A complex wireframe model of a bridge structure, featuring multiple arches and a central tower, rendered in a light gray color against a white background. The structure is composed of numerous interconnected lines forming a mesh of triangles and quadrilaterals.

Model-centered Bridge Design: Combine Inventor, Revit, and Infracore in Real Projects

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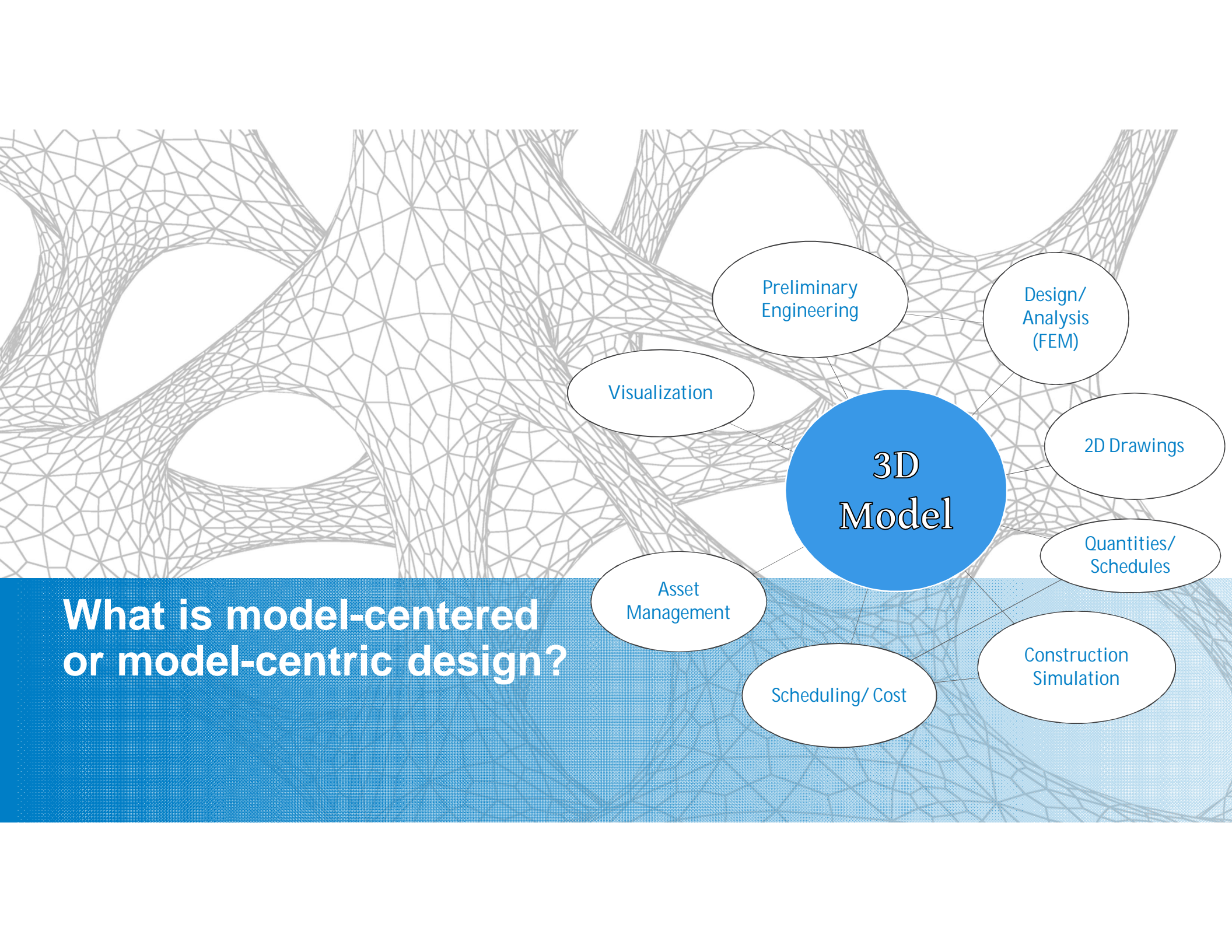
CAD Applications Manager, Gannett Fleming, Inc.

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Learning Objectives

1. Explain how bridge design workflows can be improved with a model-centric approach
2. Use Inventor as a platform to generate bridge geometry and parametric components
3. Export concrete elements into Revit and reinforce using Rebar tools
4. Integrate additional tools such as Robot Structural Analysis and Infraworks to enhance the process



What is model-centered or model-centric design?

3D Model

Preliminary Engineering

Design/Analysis (FEM)

2D Drawings

Quantities/Schedules

Construction Simulation

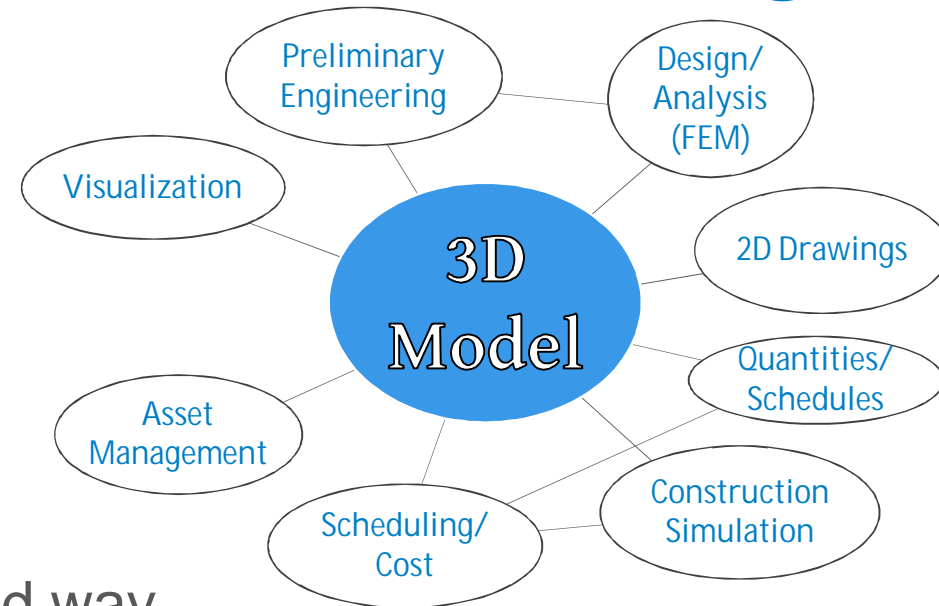
Scheduling/Cost

Asset Management

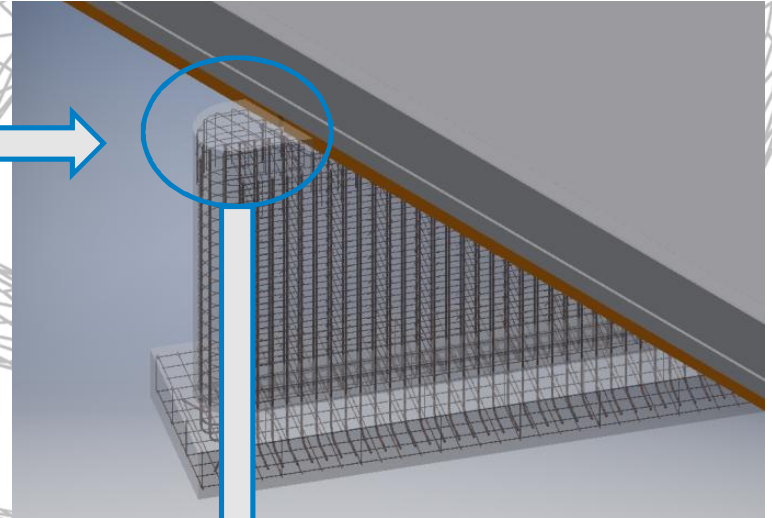
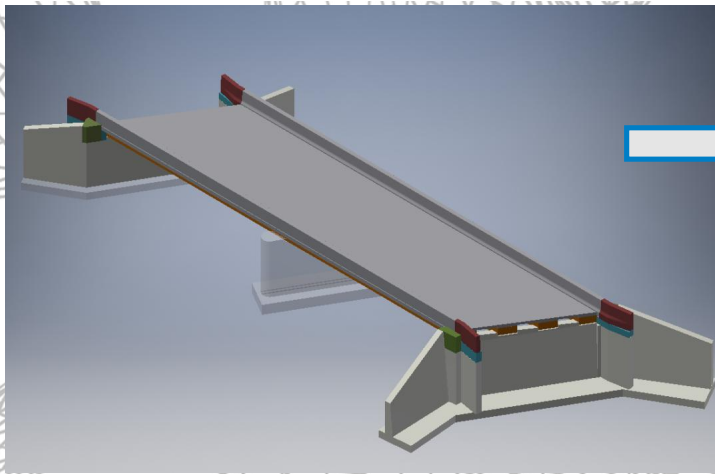
Visualization

What is model-centered or model-centric design?

- Not a new idea
- Used in many industries for years – including vertical construction
- Bridge has specific challenges...
 - Complex geometry
 - Highly standardized – not in the good way
 - Software industry is fragmented

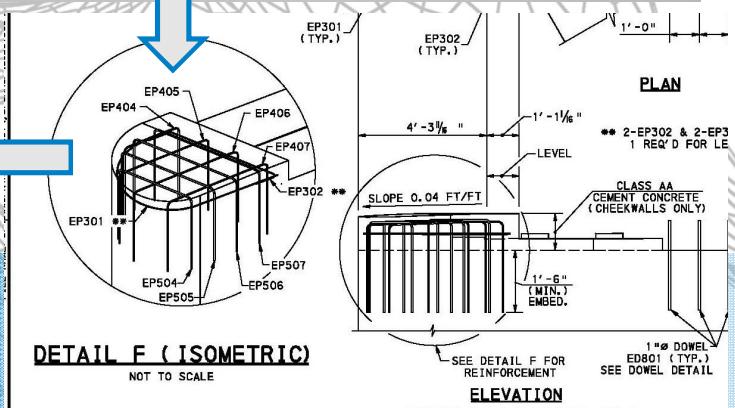


Source: Autodesk.com



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MARK	SIZE	NUMBER	LENGTH	TYPE	A	B	C	D	E	F/R	G	H	J	K	REMARK
EF401	4	48	2'-10 3/4"	T9	4 1/2"	2'-1 3/4"					4 1/2"				
EF501	5	90	8'-6"	STR											
EF502	5	20	43'-8"	STR											
EF1101	11	116	17'-8"	17		2'-0"	15'-8"	-							
EP301	3	3	9'-10"	10	1'-0"	5'-9"	3'-1"			1'-10"					
EP302	3	3	5'-11"	50		10"	4'-2 3/4"	10 1/4"				5"			
EP401	4	38	8'-9"	T18	4 1/2"	5'-6 3/4"				3'-6"	4 1/2"	3"		3'-9"	
EP402	4	38	39'-2"	T12	4 1/2"	38'-5"					4 1/2"				
EP403	4	342	4'-3"	T9	4 1/2"	3'-6"					4 1/2"				
EP404	4	2	8'-1 1/2"	17		3'-3"	2'-1 1/2"	3'-3"							
EP405	4	2	9'-1 1/2"	17		3'-3"	3'-5 1/2"	3'-3"							
EP406	4	2	10'-6 1/2"	17		3'-3"	4'-0 1/2"	3'-3"							
EP407	4	2	10'-4"	17		3'-3"	3'-10"	3'-3"							
EP408	4	40	7'-7"	17		2'-1"	3'-5"	2'-1"							

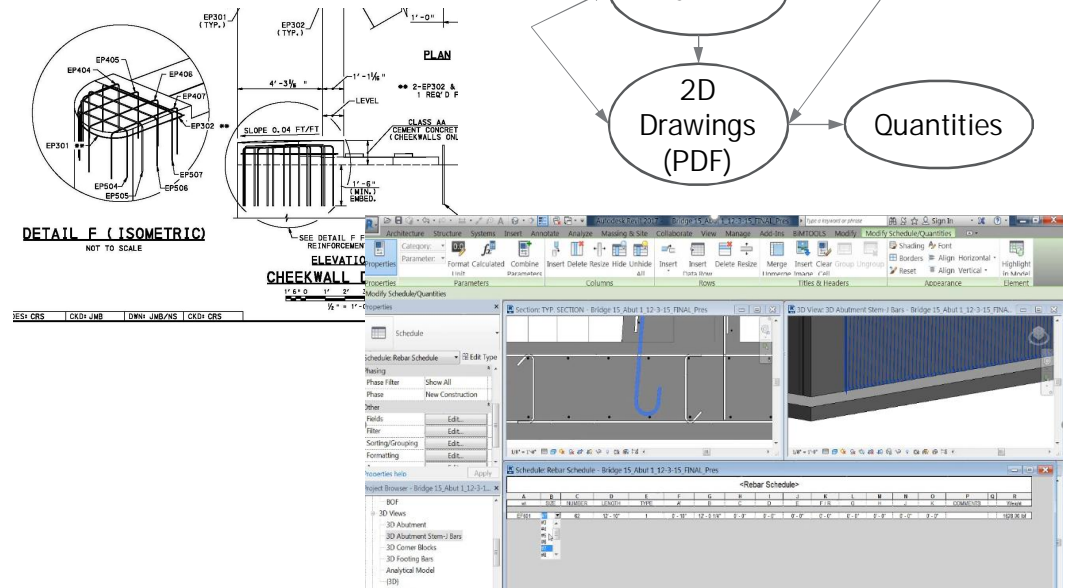
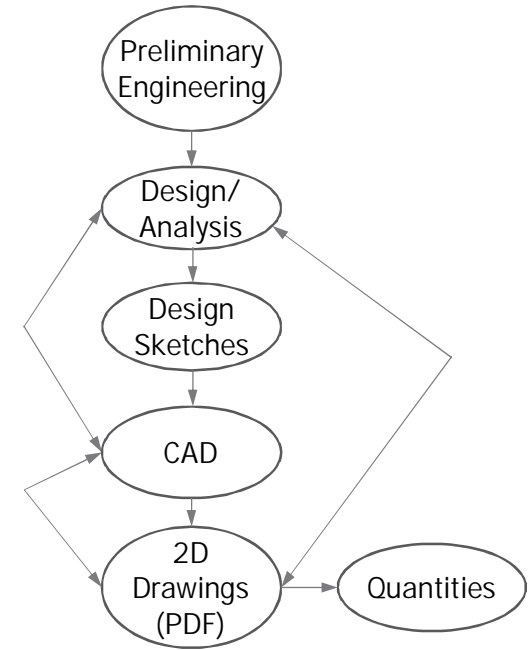


How can workflows be improved using this process?

How can workflows be improved

- Single source of truth
- Ability to respond to changes
- Automation of quantities
- Generation of 2D plans
- Semi-automation of schedules
- Visualizations

Traditional Workflow



Create
Parametric
Solids

Reinforce
Solids

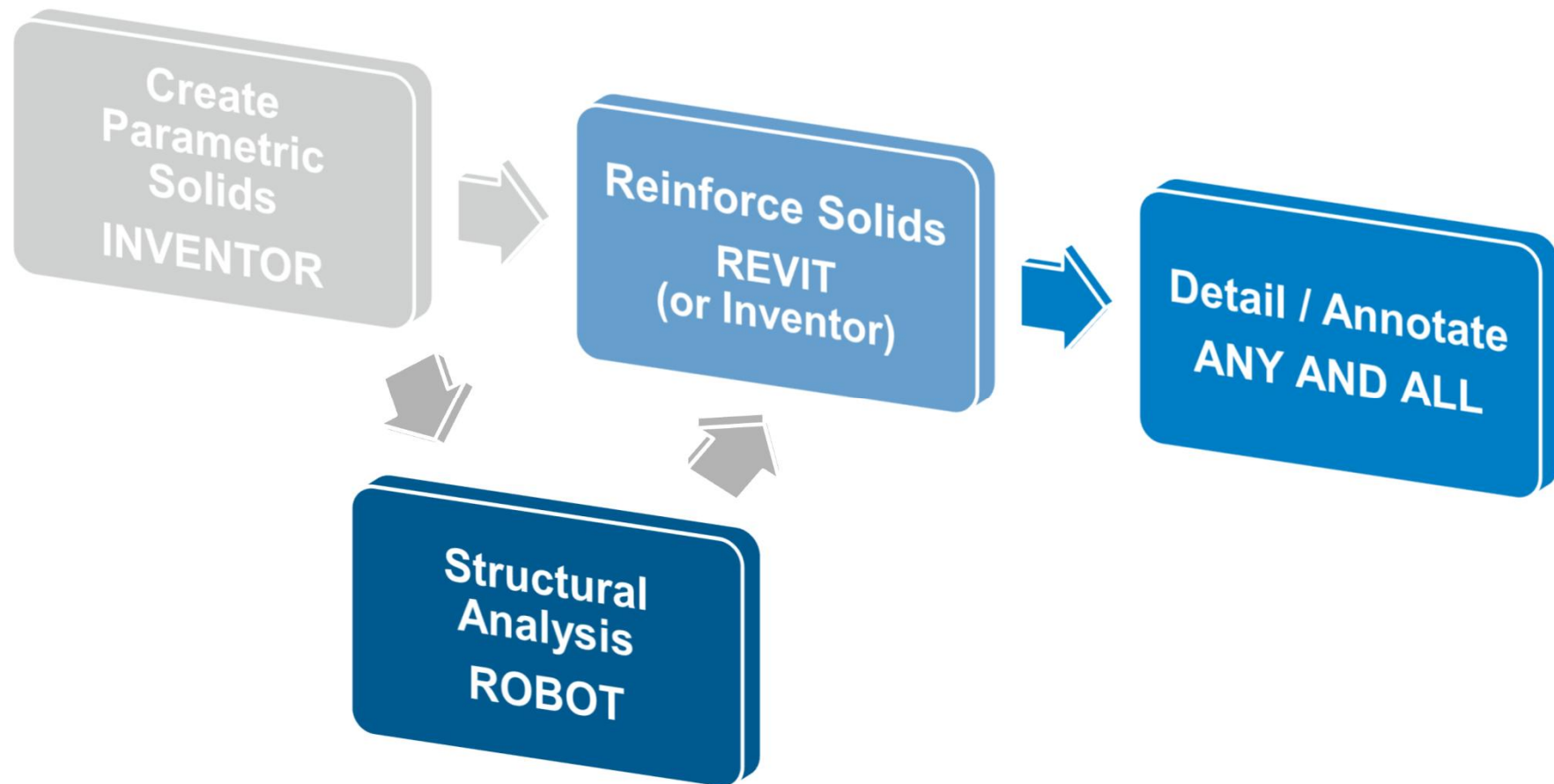
Detail /
Annotate

Structural
Analysis

Workflow with examples of real projects

Scalability and Interoperability

General workflow



The background features a complex, three-dimensional wireframe mesh structure. The mesh is composed of numerous interconnected lines forming a series of interconnected, rounded, and elongated shapes that resemble a molecular or crystalline lattice. The lines are thin and light gray, set against a plain white background. At the bottom of the image, there is a solid blue horizontal bar with a fine, dotted texture. The text 'Inventor intro and live demo' is written in white, bold, sans-serif font across the left side of this bar.

Inventor intro and live demo

Why Inventor ?

- It met our list of goals, capability to create a robust and fully accurate 3D model with the ability to:
 - Define and model the EXACT geometry of the structure(s)
 - Define and update the model parametrically
 - Drive geometry via tabular input where appropriate
 - Define and use recognizable names for variables
 - Create automated tools and functions

Why Inventor ?

- (cont'd) Ability to:
 - Perform analysis and simulation on the geometry
 - Generate bill of materials tabulations
 - Create deliverables / construction documents
 - Create real 3D model content, not schematics or view dependent 2D
- In short – it gave us a tool to create our own bridge modeling application.

Inventor Workflow

- Part Files
 - 2D Sketches / 3D Sketches
 - 3D Surface Bodies / 3D Solid Bodies
 - Work Geometry / iMates
 - Parameters
- Define/Create content once and then reference/share it elsewhere.
 - Can share all the above with other Part Files

Inventor Workflow

- Assembly Files
 - Can “assemble” one or more Part Files
 - Can “assemble” one or more Assembly Files
 - Ability to constrain part and assembly files to model the way they would behave relative to each other in the real-world.

Inventor Content Sharing

- Divide project up into components
- Determine where parameters will be placed and how they will be shared amongst the components.
- Determine where sketches will be placed and how they will be shared amongst the components.
- Determine where bodies will be placed and how they will be shared amongst the components.
- Circular paths are not allowable

Inventor Content Sharing

INVENTOR
FIGURE 1

ALIGNMENT
GEOMETRY

BRIDGE
GEOMETRY

ABUTMENT
#1

SPAN
#1

PIER
#1

SPAN
#2

ABUTMENT
#2

BEAMS
SPAN #1

BEAMS
SPAN #2

APPROACH
SLAB - NEAR

DECK

APPROACH
SLAB - FAR

SITE

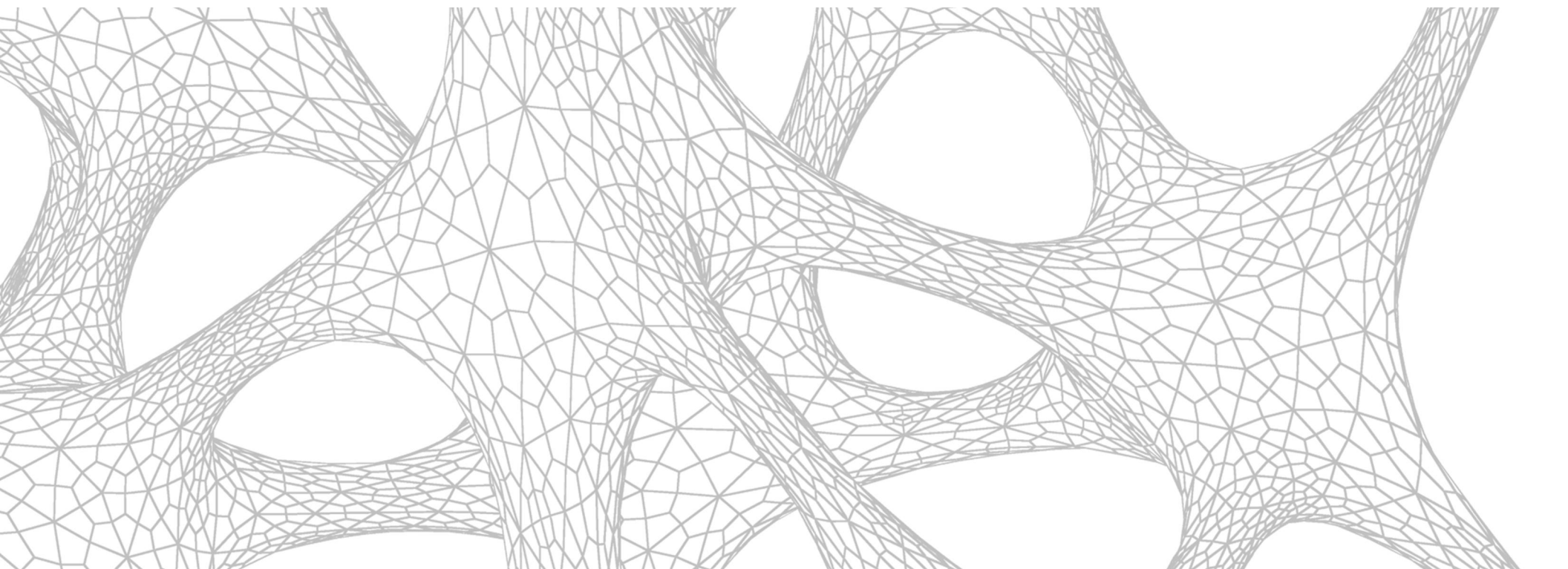
BRIDGE

Inventor Parameters

- Parameters can be used to store or calculate values which can be used to define geometry.
- **User** Parameters – User created and populated. Can contain fixed values, formulas, Text, or True-False.
 - Many Algebraic operators can be used in formulas.
- **Reference** Parameters – User created but defined by Inventor as a way to harvest measurements for reuse.
- **Model** Parameters – Values from dimensions and dialog box input fields. If you enter a value in a dialog box – it becomes a model parameter.

Inventor Parameters

- Use Logical names for parameters – BUT – do not make them overly specific as it can make using the current part file as a template for the next project difficult.
- Keep on top of your parameters – Purge unused, duplicate in nature, or orphaned parameters.
- Devise a scalable naming scheme based that will sort in a desirable fashion.
- Parameter names can be revised, but it can be tedious to do so.



Revit live demo



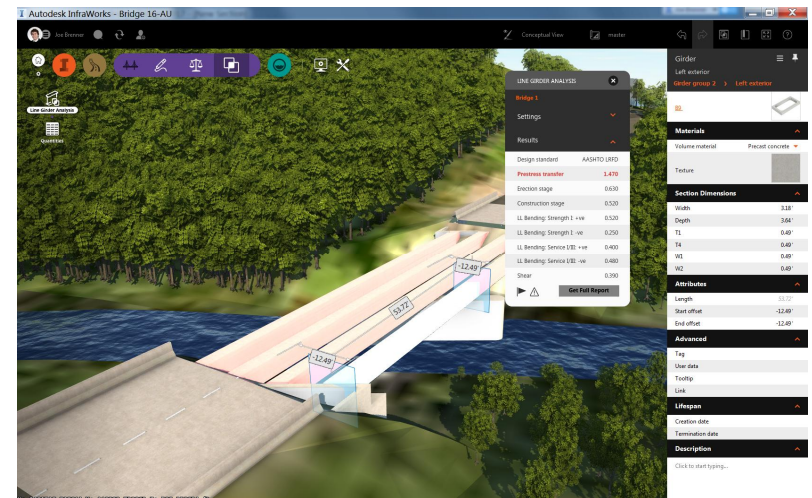
Robot live demo



What we're excited about now...

Infraworks

- Similarities to our developed workflow
- Inventor-based bridge components
- Export link to Revit for reinforcing and details
- Line girder analysis built-in and export to Structural Bridge Designer
- Still have all the visualization benefits but with enhanced bridge capabilities



The background features a complex, three-dimensional wireframe mesh structure. The mesh is composed of numerous interconnected lines forming a series of interconnected, rounded, and elongated shapes that resemble a network or a series of interconnected tubes. The lines are thin and light gray, creating a sense of depth and complexity. At the bottom of the image, there is a solid blue horizontal bar with a fine, dotted texture. The text "Infraworks live demo" is positioned on the left side of this bar.

Infraworks live demo

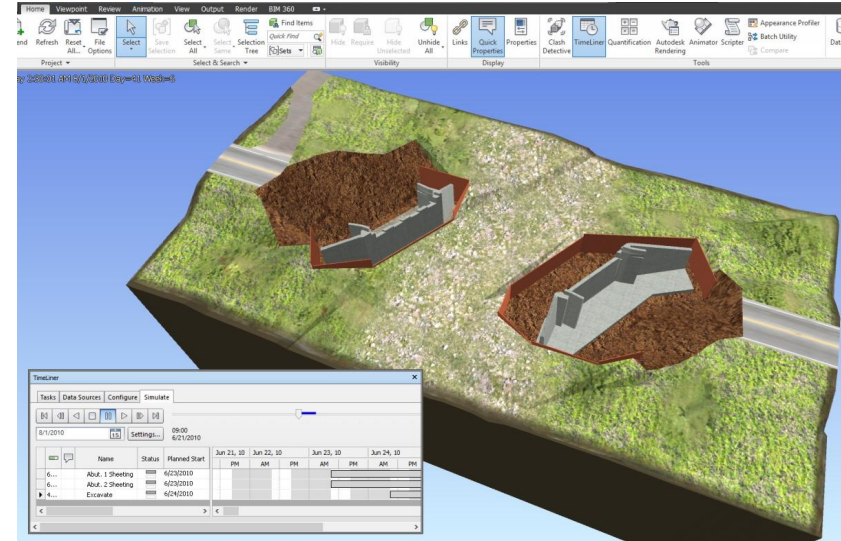


Why are we doing this?

Why are we doing this?

- It is not only about innovation
- It is not a perfect process
- It is not an easy solution...
but it is a better solution

- Tools are improving
- More and more interest
- Bottom line: it makes us better engineers





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