A “ReCap” on Plant Design

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Class Summary

This class will update Autodesk users working within industrial facility design on the latest reality capture trends, methods and workflows from laser scanning to needed plant deliverables

Key Learning Objectives

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

- Describe the latest enhancements to Autodesk reality capture technologies and explain how they affect plant design workflows
- Go from field scanning, to Autodesk Recap, to deliverables in AutoCAD and Navisworks
- Generate intelligent plant deliverables from point cloud data with AutoCAD Plant 3D software
- Learn from real user stories and demonstrations to apply these concepts and workflows at your office

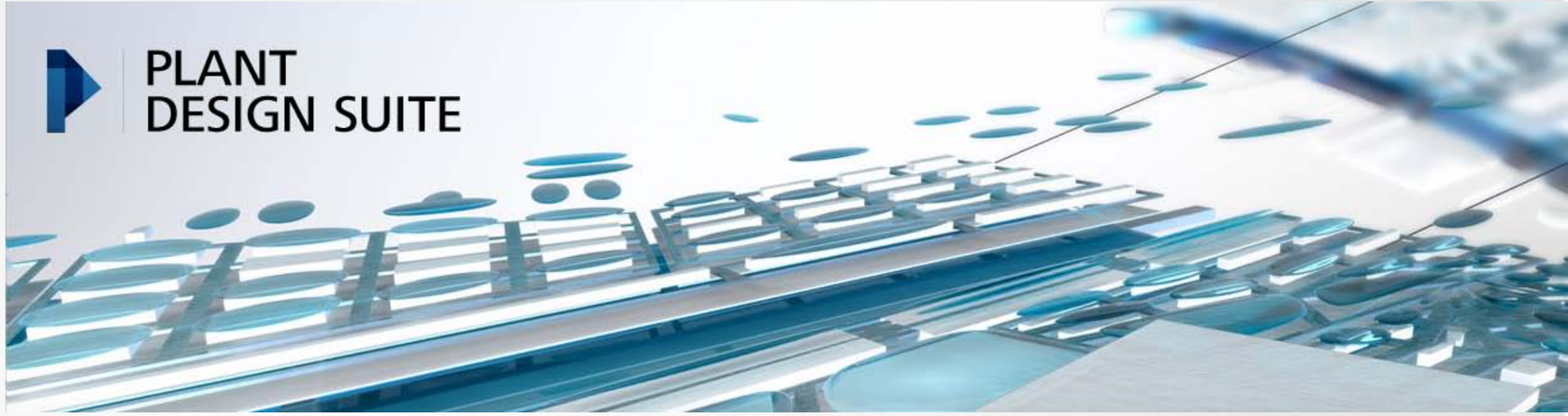
Software

Autodesk Plant Design Suite

Plant Design Suites 2013

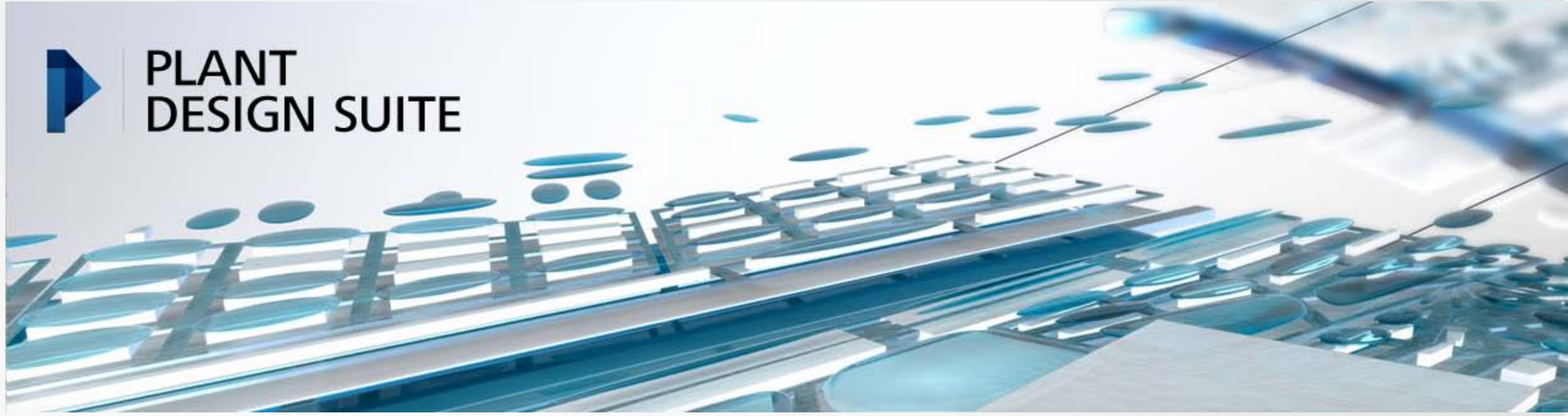
- 3 Editions
  - Plant Design Suite Standard 2014
  - Plant Design Suite Premium 2014
  - Plant Design Suite Ultimate 2014

Standard Edition



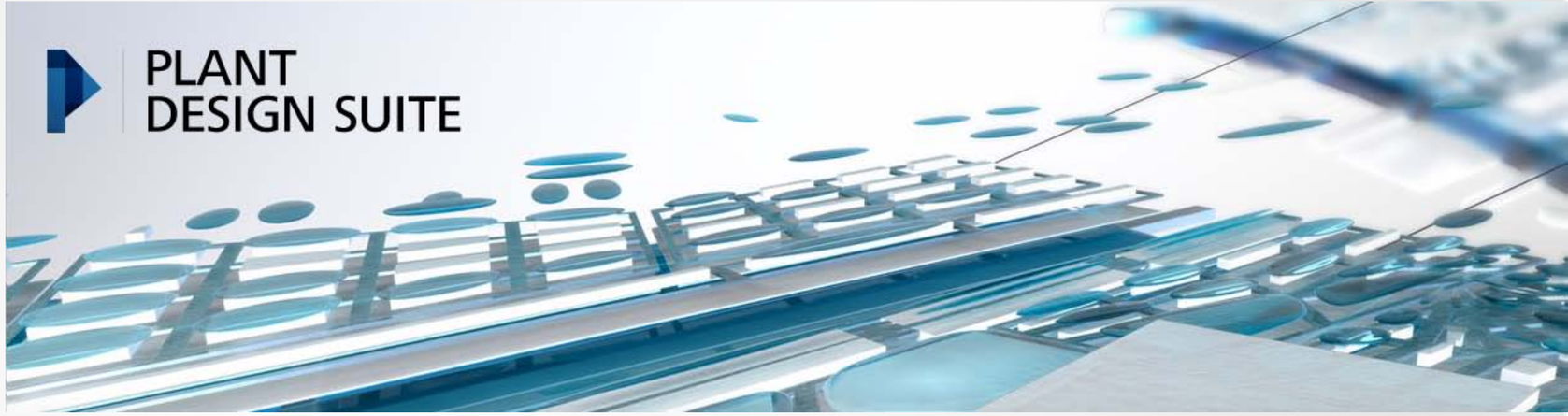
- AutoCAD® 2014
- AutoCAD® P&ID
- Autodesk® Sketchbook® Designer
- Autodesk® Showcase®
- Autodesk® Recap

Premium Edition



- AutoCAD®
- AutoCAD® P&ID
- AutoCAD® Plant 3D
- AutoCAD® Structural Detailing
- Autodesk® Revit® Structure
- Autodesk® Navisworks® Simulate
- Autodesk® Sketchbook® Designer
- Autodesk® Showcase®
- Autodesk® Recap

Ultimate Edition



- AutoCAD®
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- Autodesk® Inventor®
- Autodesk® Revit® Structure
- Autodesk® Sketchbook® Designer
- Autodesk® Showcase®
- Autodesk® Recap

Introduction to Autodesk Recap

About Autodesk® ReCap™

Autodesk® ReCap™ delivers powerful and easy to use workflow on the desktop and in the cloud to create intelligent 3D data from laser scans and captured photos.

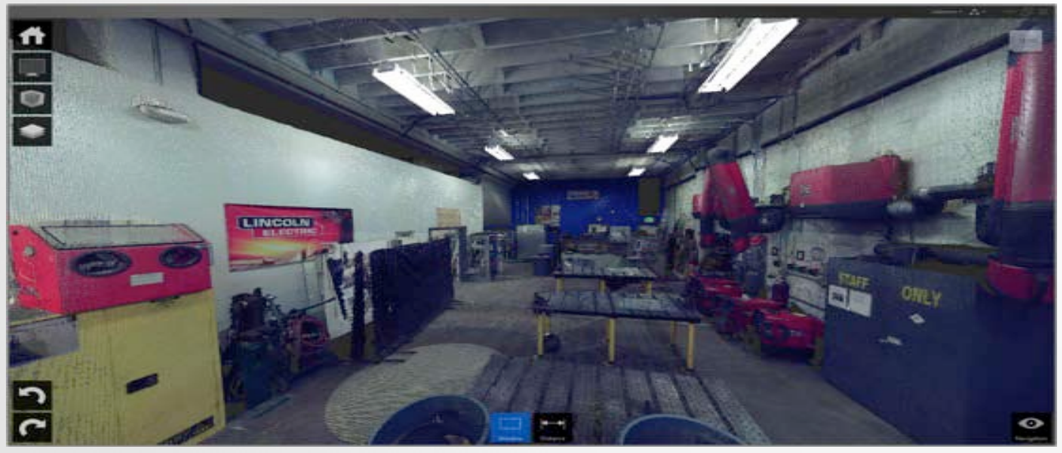
Integrated with Autodesk® Design and Creation suites, **Autodesk® ReCap™ Studio** makes it easy to clean, organize, and visualize massive datasets captured from reality. **Autodesk® ReCap™ Photo** helps users create high-resolution textured 3D models from photos using the power of cloud computing.

Rather than beginning with a blank sheet, **Autodesk® ReCap** now enables any designer, architect or engineer to add, modify, validate and document their design process in context from existing environments.

About Autodesk® ReCap™

Autodesk® ReCap™ Studio

- Desktop application
- Point cloud data preparation, QA & verification
- Direct import into Autodesk design solutions
- Included with 2014 Design Suites
- Available on Autodesk App Exchange

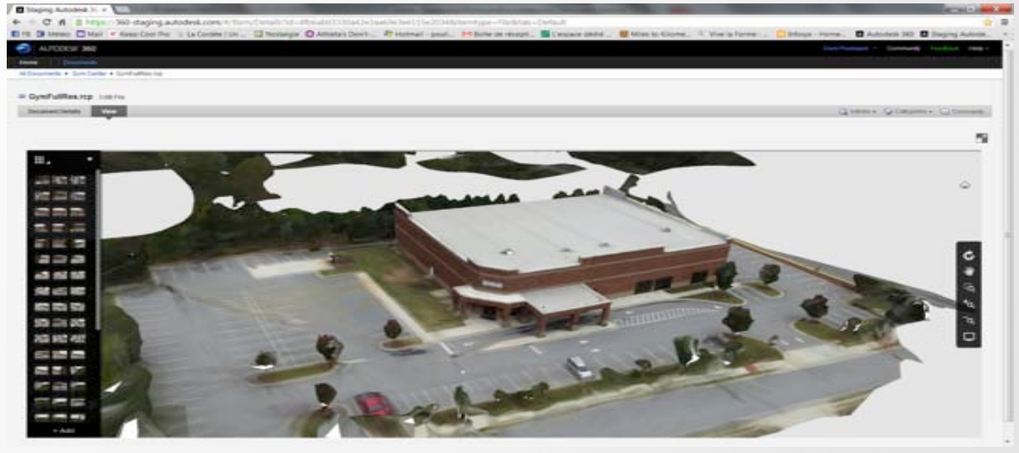


Autodesk® ReCap™ Photo

- Create high-resolution textured 3D models from photos using the power of cloud computing
- Free trial available in April

Autodesk® ReCap™ Engine

- In-product point cloud viewer
- Powerful new data format
- Segmentation, measurement, manipulation



Third-Party Software

PointSense Family

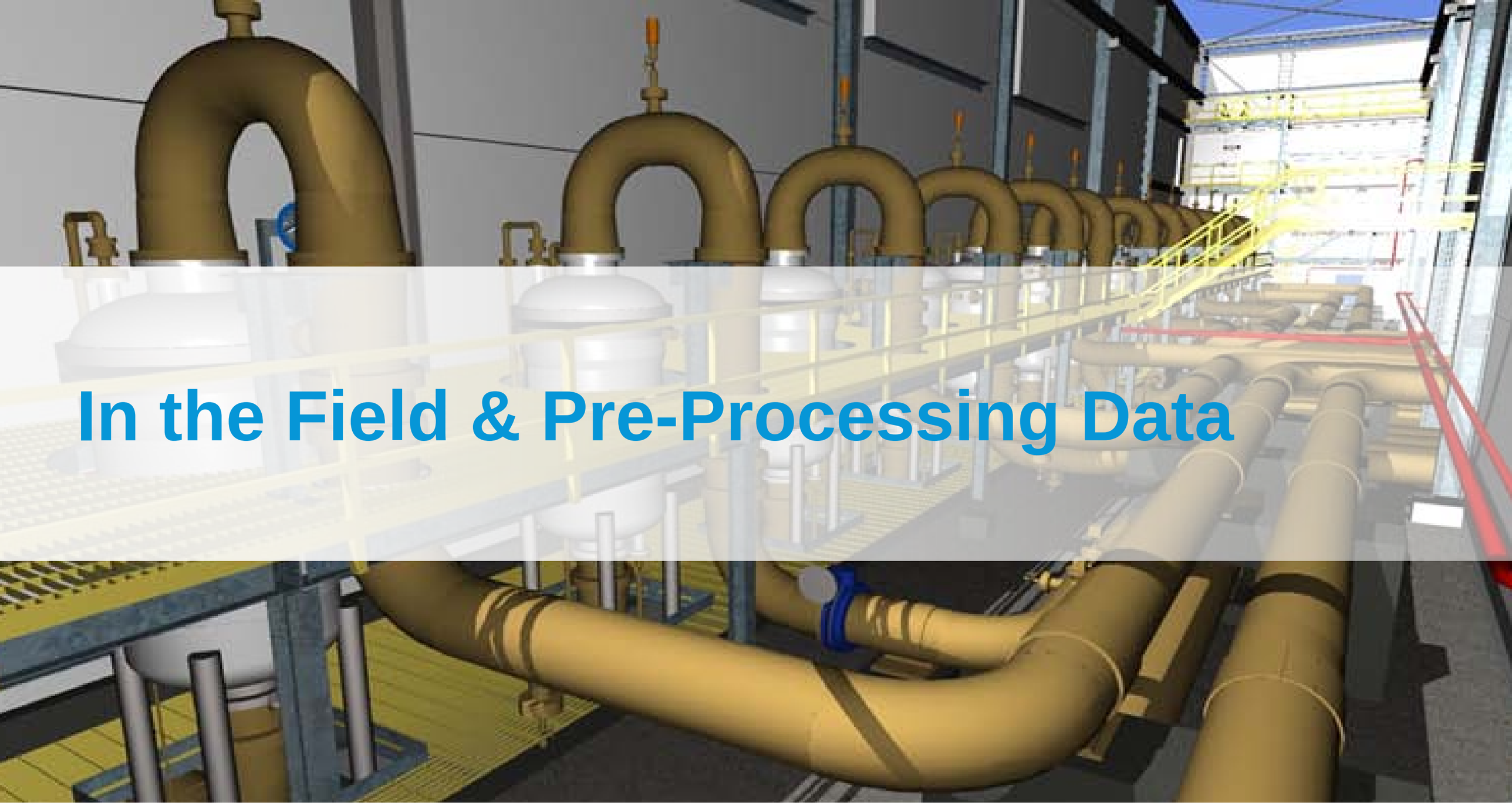
AutoCAD based products

	AutoCAD 2014	PointSense Plant
Import Scan Data		
Take Measurements		
Snap to Points		
Cropping		
Slicing		
Section Manager		
UCS Automation to Cloud		
Ortho Image		
Panoramic View Link to Cloud		
Plane Fitting		
Primitive Solid Extraction		
Line Fitting		
Piping Tools		
Structural Steel Extraction		
Tank Analysis		
Tagging		

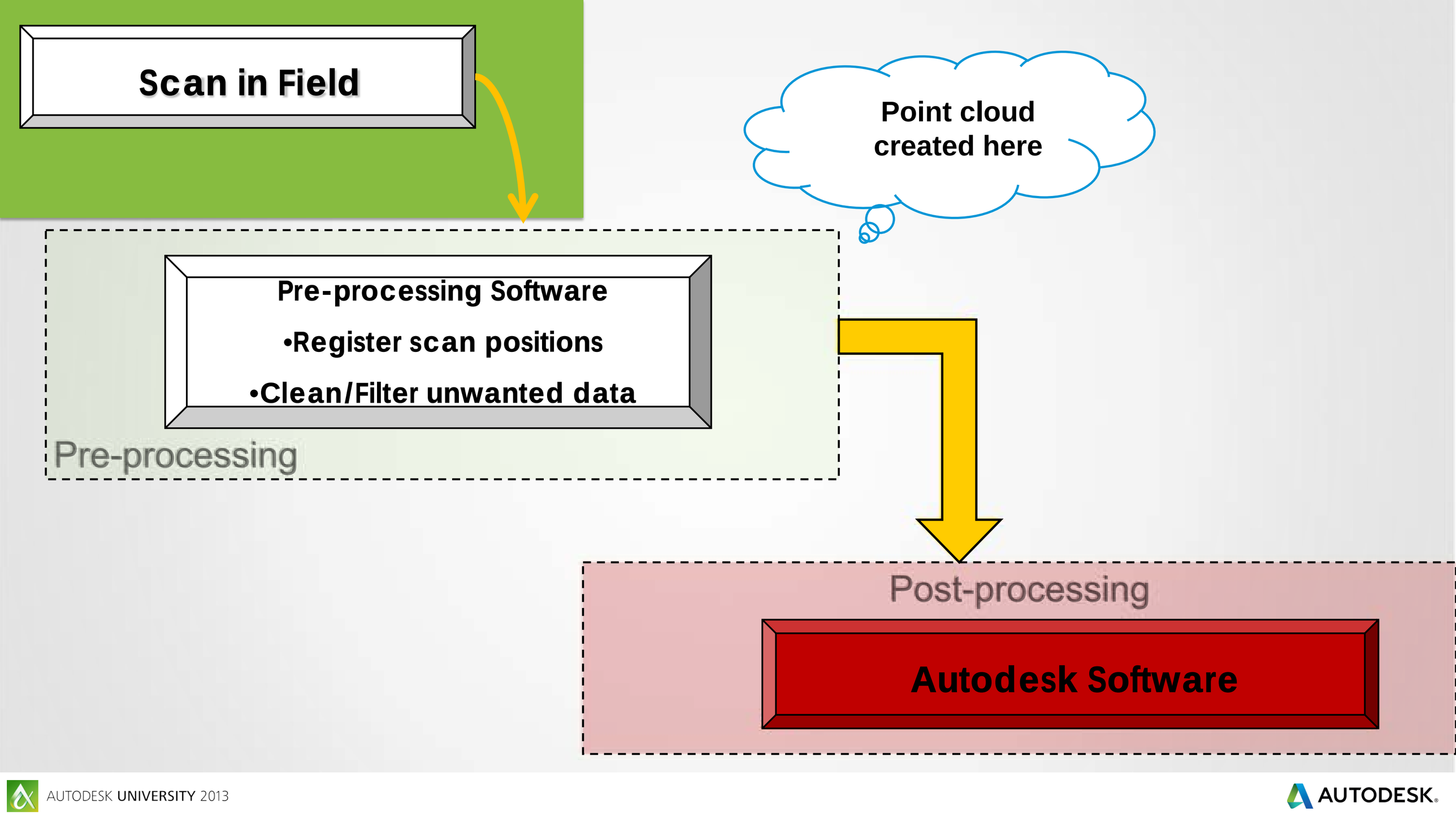
Plant3D-Integrated Products

VirtuSurv

PointSense Plant



In the Field & Pre-Processing Data


Scan in Field
Point cloud created here
Pre-processing Software
•Register scan positions
•Clean/Filter unwanted data
Pre-processing
Post-processing
Autodesk Software

Scanning (Traditional Data Collection)

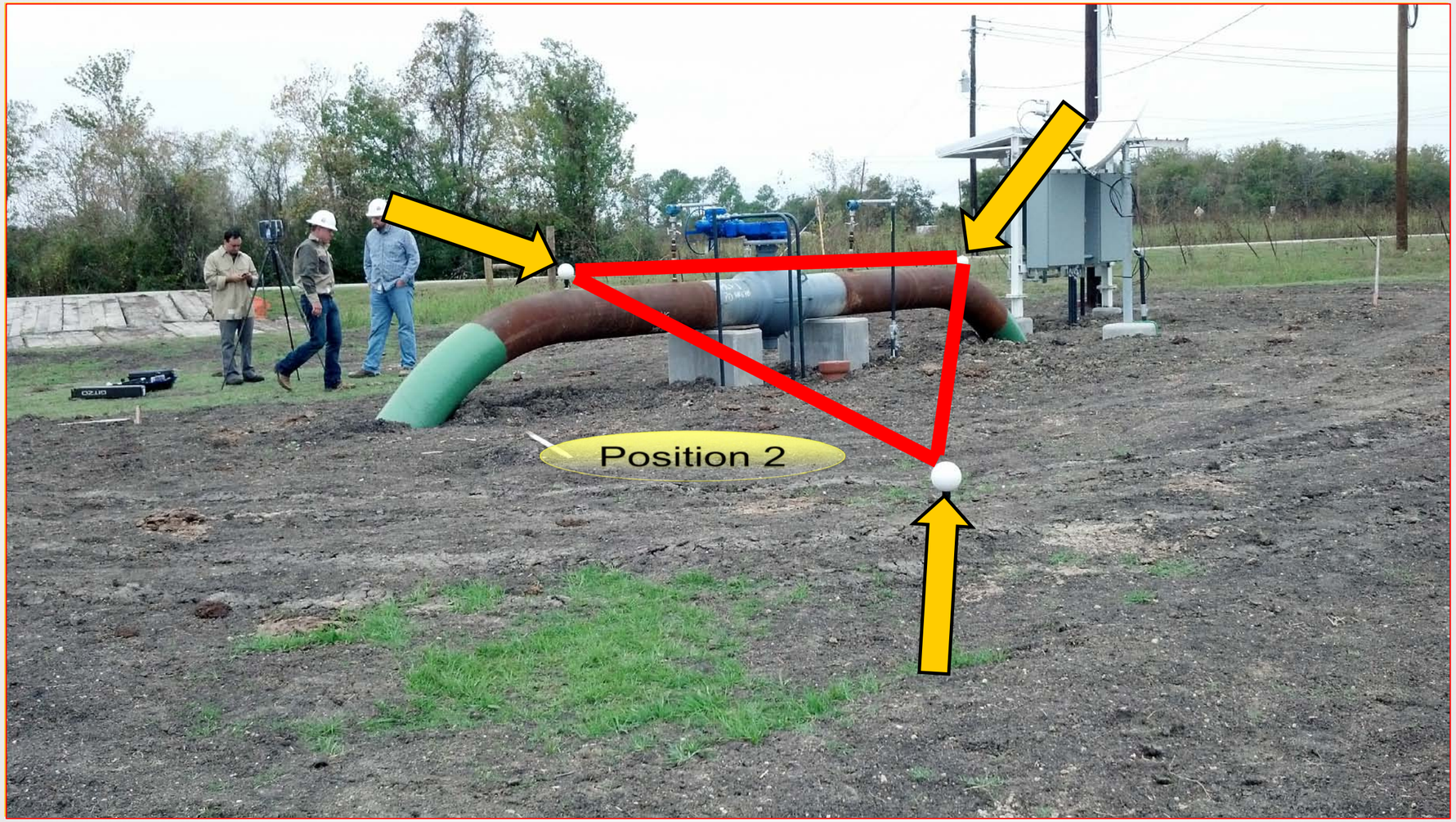
Traditional Data Collection

- Setup scanner in position 1
- Place 3+ targets in view
  - (spheres, checkerboard, survey points)
- Choose scan settings
- Start Scan

Traditional Data Collection

- Target preparation
  - Distribute multiple targets
  - Various heights and angles
  - Add more targets with more scan positions

Traditional Data Collection



Traditional Data Collection

- Moving positions
  - Scanner auto-levels
  - Previous targets visible
  - Add more targets
  - Scan and repeat

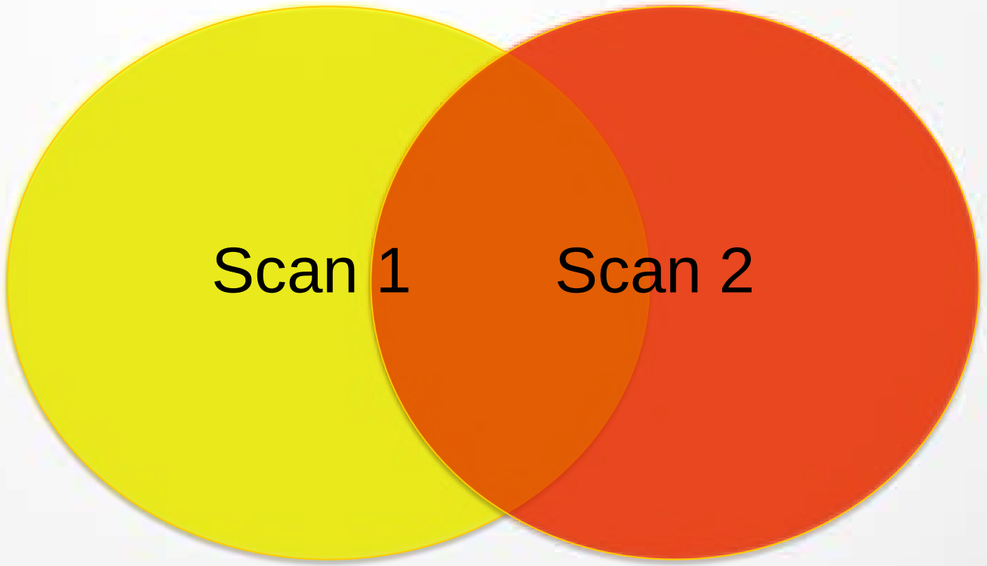
Traditional Data Collection (summary)

- More work in the field
- Target placement strategy
  - Distance
  - Angles
  - Visibility

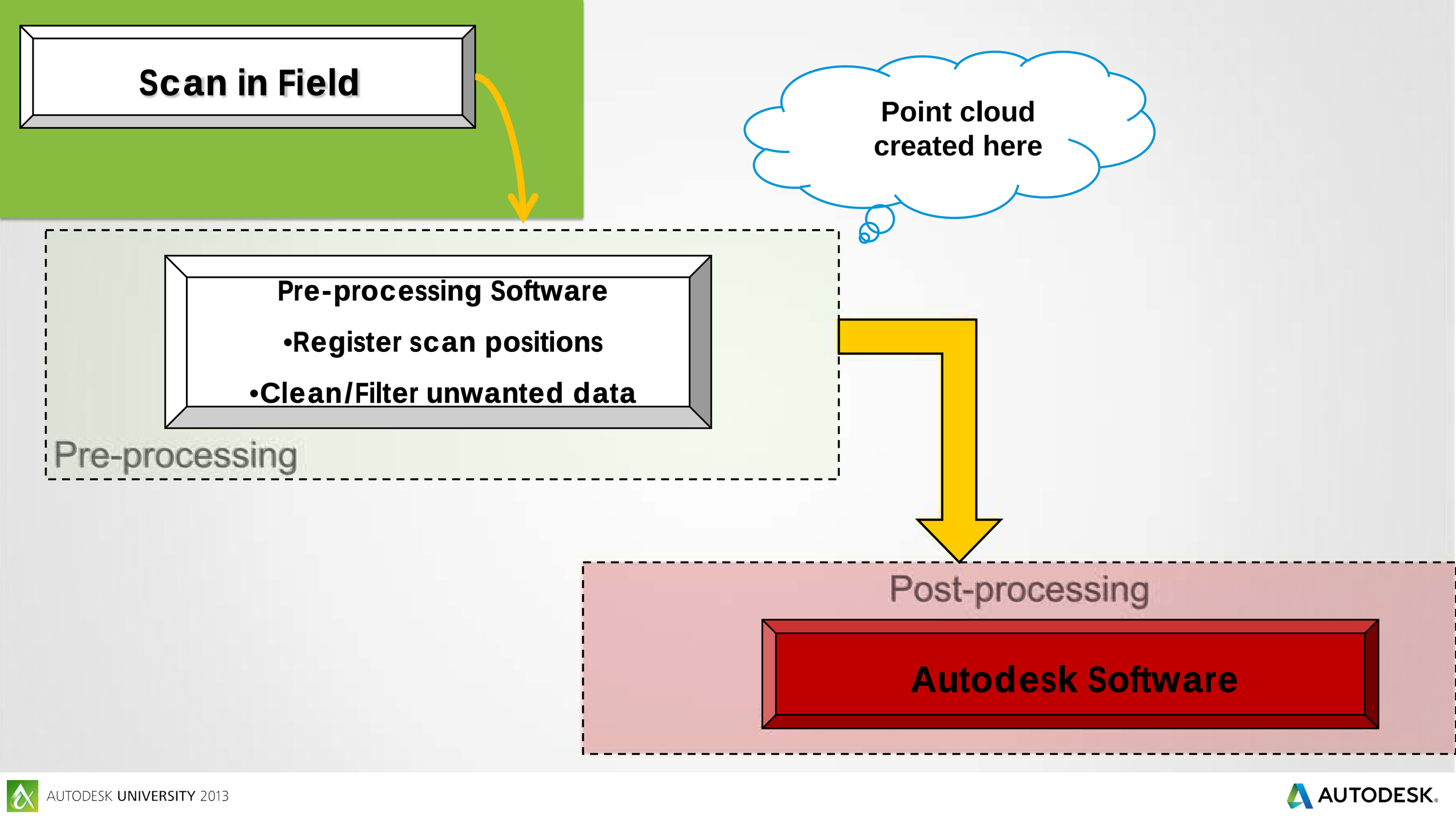
Scanning (Targetless Scanning)

Data Collection (Targetless)

- No Targets Required
- Significant data overlap required
  - Allows for pattern detection between common scans
- Now provided with Autodesk Recap Pro



Scan Data Registration (Traditional)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Traditional Registration

- Import raw scans to scanner manufacturer software
- Run “pre-processing” or registration process
- Software identifies field targets and aligns scan positions

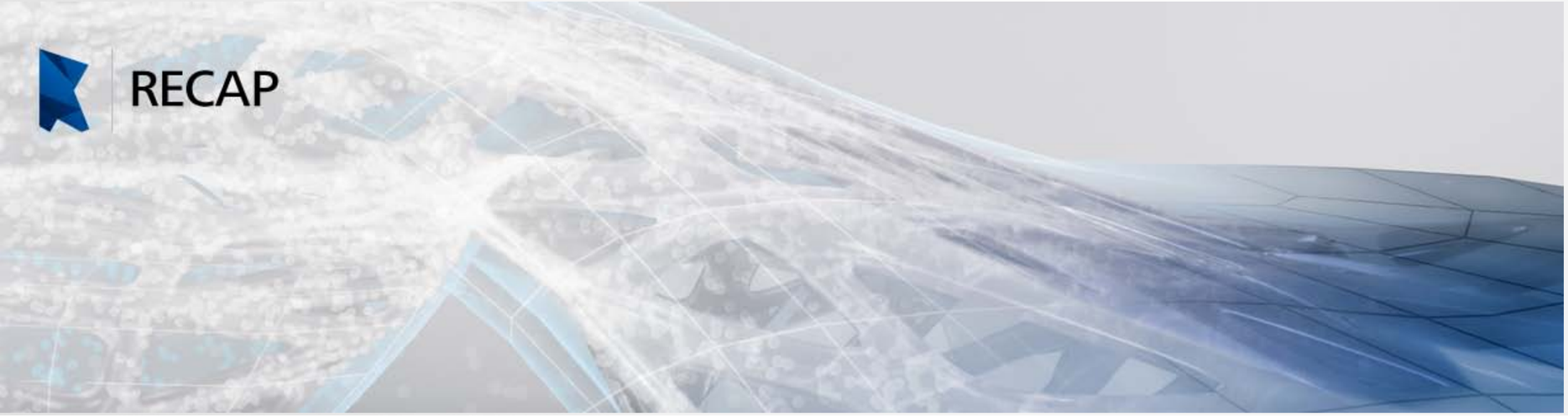
Traditional Registration – Pros and Cons

Pros	Cons
Registration software is native to scanner.	Needs many targets in the field
Able to add color to scans	Does not produce native Autodesk format directly
Proven method for high accuracy	Usually requires training to register
Automatic detection of targets in some programs	Need specific software product, based on scanner manufacturer
	Software is expensive if it isn't bundled with the scanner

Targetless Registration
(via Autodesk Recap Pro)

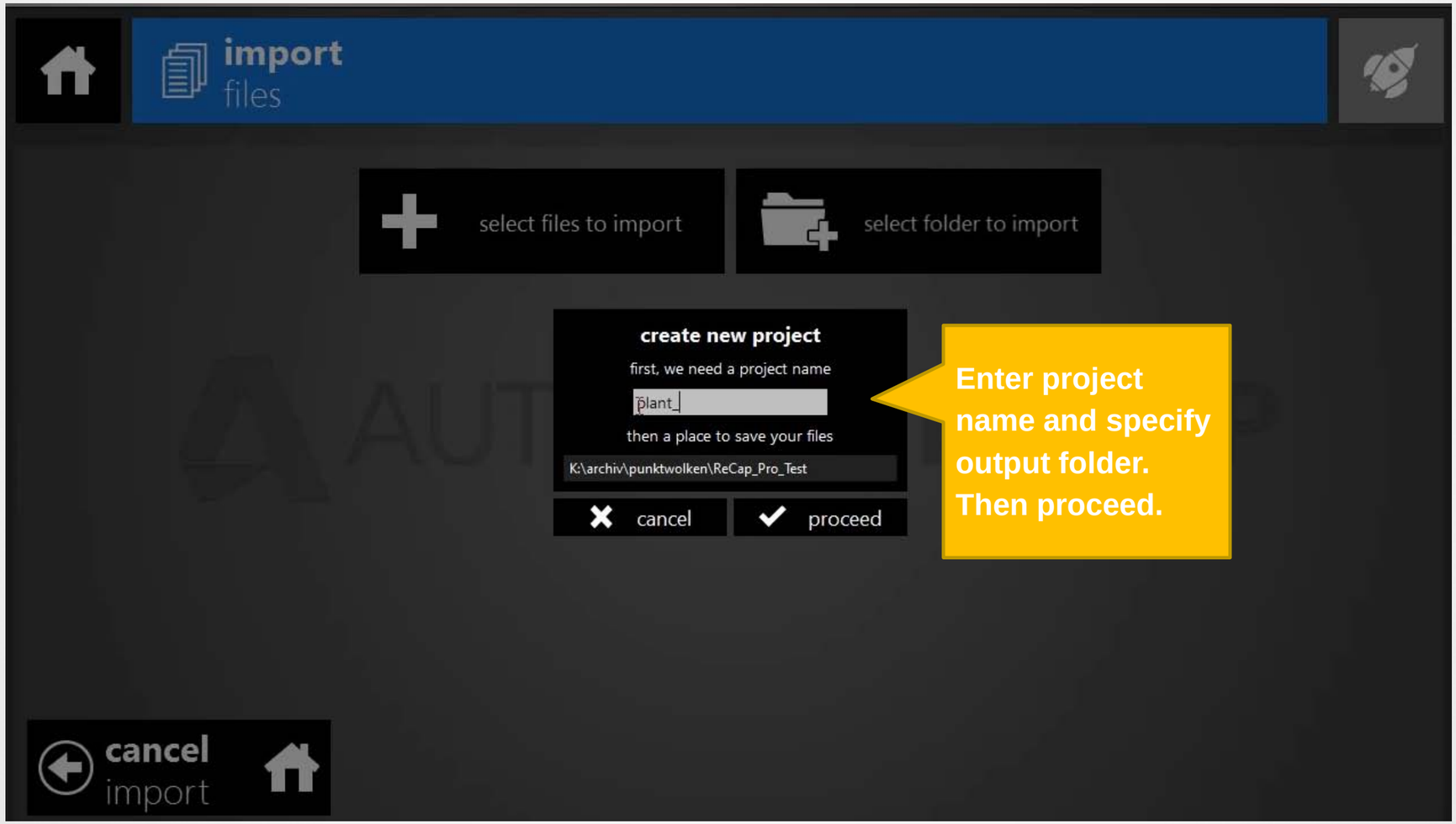
What is ReCap Pro?

- Autodesk's new software for laser scanning registration
- Professional version of Autodesk Recap
  - Paid via Autodesk 360 subscription
- Intuitive interface for scan to scan alignment
- No targets required
- Seamless workflow from raw field data to registered point cloud files

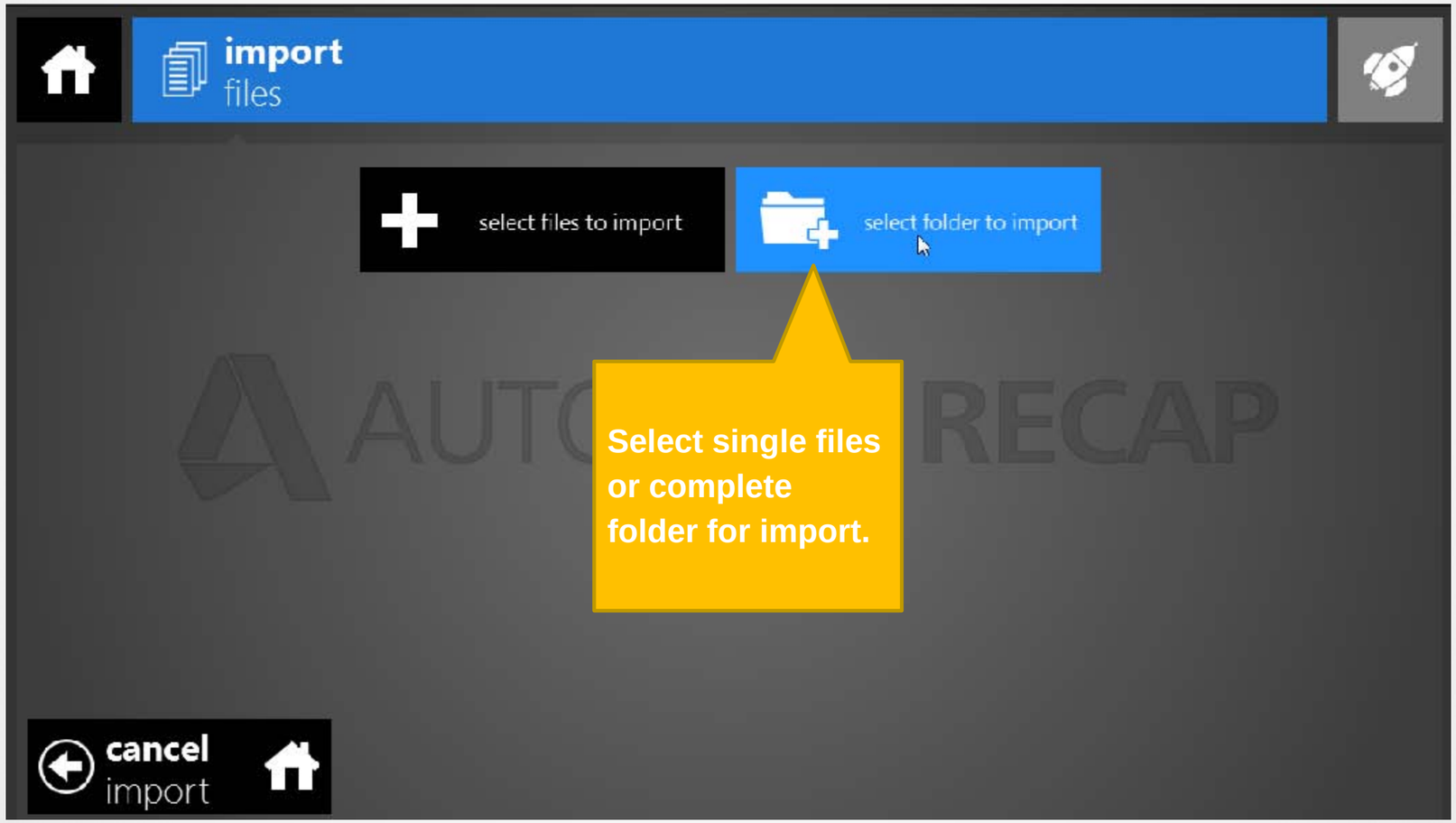


This is how it works:

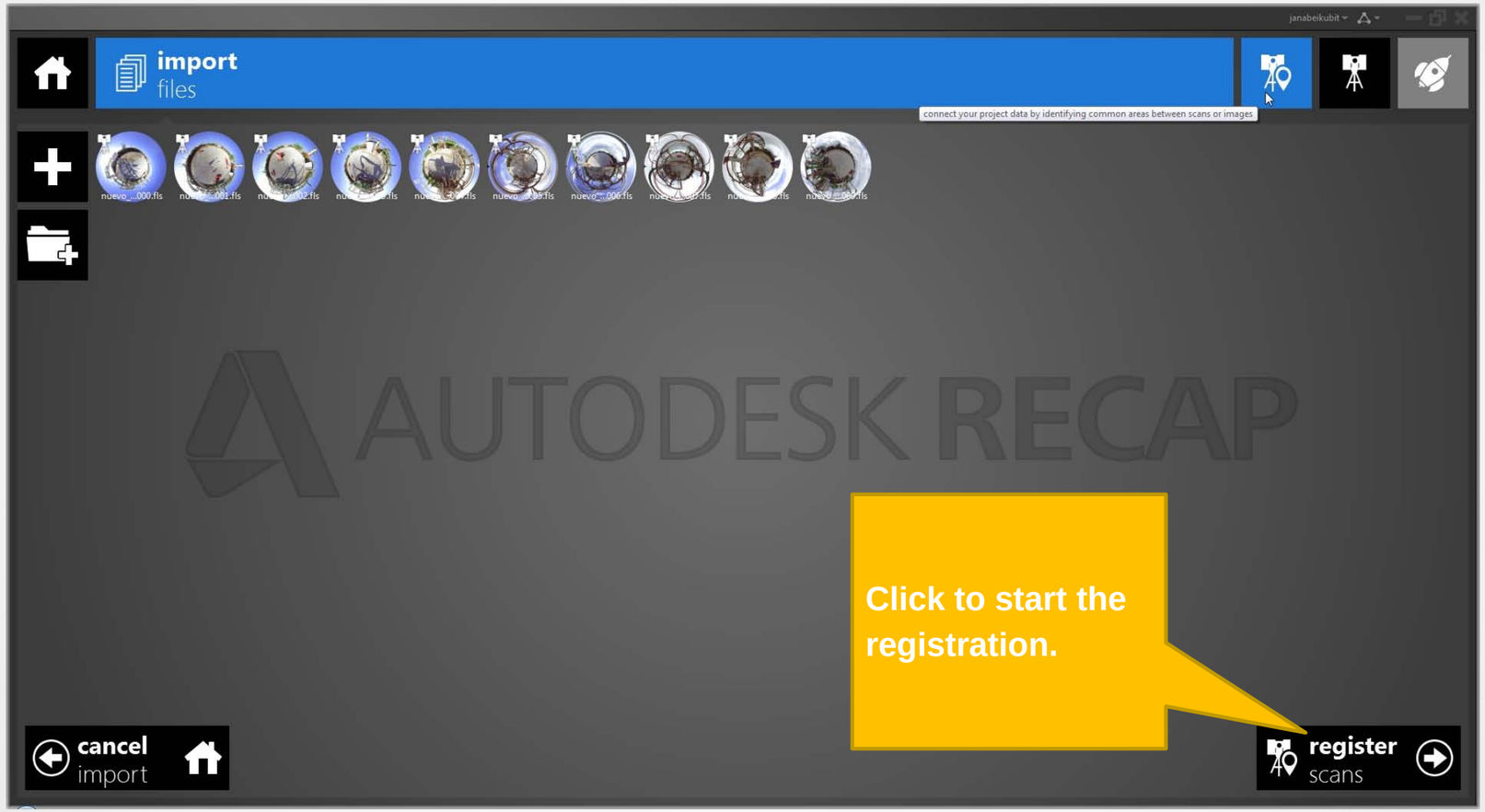
- Start ReCap Pro and create a new project



Data import


import
files
select files to import
select folder to import
Select single files or complete folder for import.
cancel
import

Pre-processing

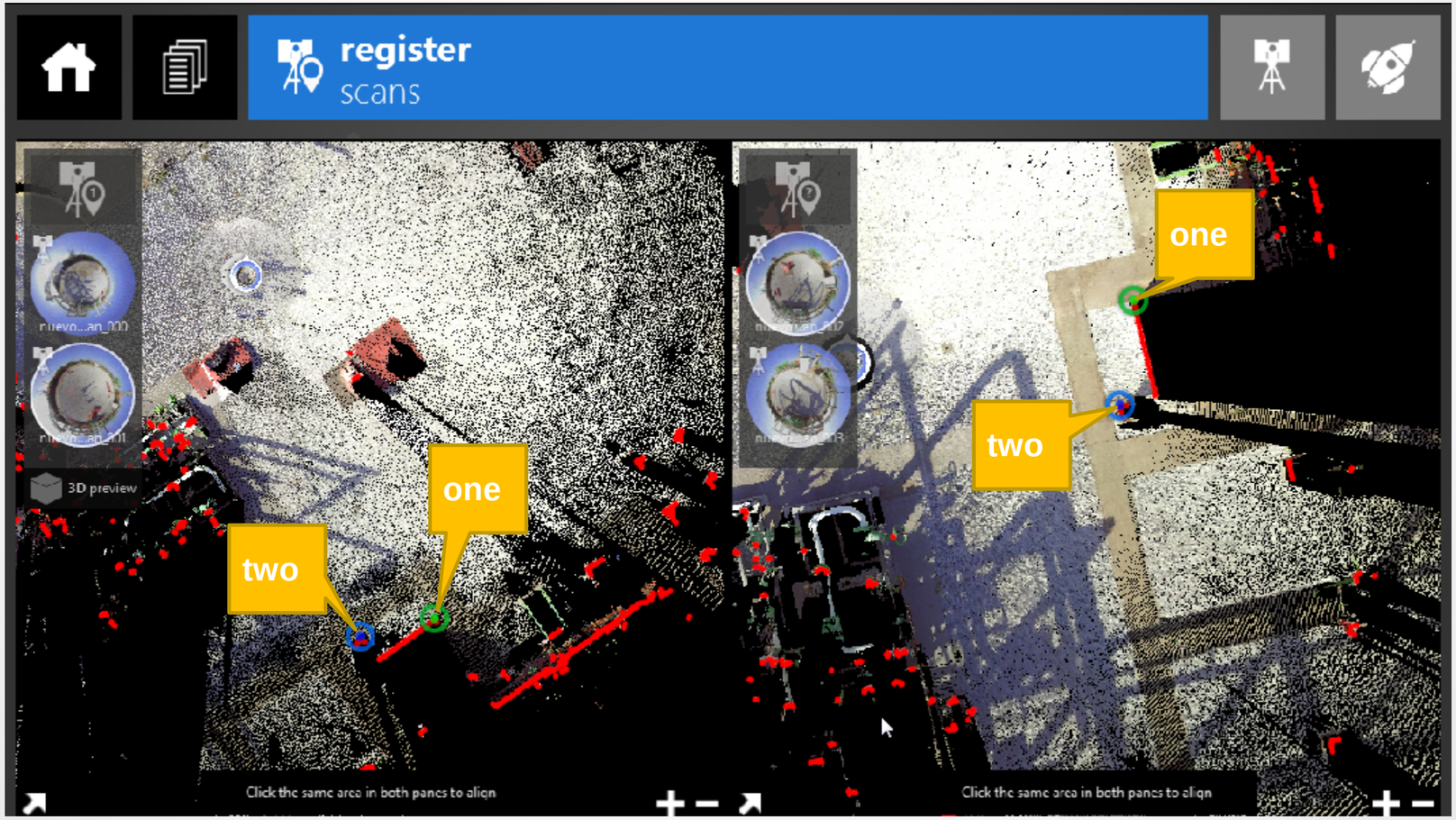


Scan registration

- Scanorama: click three corresponding locations in both scans

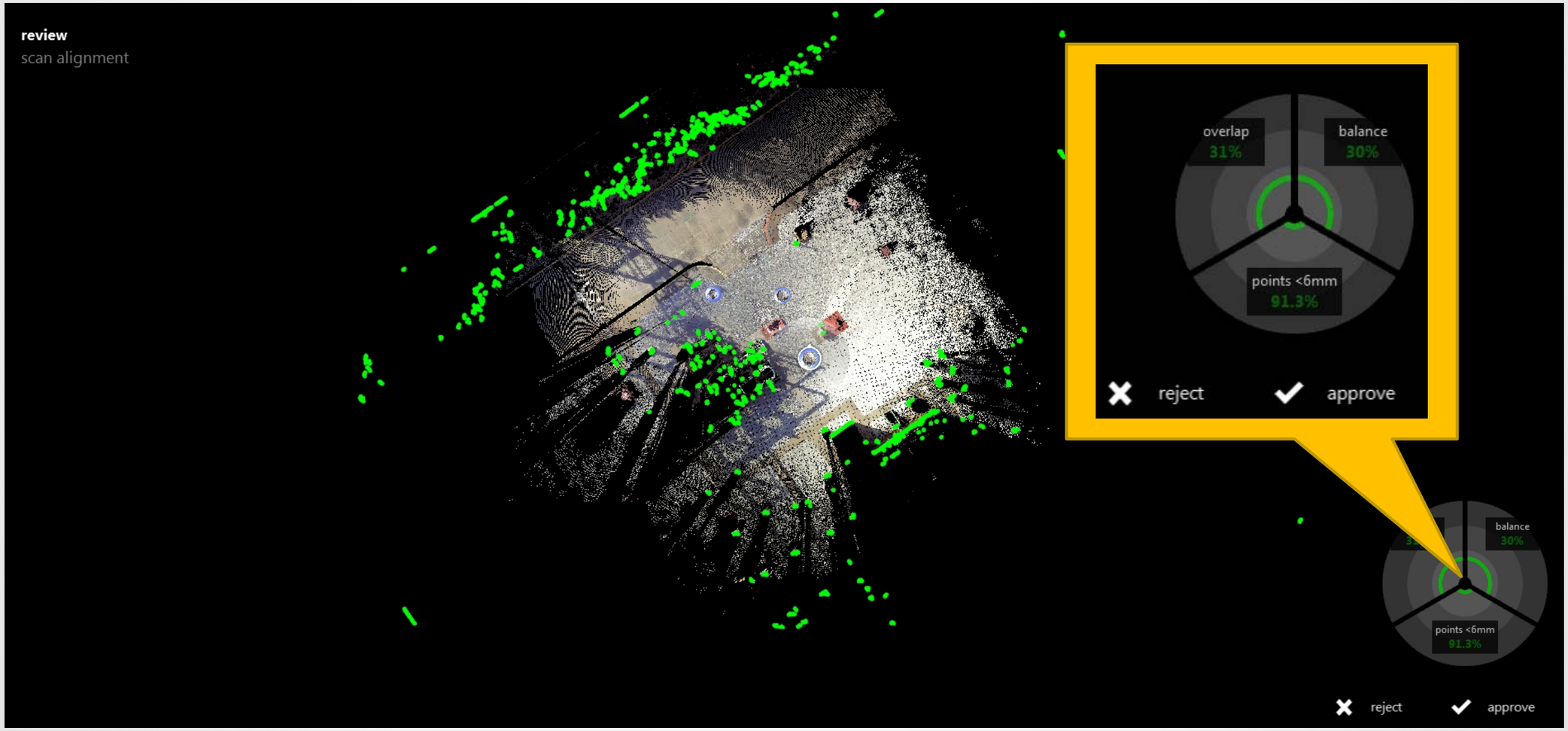
Scan registration

- Plan view: click just two corresponding locations in both scans



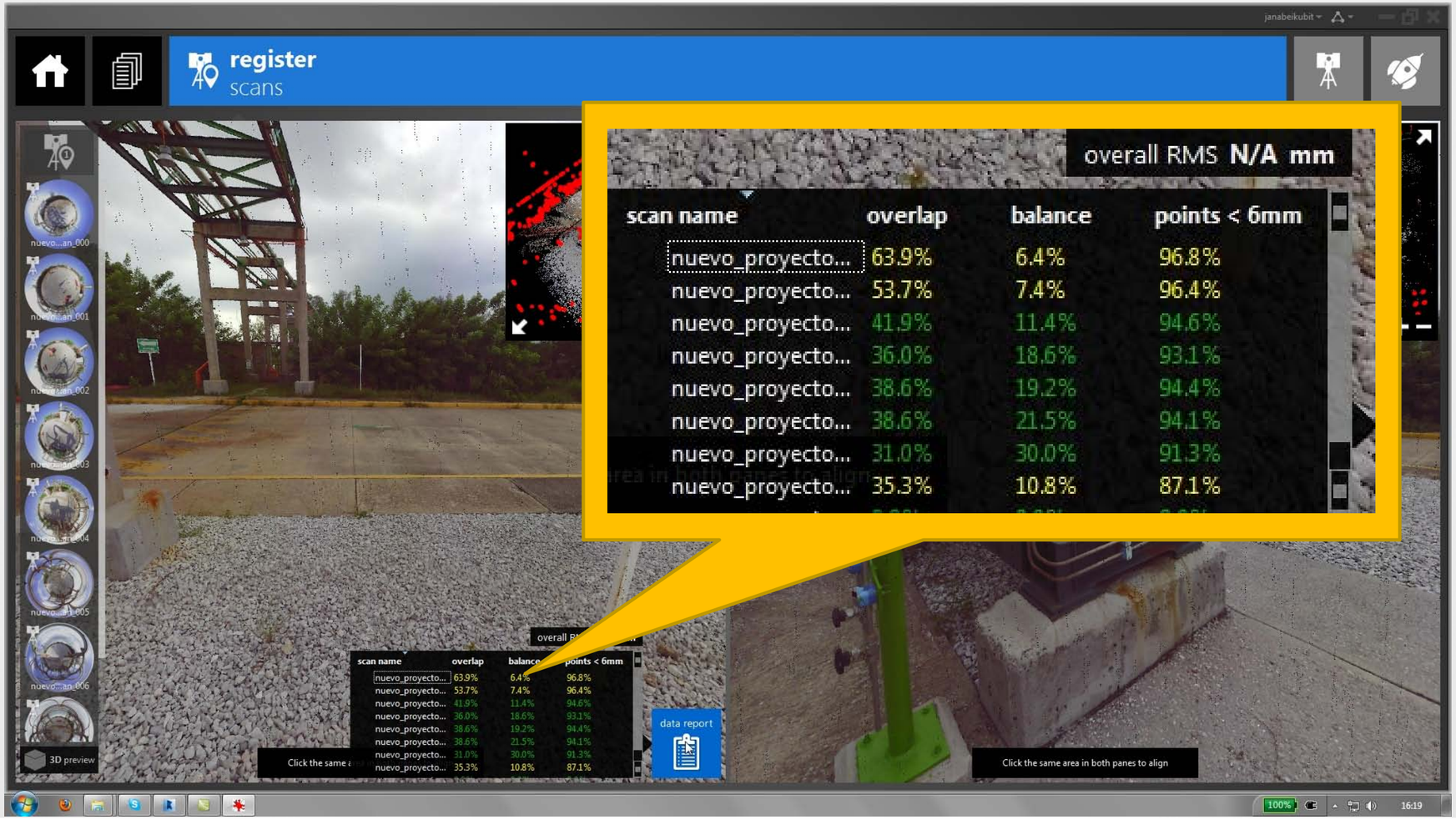
Scan registration

- A chart with the registration statistics is displayed after each step:



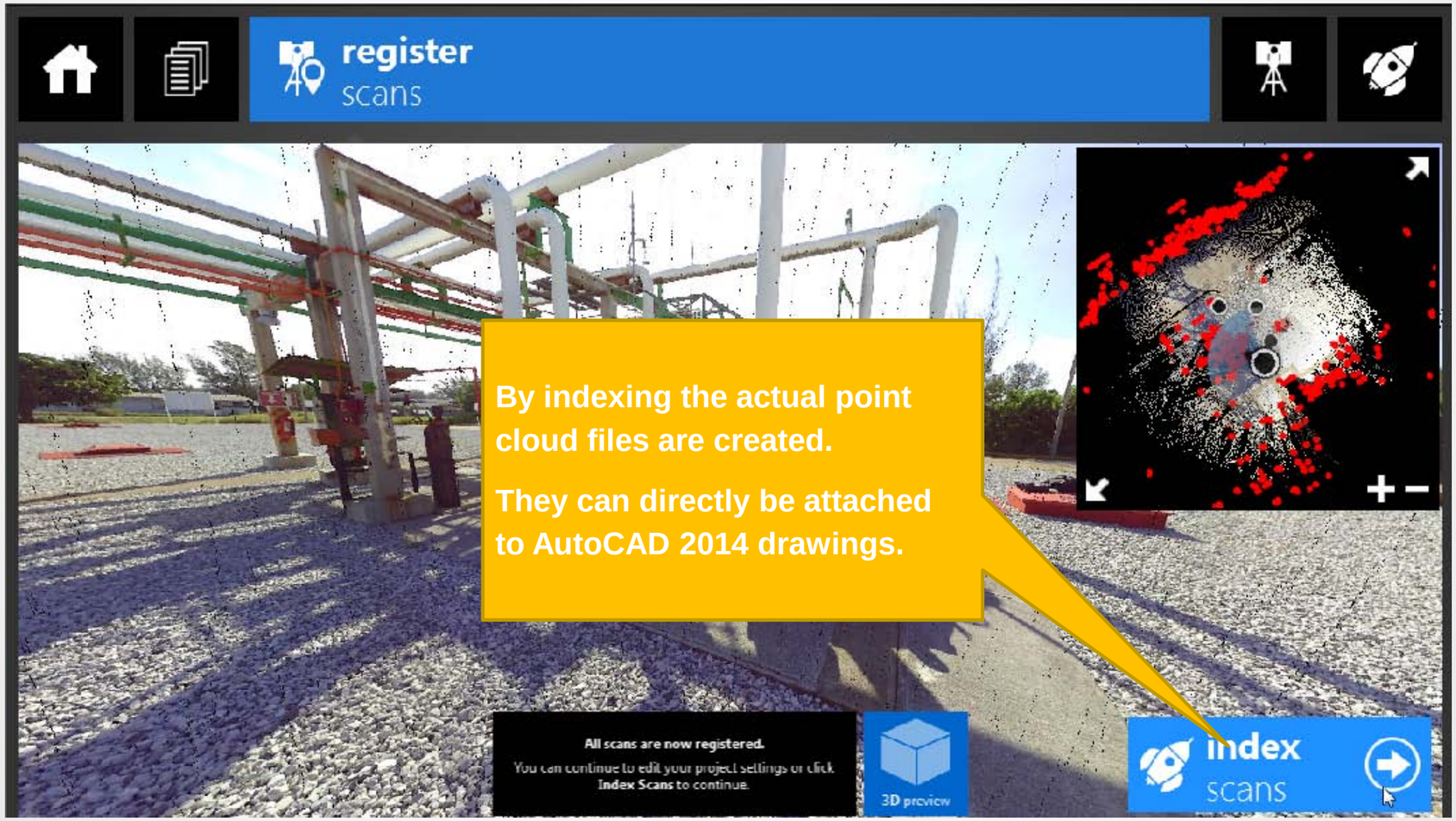
Scan registration

- A “Data report” shows the overall statistics:



Creating point clouds

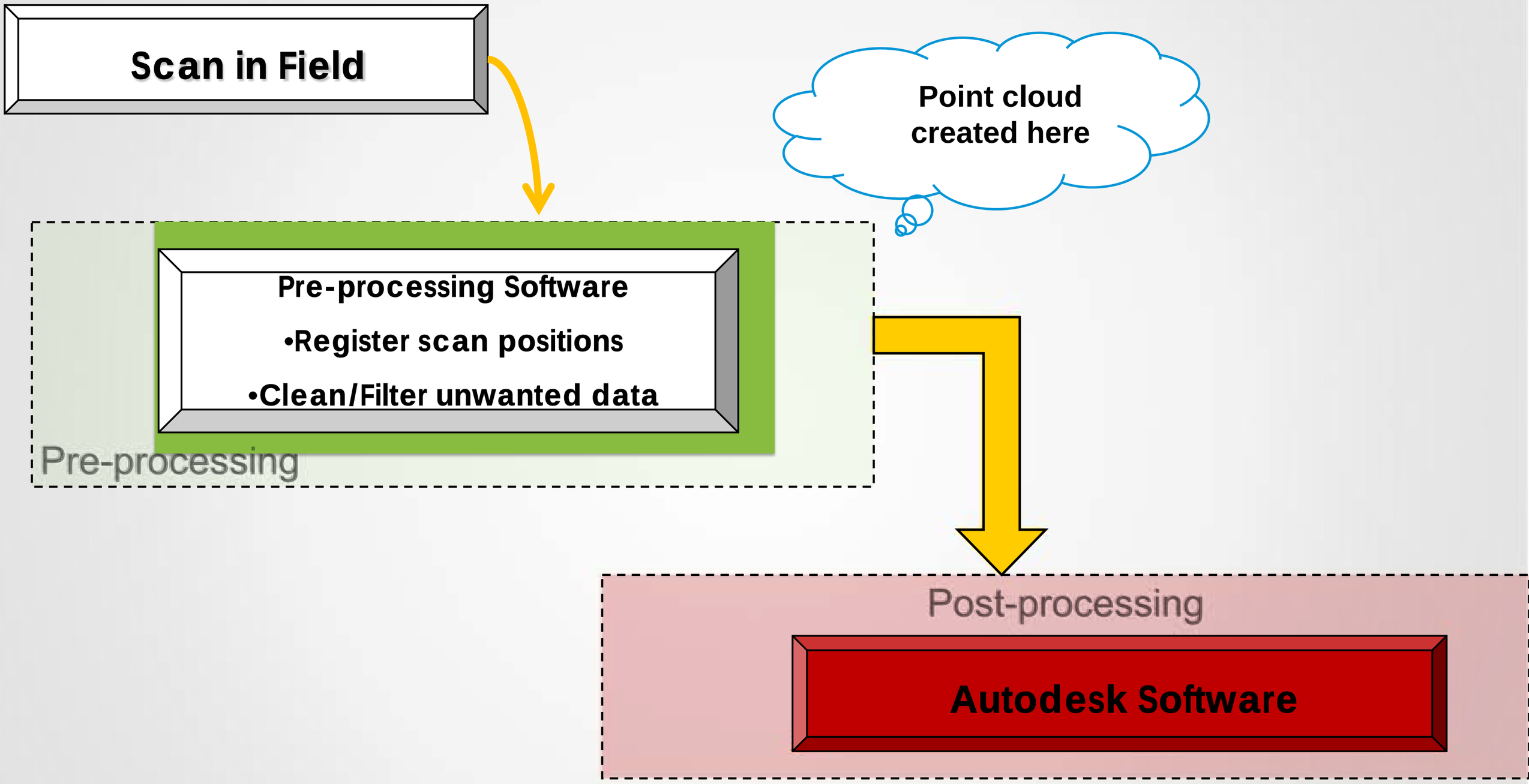
- After having finished the registration you “index” the scans:



ReCap Pro Registration – Pros and Cons

Pros	Cons
Easily manipulate scan data into custom clouds or smaller data sets for use in design programs	Not a direct import to AutoCAD
Register files directly from raw scan data, with or without targets	Conversion from manufacturer format to RCS is a slightly longer import period compared to AutoCAD import
Handles nearly unlimited data at very high resolution	Without survey control, risking lower accuracy
Creates native RCS/RCP directly from field	New product; still needs to be proven for reliability in project situations
Easy interface with reporting	Manual registration process is tedious for large projects

Scan Data Management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Bringing Data to AutoCAD
(Traditional Registration)

AutoCAD 2011-2013

Ready for AutoCAD/Revit/Inventor

Method still valid for AutoCAD 2014

Autodesk PCG file created

Only recommended for small projects in CAD

Index manufacturer format directly in AutoCAD;

Register in Scanner Manufacturer Software

AutoCAD 2014

Each scan position creates an RCS file

Register in scanner manufacturer’s software

Import to Recap; Save RCP

Crop section of interest; Export custom RCS/PCG

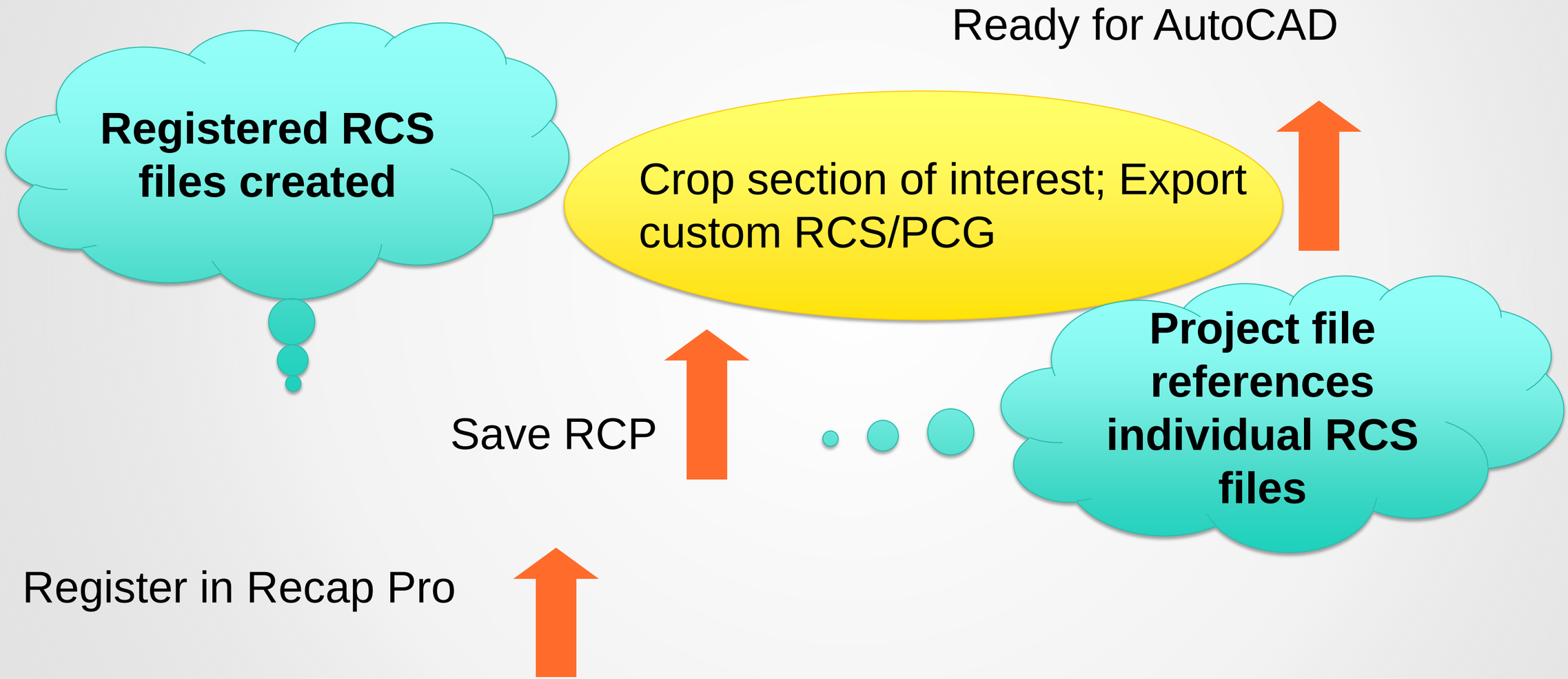
Ready for AutoCAD, Revit, Navisworks, Inventor, 3D Studio

Project file references individual RCS files

Bringing Data to AutoCAD

(Recap Pro)

AutoCAD 2014



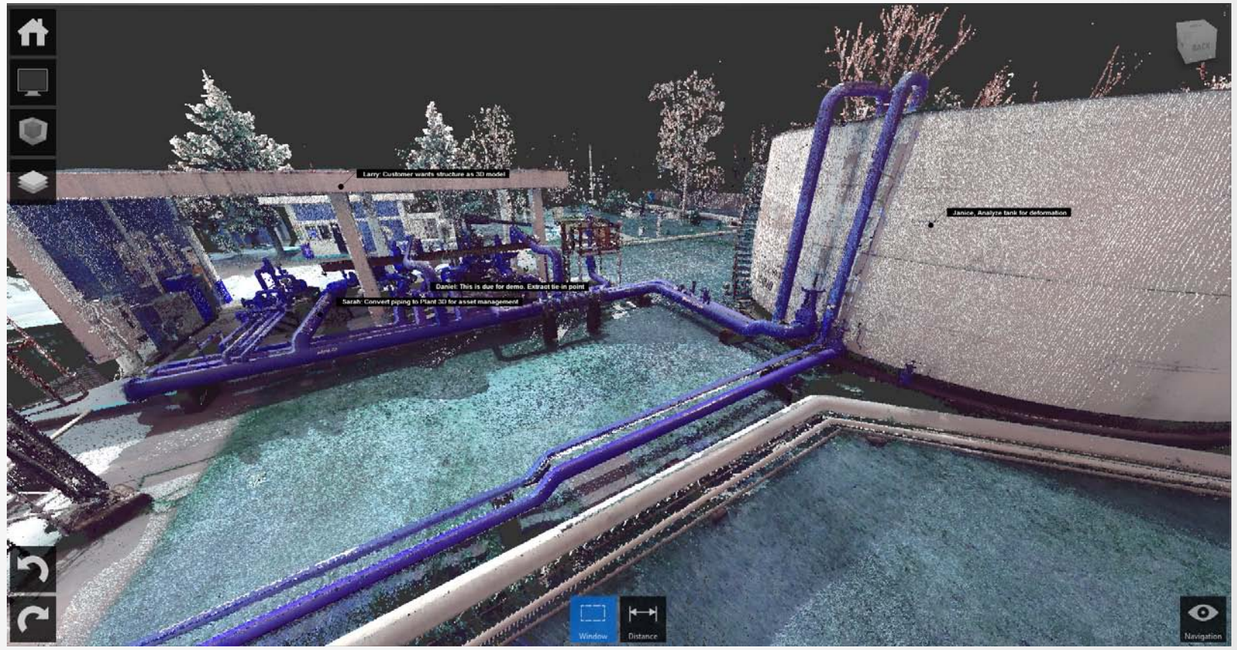
AutoCAD 2014 and the Point Cloud Engine

- Point Clouds still not optimized in AutoCAD 2014
  - Graphics engine needs improvements
  - Fewer points yields higher resolution
  - Recommended to work in smaller sections
  - Helpful settings
    - POINTCLOUDDENSITY
    - POINTCLOUDPOINTMAX
    - Auto Update

Project Management

A Recap Project for Plant Design

- Project manager distributes work to designers through Recap project
- Notes and tags designate specific jobs per person
- Design to be completed in AutoCAD Plant 3D and Navisworks



A Recap Project for Plant Design

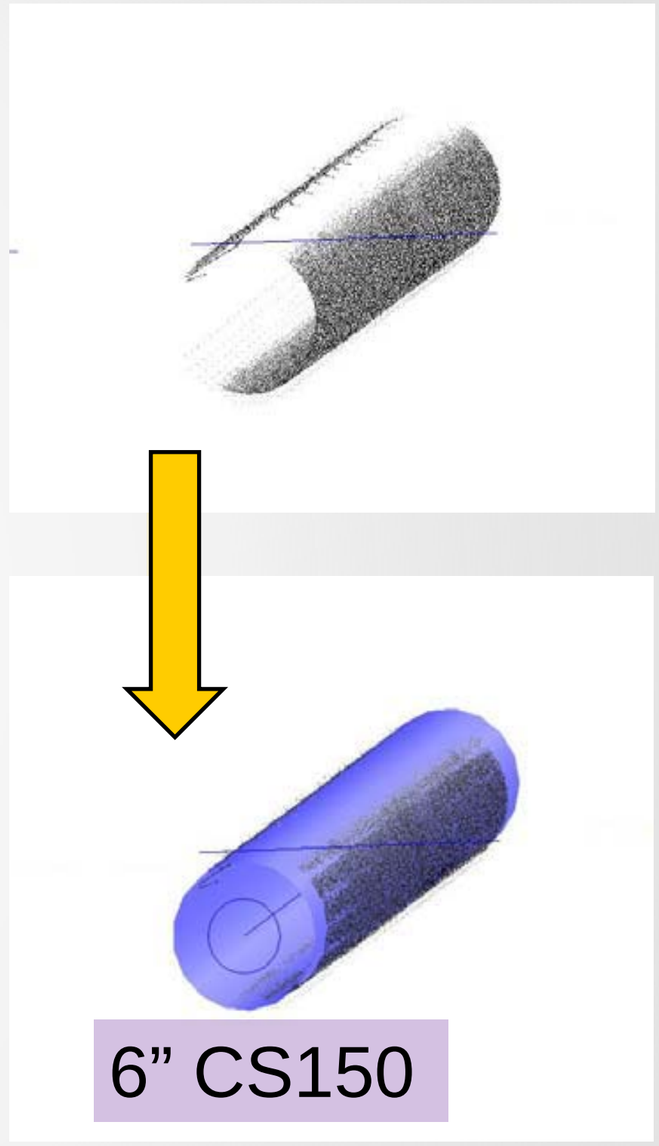
- Sarah: Convert piping to Plant 3D
- Daniel: Locate tie-in point; route new run & verify safe clearance
- Larry: Customer wants structure as 3D Model
- Janice: Analyze tank for deformation

Modeling

Modeling Piping

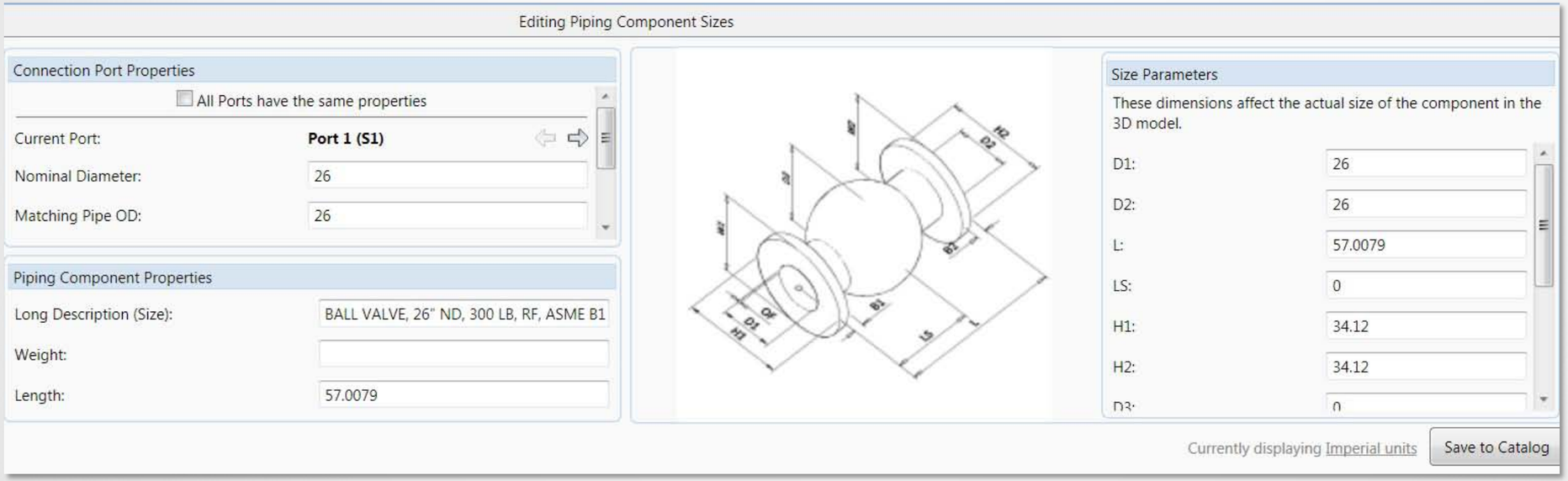
Shape Extraction for Plant Design

- Using pattern recognition algorithms to extract 2D/3D shapes from cloud data
- More efficient than manual insertion/manipulation of cloud
- Connect shape extraction directly to plant elements
  - Pipes, fittings, equipment, structural



Catalog Integration

- Detect shape and reference closest matching catalog item
  - Full Plant 3D spec/catalog import
    - Carbon Steel, Stainless Steel, 150#, 300#, etc.
    - Pipe, Elbows, Tees, Flanges, Valves, etc.



Piping Design

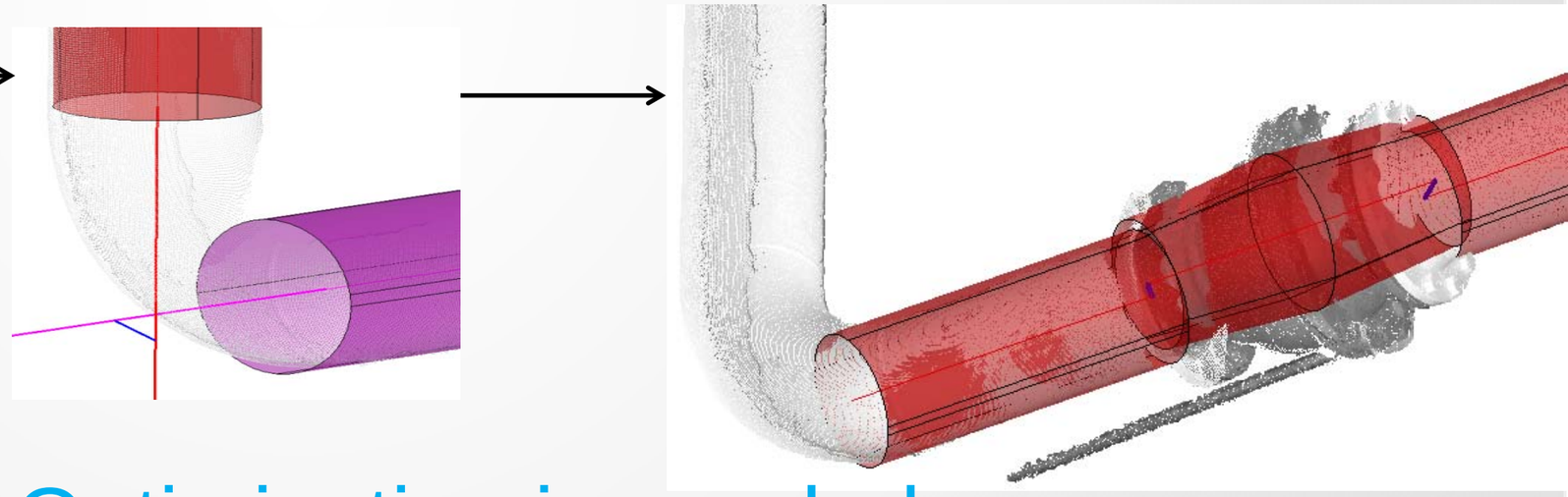
- Semi-Automatic or Automatic methods
- Catalog Driven
- Compliant to Design Software Needs

Apply Design Constraints

Design Software is made for Greenfield situations, not Brownfield.

Such programs typically expect:

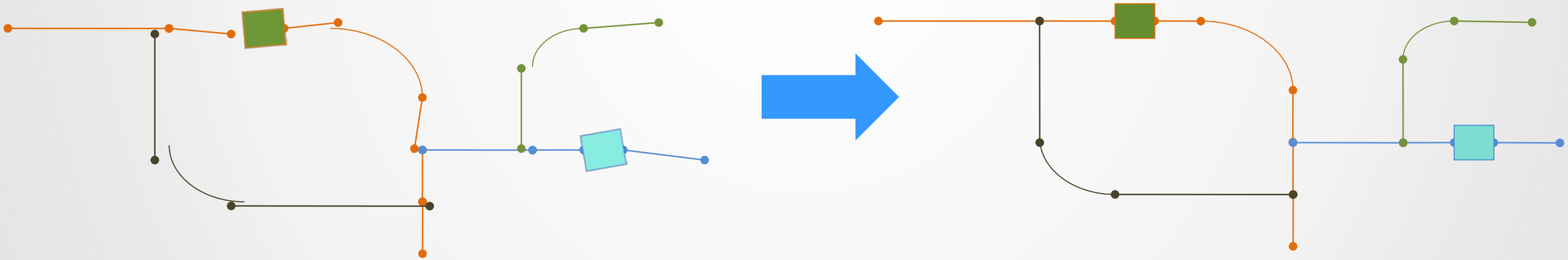
- Connected objects
- Coaxial / coplanar cylinder axis
- Perfect angles
- Standard objects



Global Optimization is needed.

Apply Design Constraints

- Fixes lines automatically
- Either align fittings to data or force fittings to comply with design constraints



A Recap Project for Plant Design

- Sarah: Convert piping to Plant 3D
  - Use pattern recognition to extract catalog components

Customer Story:

- Performance Mechanical, Inc.
  - Pittsburg, California
- Method
  - Faro Focus Scanner
  - Registration within manufacturer software
  - Import data to AutoCAD Plant 3D 2014
  - Performing piping design & structural modeling

Customer Story

- Performance Mechanical, Inc.
  - Rod Kriess, Project Manager

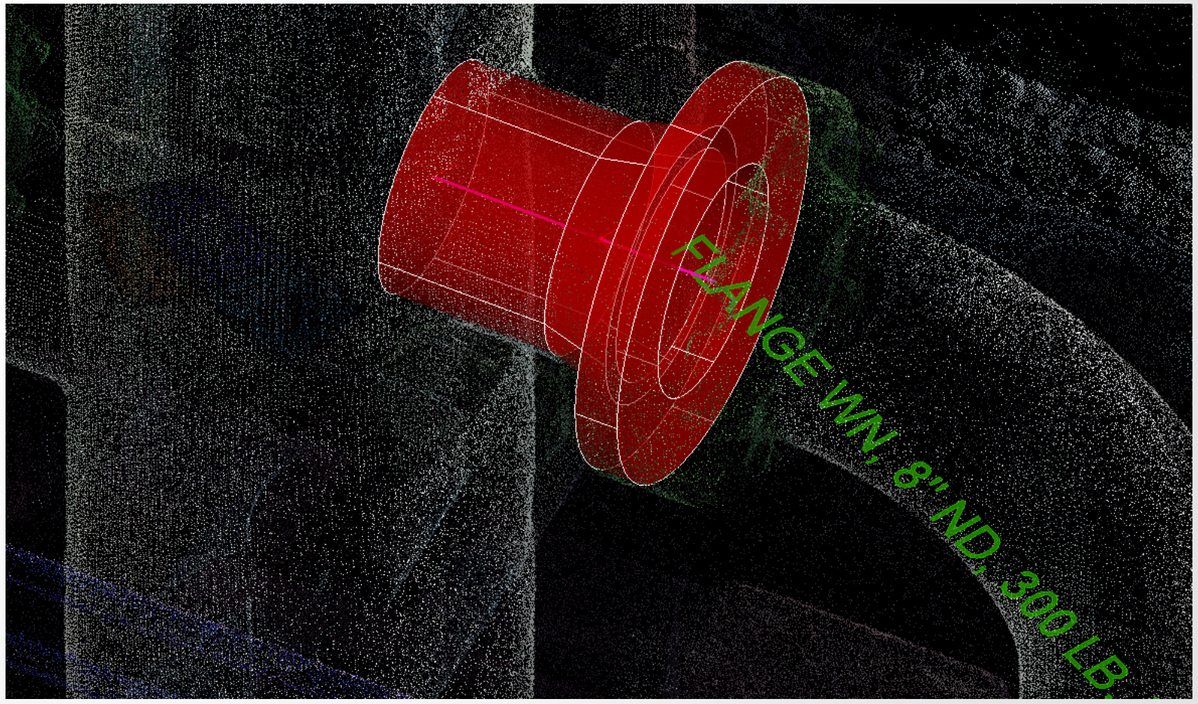
A Recap Project for Plant Design

- Sarah: Convert piping to Plant 3D
- Daniel: Locate tie-in point; route new run & verify safe clearance
- Larry: Customer wants structure as 3D Model
- Janice: Analyze tank for deformation

Extracting Tie-in Points

Using Scan Data: Tie-in Points

- Avoid full modeling
- Determine start point for new design
- Tag areas of importance

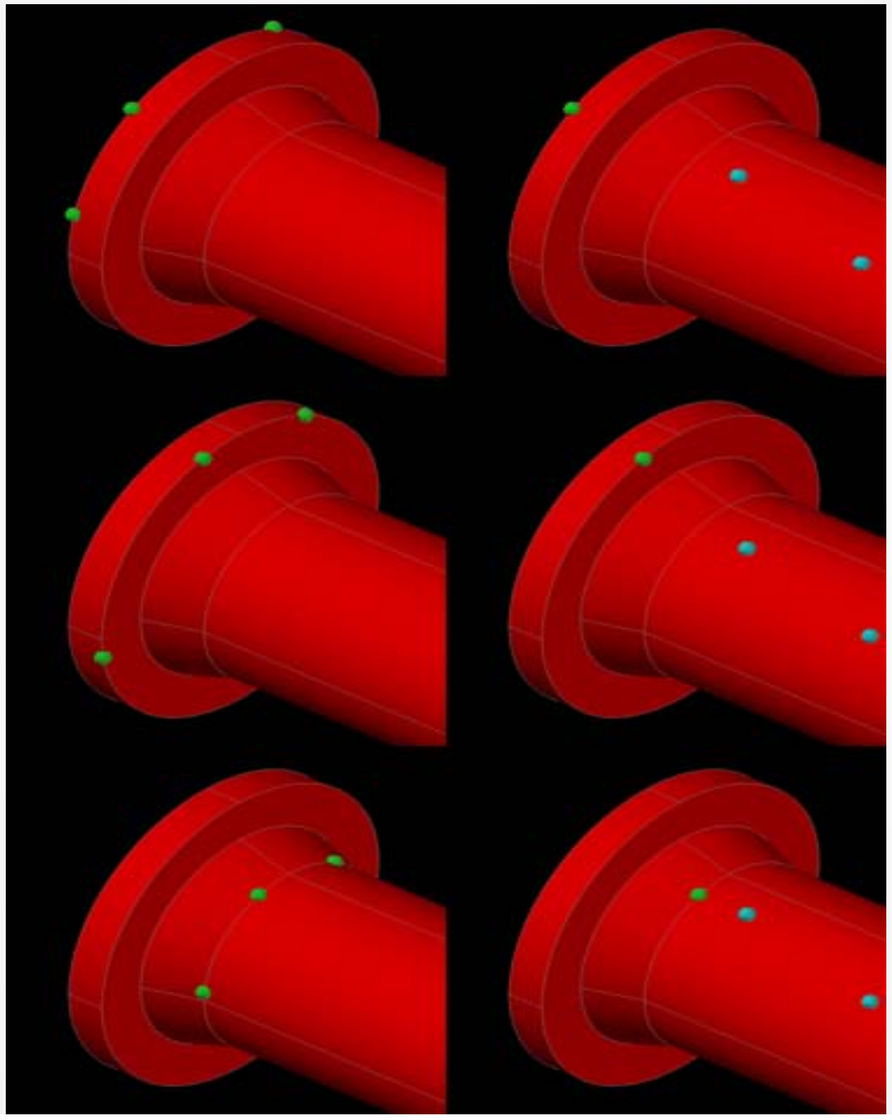


Using Scan Data: Tie-in Points

3 Points on Face

3 on back of face

3 on Hub



Define cylinder axis + point on face

Define cylinder axis + point on back of face

Define cylinder axis + point on hub

Clash Detection

Clash Detection with Navisworks Manage

- Detect issues between existing conditions and proposed design

- Proposed Workflow
  - Remove point cloud from completed DWG
  - Append DWG; then Append RCP
  - Detect clash between points (RCP) and surfaces (model)
  - Set appropriate tolerance
  - Generate reports

A Recap Project for Plant Design

- Daniel: I need this tie-in, then route new line. Check for clearance

Customer Story:

- WM.T. Spaeder Co, Inc.
  - Erie, PA
- Method
  - Import data directly to AutoCAD
  - Locate tie-in points and route new lines
  - Avoid full modeling
  - Verify clearances in Navisworks

Customer Story:

- WM.T. Spaeder Co, Inc.
  - Jonathan Marsh

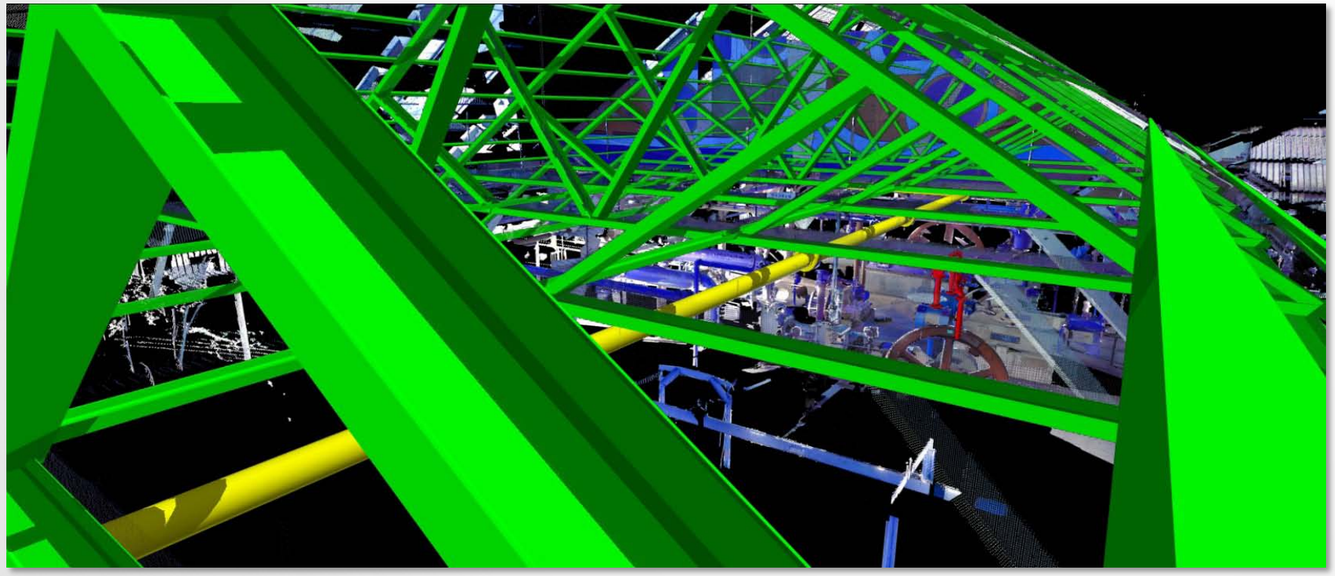
A Recap Project for Plant Design

- Sarah: Convert piping to Plant 3D
- Daniel: Locate tie-in point; route new run & verify safe clearance
- Larry: Customer wants structure as 3D Model
- Janice: Analyze tank for deformation

Modeling Structural

Modeling Structural

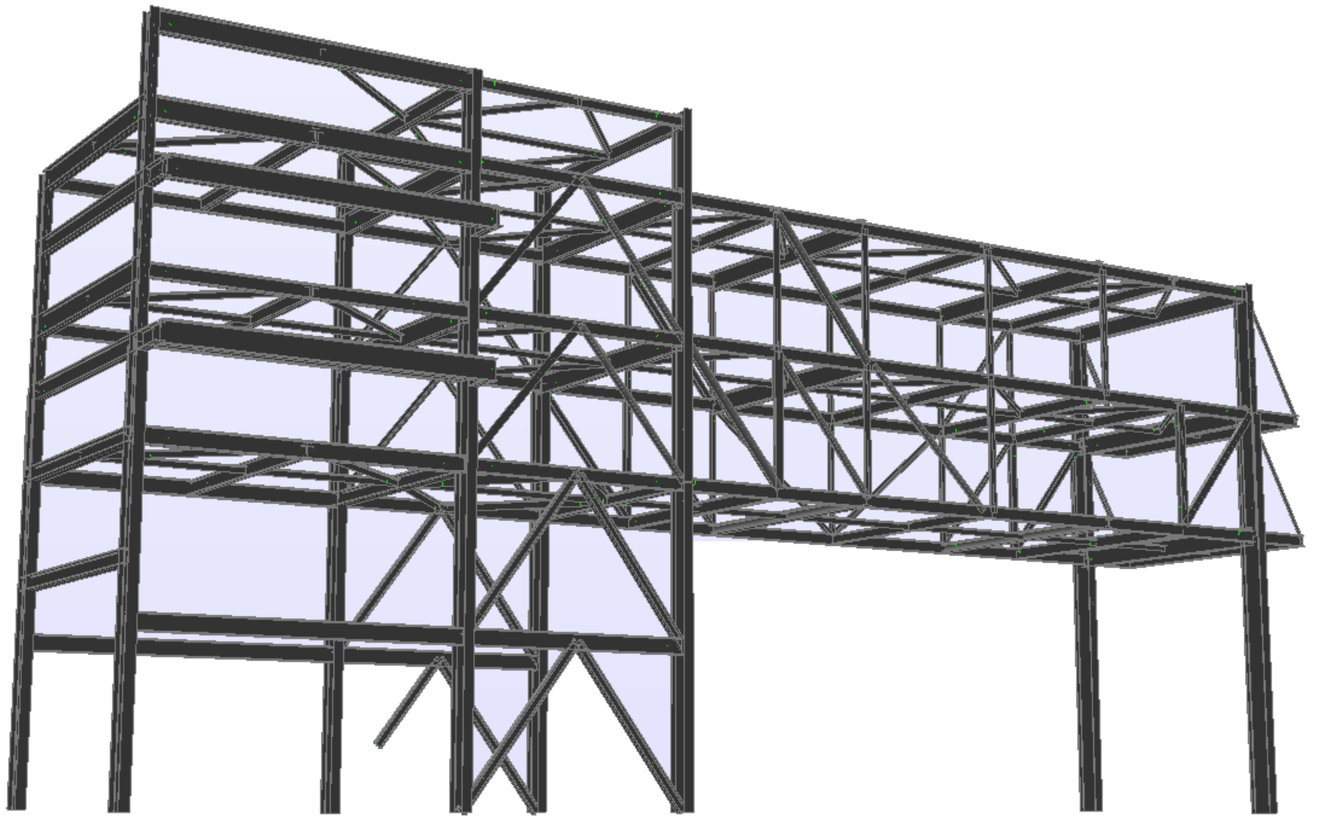
- Shape Extraction combined with standard catalogs
  - AISC, CISC, DIN, etc.
- More complicated algorithm
  - Scanner typically does not collect all beam faces



Steel – Apply Constraints

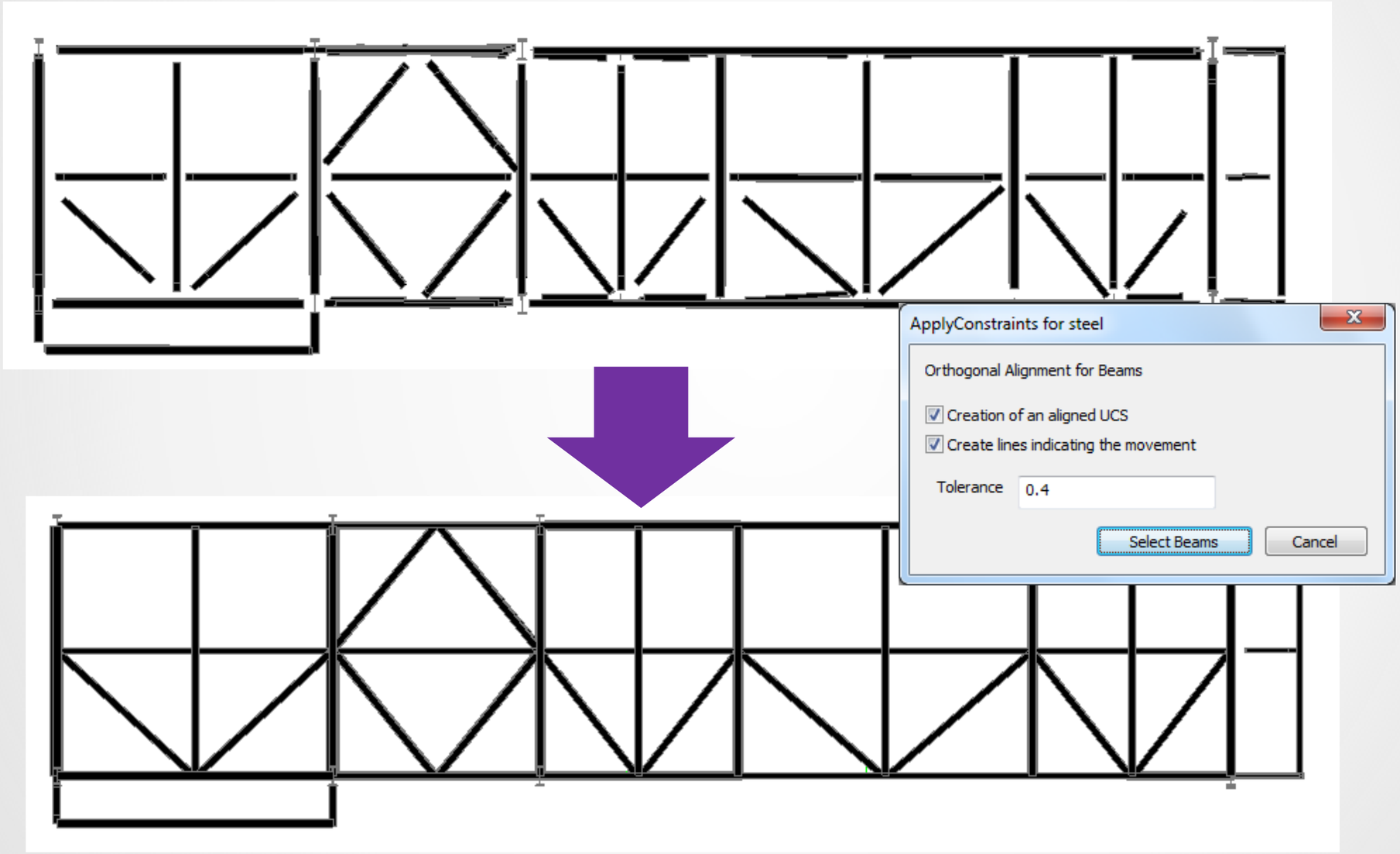
Adjust and align members to a common axis/grid

- → Creates co-planar, perpendicular members
- → Ready for use in intelligent structural programs
- → Reporting on adjustments available



Steel – Apply Constraints

Results of Apply Constraints (Before and After):



A Recap Project for Plant Design

- Larry: Customer wants structure as 3D model

Customer Story:

- Summit Engineering & Design
  - Blaine, WA
- Method
  - Isolate needed data from raw point cloud
  - Import to AutoCAD
  - Extract catalog steel members via shape extraction

Customer Story:

- Summit Engineering & Design
  - Daryl Sharp, Engineering Manager

A Recap Project for Plant Design

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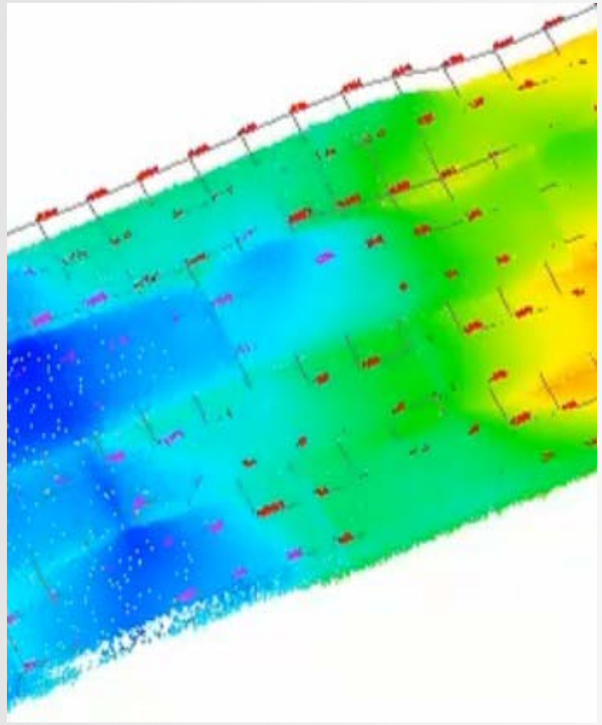
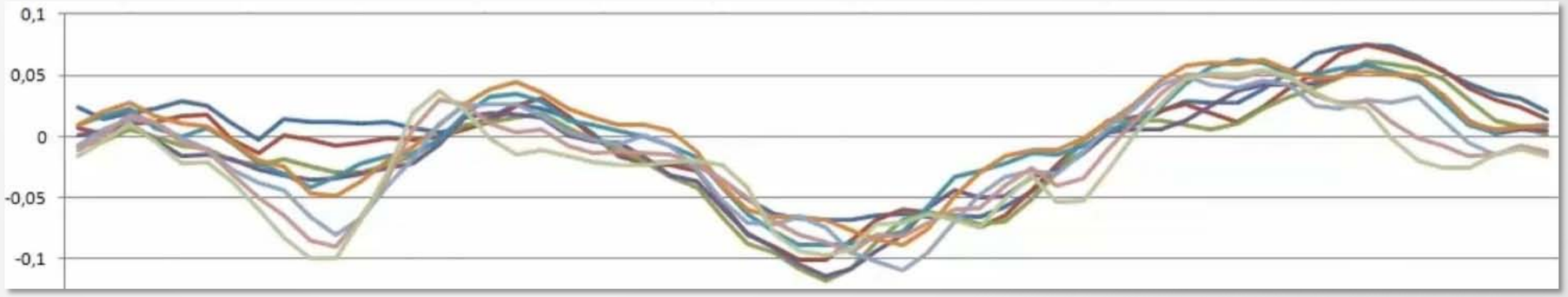
Modeling Tanks & Analysis

Tank Analysis

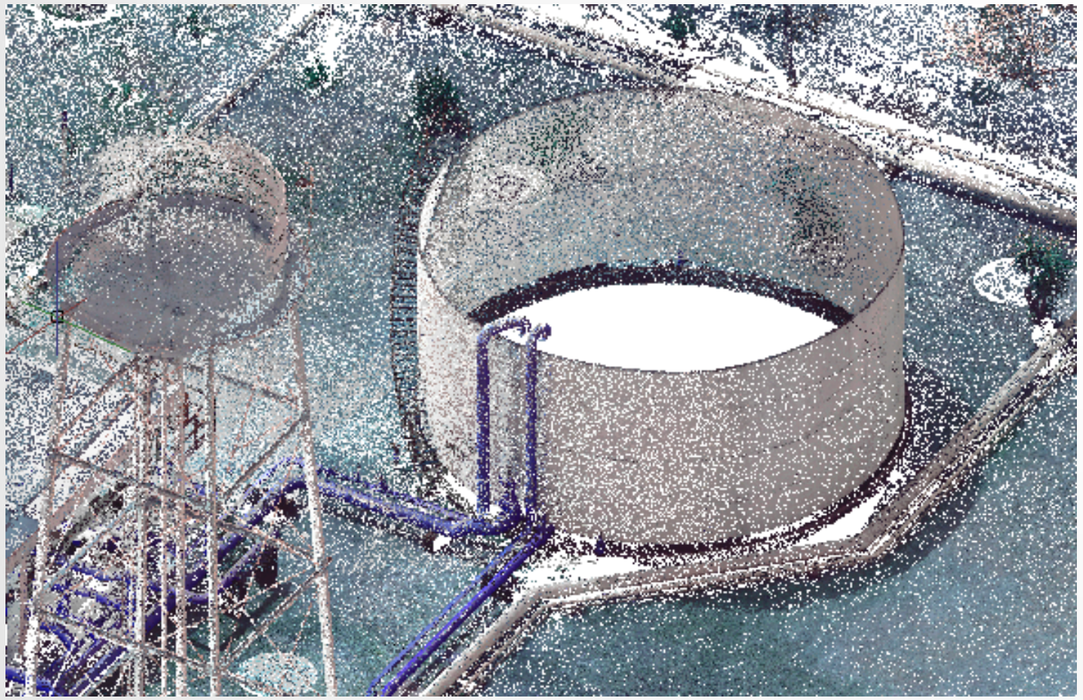


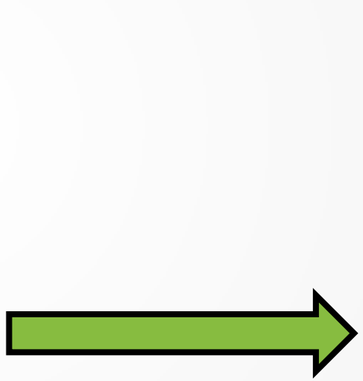
- Unwrap point cloud for easier analysis
- Color-code by deviation
- Create reports and export data in Excel or ASCII formats
- Generate polylines, solids, deviation grids, etc.
- Calculate Volumes at different intervals and include/exclude deadwood

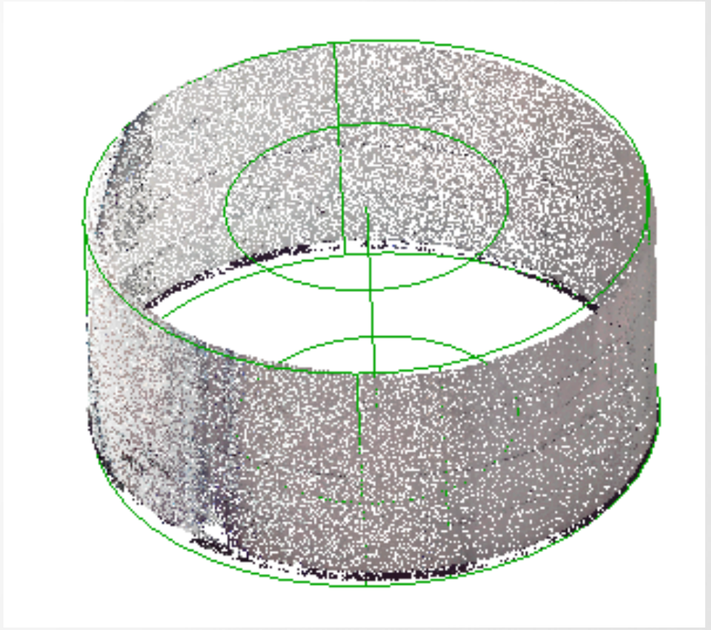


Tank Analysis

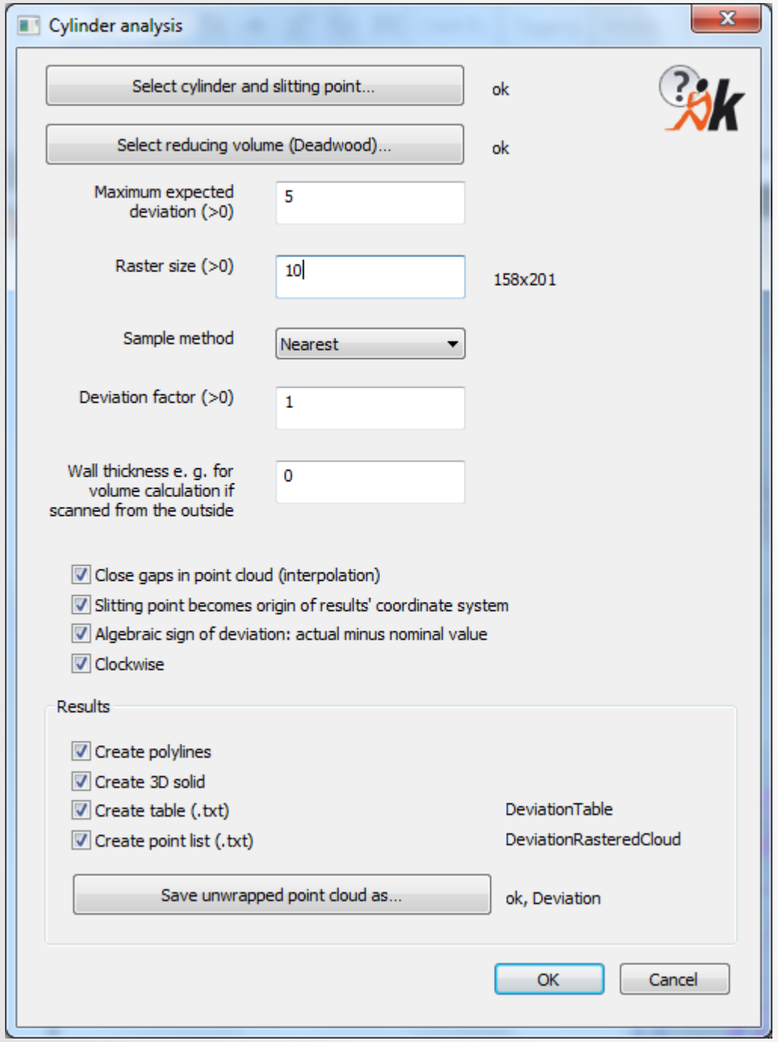
Perfect cylinder extracted for comparison to cloud



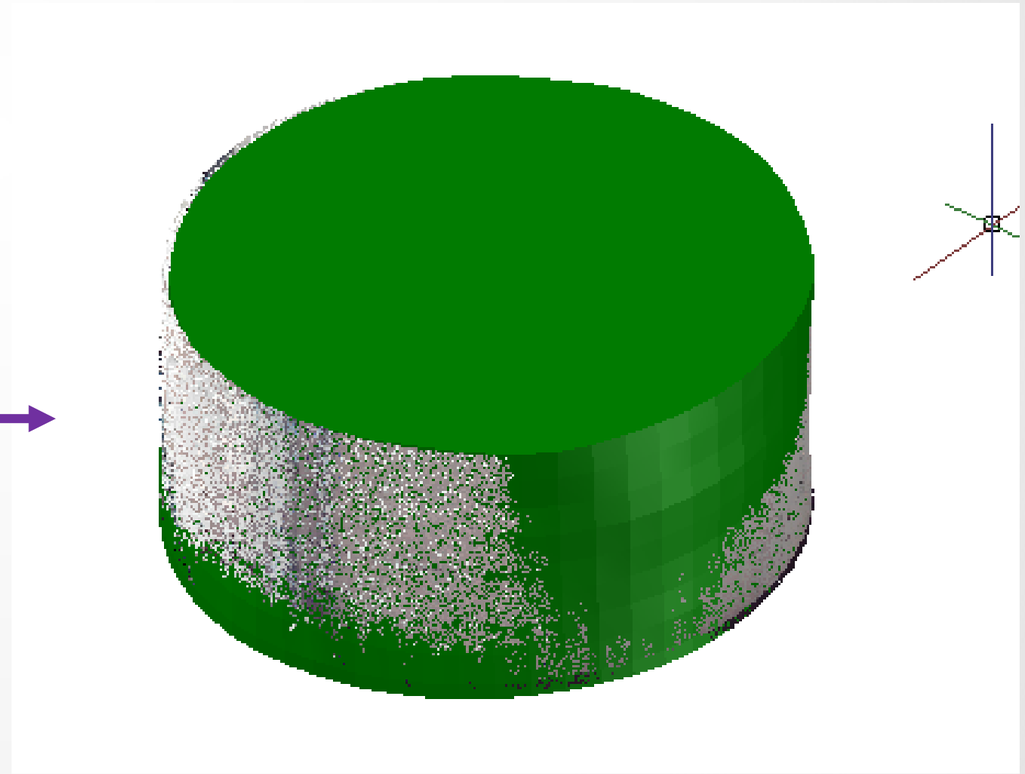




Tank Analysis

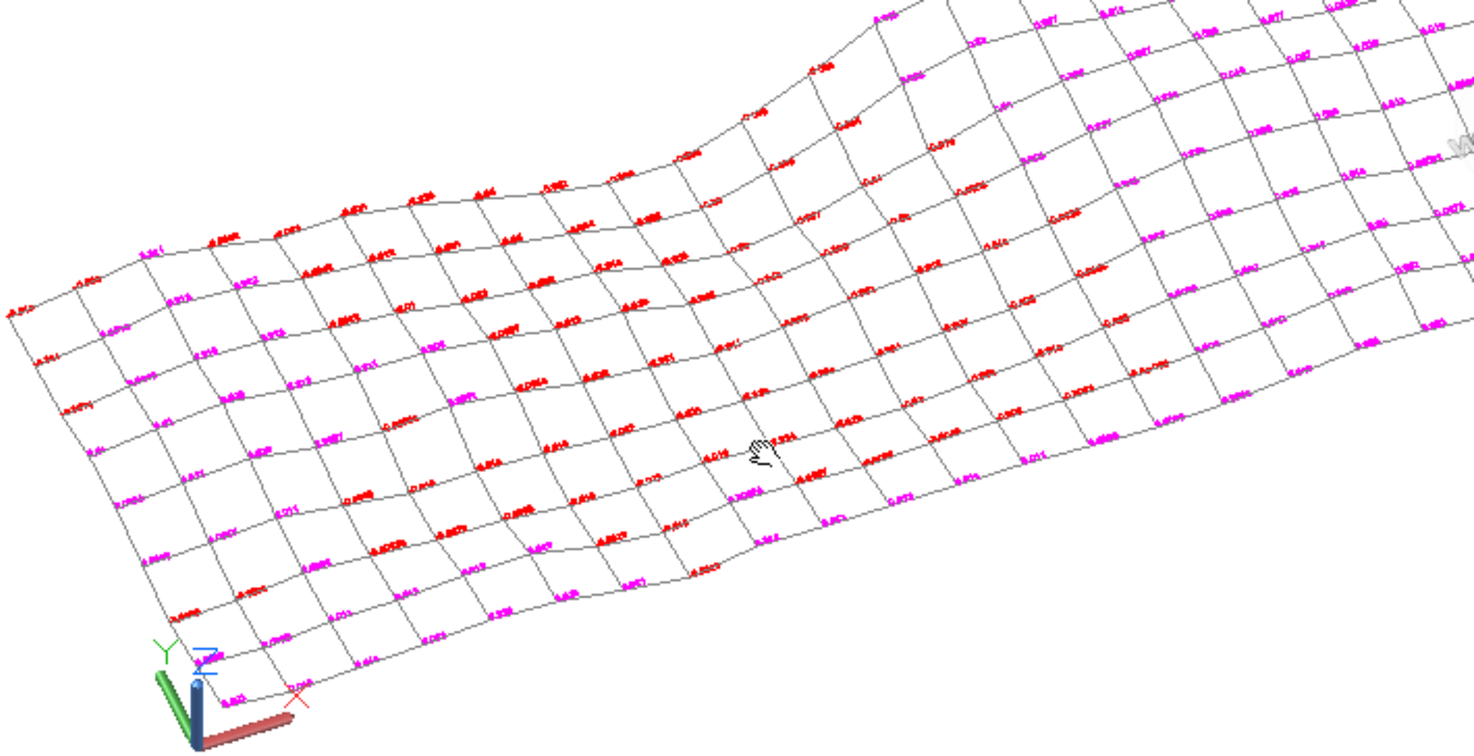


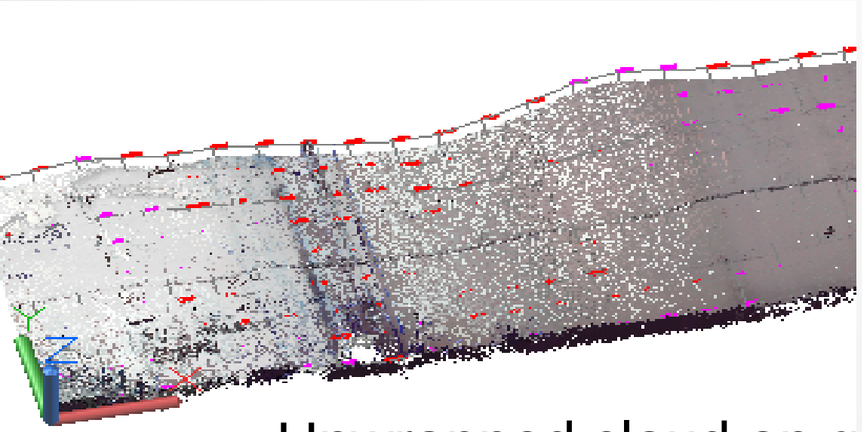
Result of 3D Solid Option



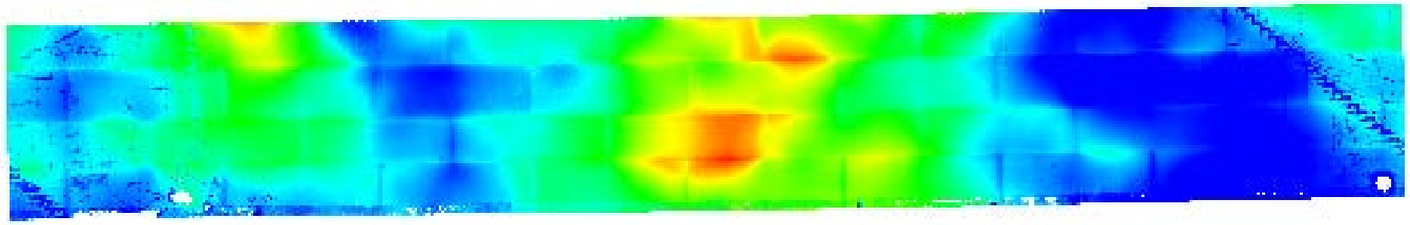
Tank Analysis

Graphical deformation grid with reporting





Unwrapped cloud on grid



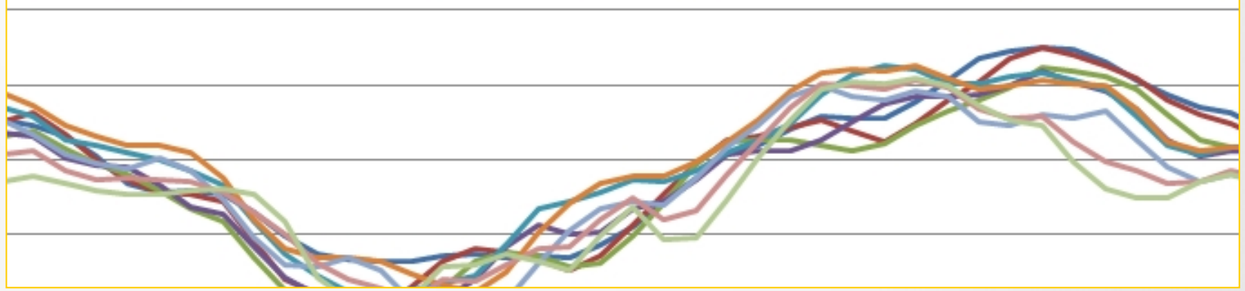
Color deformation map

Tank Analysis

Statistical Results:

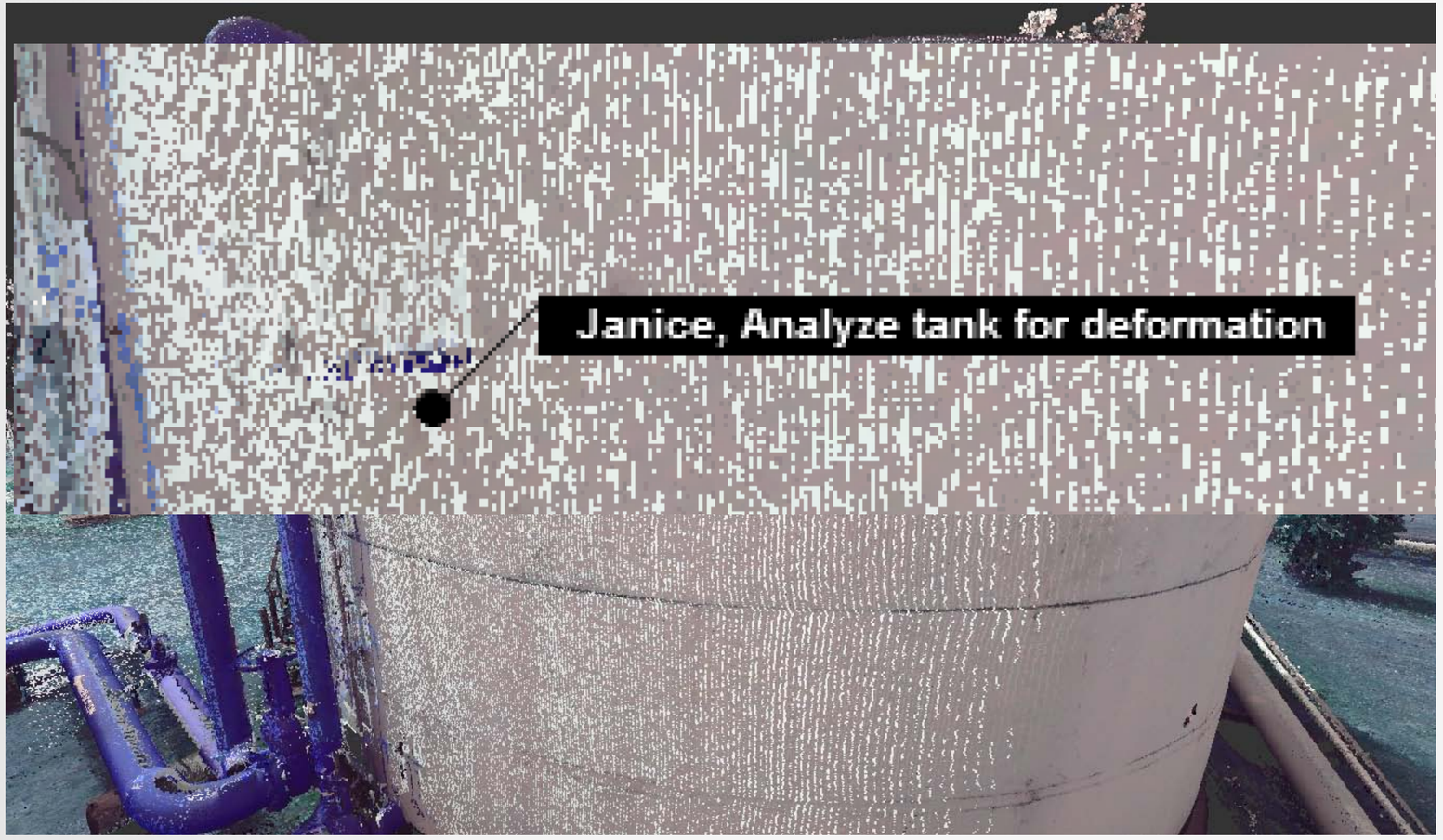
- Deformation
- Volume
- Deadwood

O	P	Q	R	S	T	U
3°	365.5°					
1485	1595	circumference	slice volume	total volume	deadwood slice volume	reduced slice volum
9109434	-6,8218704	1478,031174	9402545,045	9402545,045	550000	8852545,04
1207494	-6,78020867	1478,031174	18775049,98	28177595,02	1345559,321	17429490,6
8882304	-6,85134298	1475,723797	18708858,09	46886453,11	1012742,42	17696115,6
9526377	-6,89853186	1472,94465	18636655,89	65523109,01	521474,086	18115181,8
5569277	-6,9252417	1470,17916	18557103,63	84080212,64	193292,4704	18363811,1
8418019	-6,92727824	1466,832436	18465199,03	102545411,7	2204449,733	16260749,2
3914735	-6,88335438	1463,116362	18363972,31	120909384	2412560,682	15951411,6
8398186	-6,86245613	1459,065237	18214054,3	139123438,3	822969,87	17391084,4
7777517	-7,11476124	1451,61436	19228319,07	158351757,3	0	19228319,0
4530201	-7,03813088	1544,138841	20608407,32	178960164,7	0	20608407,3
3495113	-7,046502	1567,984304	20432359,97	199392524,6	0	20432359,9
4679387	-7,10930905	1536,900657	18595588,86	217988113,5	0	18595588,8
3496552	-7,15904086	1427,913648	16475341,14	234463454,6	0	16475341,1
1683219	-7,12762188	1373,420825	15459156,76	249922611,4	0	15459156,7
2854187	-7,10409905	1356,707375	15267840,72	265190452,1	0	15267840,7
5357482	-7,21189739	1352,782537	15418944,26	280609396,4	0	15418944,2
4985341	-7,17642542	1352,35098	14984619,47	295594015,8	0	14984619,4
5876532	-7,13803496	1316,028999	13638847,6	309232863,4	0	13638847
,626925	-193,382274	1263,088457	3926409,985	313159273,4	0	3926409,98



A Recap Project for Plant Design

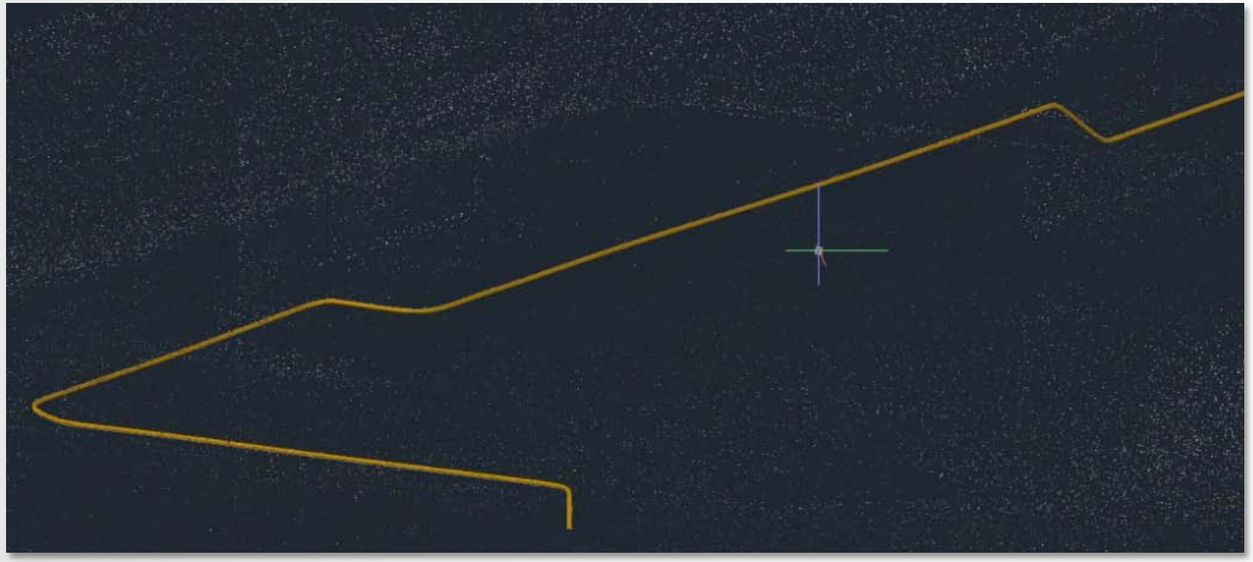
- Janice: Analyze tank for deformation

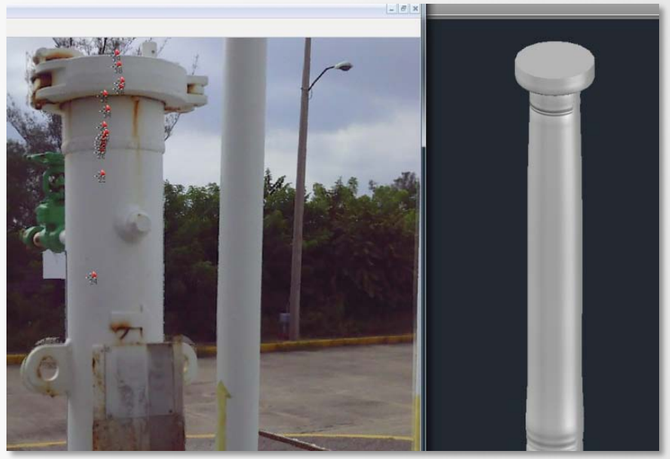


Modeling Additional Features

Equipment, Conduit, etc.

1. Various methods based on software and data
2. Model objects that are not defined in a catalog or have many various iterations
3. Very useful for clash detection





Questions?