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

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EPIC

Agenda

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

EPIC Digital Engineering Efforts – Advanced Construction

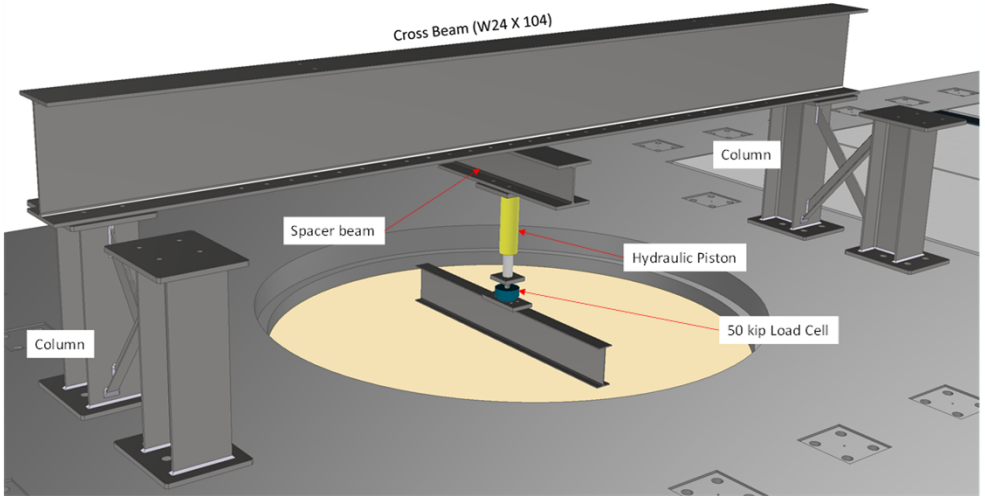
Characterized by:
- All digital design
- Automated component production by supply chain
- Repeatable component dimensions
- Reliable assembly by OEM
- Cost competitive
- High production rates
- Achieved in a regulated environment designed for safety

NRIC National Reactor Innovation Center

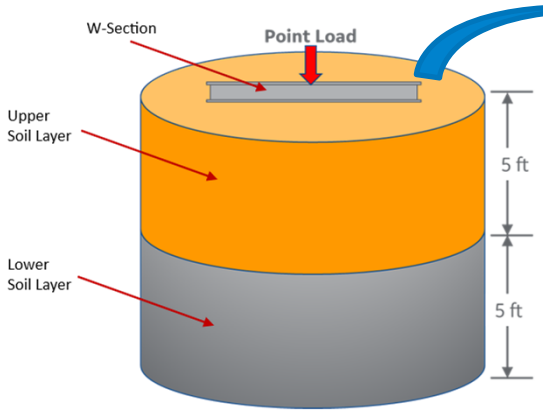
Characterized by:
- Single design (no two airports alike)
- Local fabrication
- No complete digital design
- Diminishing supply chain

What Constitutes a Digital Twin?

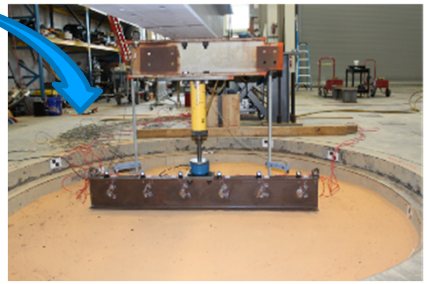
Is this a "Twin"?

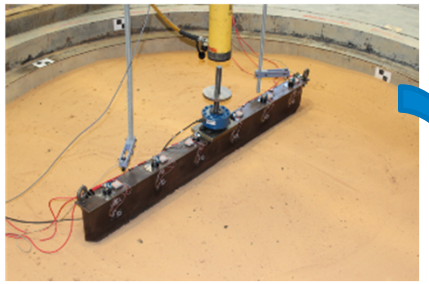


Soil Conditions Modeled



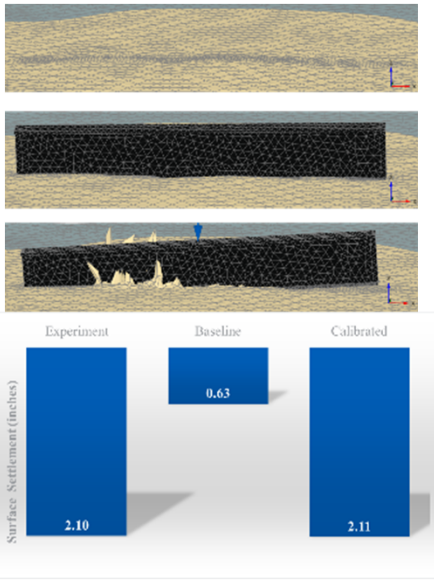
System Loaded in The Lab



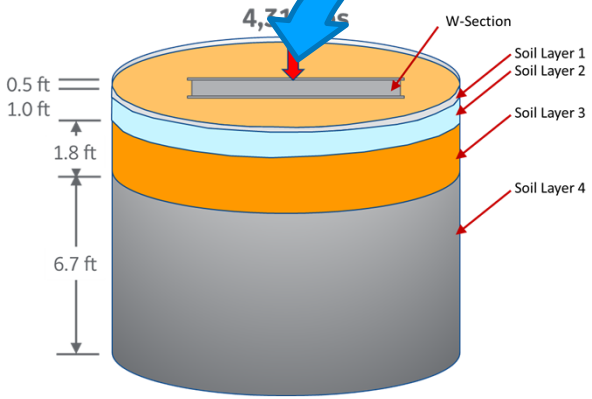


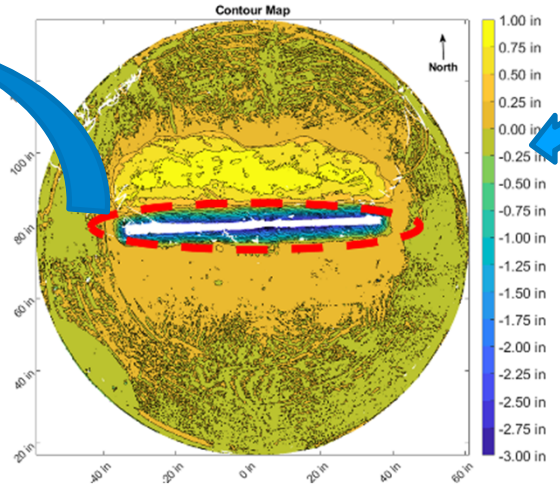
Model & Predictions Don't Agree!

Settlement Measured



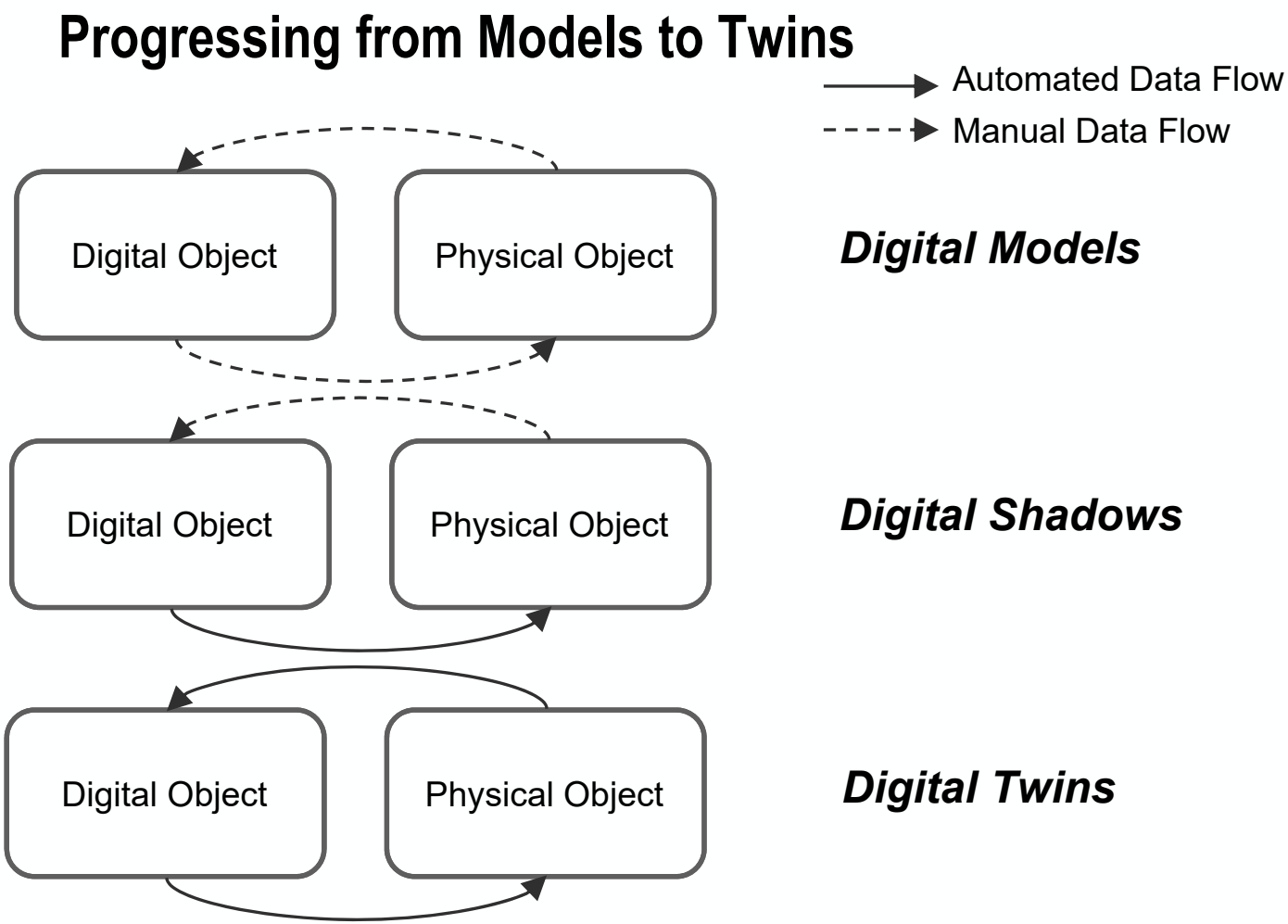
Soil Model Updated



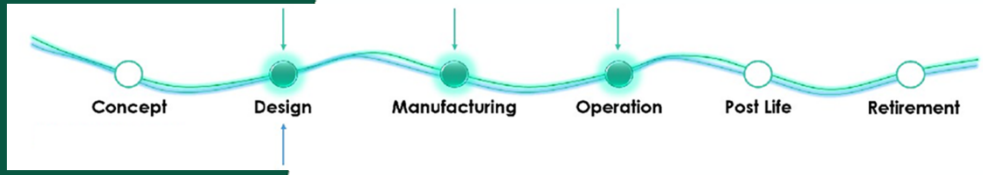


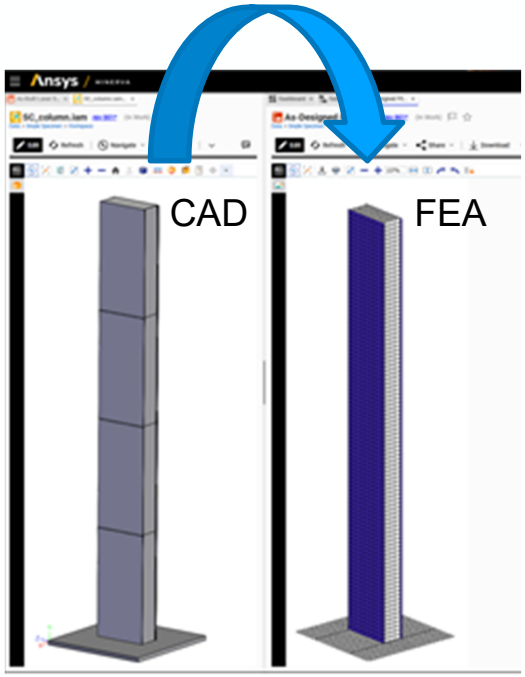
Is this calibrated model a "Twin"?

Progressing from Models to Twins



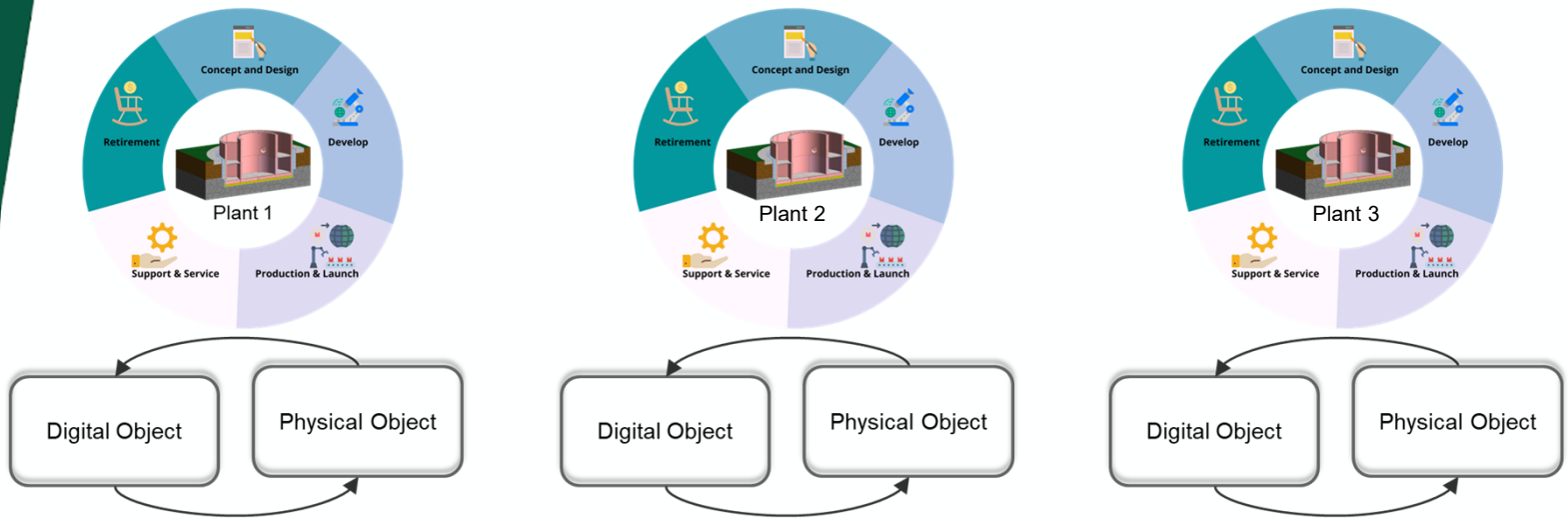
Advancing PLM Using Digital Thread





- 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

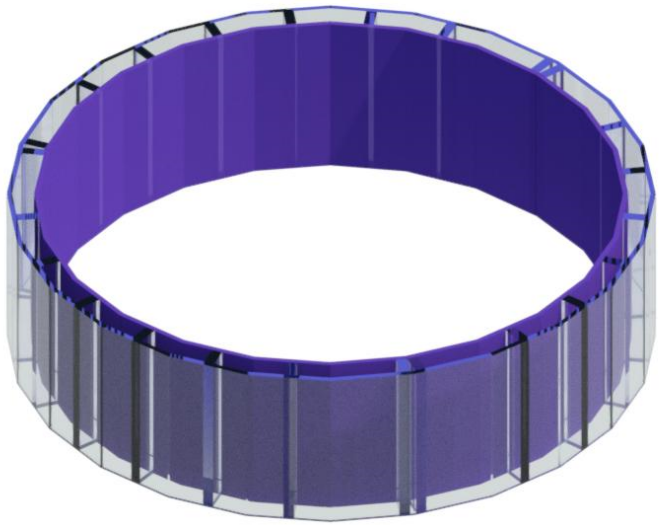
Digital Twin Utilizes PLM For Each Individual System



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

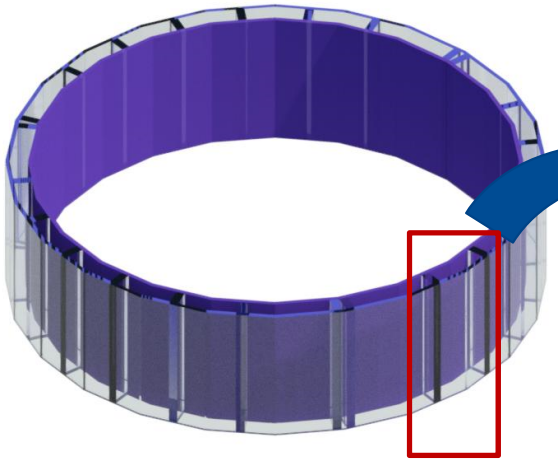
Lessons Learned & Emerging Opportunities

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

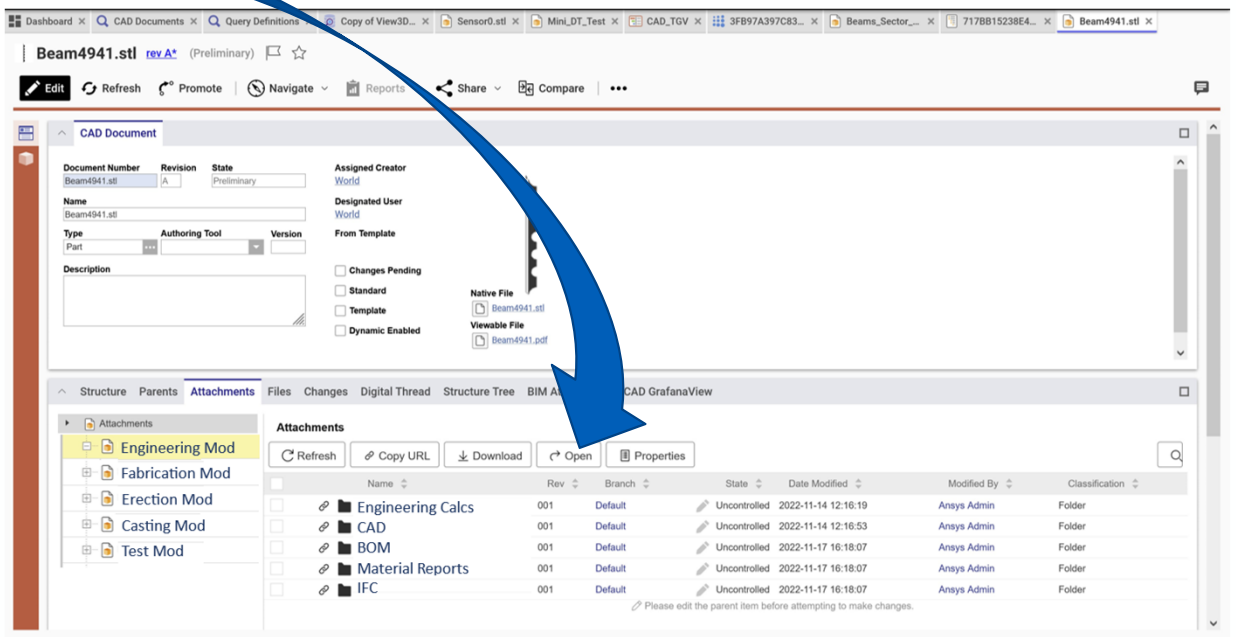


Managing Tolerance as Modules are Placed

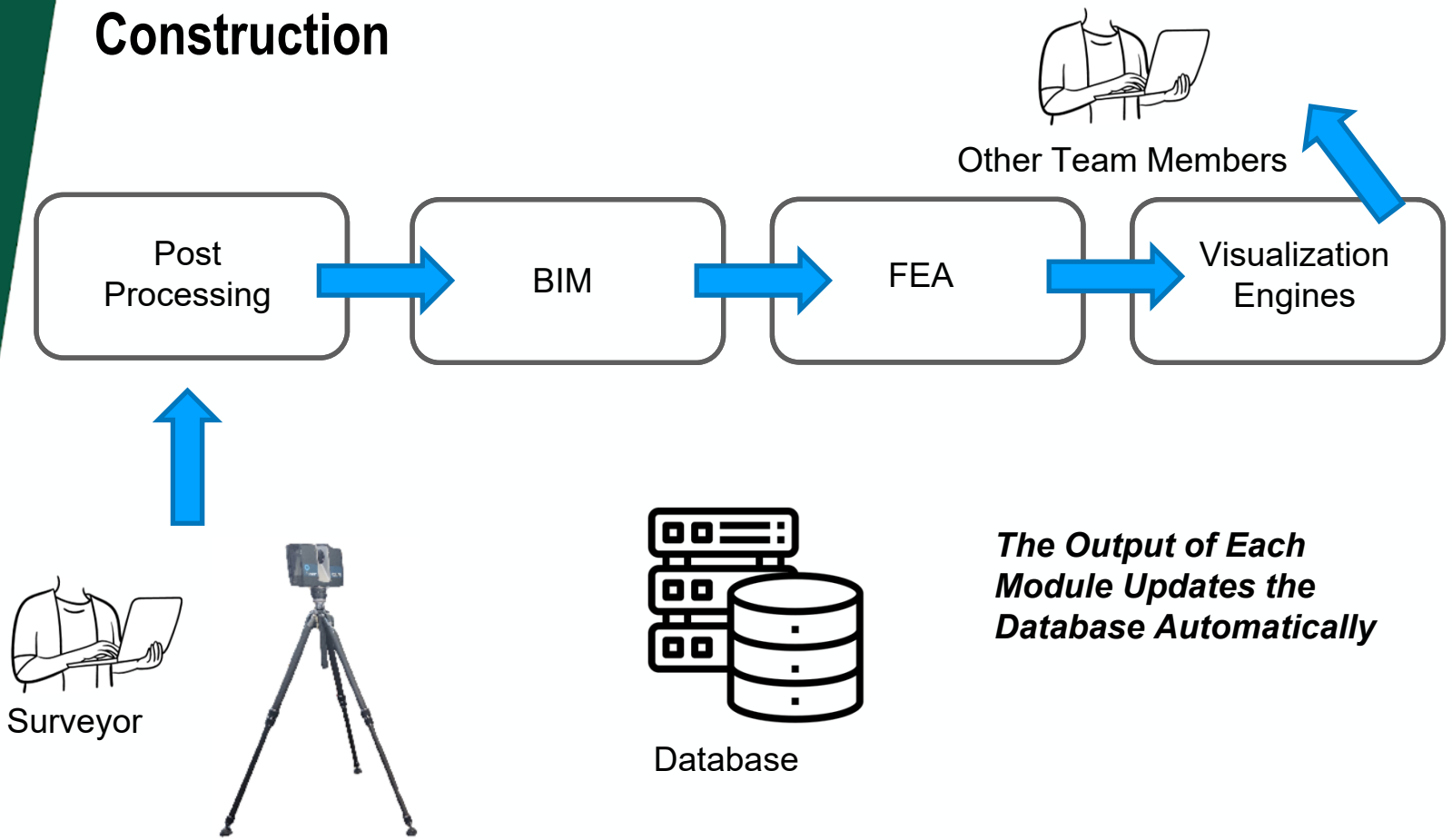
Dynamic Product Navigation Enabled By BIM



Users can drill down on available data as desired

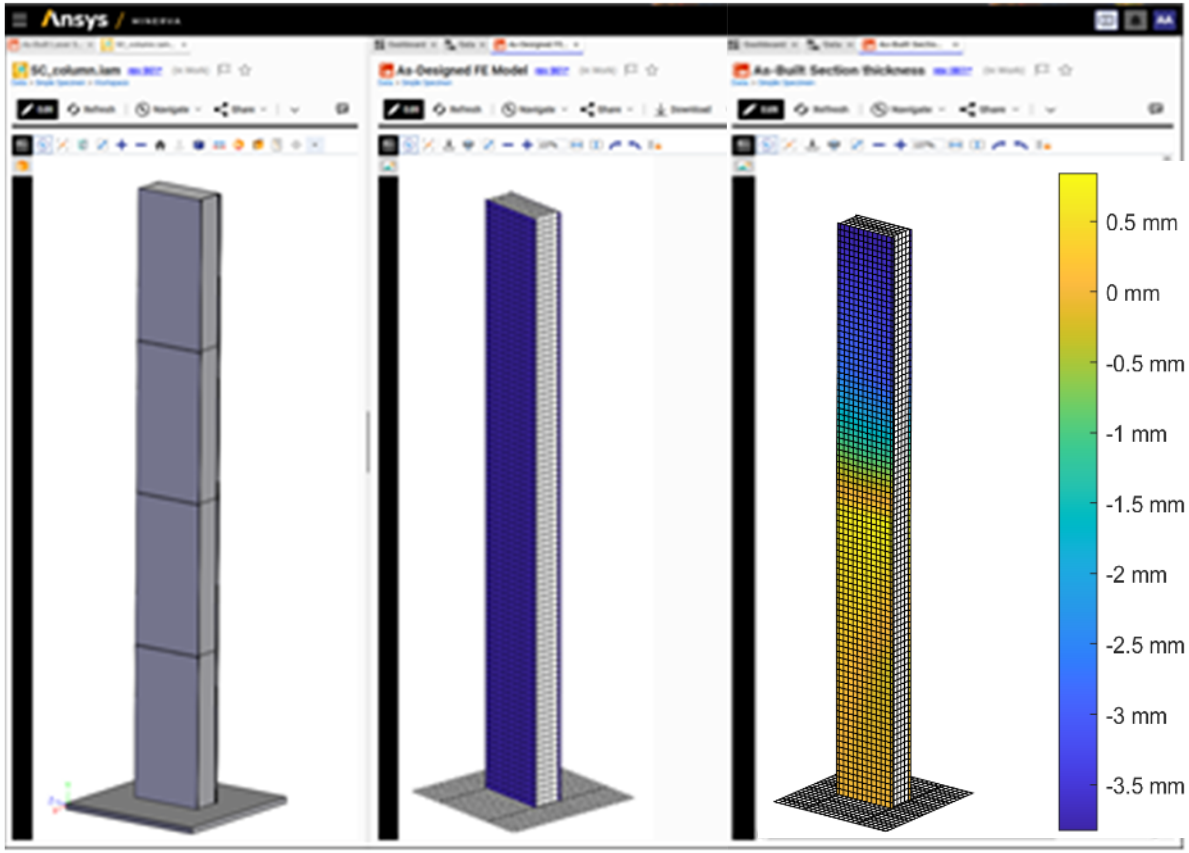


Example Benefit of the Single Source of Truth in Construction



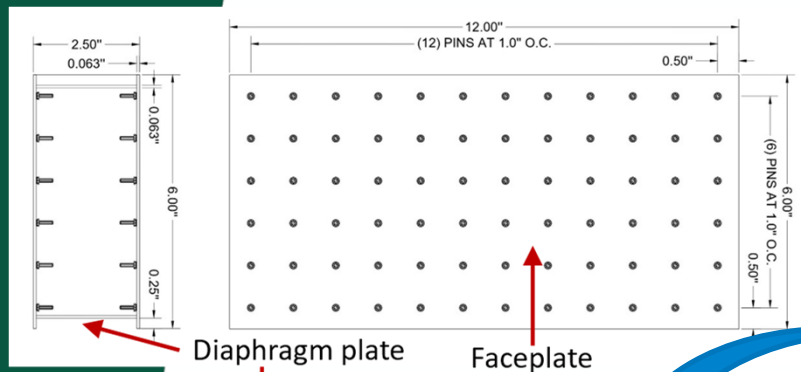
The Output of Each Module Updates the Database Automatically

Towards a Single-Source of Truth



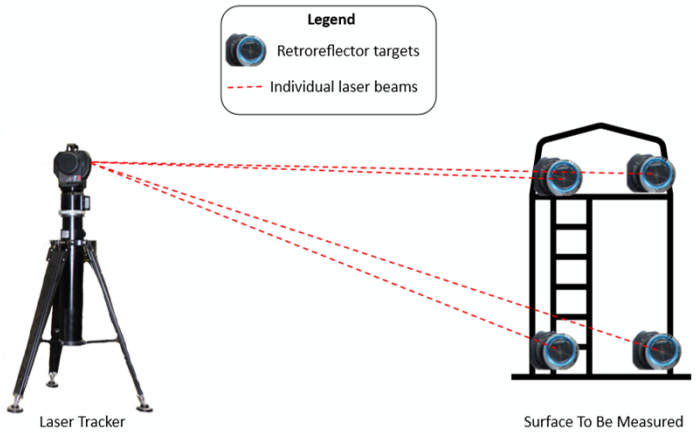
As Designed BIM As Designed FEA As Built BIM

Using a Single-Source of Truth

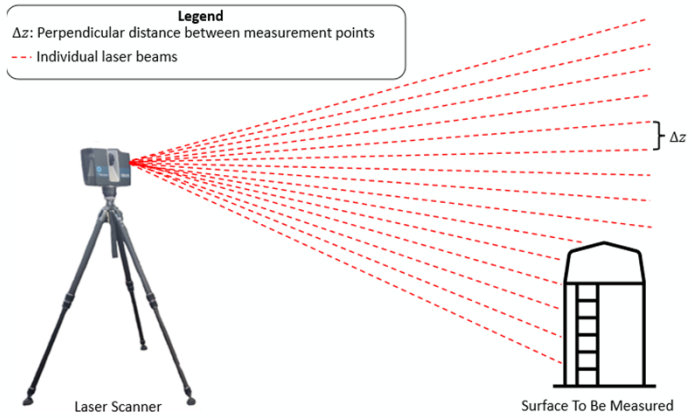


Name	Label	Data Type	Data Source [...]
a_a	a	Float	
a_c	c	Float	
a_cad	CAD	Item	CAD
a_crosssectional...	Cross Sec. Area	Float	
a_d	d	Float	
a_e	e	Float	
a_grossarea	Gross Area	Float	
a_grosssurfacear...	Gross Surf Area	Float	
a_grossvolume	Gross Volume	Float	
a_grossweight	Gross Weight	Float	
a_id	ID	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	

Today's Technologies: Scans & Tracking

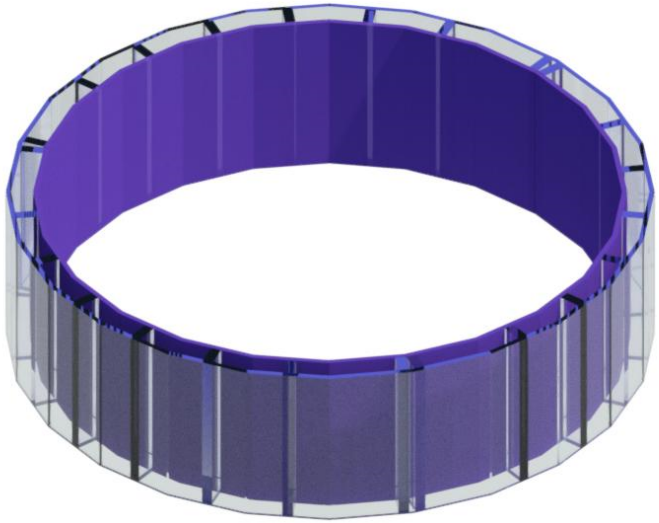


- Tracks locations of individual points with high accuracy
- Low resolution
- Updates geometry quickly in the field

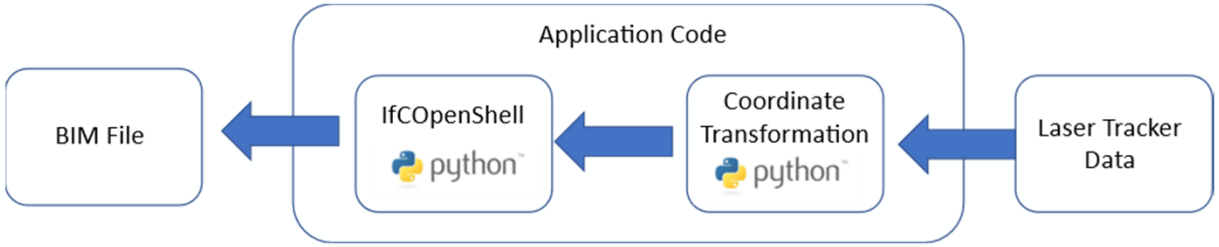


- Creates dense point cloud to profile the surface contour of an object
- High resolution
- High processing time
- Often requires manual intervention

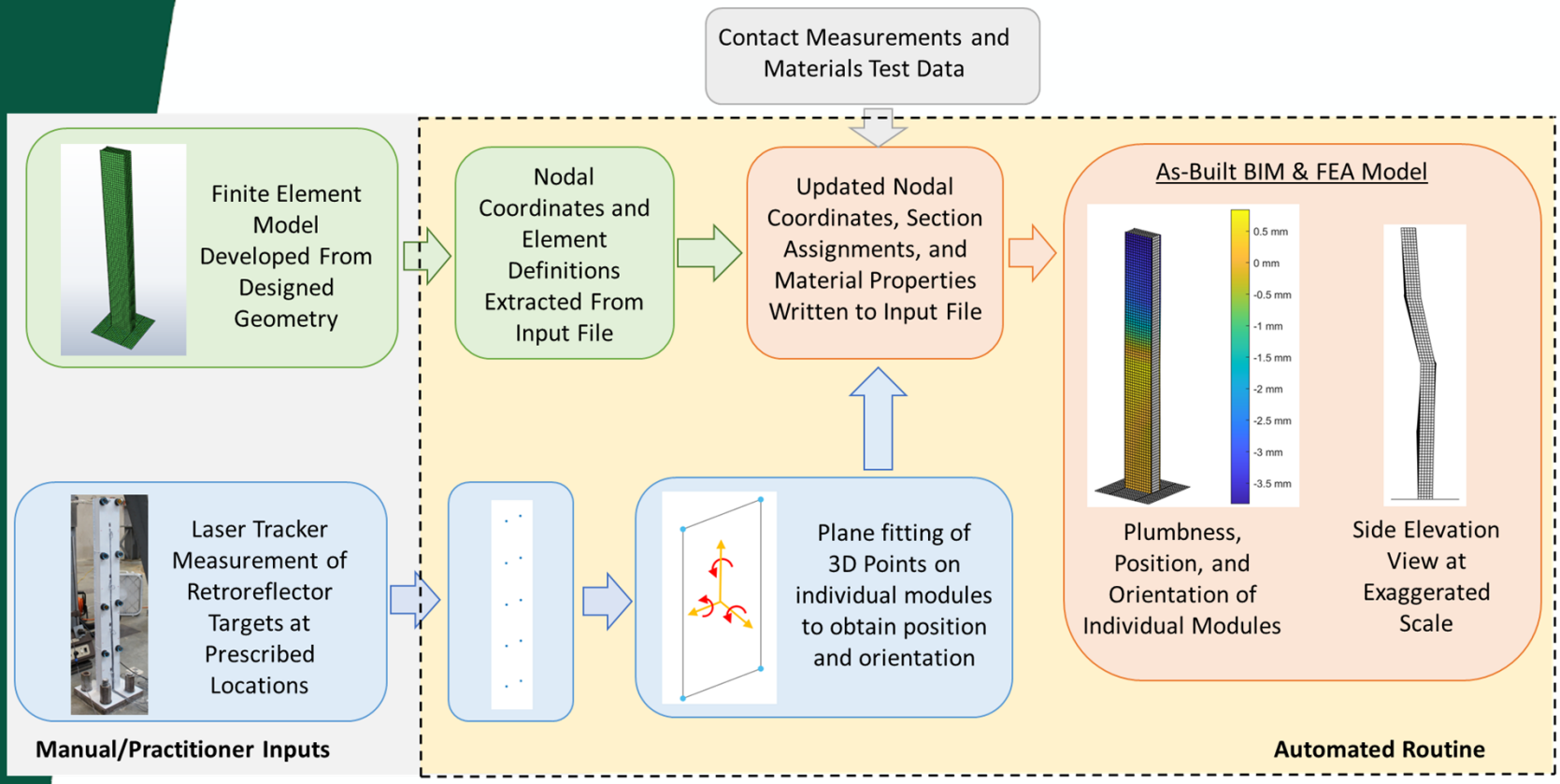
Laboratory Example: Tolerance Management



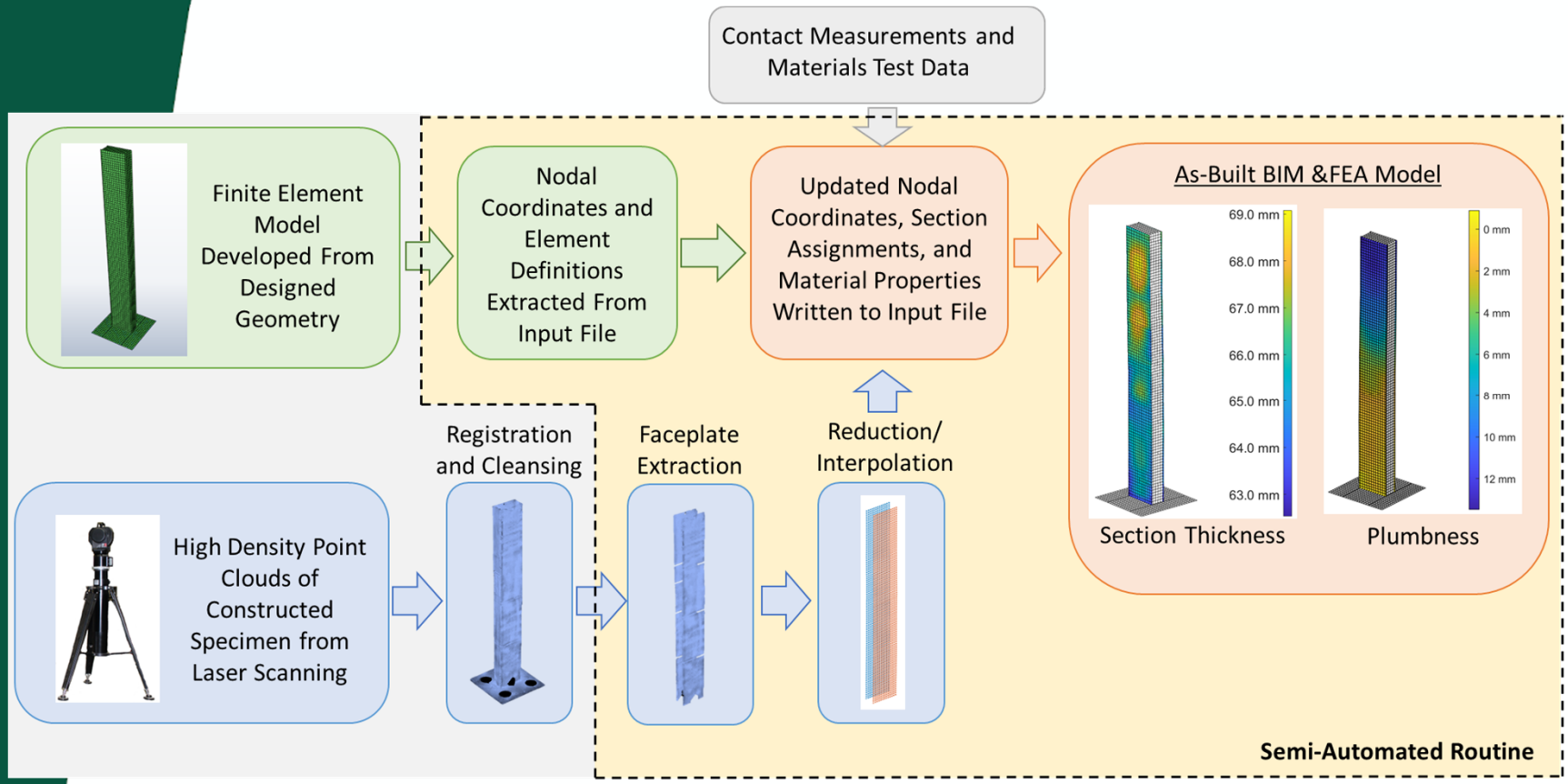
Managing Tolerance as Modules are Placed



Automated Model Updating Via Laser Tracker

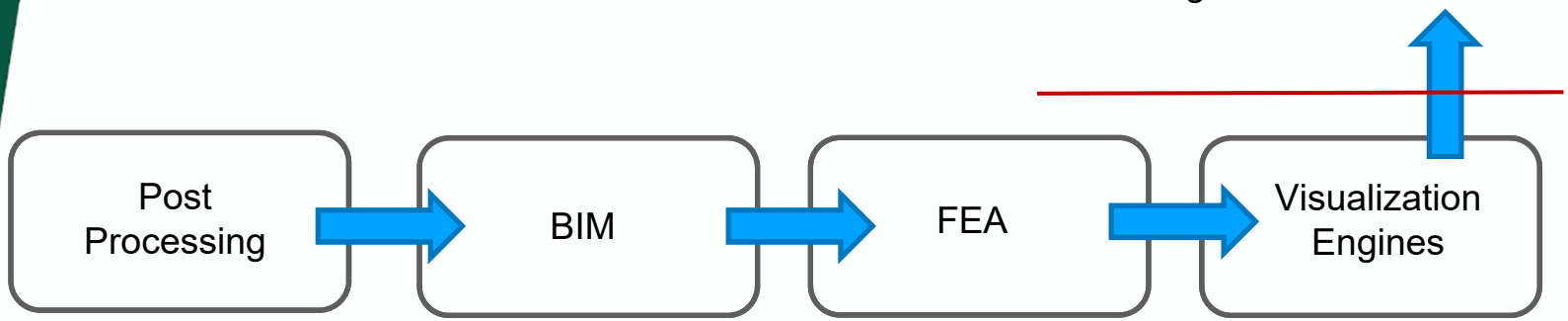


Semi-Automated Model Updating Via Laser Scan



Regulatory Interface?

Regulator



Surveyor

Database

Workflows can be defined to easily show the results of specific analyses

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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