

# The Pathway to Complete Digital Twins in Construction: Where Are We Now and Where Are We Going?

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## Agenda

- Defining a Digital Twin
- Beginning the Digital Twin journey
- Example use cases for tolerance management
- Future directions

## EPIC Digital Engineering Efforts – Advanced Construction

### Characterized by:

- All digital design
- Automated component production by supply chain
- Repeatable component dimensions
- Reliable assembly by OEM
- Cost competitive
- High production rates
- Achieved in a regulated environment designed for safety



### Characterized by:

- Single design (no two airports alike)
- Local fabrication
- No complete digital design
- Diminishing supply chain

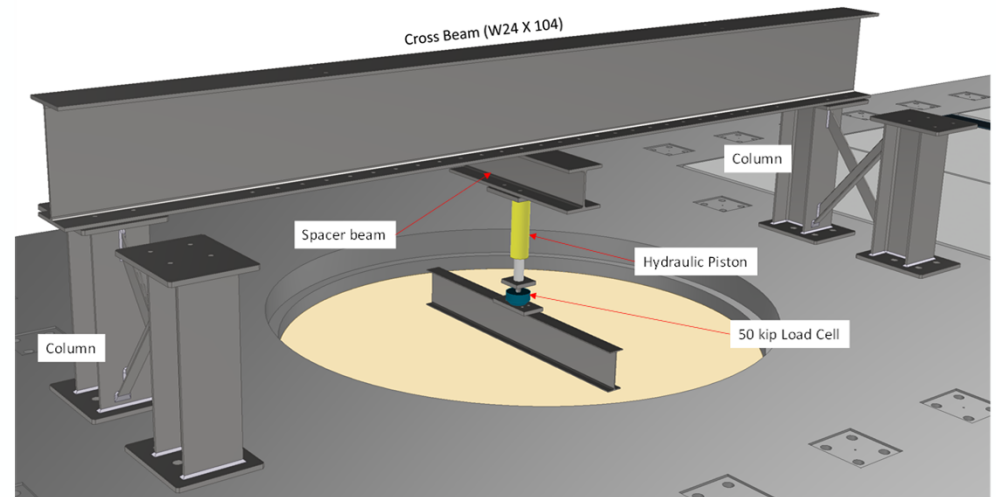




## What Constitutes a Digital Twin?

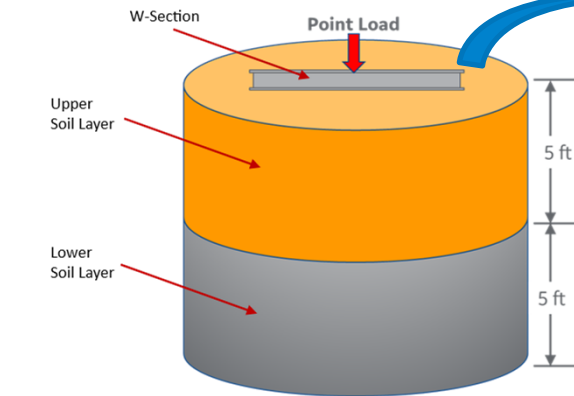


*Is this a “Twin”?*

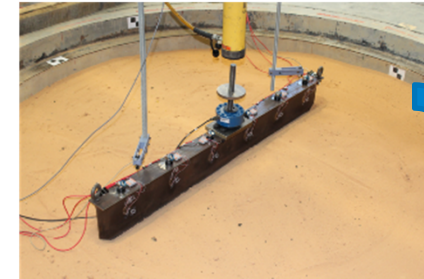
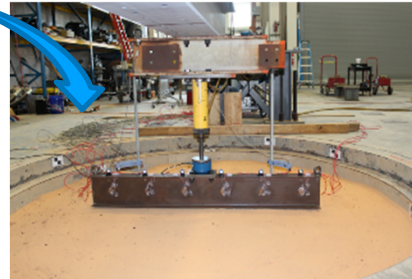




## Soil Conditions Modeled

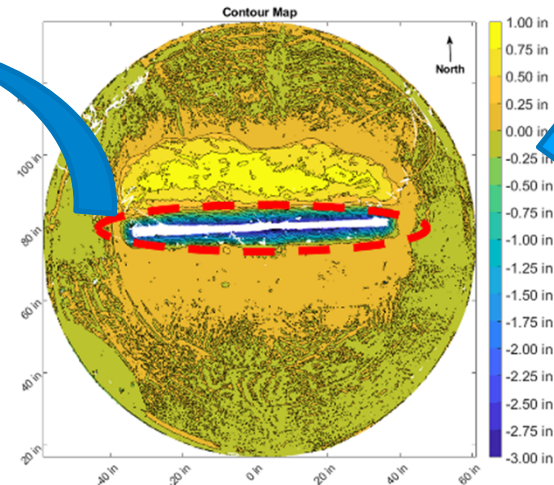
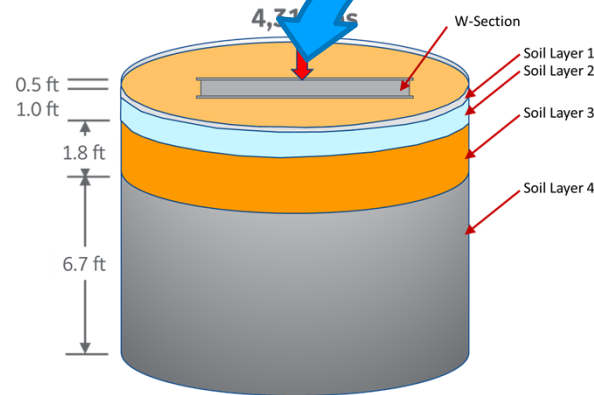


## System Loaded in The Lab

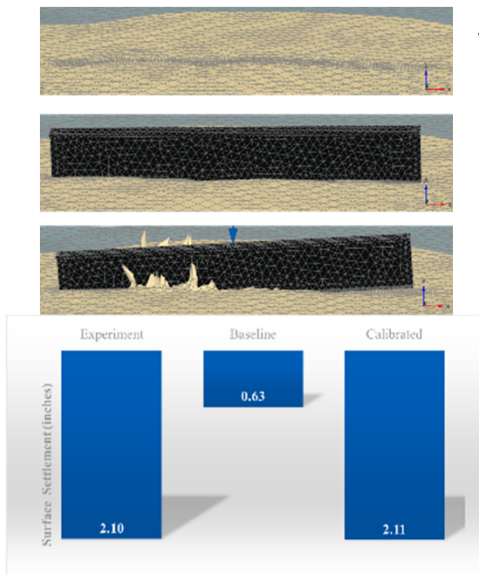


Model & Predictions Don't Agree!

## Soil Model Updated





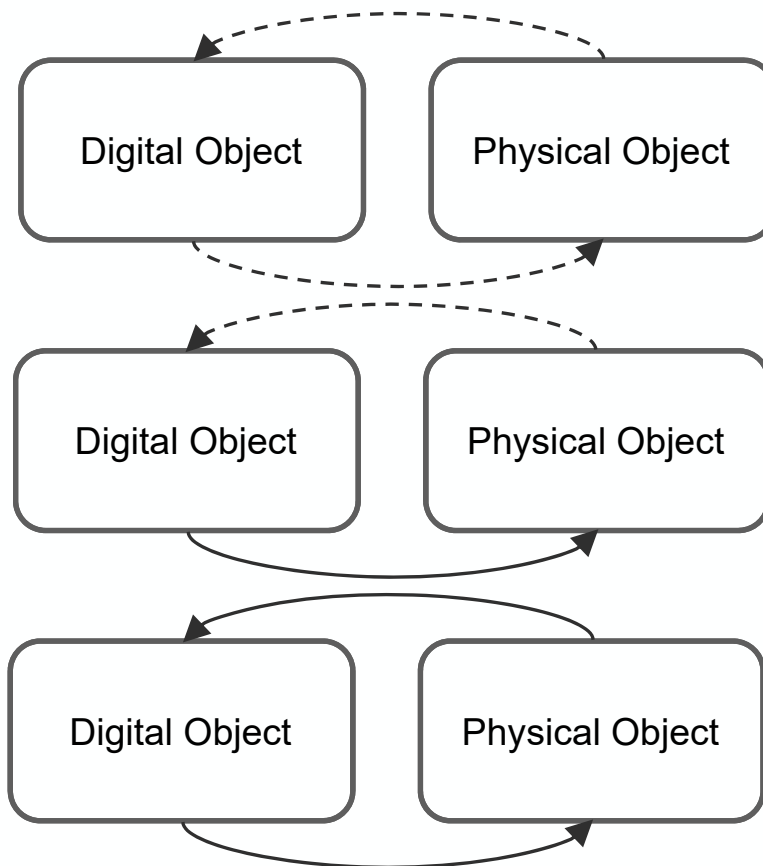
Settlement Measured



*Is this calibrated model a “Twin”?*

## Progressing from Models to Twins

 Automated Data Flow  
 Manual Data Flow



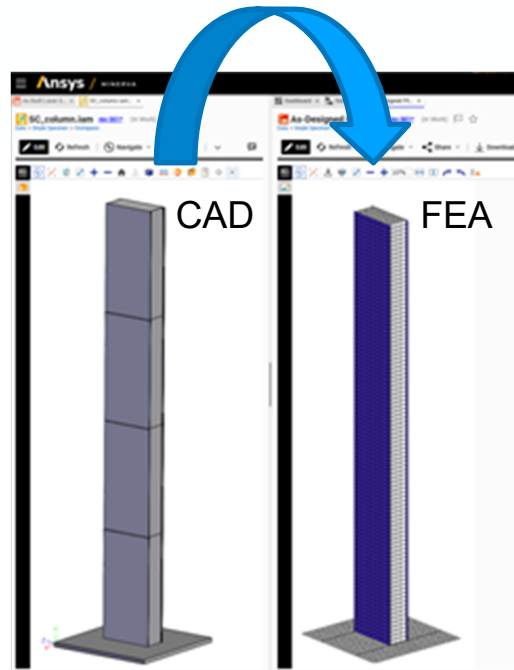
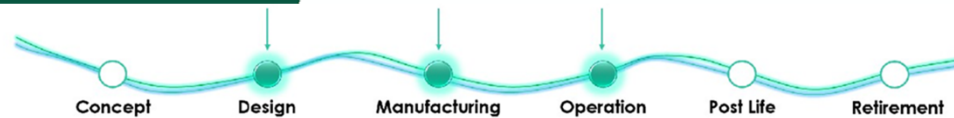
***Digital Models***

***Digital Shadows***

***Digital Twins***

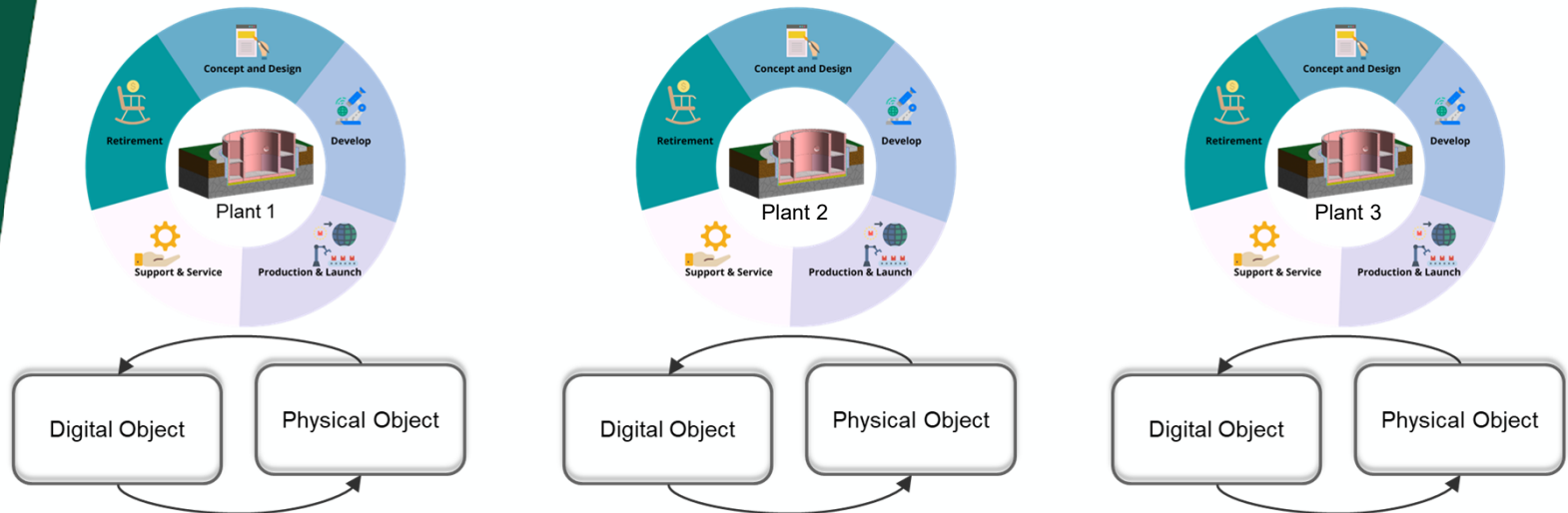


## Advancing PLM Using Digital Thread



- Adopt a ***model-based systems engineering (MBSE)***
- Two key steps:
  - Data untethers from documents
  - Models link to each other using a common framework
- Linkage occurs throughout lifetime
- Example:
  - Steel Composite Structure

# Digital Twin Utilizes PLM For Each Individual System

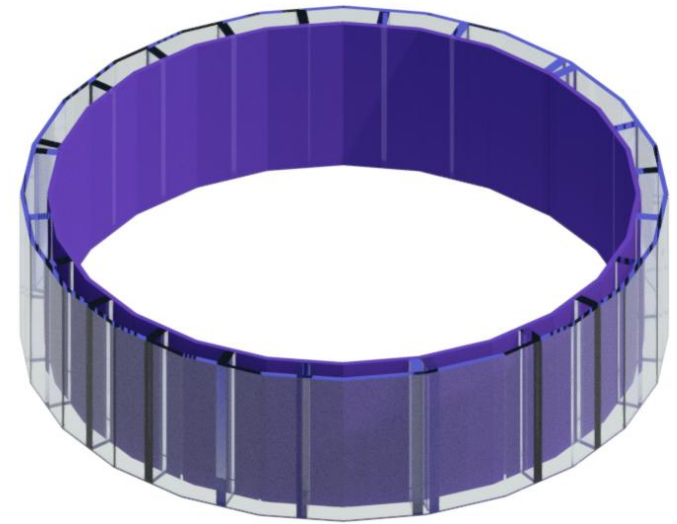


- *Physical system and digital system are so closely connected, they adapt together*
- *PLM is used for each individual instance, not general product families*



## Lessons Learned & Emerging Opportunities

- Outdated design processes
- Managing documentation packages
- Fully exploiting the benefits of modularity
- Improved decision-making during construction

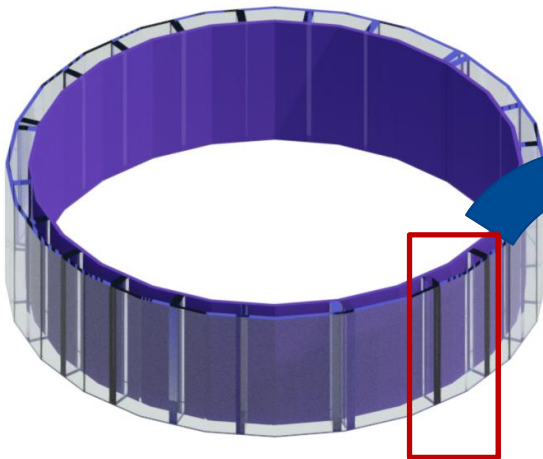


***Managing Tolerance as  
Modules are Placed***



## Dynamic Product Navigation Enabled By BIM

Users can drill down on available data as desired



The screenshot displays the EPIC software interface for a CAD Document titled "Beam4941.stl". The interface includes a top navigation bar with tabs for Dashboard, CAD Documents, Query Definitions, Copy of View3D..., Sensor0.stl, Mini\_DT\_Test, CAD\_TGV, 3FB97A397C83..., Beams\_Sector..., 717BB15238E4..., and Beam4941.stl. The main content area is divided into two sections: "CAD Document" and "Attachments".

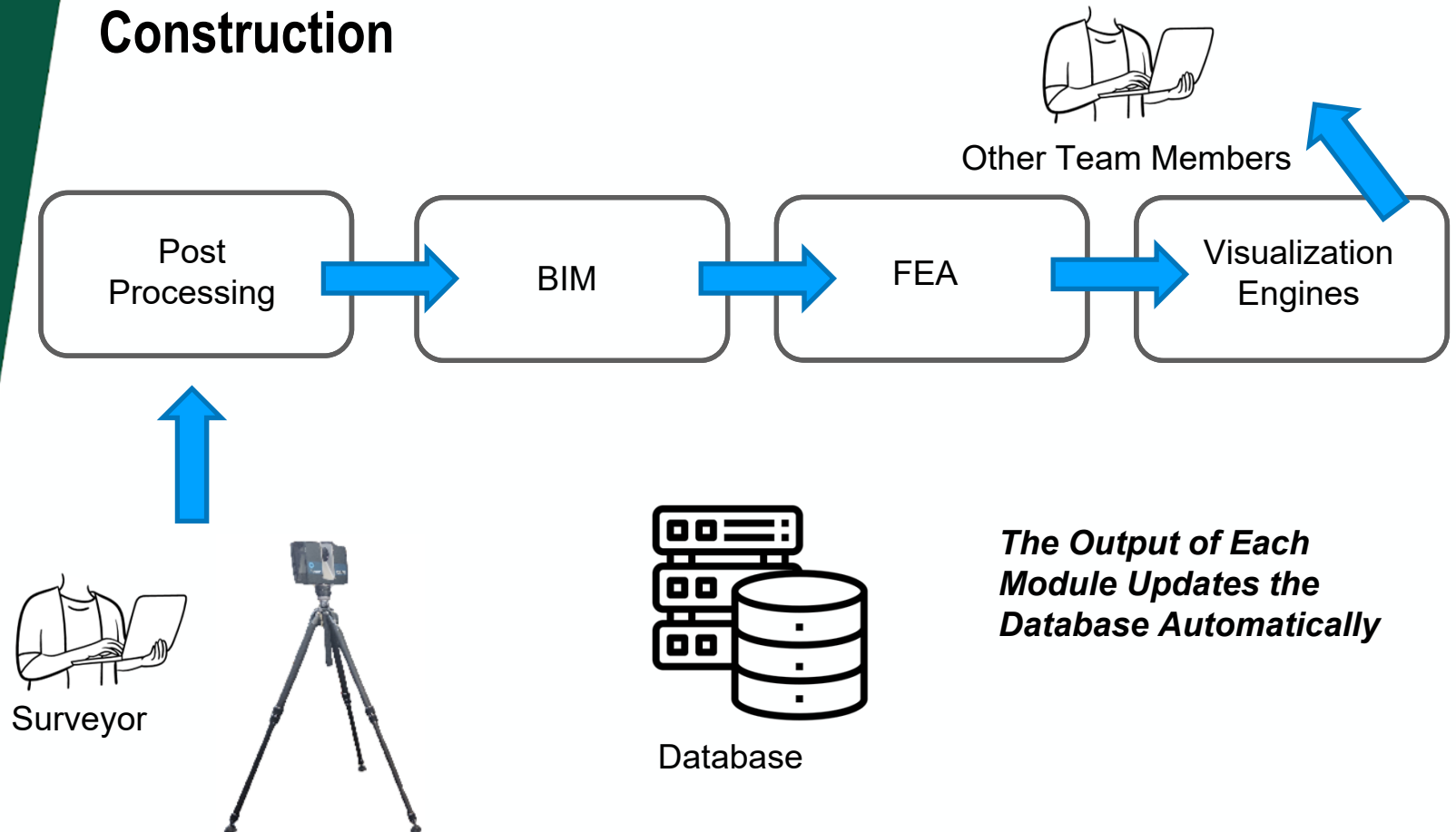
The "CAD Document" section contains fields for Document Number (Beam4941.stl), Revision (A), State (Preliminary), Name (Beam4941.stl), Type (Part), Authoring Tool, Version, and Description. It also includes checkboxes for "Changes Pending", "Standard", "Template", and "Dynamic Enabled". The "Assigned Creator" is listed as "World", and the "Designated User" is also "World".

The "Attachments" section shows a list of files and folders. The "Attachments" tab is selected, displaying a table of attachments. The table has columns for Name, Rev, Branch, State, Date Modified, Modified By, and Classification. The attachments listed are:

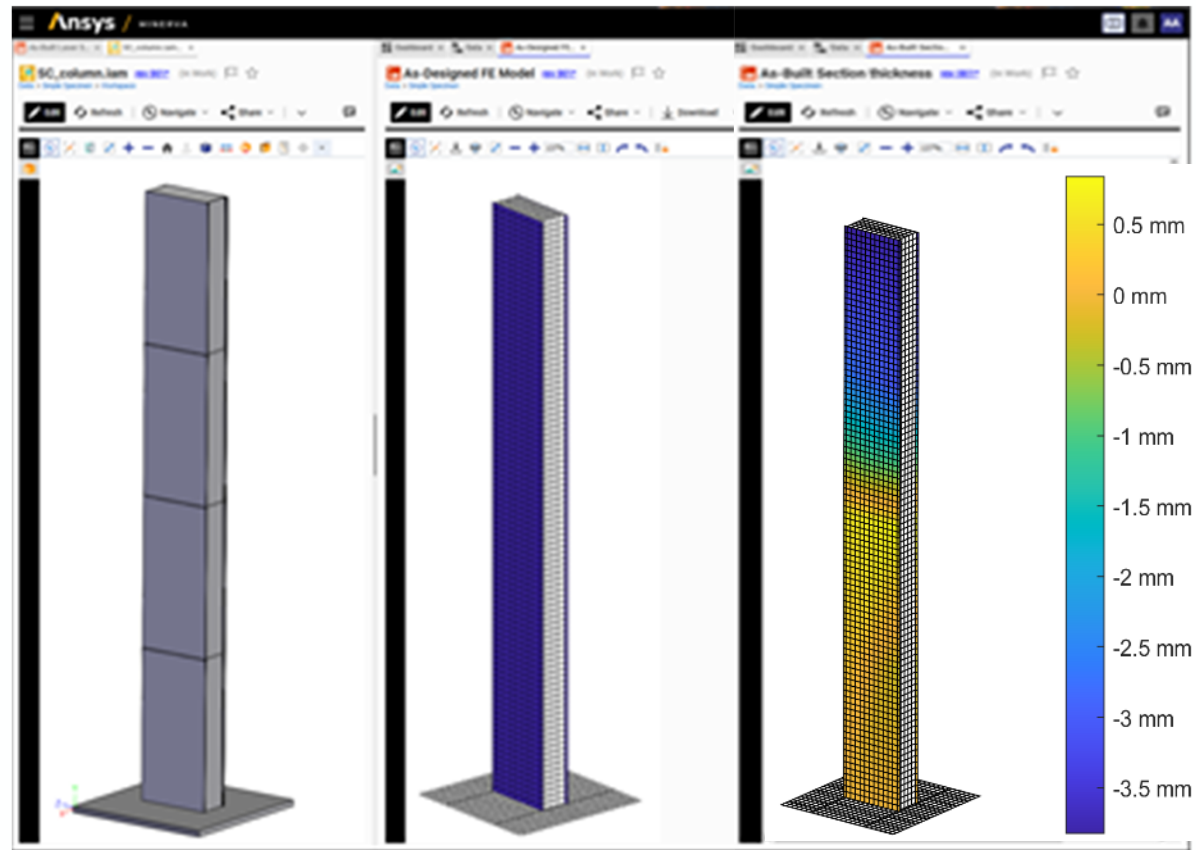
Name	Rev	Branch	State	Date Modified	Modified By	Classification
Engineering Calcs	001	Default	Uncontrolled	2022-11-14 12:16:19	Ansys Admin	Folder
CAD	001	Default	Uncontrolled	2022-11-14 12:16:53	Ansys Admin	Folder
BOM	001	Default	Uncontrolled	2022-11-17 16:18:07	Ansys Admin	Folder
Material Reports	001	Default	Uncontrolled	2022-11-17 16:18:07	Ansys Admin	Folder
IFC	001	Default	Uncontrolled	2022-11-17 16:18:07	Ansys Admin	Folder

Below the table, there is a note: "Please edit the parent item before attempting to make changes."

## Example Benefit of the Single Source of Truth in Construction



## Towards a Single-Source of Truth



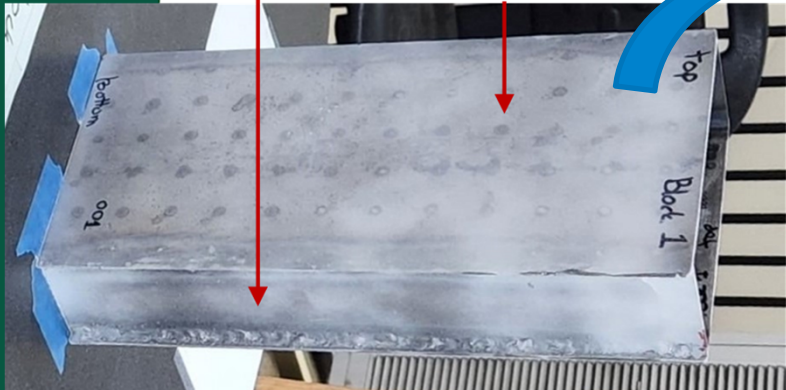
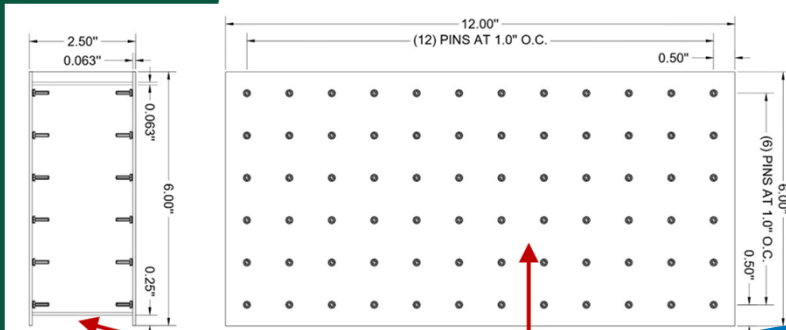
As Designed BIM

As Designed FEA

As Built BIM

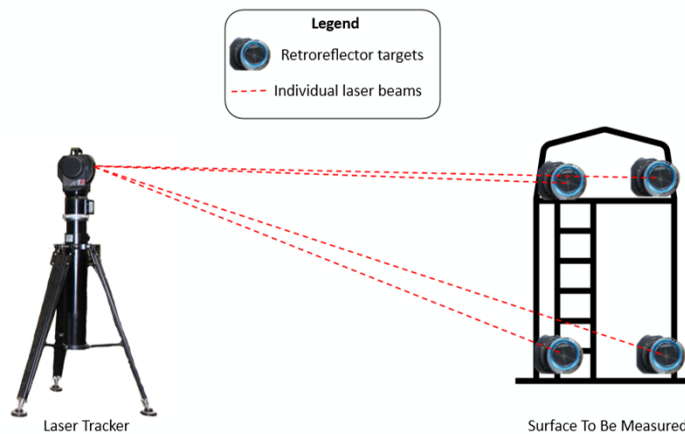


# Using a Single-Source of Truth

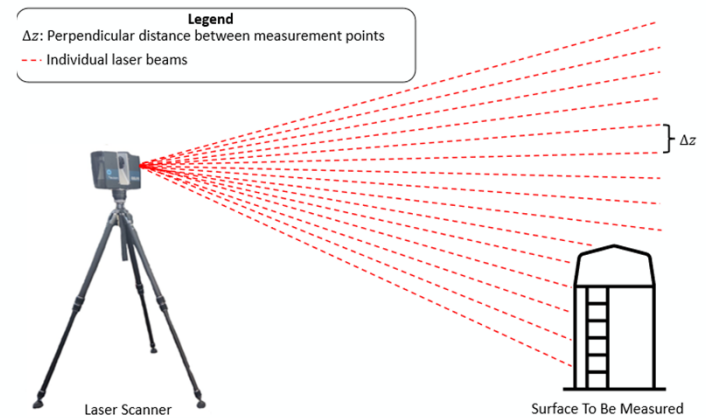


Name ↑	Label	Data Type	Data Source [...]
a_a	a	Float	
a_c	c	Float	
a_cad	CAD	Item	<a href="#">CAD</a>
a_crosssectional...	Cross Sec. Area	Float	
a_d	d	Float	
a_e	e	Float	
a_grossarea	Gross Area	Float	
a_grosssurfacear...	Gross Surf Area	Float	
a_grossvolume	Gross Volume	Float	
a_grossweight	Gross Weight	Float	
a_id	ID	String	
a_intermittent	Intermittent	Boolean	
a_isexternal	Is External	Boolean	
a_l	l	Float	
a_length	Length	Float	
a_loadbearing	Load Bearing	Boolean	
a_material	Material	Text	
a_matrix	Matrix	String	
a_n	n	Float	
a_netarea	Net Area	Float	
a_netarea...	Net Surf Area	Float	

# Today's Technologies: Scans & Tracking

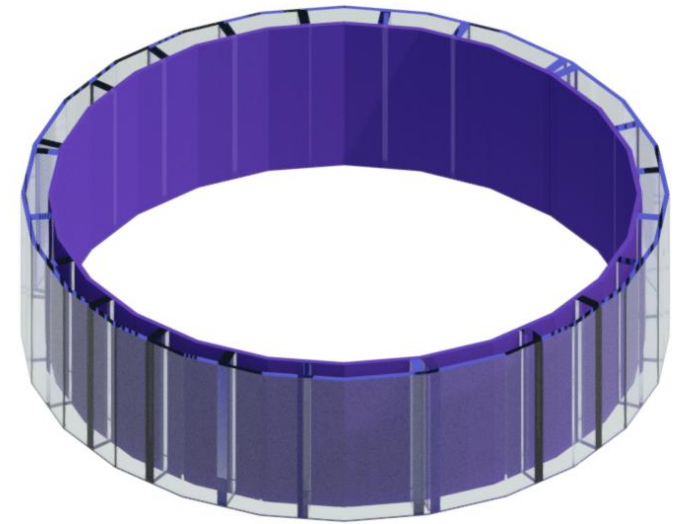


- Tracks locations of individual points with high accuracy
- Low resolution
- Updates geometry quickly in the field

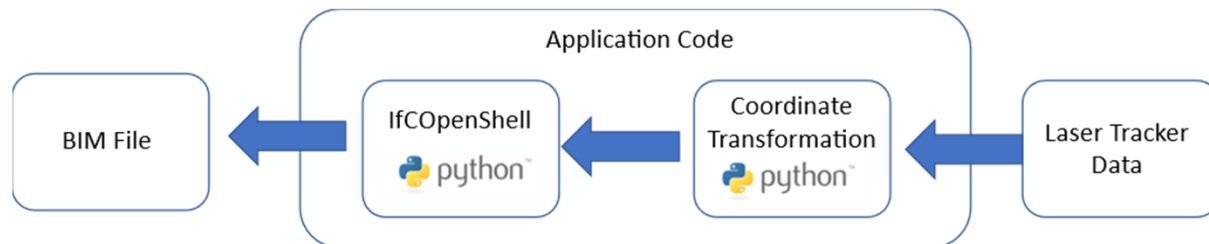


- Creates dense point cloud to profile the surface contour of an object
- High resolution
- High processing time
- Often requires manual intervention

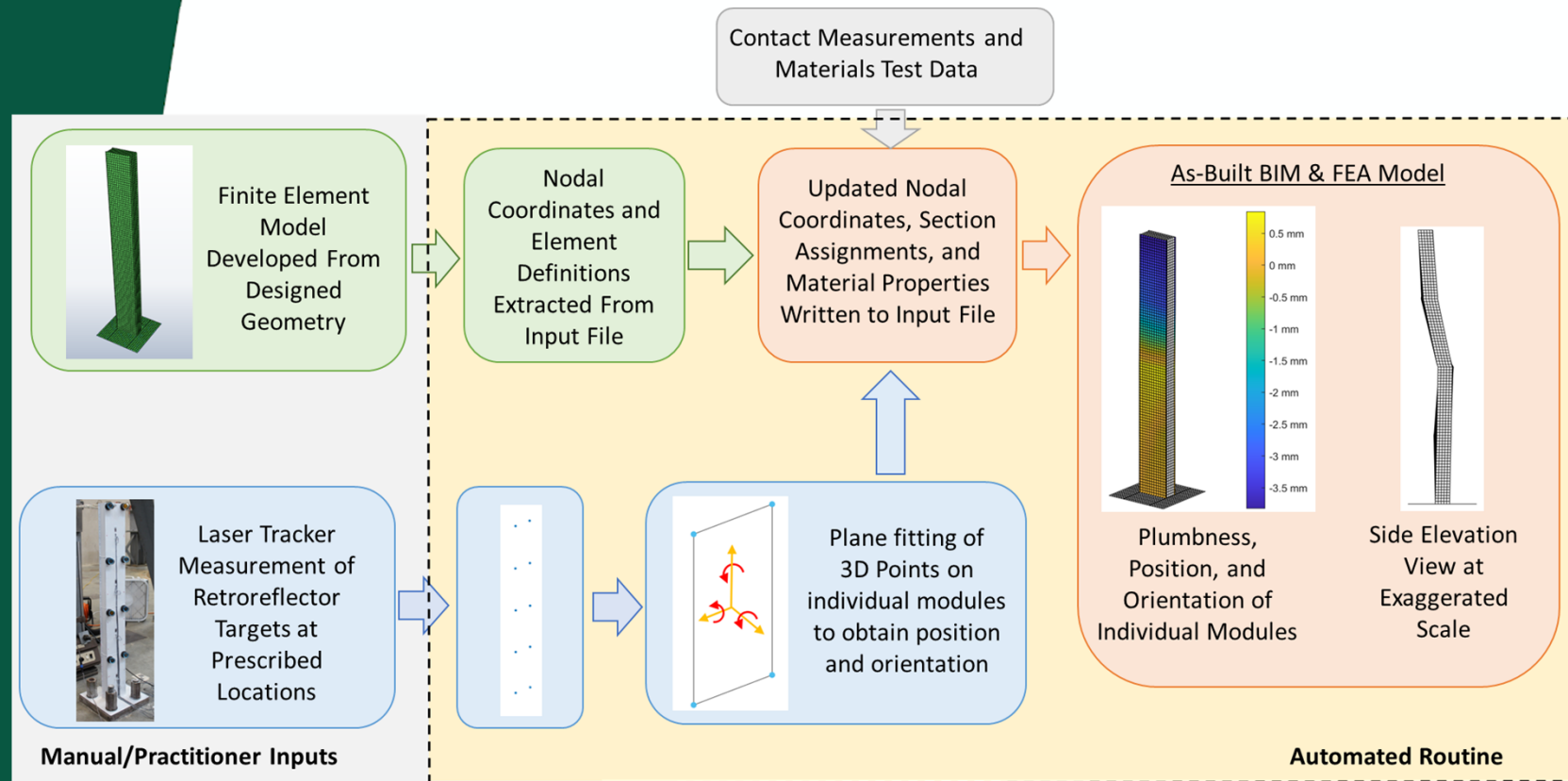
## Laboratory Example: Tolerance Management



*Managing Tolerance as Modules are Placed*

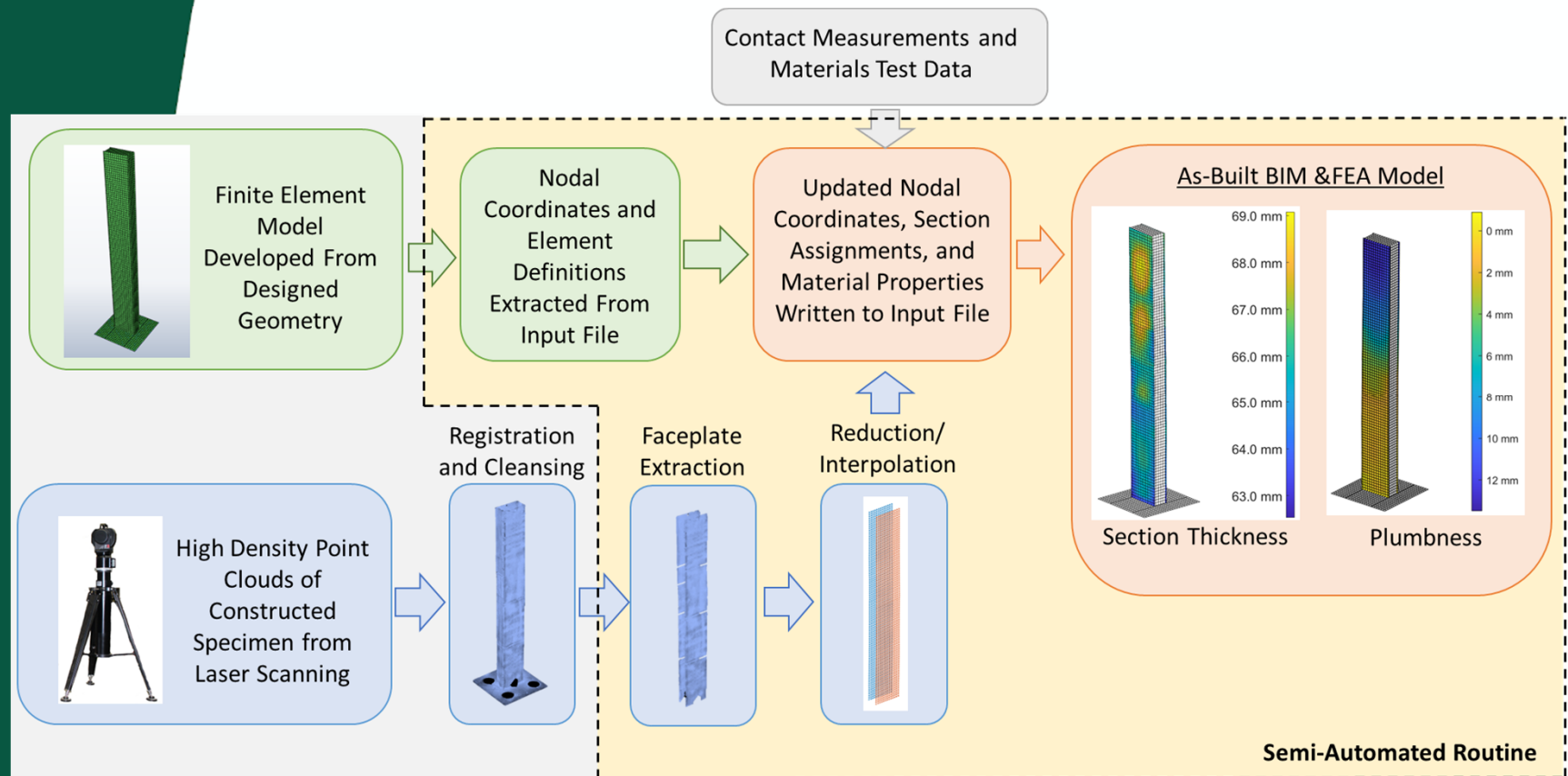


# Automated Model Updating Via Laser Tracker

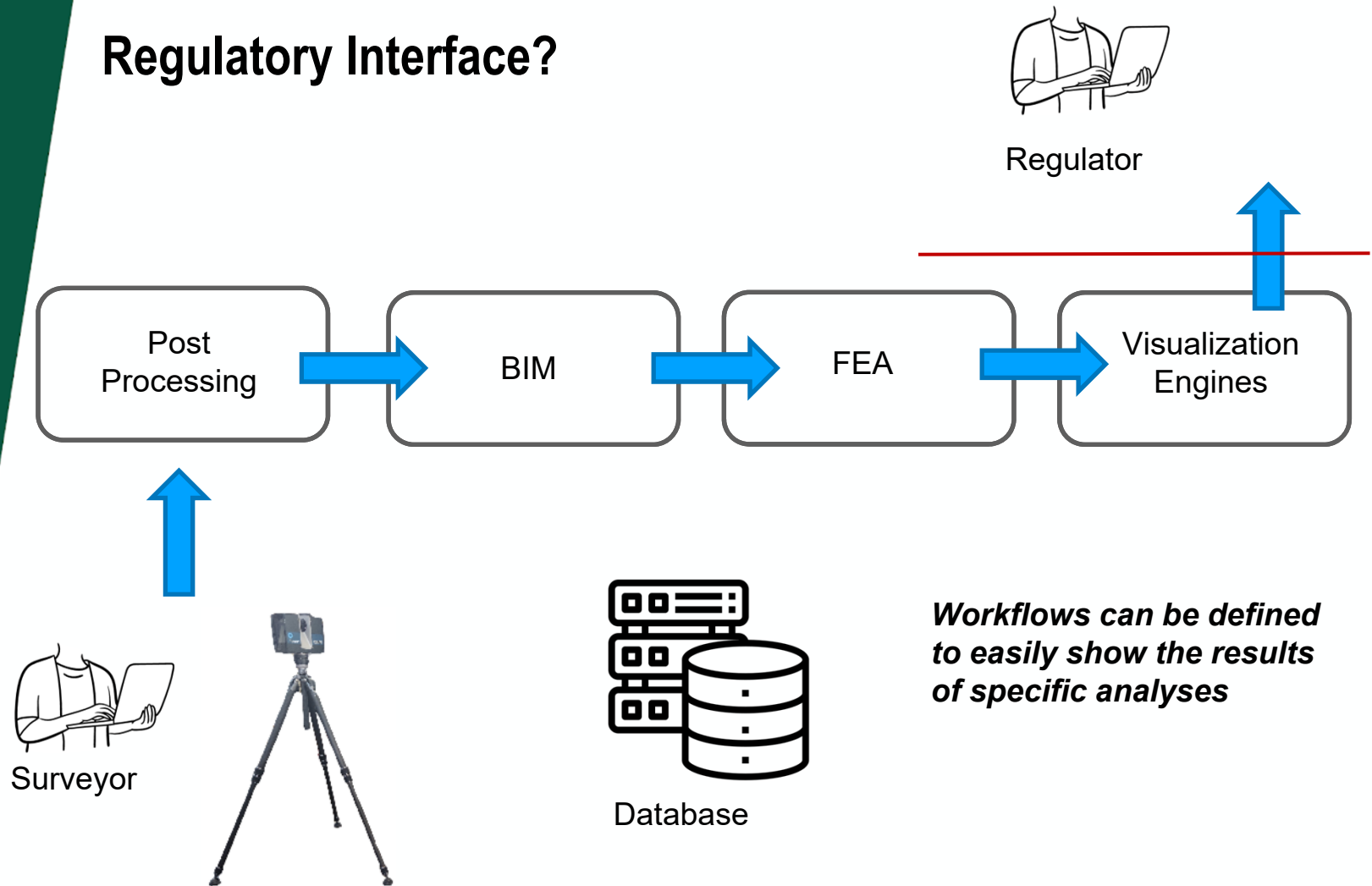




# Semi-Automated Model Updating Via Laser Scan



## Regulatory Interface?





## Gaps to Address

- Behavioral challenges in the industry – trust in data
- ***Rapid*** feature extraction and cleansing of laser scans and approaches for seamless integration with construction
- Better understanding of how to fully exploit modularity

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