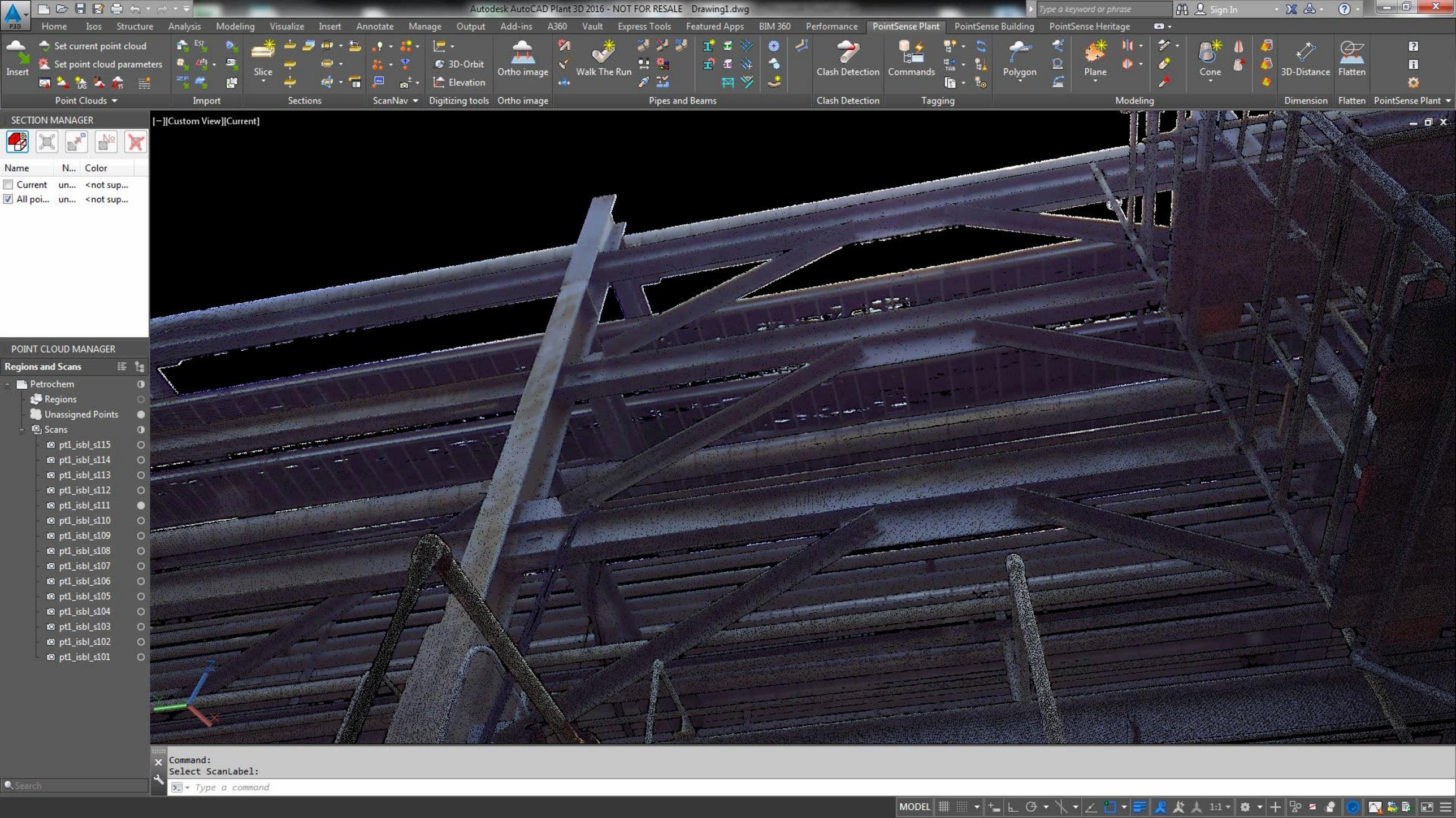


Structural Exports

“Bringing Beams to Structural Design Packages with Intelligence”

- Two major exports
  - Advance Steel Export
  - SDNF 3.0
    - Revit
    - ProSteel
    - RISA
    - Tekla
    - etc



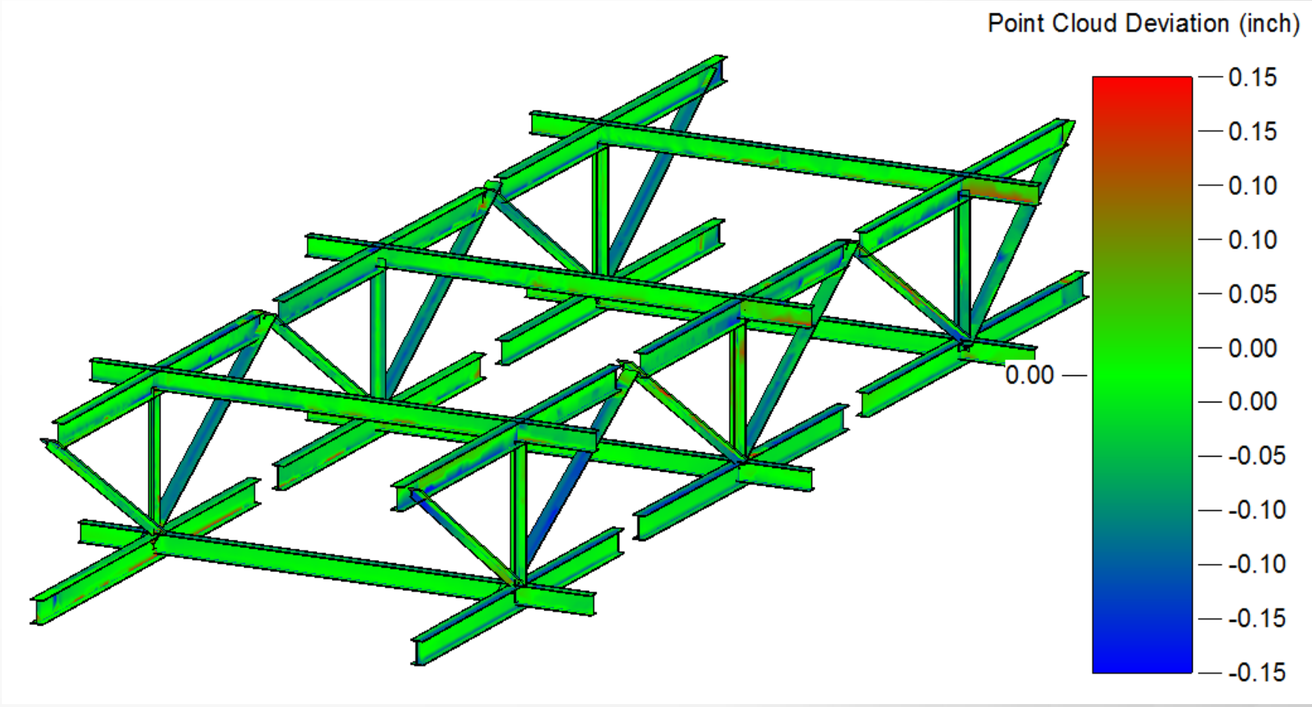

Autodesk AutoCAD Plant 3D 2016 - NOT FOR RESALE Drawing1.dwg
Home Isos Structure Analysis Modeling Visualize Insert Annotate Manage Output Add-ins A360 Vault Express Tools Featured Apps BIM 360 Performance PointSense Plant PointSense Building PointSense Heritage
Insert
Set current point cloud
Set point cloud parameters
Point Clouds
Import
Slice
Sections
ScanNav
3D-Orbit
Elevation
Digitizing tools
Ortho image
Walk The Run
Pipes and Beams
Clash Detection
Commands
Tagging
Polygon
Plane
Cone
Modeling
3D-Distance
Dimension
Flatten
PointSense Plant
SECTION MANAGER
Name N... Color
Current un... <not sup...
All poi... un... <not sup...
POINT CLOUD MANAGER
Regions and Scans
Petrochem
Regions
Unassigned Points
Scans
pt1_isbl_s115
pt1_isbl_s114
pt1_isbl_s113
pt1_isbl_s112
pt1_isbl_s111
pt1_isbl_s110
pt1_isbl_s109
pt1_isbl_s108
pt1_isbl_s107
pt1_isbl_s106
pt1_isbl_s105
pt1_isbl_s104
pt1_isbl_s103
pt1_isbl_s102
pt1_isbl_s101
[−][Custom View][Current]
Command:
Select ScanLabel:
Type a command
MODEL

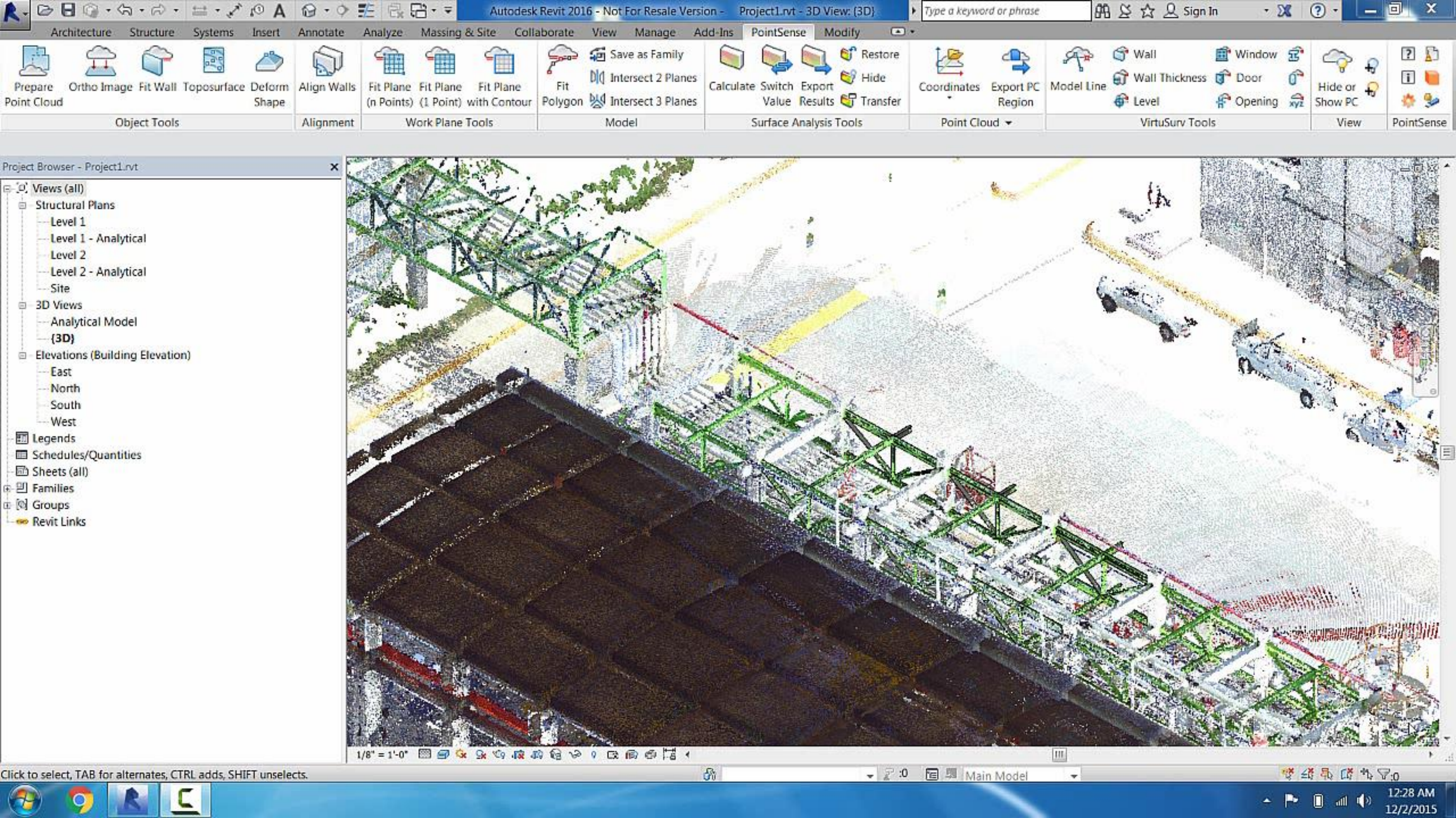
Analysis of Results

As-Built Analysis

“Comparing Real World to Pure Design”

- Analyze objects for
  - Clash Detection
  - Plumbness, Straightness, etc.
- Analysis Types
  - Model vs Point Cloud
  - Cloud vs Cloud




Autodesk Revit 2016 - Not For Resale Version - Project1.rvt - 3D View: {3D}
Type a keyword or phrase
Sign In
Architecture Structure Systems Insert Annotate Analyze Massing & Site Collaborate View Manage Add-Ins PointSense Modify
Prepare Point Cloud
Ortho Image
Fit Wall
Toposurface
Deform Shape
Object Tools
Align Walls
Alignment
Fit Plane (n Points)
Fit Plane (1 Point)
Fit Plane with Contour
Work Plane Tools
Fit Polygon
Save as Family
Intersect 2 Planes
Intersect 3 Planes
Model
Calculate
Switch Value
Export Results
Restore
Hide
Transfer
Surface Analysis Tools
Coordinates
Export PC Region
Point Cloud
Model Line
Wall
Wall Thickness
Level
Window
Door
Opening
VirtuSurv Tools
Hide or Show PC
View
PointSense
Project Browser - Project1.rvt
Views (all)
Structural Plans
Level 1
Level 1 - Analytical
Level 2
Level 2 - Analytical
Site
3D Views
Analytical Model
{3D}
Elevations (Building Elevation)
East
North
South
West
Legends
Schedules/Quantities
Sheets (all)
Families
Groups
Revit Links
1/8" = 1'-0"
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model
12:28 AM
12/2/2015

3D Tank Analysis with a FARO Focus 3D Scanner & Kubit PointSense Plant

Jon Sever

HDLS Project Manager, Pennoni Associates, Inc.

Twitter: @SEVER3DSCANNING

YouTube: SEVER3DSCANNING

3D Tank Analysis with a FARO Focus 3D Scanner & Kubit PointSense Plant

Jon Sever

HDLS Project Manager, Pennoni Associates Inc.

Twitter: @SEVER3DSCANNING

YouTube: SEVER3DSCANNING

Thank you for watching!

Questions?