Leveraging Point Clouds to Assemble and Maintain Digital Twins

Presented by Elysium Inc and NNS

GLOBAL PRODUCT DATA INTEROPERABILITY

SUMMIT 2021

Virtual Sessions

Presenters Bio

- Nate Soulje – Elysium Inc
- Application Support Specialist 2016 - Present
- Focus in point cloud technology and CAD migration support
- Graduated 2015 BS in Nuclear Engineering from University of Tennessee Knoxville
- Certified by NCEES as an EIT in October 2015
- Graduated 2017 MS in Mechanical Engineering from Wayne State University in Detroit, MI

Presenters Bio

- Mark Debbink – Technical Point of Contact from NNS
- Digital Transformation at Huntington Ingalls Industries – Newport News Shipbuilding
- Received M.B.A. from College of William and Mary
- Received B.S. Engineering from Michigan State University
- Extensive Shipbuilding experience and is currently responsible setting goals for digital transformation architecture strategy, planning, and implementation of Model Base Enterprise (MBE) and “Digital Thread & Digital Twin” capabilities.
- Work involves close collaboration with Government agencies and software suppliers to test and evaluate new technology, workforce cultural impact, and the integration of processes and tools.

Agenda

- Digital Transformation at Newport News Shipbuilding
- Project Overview
- Technical Approach
- Elysium New Capabilities for comparing Laser Scan data to 3D CAD models
  - Test Data & Import
  - Automatic Segmentation
  - Test & Reporting
  - Workflow
  - Automatic Recognition
- Savings & Benefits
- Follow-On Projects
- Question & Answers

Newport News Shipbuilding

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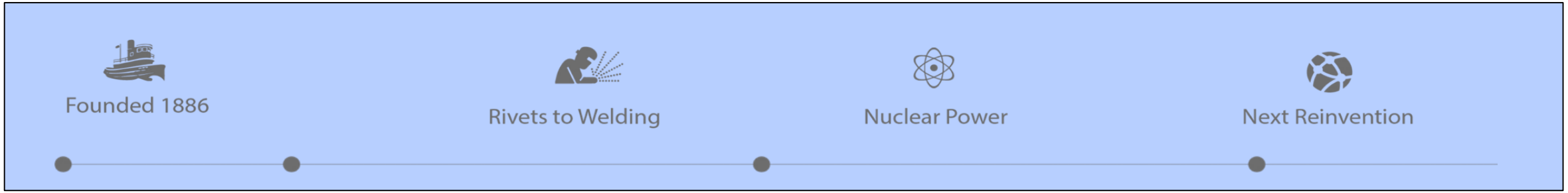

- Largest industrial employer in Virginia, employing about 25,000 people, many of whom are third-and fourth-generation shipbuilders

- Only company capable of designing, building, refueling, overhauling and inactivating nuclear aircraft carriers for U.S. Navy
- One of only two companies capable of designing and building nuclear submarines for U.S. Navy

- Transforming our 130+ year company's paper-based processes to the Digital Age

- Eliminating drawings and moving toward a Model-Based Enterprise (MBE)
- Adopting technologies like laser scanning, digital twin, mobile computing and augmented reality

Reinvention: Utilizing the Digital Thread

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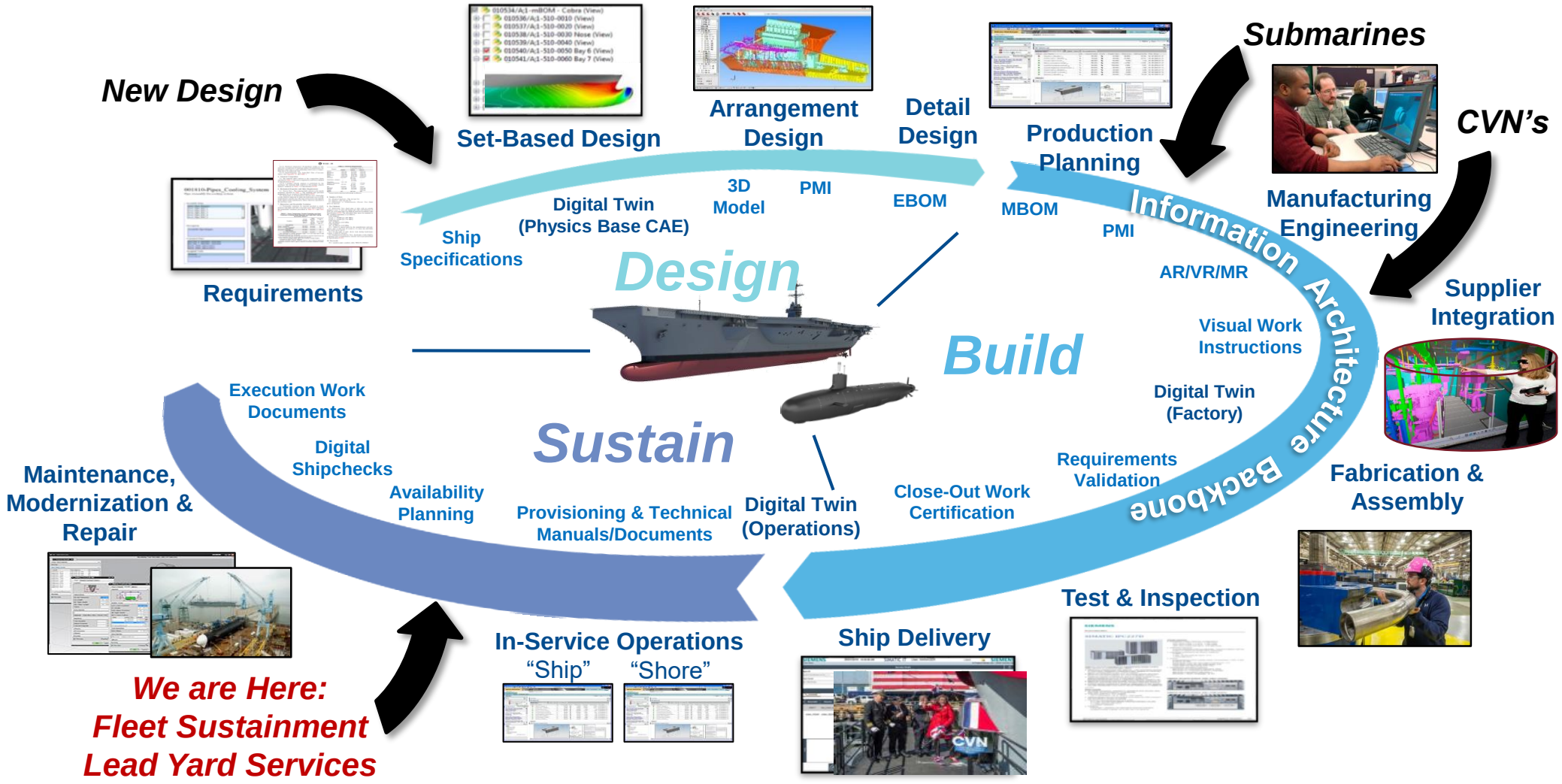
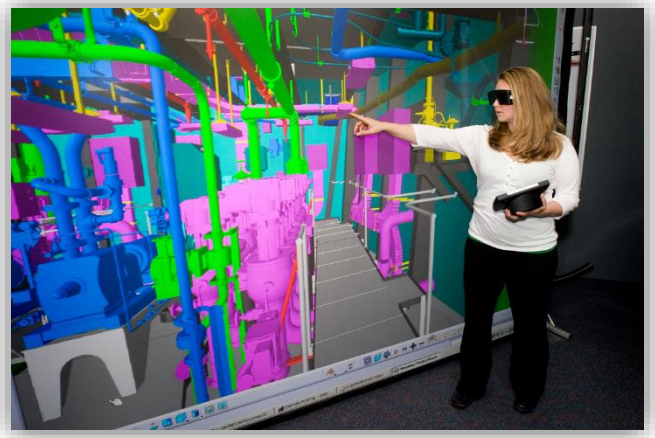


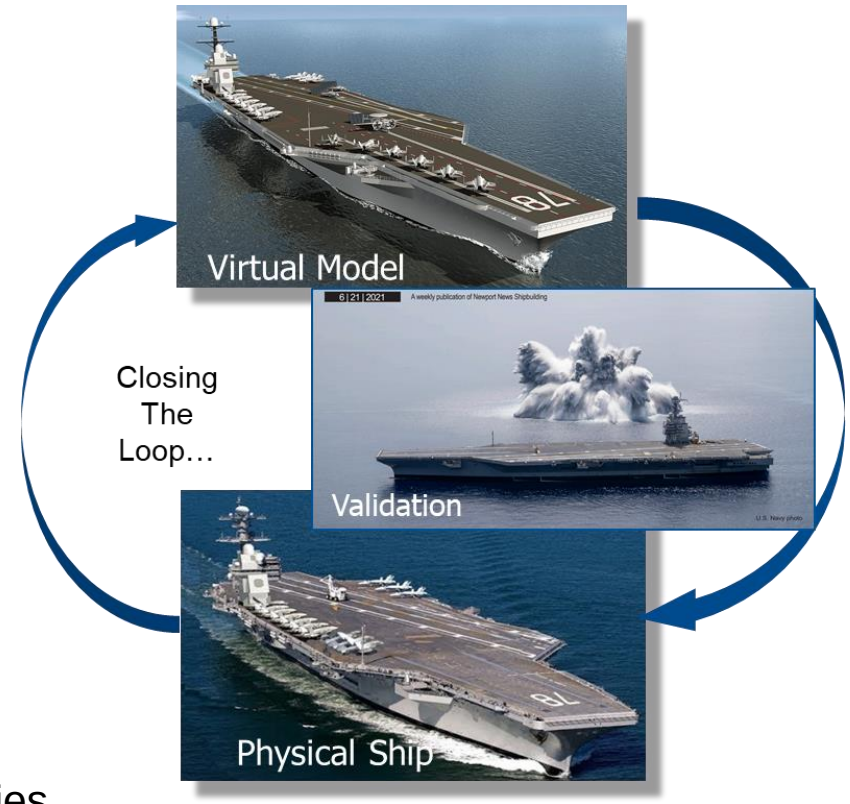
Aircraft Carrier USS GERALD R. FORD The Big Picture

10+ Year Build Cycle

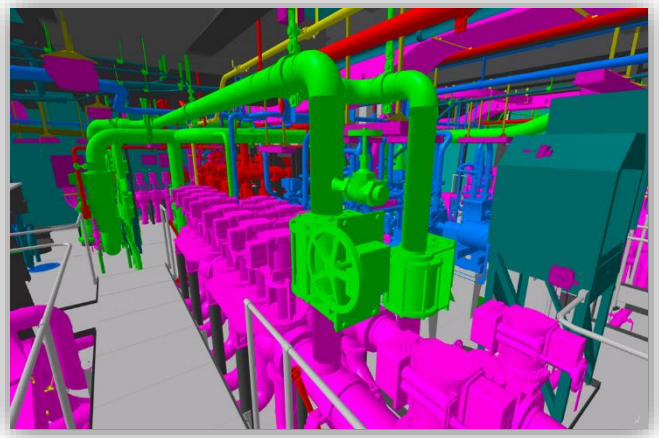


Design
~ 3 Million Piece Parts
Over 2,000 Suppliers
Over 70,000 Part Numbers

Build
150,000 Shop Work Packages
50,000 Tons of Fabricated Steel Assemblies



~55 Million Man-Hours of Navy Investment



Shipboard
Over 50,000 Ship Work Packages
9 Million Feet of Cable
4 Million Feet of Fiber

Sustain
50-Year Life
Obsolescence Management
Continuous Modernization Throughout

Our Challenge is Managing Complexity While Implementing Disruptive Technologies

Digital Thread: Advancing Data Management Through Ship's Lifecycle

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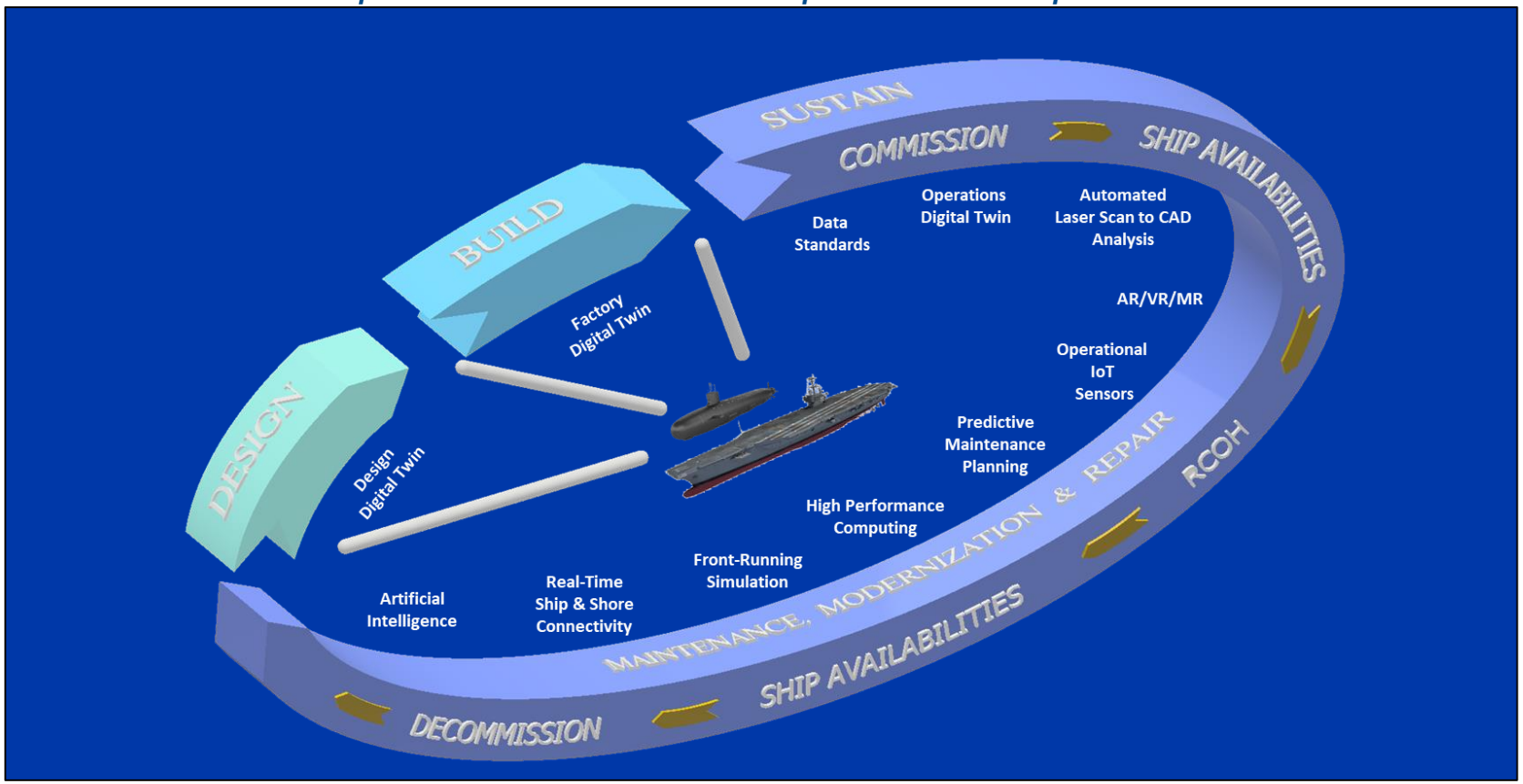
"Ship Sustainment Will Require New Capabilities"



The "**Digital Thread**" bridges the virtual and physical components of the "**Digital Twin**"

Laser Scan to CAD Analysis: Problem and Objective

Problem to be addressed: The success of an in-service digital environment is predicated on a continued synchronization methodology between the most current ship's configuration and the 3D product model. There are two legacy processes that do not configuration manage unauthorized changes that will have to be changed to maintain accurate ship configuration.

- Changes preceding ship delivery that are documented on inspection reports (IRs) in lieu of 3D product model updates.
- During in-service operation, changes made by Ship's Force, executing yards or participating acquisition resource managers (PARMs) and alteration installation teams.

Project objective:

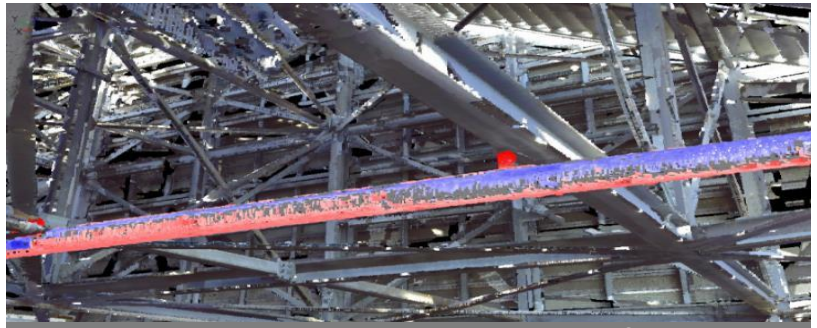
- Develop capabilities to capture and maintain the current ship configuration through the use of laser scan data overlaid on the 3D product model.
- Manage configuration deviations between the ship laser scan and FORD Class Hull Planning Yard (HPY) 3D product model by visual display, enabling the HPY to investigate the deviations and communicate with the organization that made the change.
- Provide an opportunity to educate organizations on the process and demonstrate TOC reduction benefit of preserving ship configuration management for in-service applications.

Laser Scan to CAD Analysis: Technical Approach

Technology related to laser scanning and 3D product model configuration-management processes have advanced significantly and have positioned the shipbuilding industry to move the “Capturing In-Service Ship Configuration” project to deliver production-ready capabilities.

- Utilize and integrate digital data from the FORD Class Digital Data Environment along with on-board ship laser scan information to provide needed 3D product-model ship-sustainment information in an environment where 2D drawings do not exist.
- Concentrate on data at the ship compartment level. Typically, ship scans are conducted and configuration-managed at the compartment level. This compartment scan data will match 3D product model partitions that are at the compartment level for in-service use. Thus, a direct comparison of the current configuration and the baseline FORD Class Hull Planning Yard (HPY) 3D product model can be made.
- Leverage Elysium’s state-of-the art technical capabilities for software development and integration. Elysium has vast experience and knowledge of the NNS 3D product-model environment and was responsible for the migration and validation code development when NNS transitioned for CATIA to a NX 3D CAD environment.

Elysium
InfiPoints®

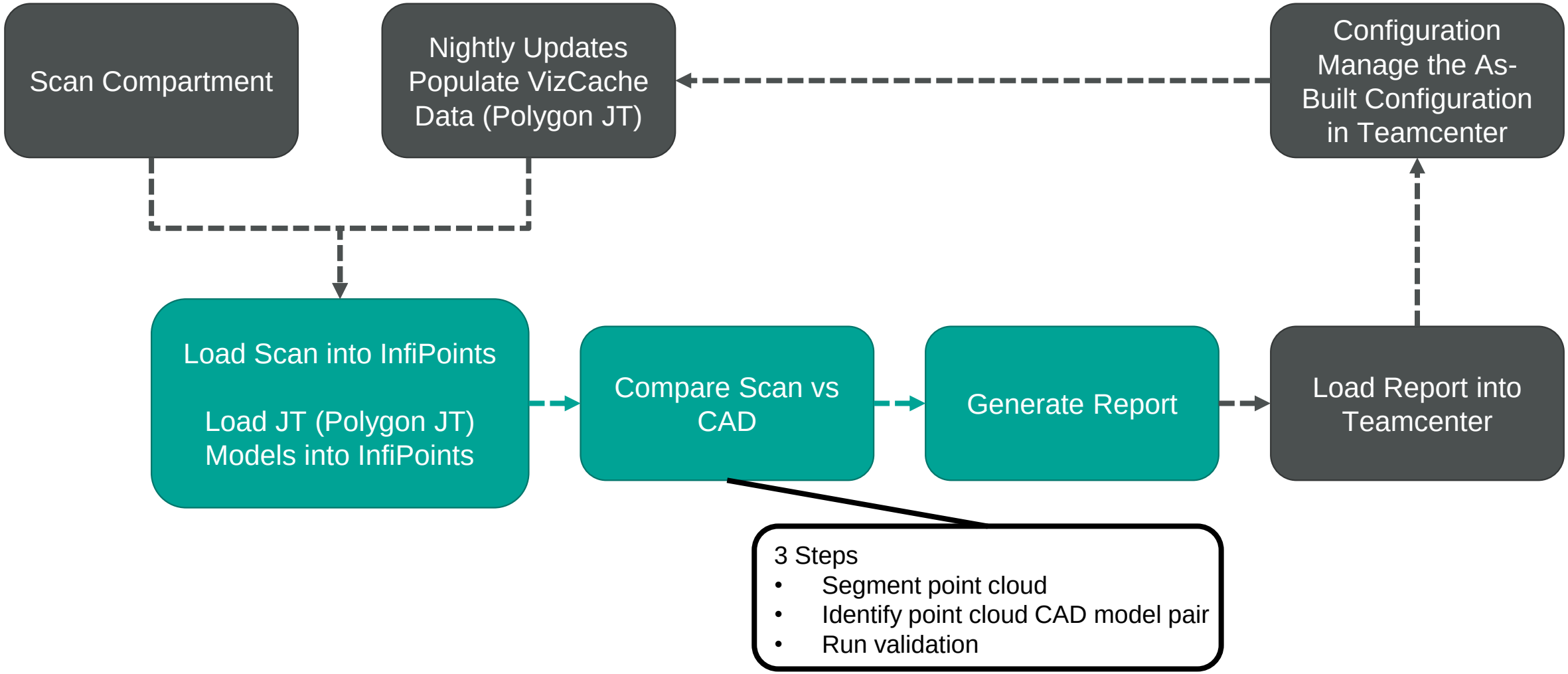


COTS - Detect deviation of
CAD vs. Point Cloud environment

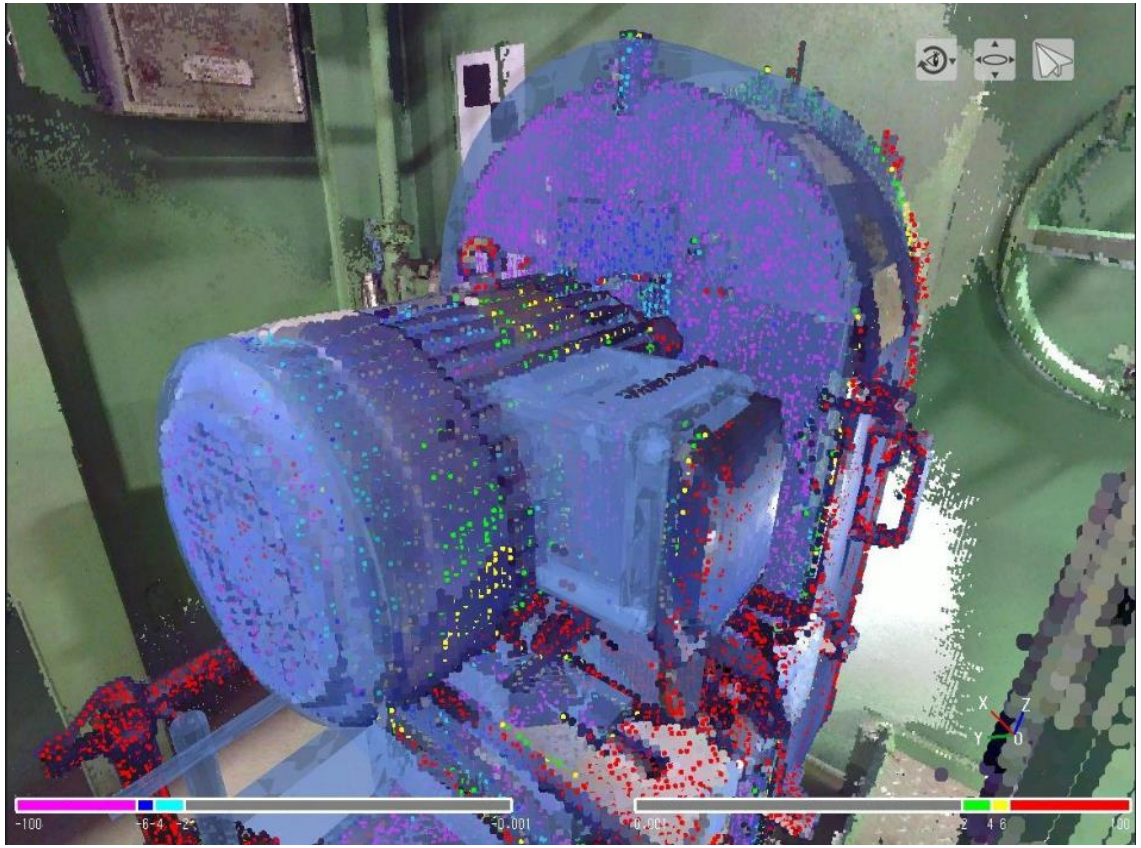
InfiPoints Capabilities:

- Point cloud processing
- Visualization & modeling
- Validation: Comparison of component and assembly-level comparison with detailed statistical reporting for users to evaluate
- Identifies highly mathematical information and reports in a user-friendly way
- Collision detection
- Digital measurement
- ID recognition: Alpha-numeric interpretation

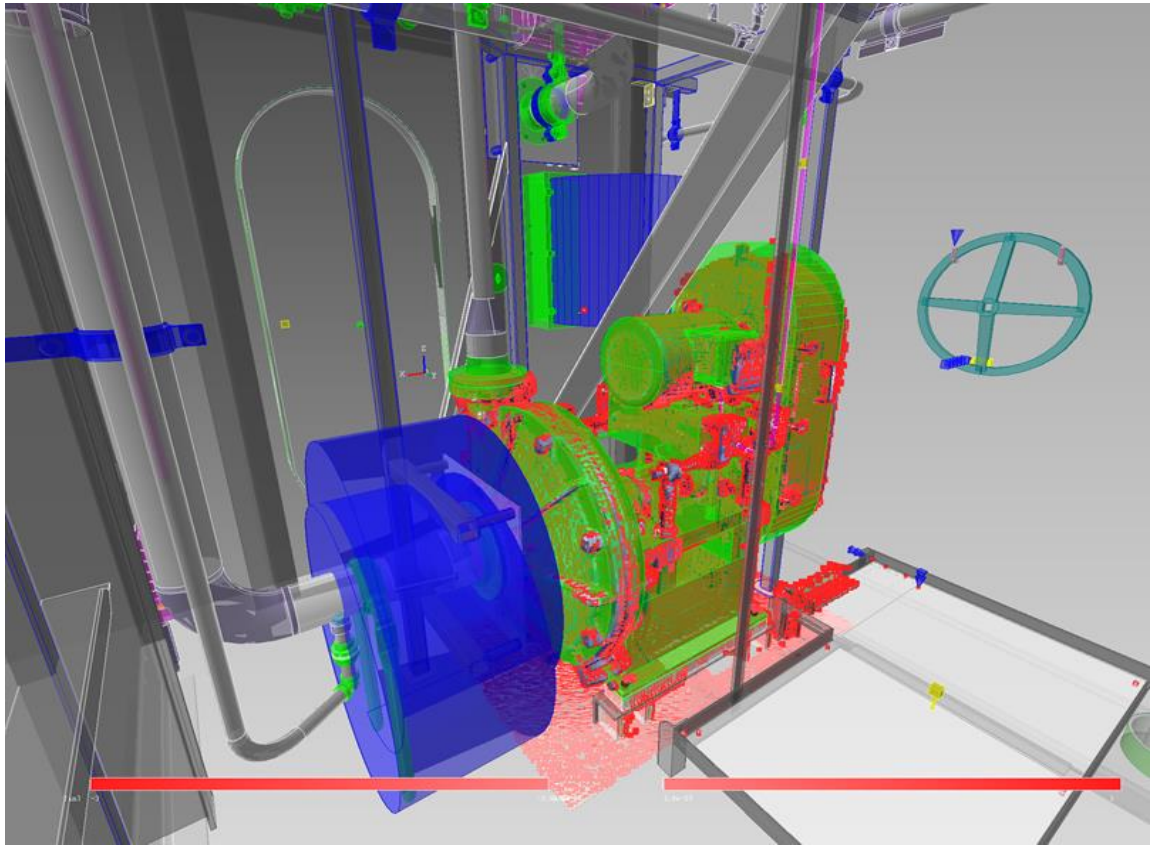
Workflow Summary and Review: Validation



Initial Capabilities



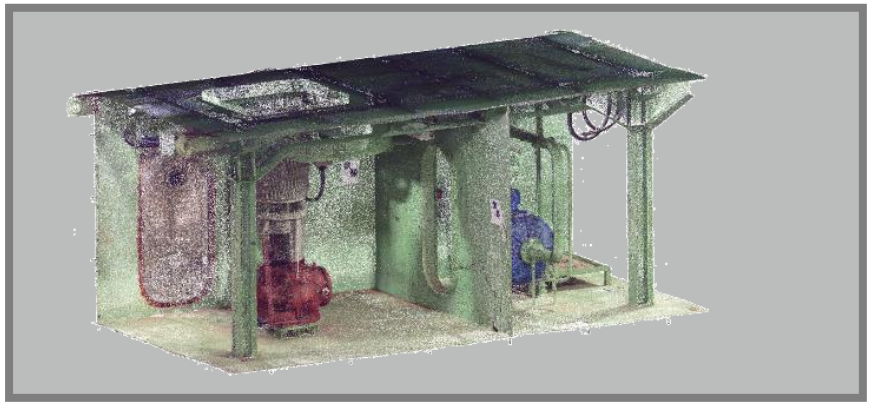
Initial Deviation Check



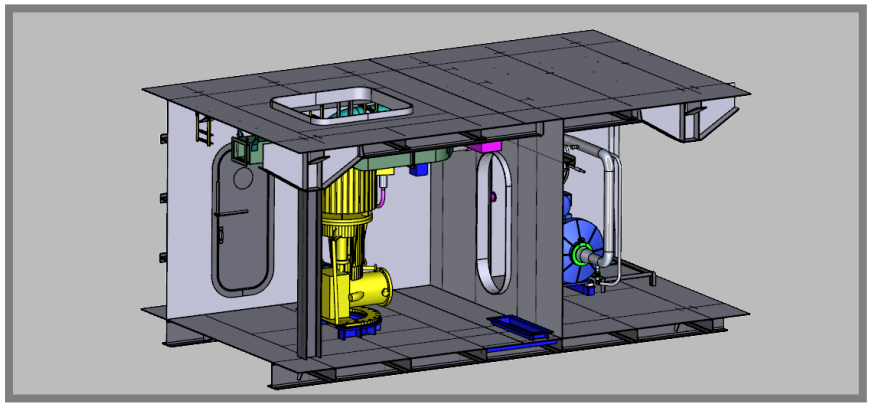
Deviation Check (Rev. B)

Test Data and Import

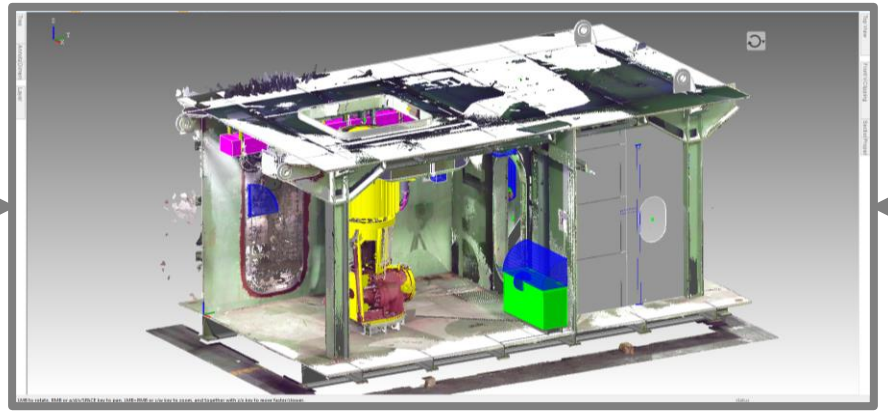
- Register point cloud scans then import and align the CAD model



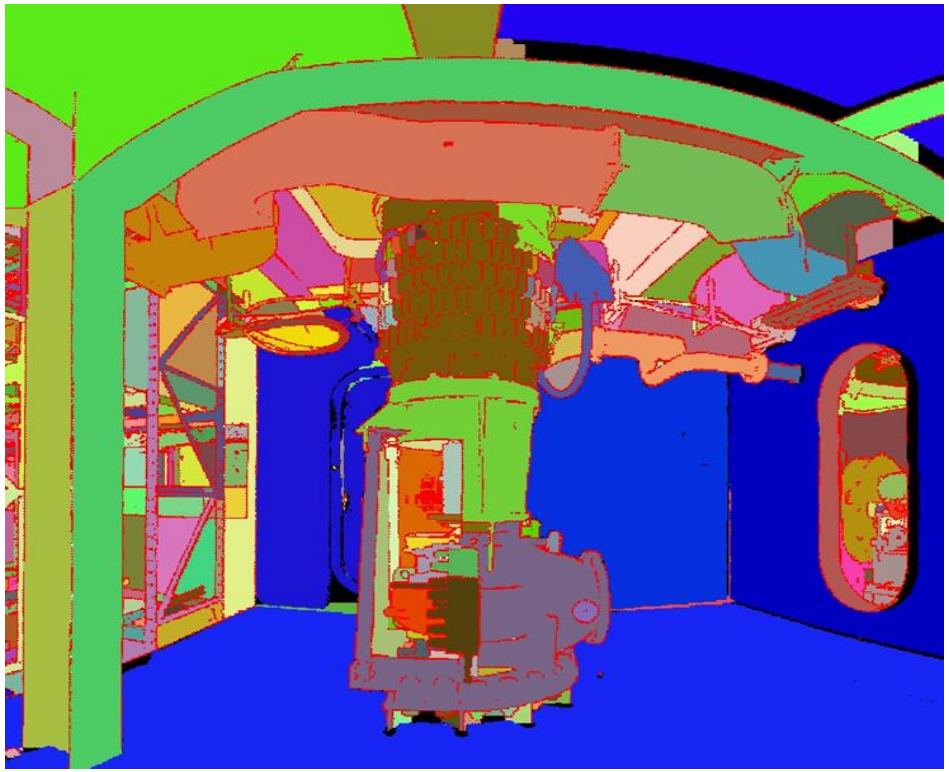
Scanner



JT Model

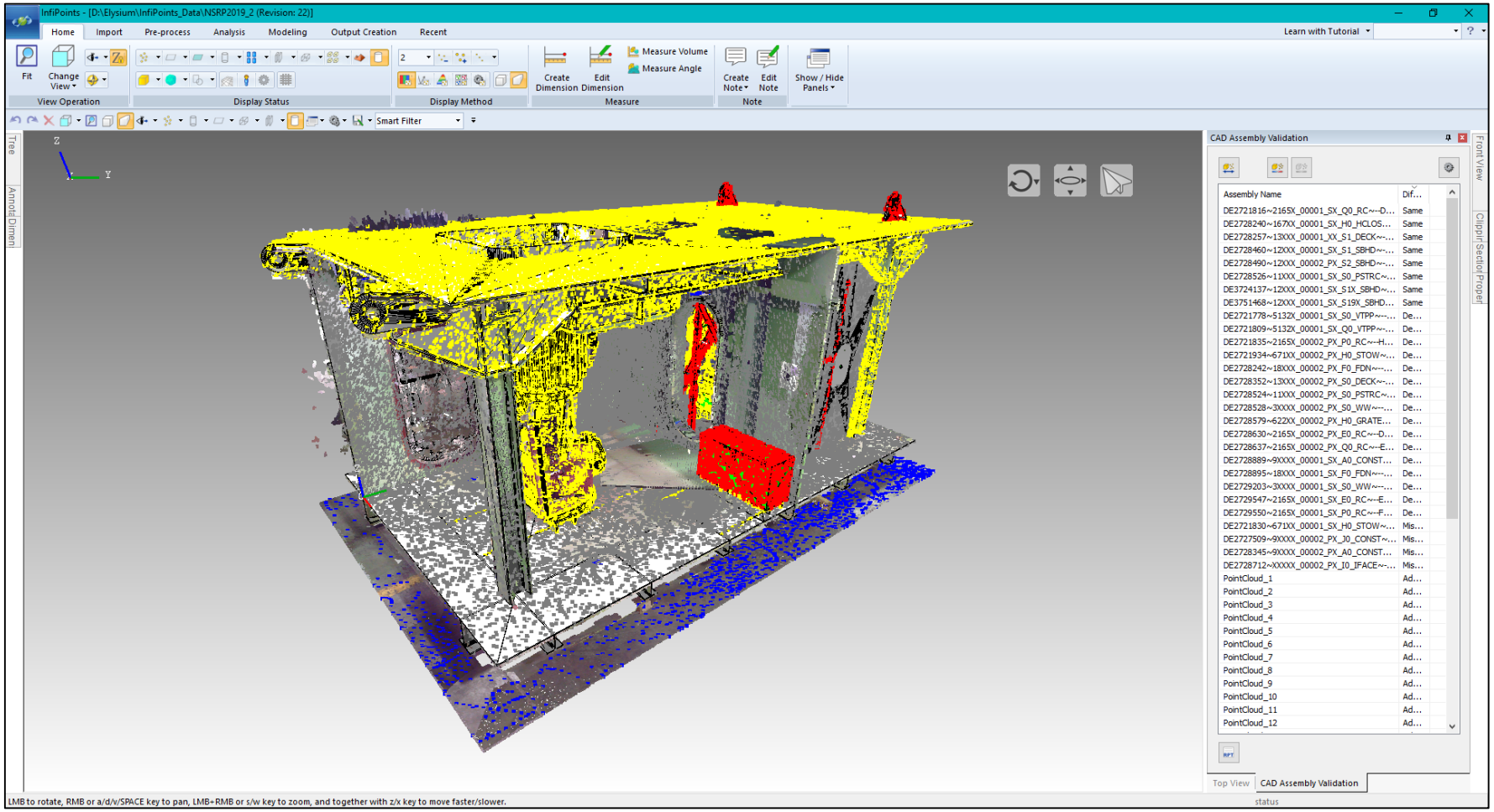


Automatic Segmentation



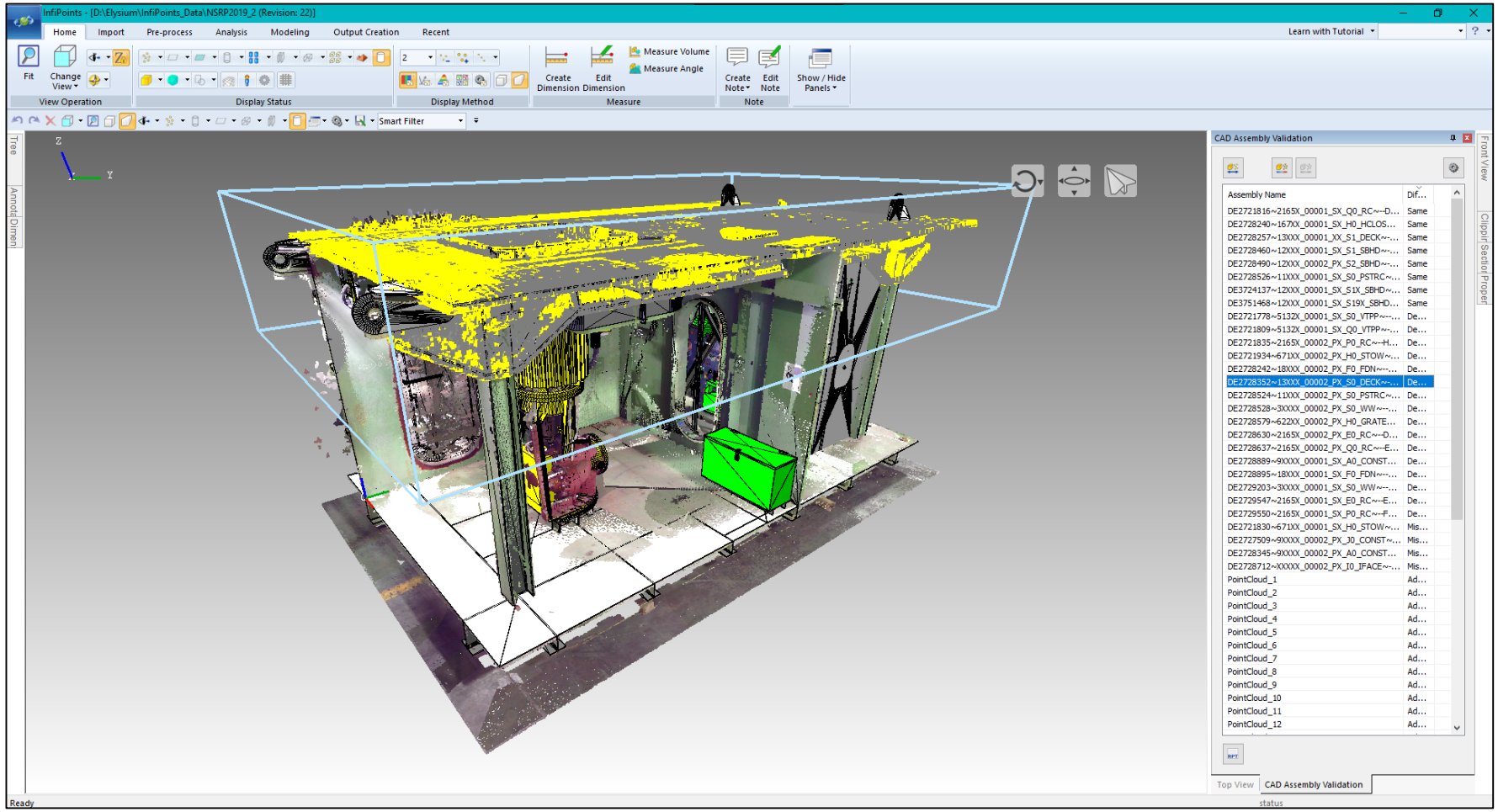
Analysis and Reporting

- Segmented point cloud is automatically paired with part or sub-assembly
- Once paired, the comparison is automatically performed and categorized



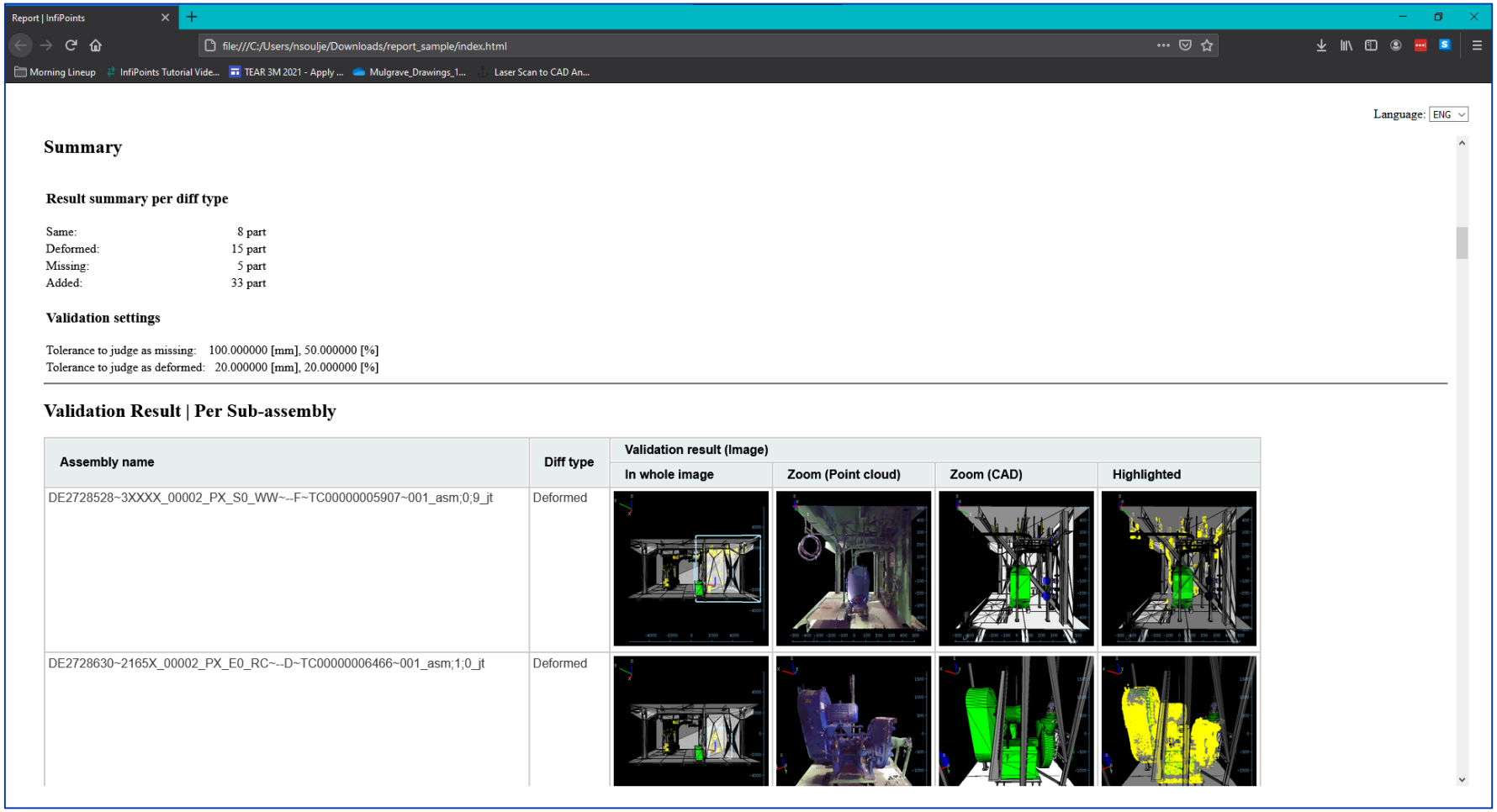
Analysis and Reporting

- Users can select results per sub-assembly/part for detailed review



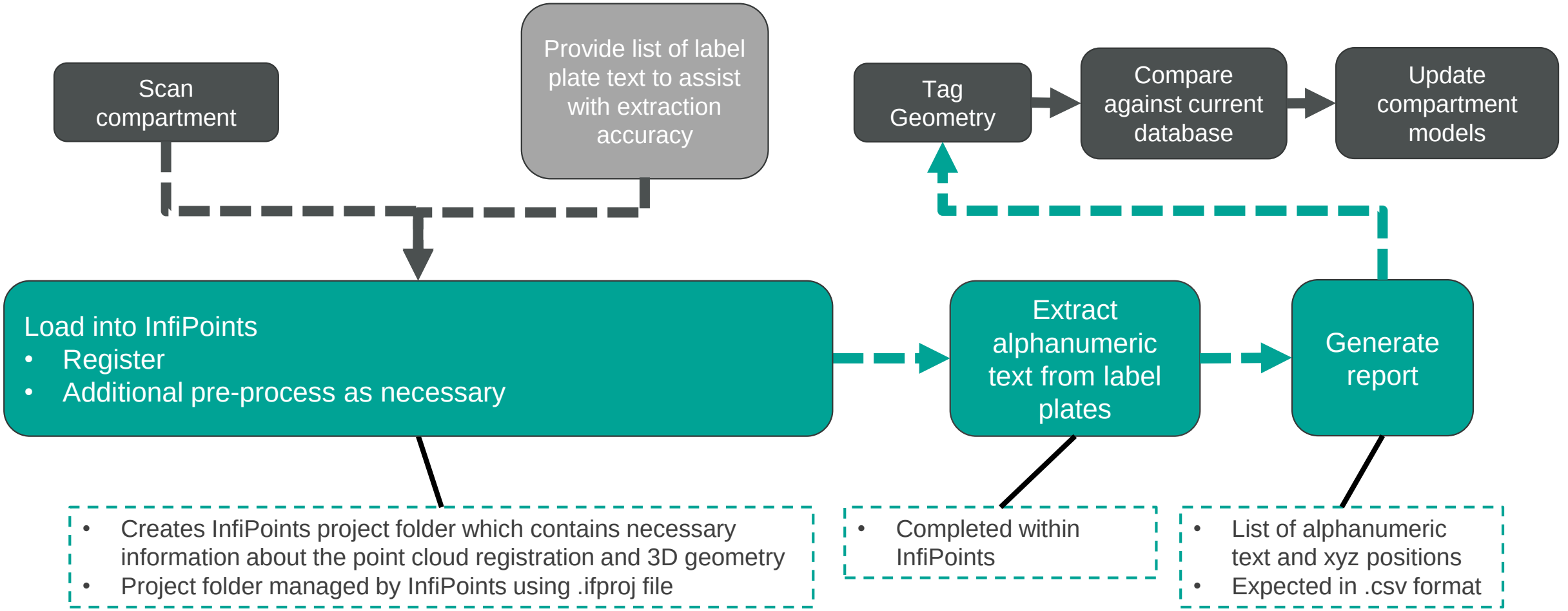
Generate HTML Report

- Once the validation is completed, users can export a HTML report for distribution
- The report includes a summary of differences
- Each sub-assembly/part is provided detailed information of location in point cloud and difference type



Automatic Text Recognition – Elysium Headquarters Test Environment

Workflow Summary and Review: Automatic Text Recognition



Automatic Text Recognition

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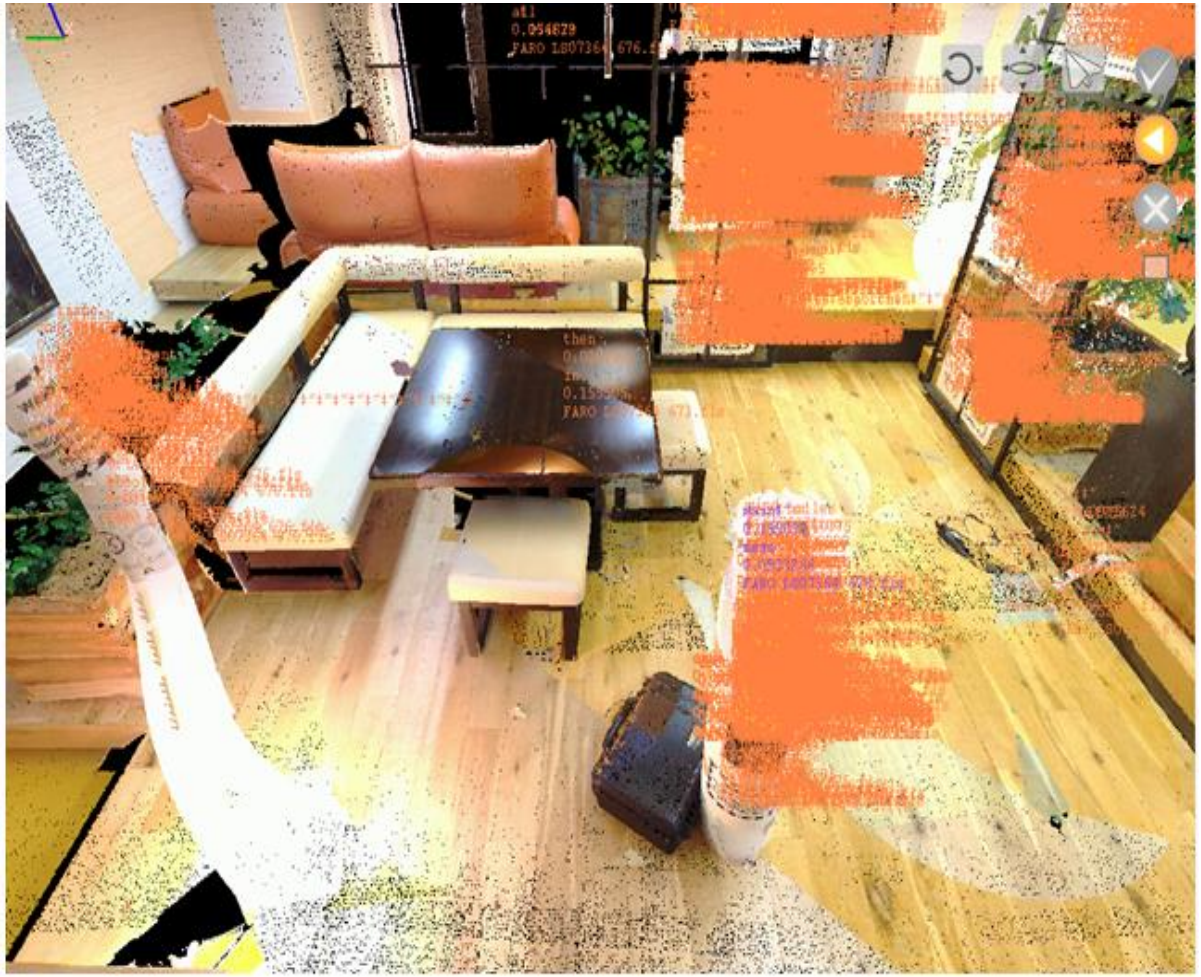
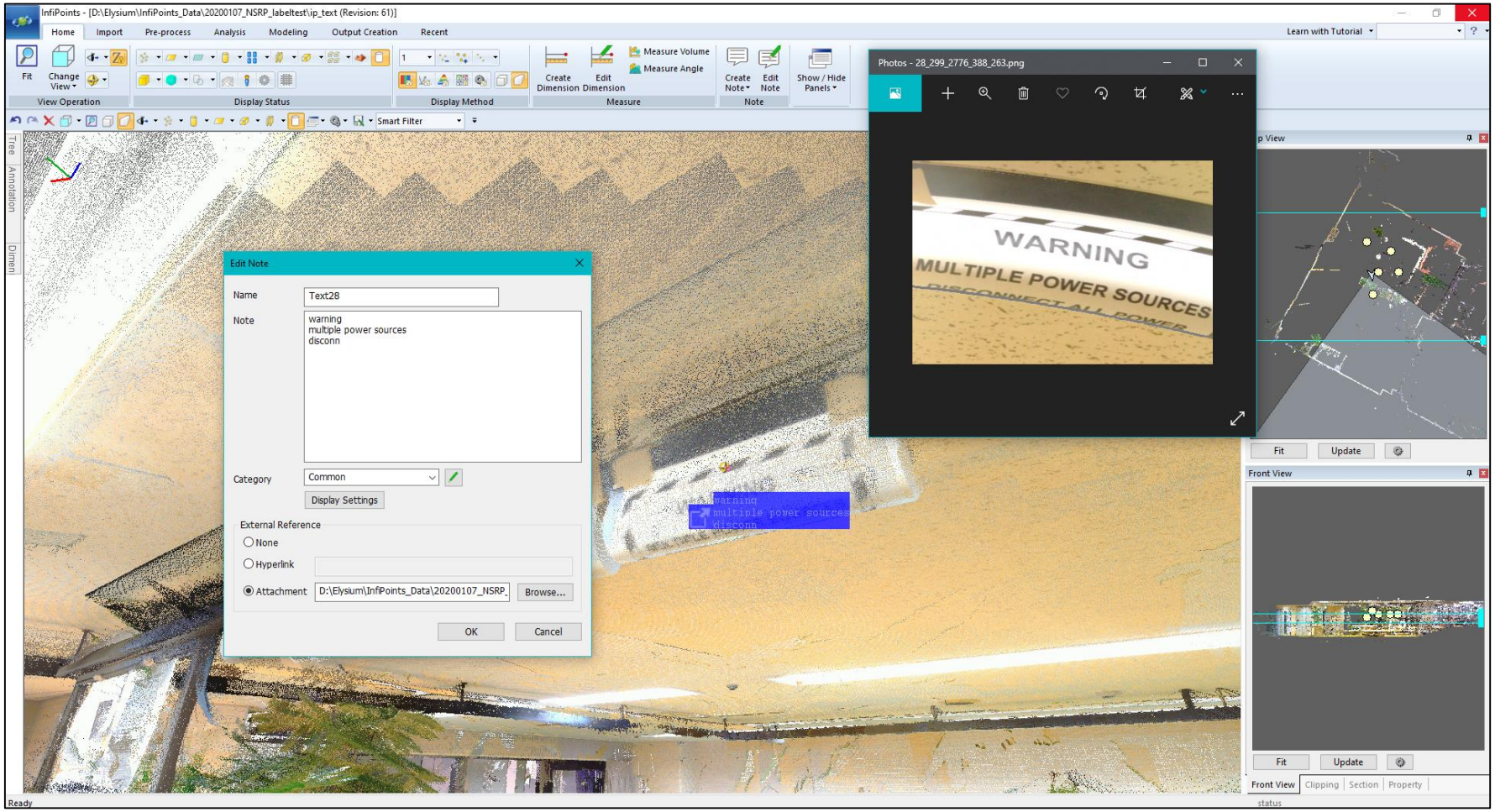


Automatic Text Recognition

- InfiPoints allows for rapid verification by the user and export to .csv for downstream processes.



Automatic Text Recognition – Secondary Test Environment

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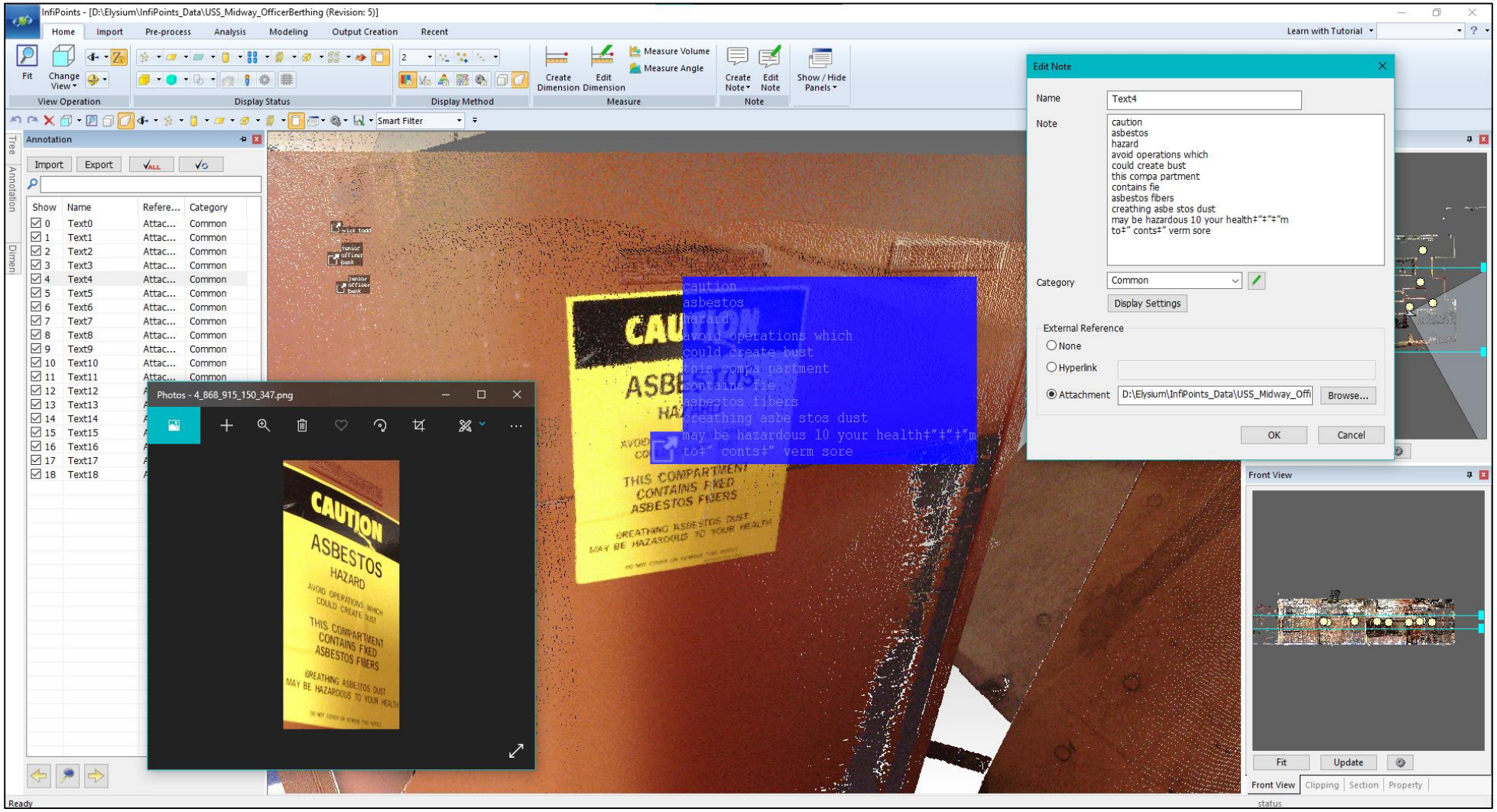

Automatic Text Recognition

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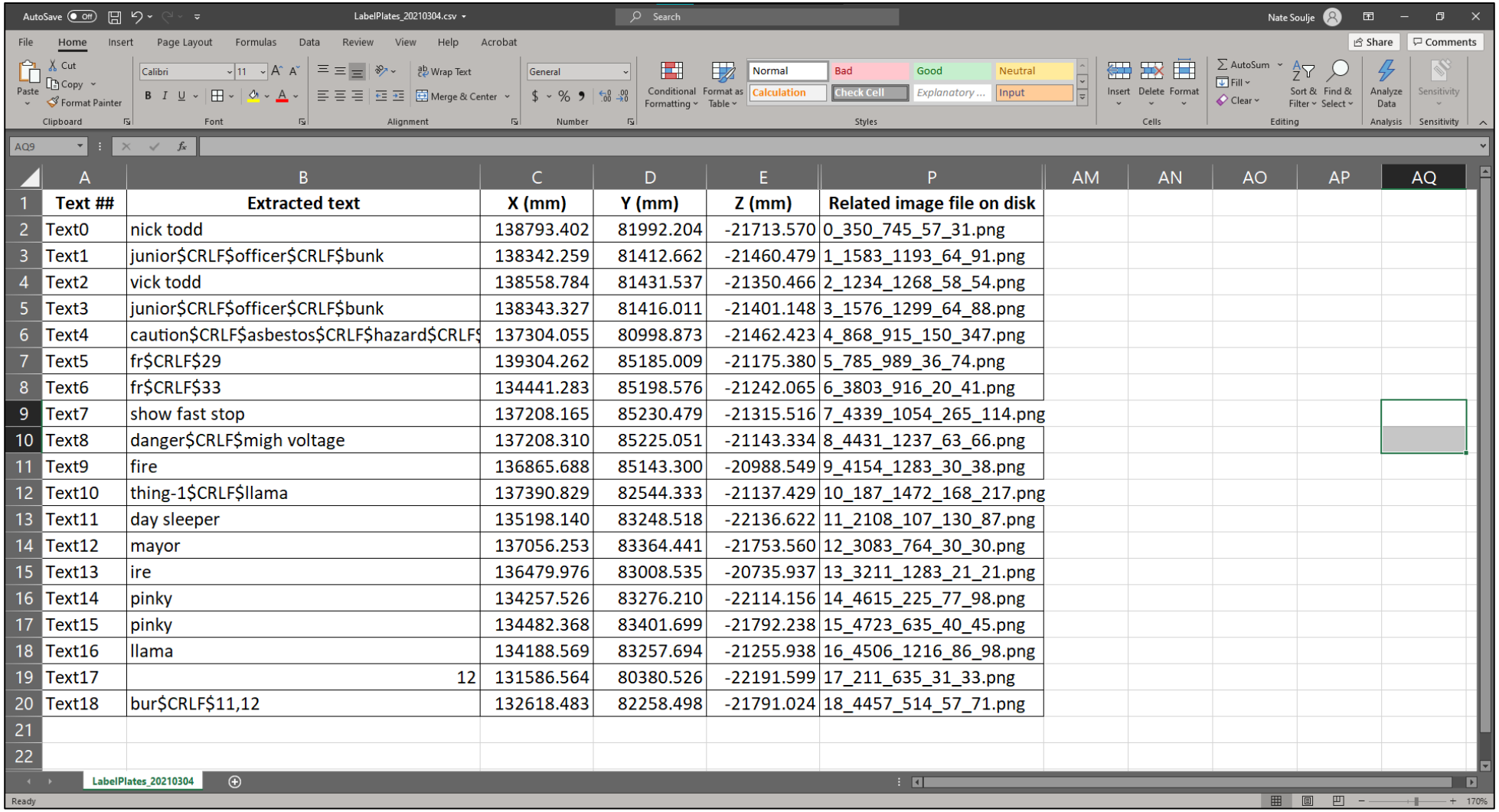

	A	B	C	D	E	P	AM	AN	AO	AP	AQ
1	**Text ##**	**Extracted text**	**X (mm)**	**Y (mm)**	**Z (mm)**	**Related image file on disk**					
2	Text0	nick todd	138793.402	81992.204	-21713.570	0_350_745_57_31.png					
3	Text1	junior$CRLF$officer$CRLF$bunk	138342.259	81412.662	-21460.479	1_1583_1193_64_91.png					
4	Text2	vick todd	138558.784	81431.537	-21350.466	2_1234_1268_58_54.png					
5	Text3	junior$CRLF$officer$CRLF$bunk	138343.327	81416.011	-21401.148	3_1576_1299_64_88.png					
6	Text4	caution$CRLF$asbestos$CRLF$hazard$CRLF$	137304.055	80998.873	-21462.423	4_868_915_150_347.png					
7	Text5	fr$CRLF$29	139304.262	85185.009	-21175.380	5_785_989_36_74.png					
8	Text6	fr$CRLF$33	134441.283	85198.576	-21242.065	6_3803_916_20_41.png					
9	Text7	show fast stop	137208.165	85230.479	-21315.516	7_4339_1054_265_114.png					
10	Text8	danger$CRLF$migh voltage	137208.310	85225.051	-21143.334	8_4431_1237_63_66.png					
11	Text9	fire	136865.688	85143.300	-20988.549	9_4154_1283_30_38.png					
12	Text10	thing-1$CRLF$llama	137390.829	82544.333	-21137.429	10_187_1472_168_217.png					
13	Text11	day sleeper	135198.140	83248.518	-22136.622	11_2108_107_130_87.png					
14	Text12	mayor	137056.253	83364.441	-21753.560	12_3083_764_30_30.png					
15	Text13	ire	136479.976	83008.535	-20735.937	13_3211_1283_21_21.png					
16	Text14	pinky	134257.526	83276.210	-22114.156	14_4615_225_77_98.png					
17	Text15	pinky	134482.368	83401.699	-21792.238	15_4723_635_40_45.png					
18	Text16	llama	134188.569	83257.694	-21255.938	16_4506_1216_86_98.png					
19	Text17	12	131586.564	80380.526	-22191.599	17_211_635_31_33.png					
20	Text18	bur$CRLF$11,12	132618.483	82258.498	-21791.024	18_4457_514_57_71.png					
21											
22											

Laser Scan to CAD Analysis: Summary

- Today we are:
  - Continuing improvement of automatic text recognition and label plate extraction
  - Continuing improvement of automatic segmentation
  - Developing and implementing an efficient method for comparing the point cloud against the CAD model
  - Testing/validating the current processes and capabilities of InfiPoints

Laser Scan to CAD Analysis: Savings & Benefits

This project addresses synchronization of the digital 3D product model & in-service ship configuration. This provides near-real-time ship configuration to the FORD Class Hull Planning Yard (HPY) and maintenance and repair teams for lifecycle-planning activities. This project :

- Strengthens ship's configuration – HPY product model synchronization
- Acts as a tool to communicate and educate organizations that implement a change without HPY approval
- Helps with the process of changing the culture from 2D legacy to configuration-managed 3D environment
- Automates manual process to identify and capture unauthorized changes and deviations to the base-ship configuration
- Efficiently captures and displays geometric change documented on inspection reports (IRs)
- Provides real-time configuration status thus reducing schedule time and resources required for shipboard ship checks
- Improves quality and timeliness to deliver logistics information directly to the Navy
- Significantly reduces the need for non-Ship's Force ship accessibility
- Allows for continued ship configuration control and management regardless of ship's geographic location

Mobile Laser Scanning Follow Up Project

NNS and Elysium to work together to expand Laser to CAD Analysis enhancements to mobile/handheld laser scanners.

- Give users the ability to work in spaces that are more difficult to reach with tripod scanners
- Enable users to validate a range of cases
  - Manufactured components
  - Compartments
  - Planning maintenance

Questions?

Leveraging Point Clouds to Assemble and Maintain Digital Twins

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- **Thank you!**