Connected BIM for Structures

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The slide deck that is used in the class at Autodesk University 2018, contains a lot of video material. Due to file size restrictions, the original powerpoint can not be uploaded to the class materials.
You can find a full version of this powerpoint, including video material on this link:

https://www.dropbox.com/s/q8a697n2exgfko9/BES224257%20-%20Connected%20BIM%20for%20Structures.pptx?dl=0

About us: Dieter Vermeulen

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AU Online Profile

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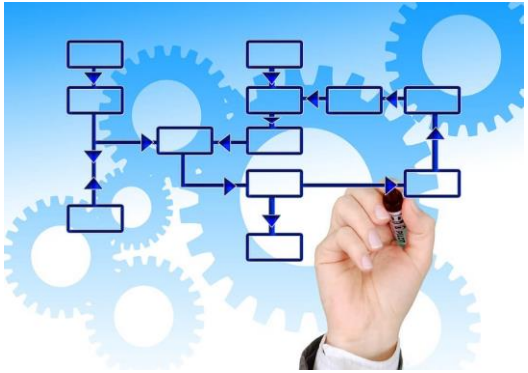
AU Online Profile

Key Learning Objectives

After this class you will be able to...

- position the products in the AEC Collection with each BIM Project Lifecycle phase
- understand efficient workflows from design to analysis to fabrication
- choose the right tool for the integration of design and data between each engineering BIM phase
- understand how BIM360 Design and Document Management helps the digitization process



Connected BIM

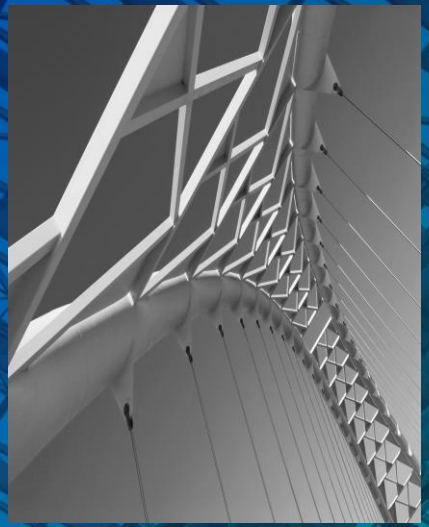
Industry Challenges

Structures.
Why Important for AEC?

- **Most** critical part of building design for ensuring occupant safety
- **10%** of construction costs are for structure
- **1st** on site to build foundations and building core, setting overall schedule
- **14+** “structural” materials used on projects
- **Offsite/prefab** is a growing opportunity WW with precast and timber

Source: McGraw Hill Smart Market Report, World Economic Forum, Statistica, ENR

Challenges for Structural Industry



Increasing project complexity

Disconnection between design and detailing

Great diversity in structural materials and methods

Material waste and delays on the jobsite

Industry Change and Opportunity

ENGINEERS

TRADE CONTRACTORS

DETAILING & FABRICATION

EXTENSION OF SERVICES

EXTENSION OF SERVICES

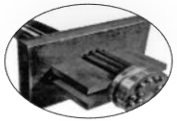
Common structural “material types”

Foundations

Concrete Formwork

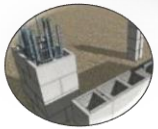
Concrete Rebar

Concrete Mix



Stressing Tendons

Precast Concrete



Concrete Masonry

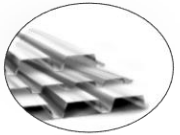
Structural Steel

Interior Stud Walls

Metal Buildings

Steel Joists

Metal Deck

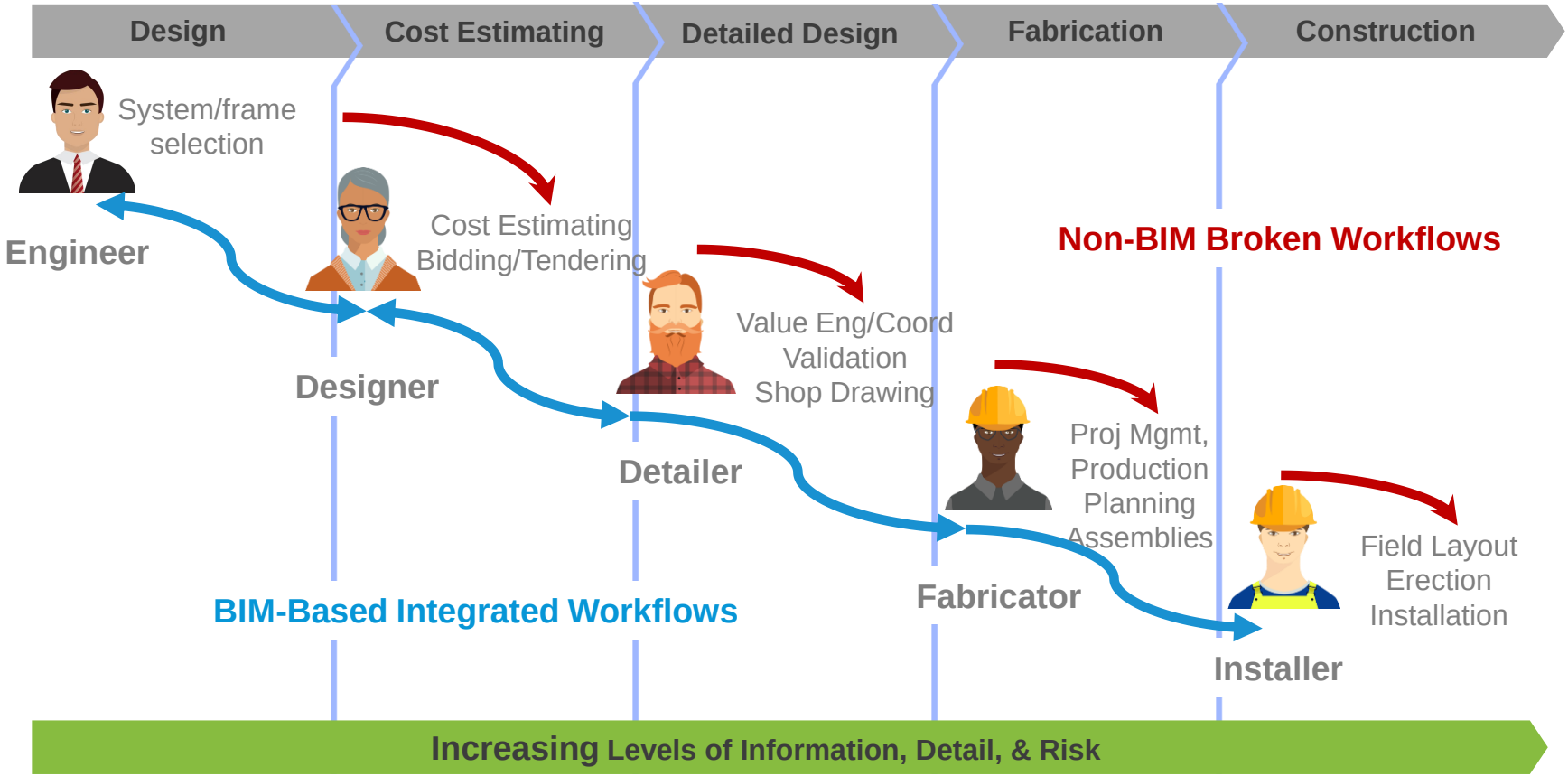


Cold-formed Steel

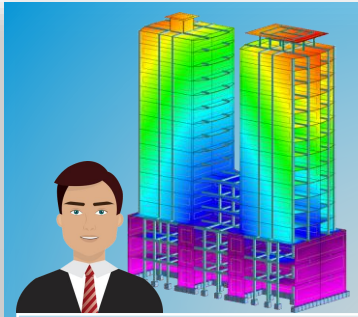
Timber

Structural Personas

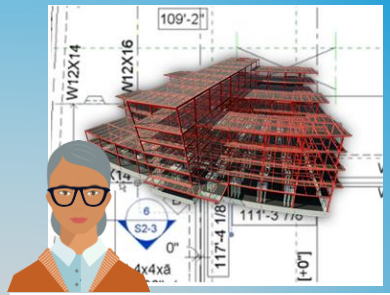
Structure Industry Workflows & Personas



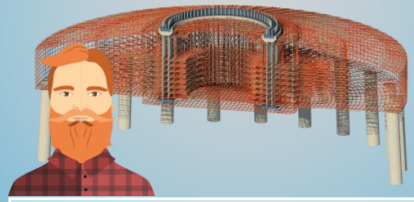
Structural Industry Personas



Structural Engineers

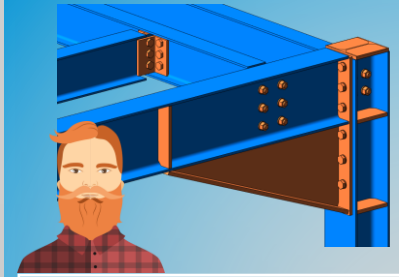


Structural Designers

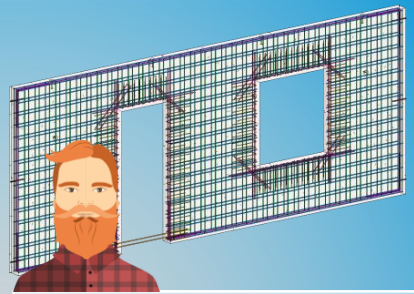


Rebar Detailers

Engineering Service Providers
Design, Analysis & Detailing



Steel Detailers



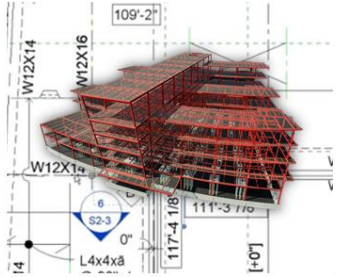
Precast Detailers

Fabricators

Building Products Manufacturing
Detailing & Fabrication

Persona: Structural Designer

Collaborates tightly with the Engineer



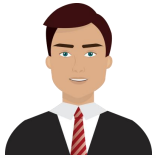
Needs to deliver

- ❑ Structural system concept
- ❑ Design of the structural layout
- ❑ Detailing the structure
- ❑ Documentation drawings of the structure
- ❑ Material Take-Offs of the structure

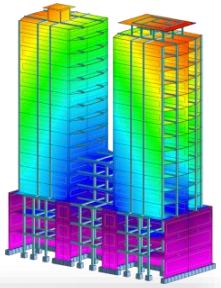
Struggles with

- ❑ Being in between different design disciplines
- ❑ Rework due to changes by other disciplines
- ❑ Collaboration with other stakeholders
- ❑ Different construction methods for structures
- ❑ Inaccuracies of MTOs in CAD environment
- ❑ Creation of MTOs on time

Persona: Structural Engineer



Communicates with the Designer and Detailer



Needs to deliver

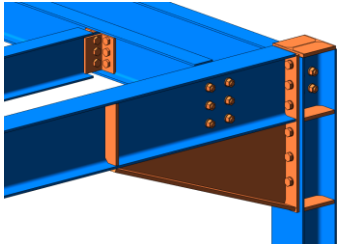
- ❑ Verification of the structural layout
- ❑ Analysis of the structure
- ❑ Sizing of the structural elements
- ❑ Preliminary design of critical steel connections
- ❑ Definition of required concrete reinforcement
- ❑ Checks performance against local codes

Struggles with

- ❑ Project complexity
- ❑ The use of disparate tools
- ❑ Non-integrated workflows
- ❑ Inefficient review methods
- ❑ Sharing designs with architects & fabricators

Persona: Structural Steel Detailer

Employed mostly by the fabricator



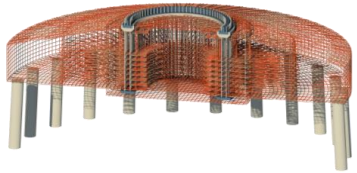
Needs to deliver

- ❑ Increase of the LOD of the structural model
- ❑ Single part drawings
- ❑ Assembly drawings for structures
- ❑ Structure erection drawings
- ❑ Optimized workshop deliverables
- ❑ Bill of Materials

Struggles with

- ❑ Using the design model
- ❑ Training staff on highly specialized tools
- ❑ Repetitive tasks / Automation
- ❑ Rework due to non-integrated solutions
- ❑ Lack of digital information

Persona: Structural Rebar Detailer



Gets input from the structural engineer

Needs to deliver

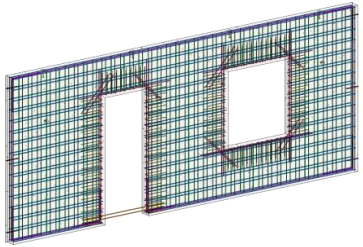
- ❑ Increase of the LOD of the structural model
- ❑ Optimized workshop deliverables
- ❑ Concrete formwork drawings
- ❑ Reinforcement drawings
- ❑ Rebar bending schedules
- ❑ Bill of Materials

Struggles with

- ❑ Using the design model
- ❑ Repetitive tasks / Automation
- ❑ Rework due to changes
- ❑ Lack of digital information
- ❑ Inaccurate metrics for BOM creation

Persona: Structural Precast Detailer

Employed mostly by the BPM



Needs to deliver

- ❑ Increase of the LOD of the structural model
- ❑ Optimized workshop deliverables
- ❑ Assembly drawings for precast elements
- ❑ Concrete formwork drawings
- ❑ Reinforcement drawings
- ❑ Bill of Materials / Bending schedules

Struggles with

- ❑ Non-constructible design model
- ❑ Repetitive tasks / Automation
- ❑ Rework due to non-integrated solutions
- ❑ Lack of digital information

Persona: Fabricator

Gets input from designer/engineer/detailer

Needs to deliver

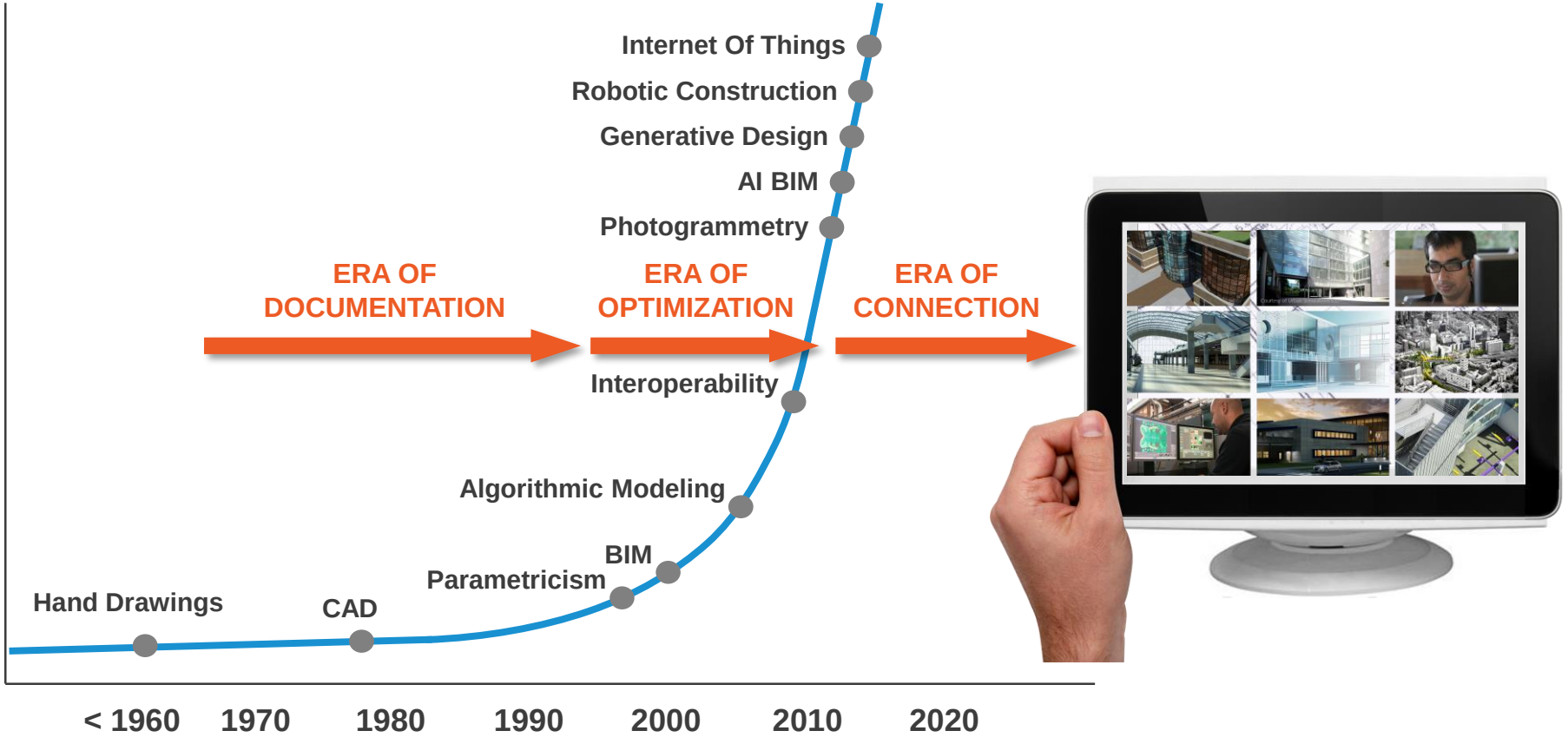
- ❑ Procurement of the structural building
- ❑ BIM fabrication models with a high LOD
- ❑ Fabricated & assembled structural elements
- ❑ Accurate cost calculation of the structure

Struggles with

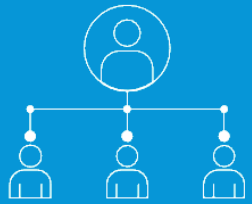
- ❑ Selling design-assist services
- ❑ Process automation
- ❑ Lack of digital data
- ❑ Global competition
- ❑ Accurate estimations for bidding
- ❑ Risk management

Era of Connection

Accelerating Growth in AEC Technology

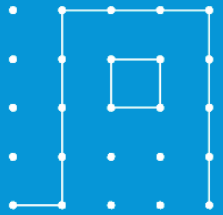


Connected technology



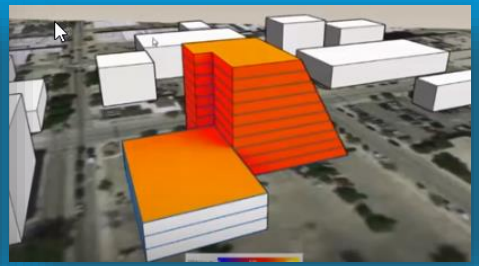
Connecting teams

Connecting insight



Connecting outcomes

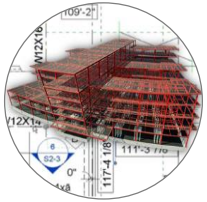
Connecting delivery



Connected BIM
In Practice

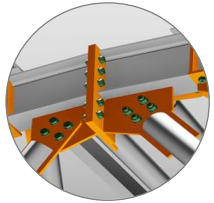
Challenges & Cost Impact in a project lifecycle

Structural Design



- Not engaging early enough in design
- Fab & installation costs not considered in design

Detailing



- Accurate coordination
- Impact of poor design decisions

Fabrication

- Material management and optimization
- Inaccurate bids due to lack of information
- Cost of material wastage & changes

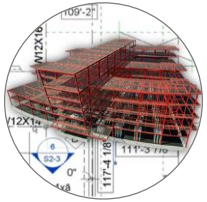
Installation

- Ensure quality field installation
- Poor coordination with other trades
- Owner receives incomplete as-built

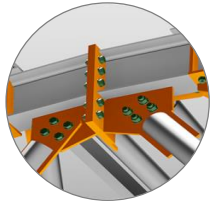
Designer Engineer | Detailer | Fabricator | Contractor

Benefits of BIM enabled workflows

Structural Design



Detailing



Fabrication

Installation

Collaborate in a dynamic environment

Reduce errors in shop fabrication

Extend fabrication to the field

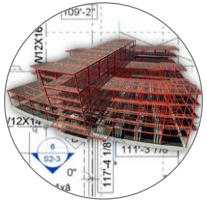
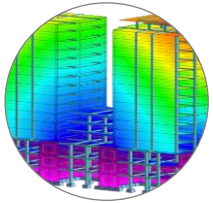
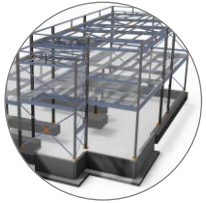
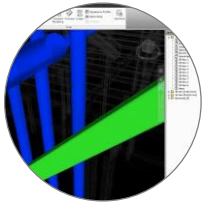
Designer
Engineer

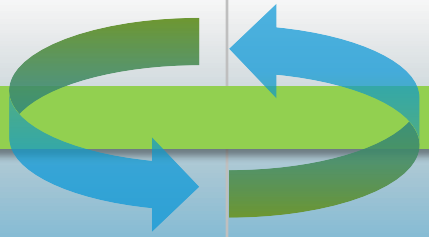
Detailer

Fabricator

Contractor

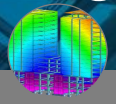
Connecting Design & Construction

Structural Model	Analyze & Verify	Detailing	Fabricate & Install
			



Designer	Engineer	Detailer	Fabricator Contractor

Structural Engineering Portfolio

Structural Model	Analyze & Verify	Detailing	Fabricate & Install

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AUTODESK® BIM 360™ DOCS

Products in the AEC Collection for structural professionals

AUTODESK® REVIT®

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AUTODESK® RECAP™

AUTODESK® ADVANCE STEEL

AUTODESK® ROBOT™ STRUCTURAL ANALYSIS PROFESSIONAL

AUTODESK® AUTOCAD®

AUTODESK® NAVISWORKS®

DYNAMO FOR REVIT®

Designer	Engineer	Detailer	Fabricator Contractor

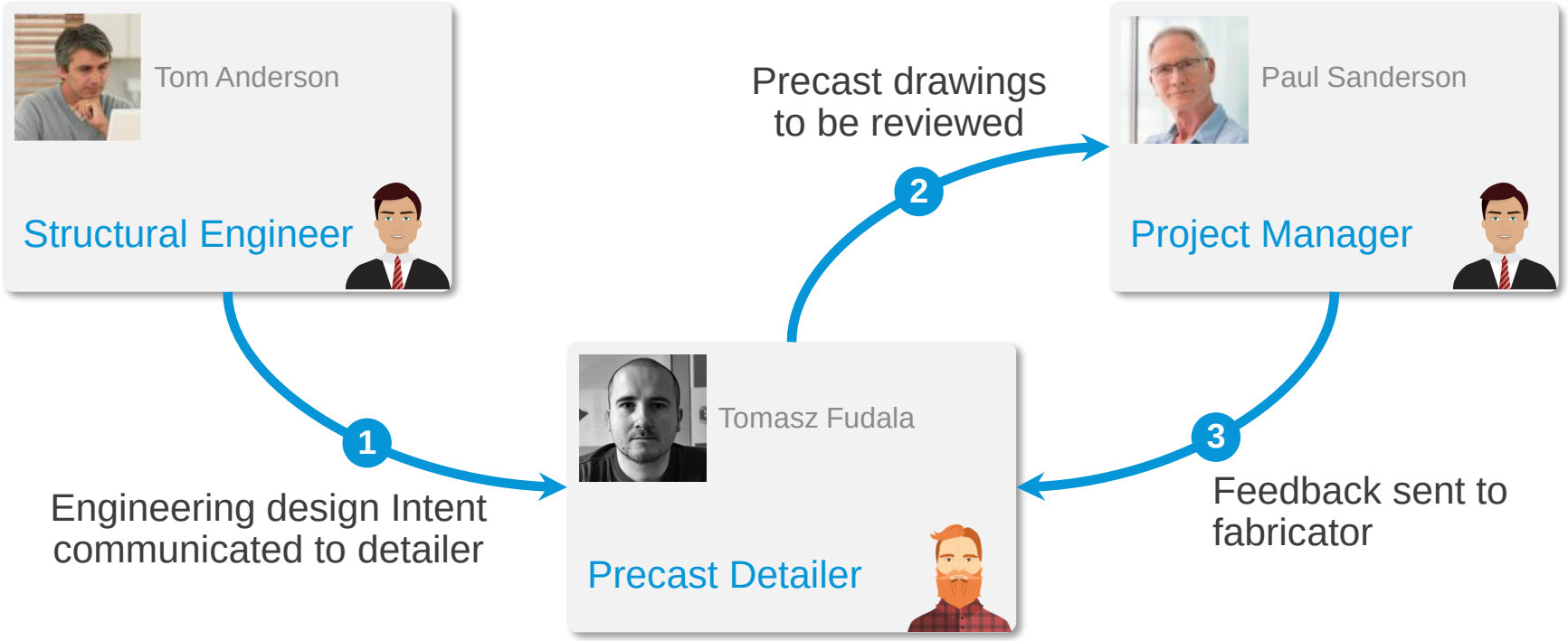
Workflows

Connected BIM	Practical Workflow
Connecting Teams	WF 1 - Connected BIM for Concrete Structures WF 2 - Collaboration With Multi-disciplinary Teams
Connecting Insight	WF 3 - Integration of BIM and Analysis
Connecting Outcomes	WF 4 - Structural Optimization of Constructions
Connecting Delivery	WF 5 - Connect design to fabrication for steel structures

CONNECTING TEAMS

Connected BIM for Concrete Structures

Connected Teams - Workflow 1



Connected BIM for Concrete Structures

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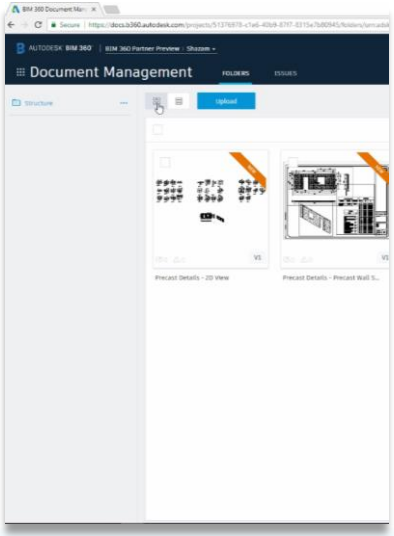
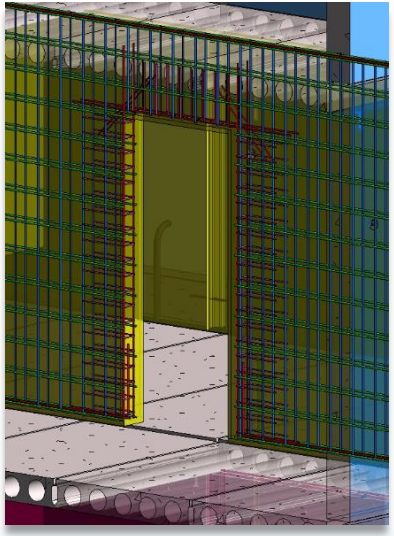
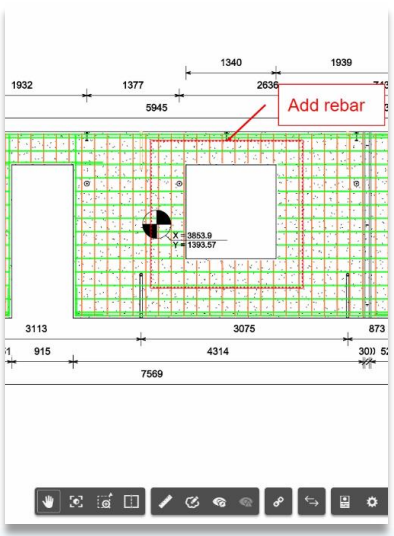
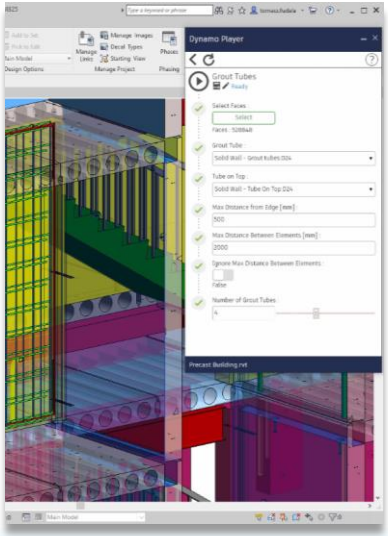








Communication of initial design

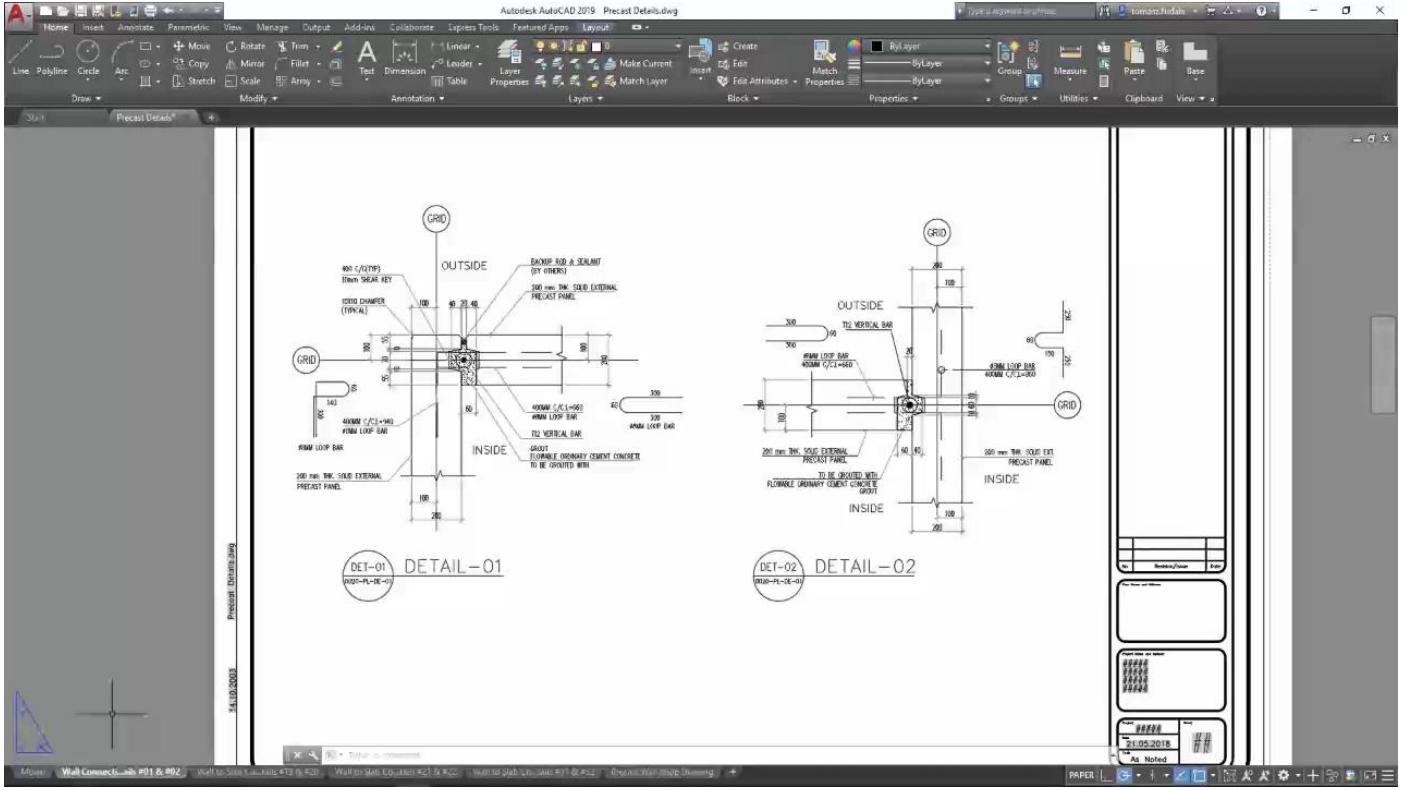
Creation of detailed design LOD 400

Review of detailed design

Update based on feedback

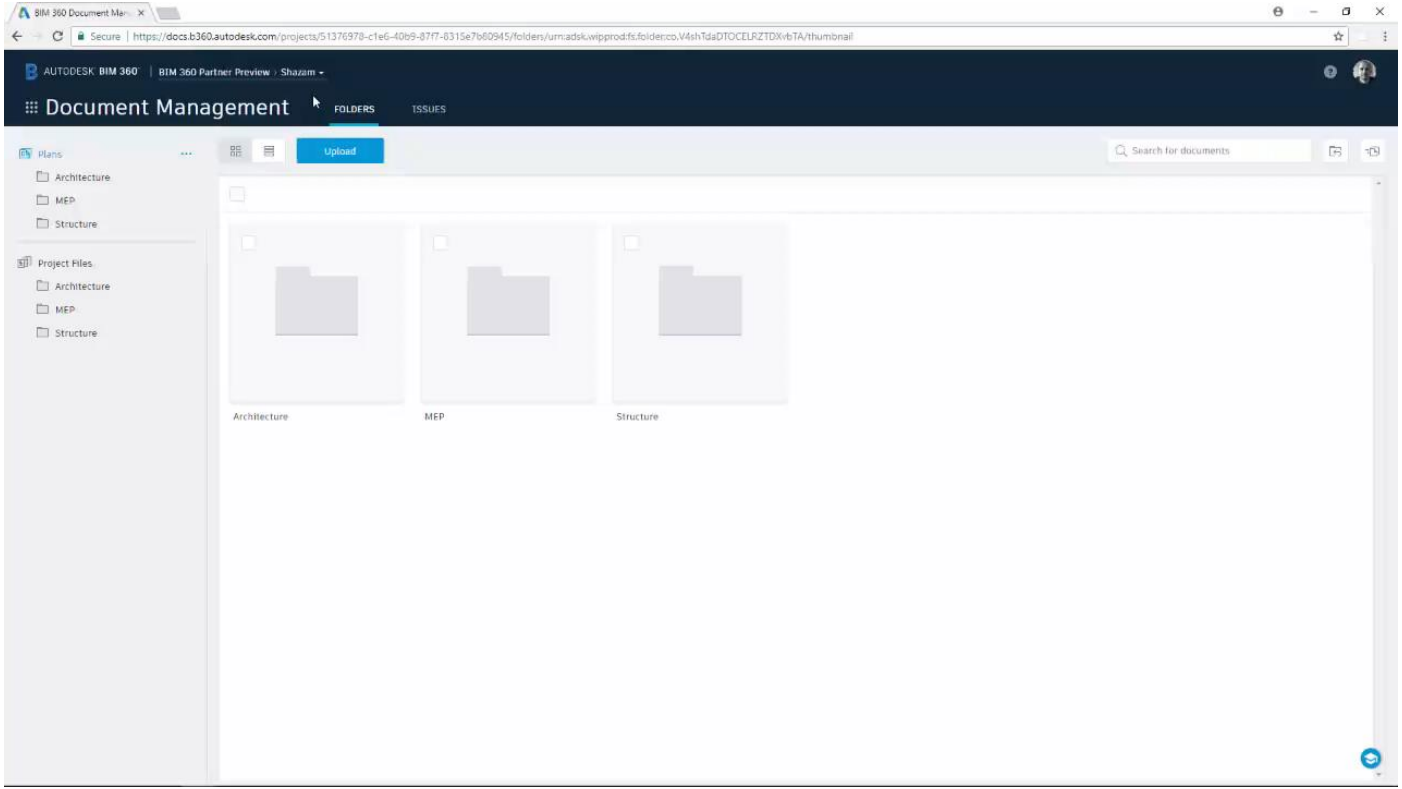
Connected BIM for Concrete Structures

Communication of Designs using BIM 360 Docs



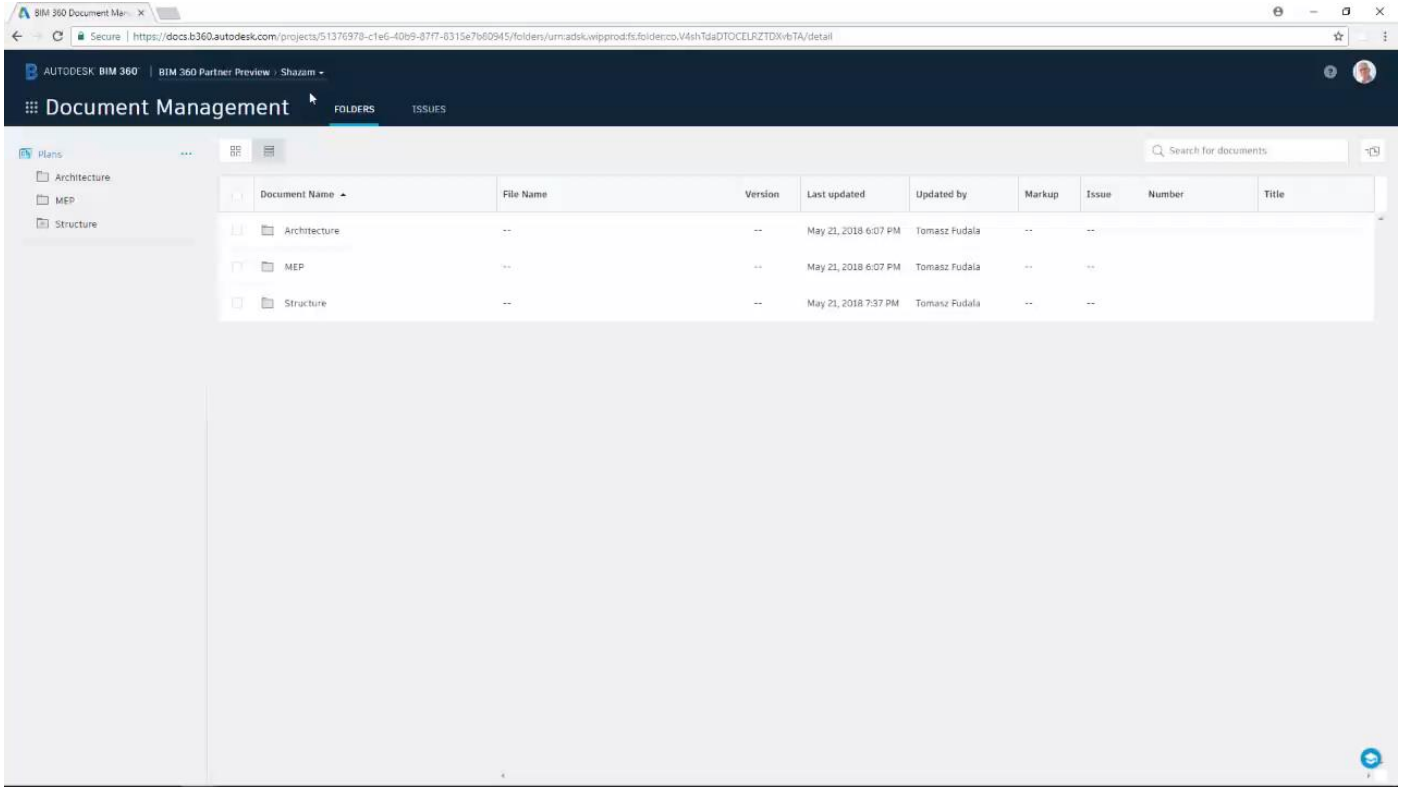
Connected BIM for Concrete Structures

Creation of LOD 400 model



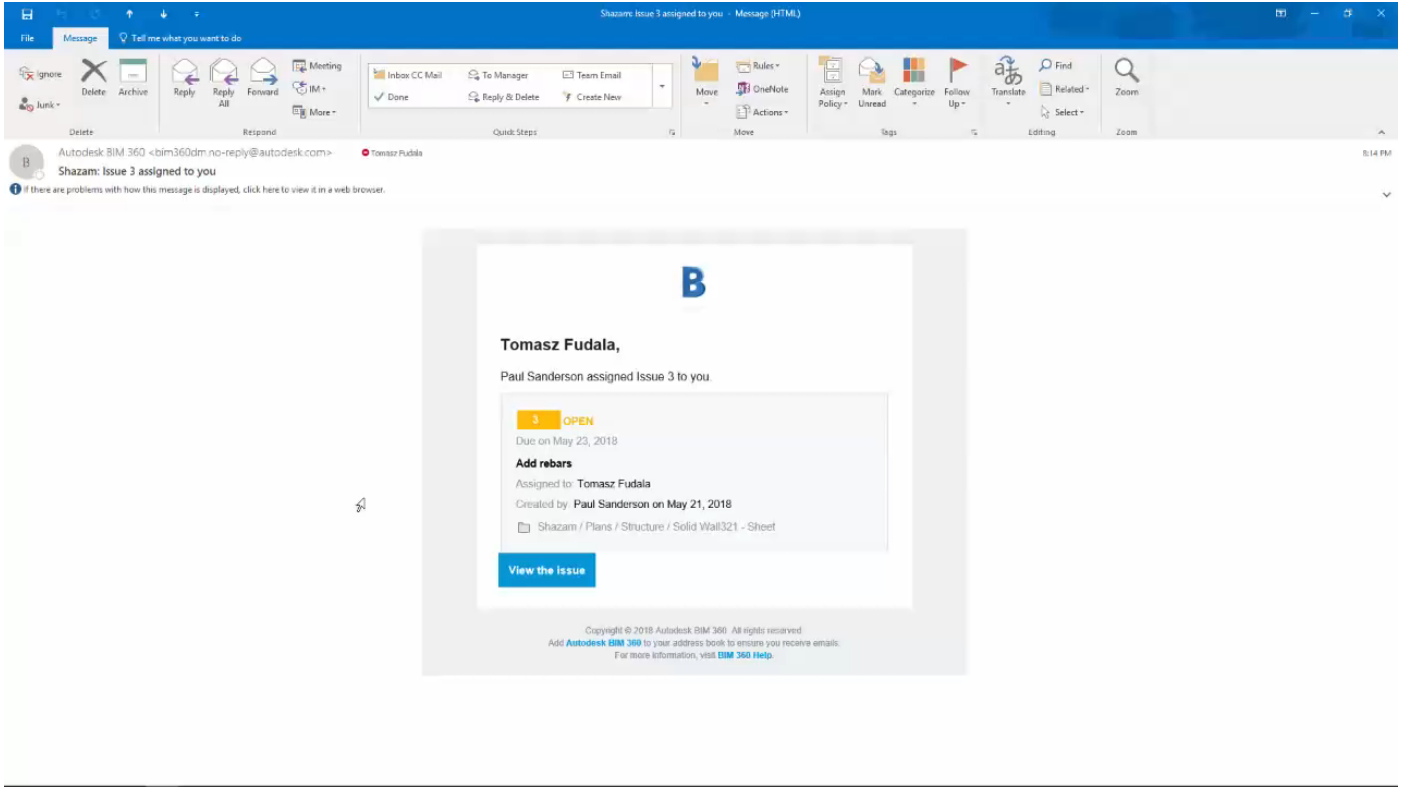
Connected BIM for Concrete Structures

Design Review Process



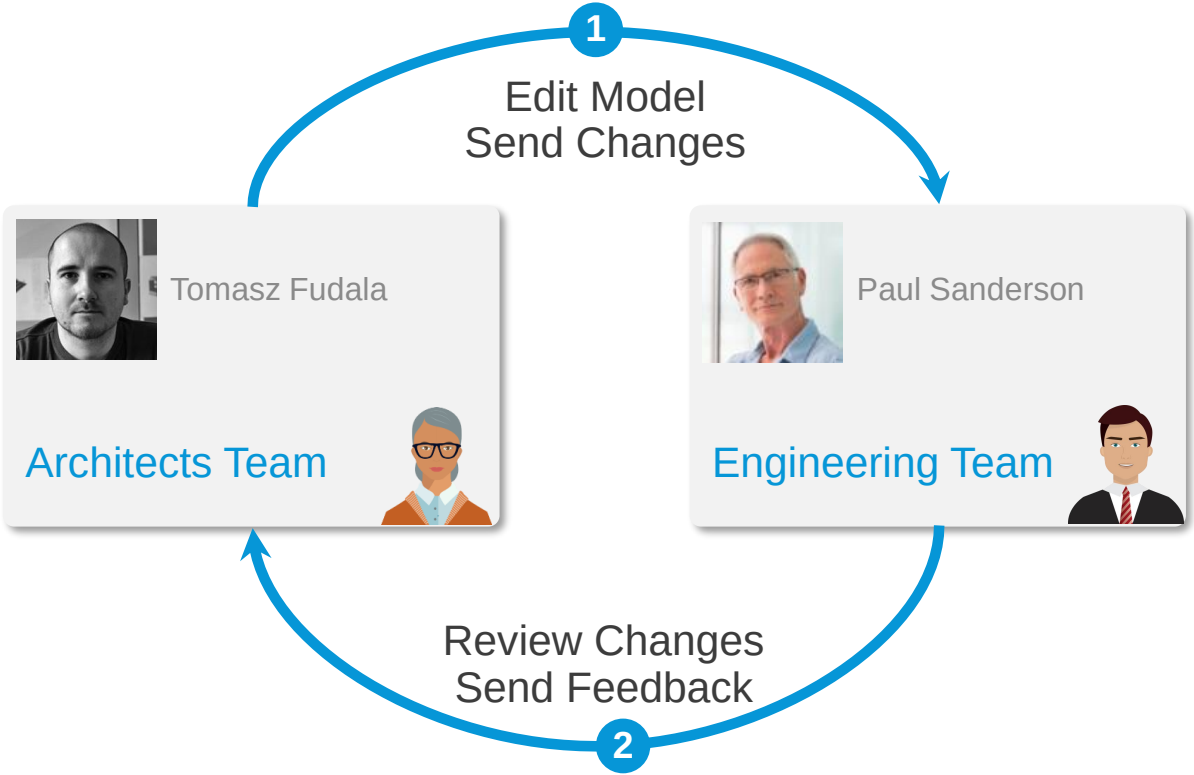
Connected BIM for Concrete Structures

Update Design



Collaboration with Multi-Disciplinary Teams

Connected Teams - Workflow 2



Collaboration with Multi-Disciplinary Teams

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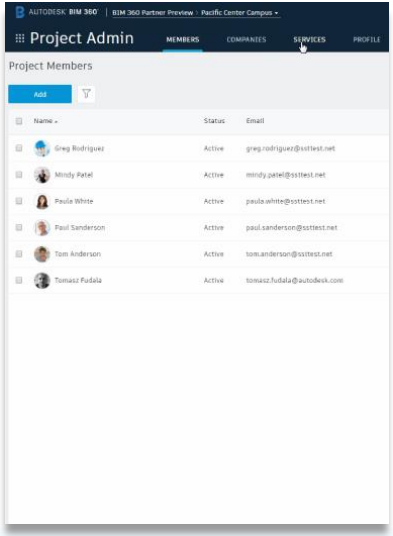
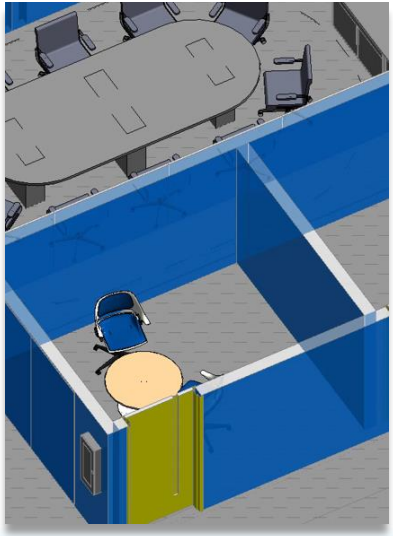
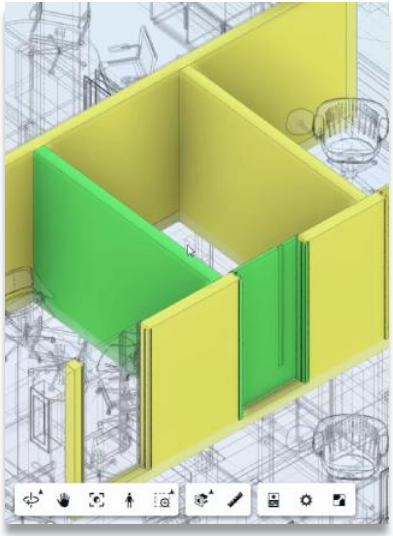






Setup Project Teams

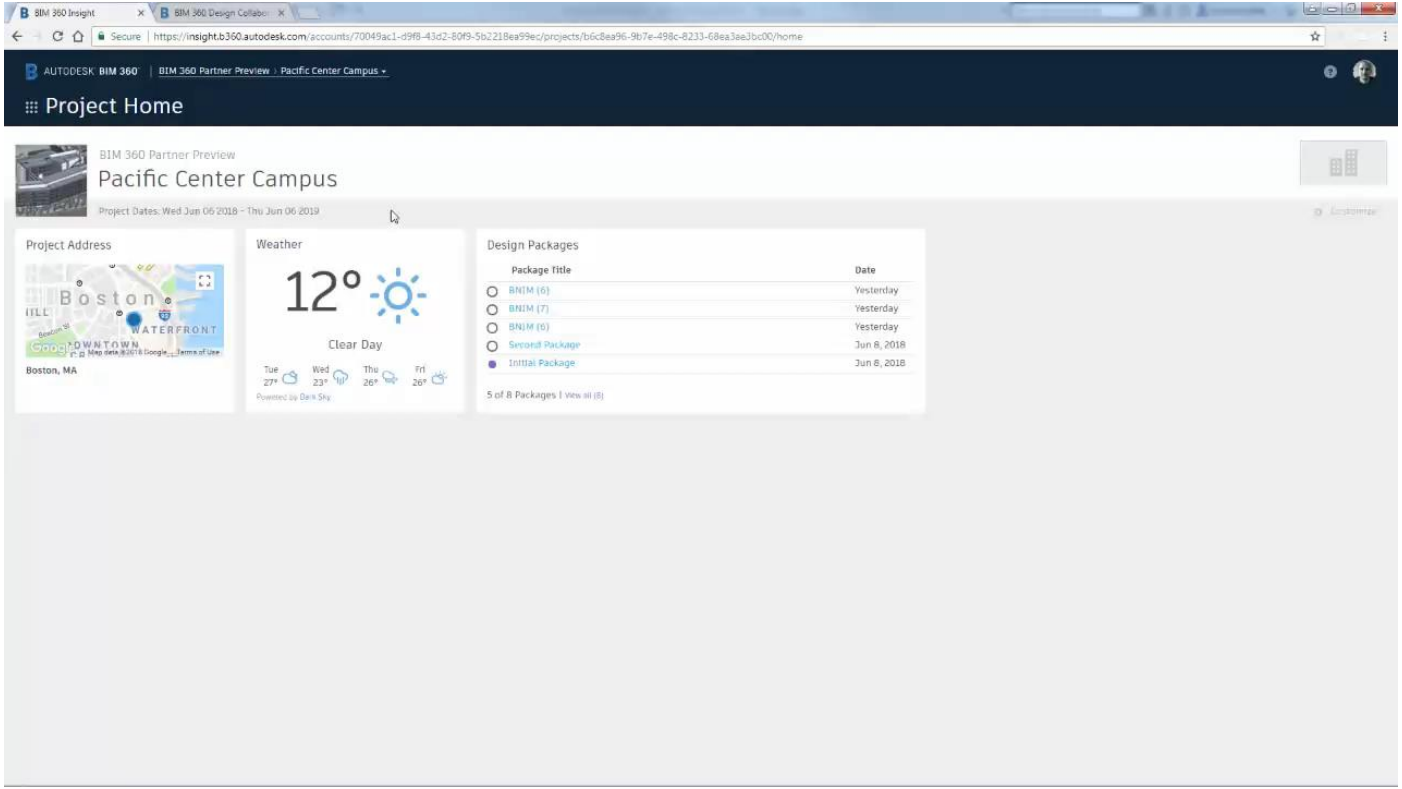
Architects Team
Edit & Update Model

Communication
between teams

Engineers Team
Review Changes

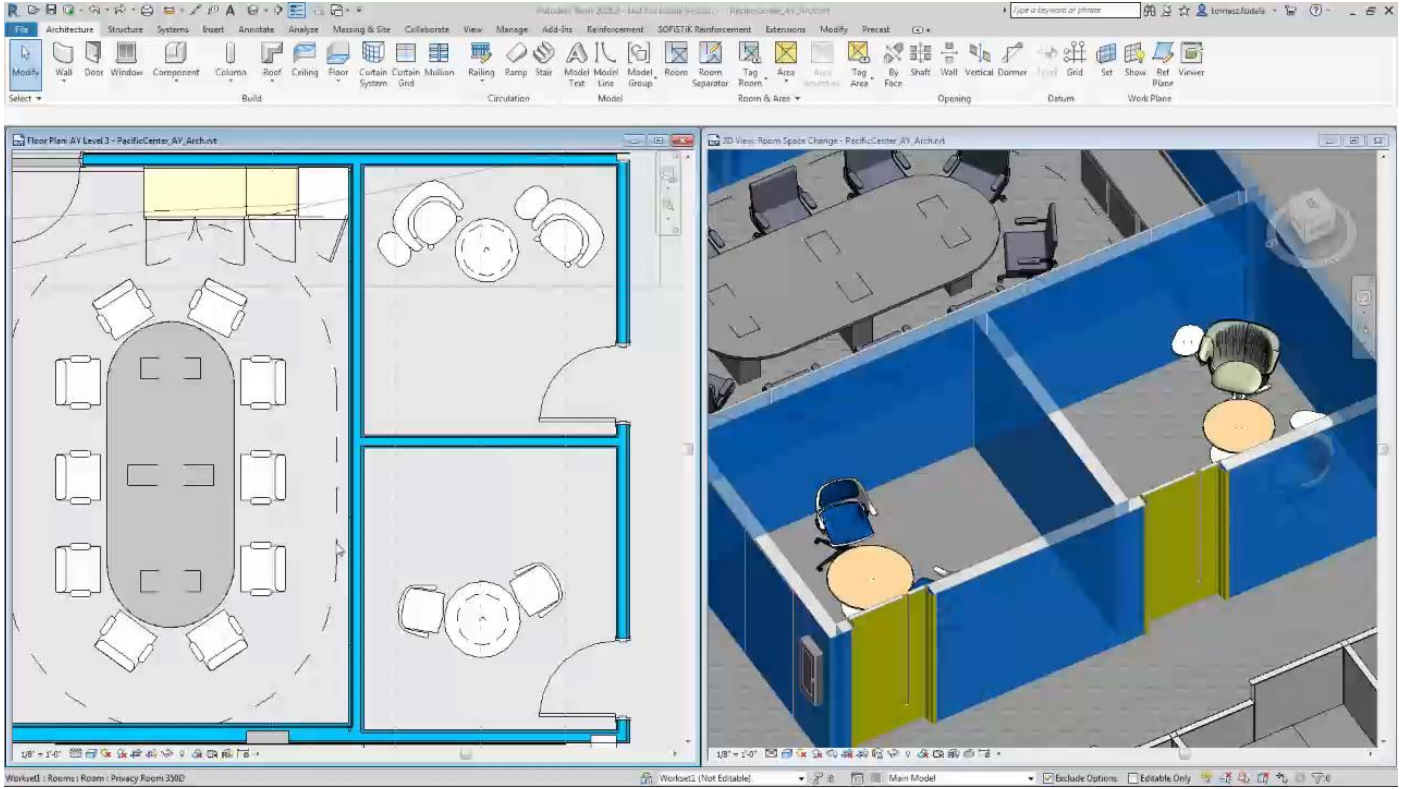
Collaboration with Multi-Disciplinary Teams

Setup Project Teams



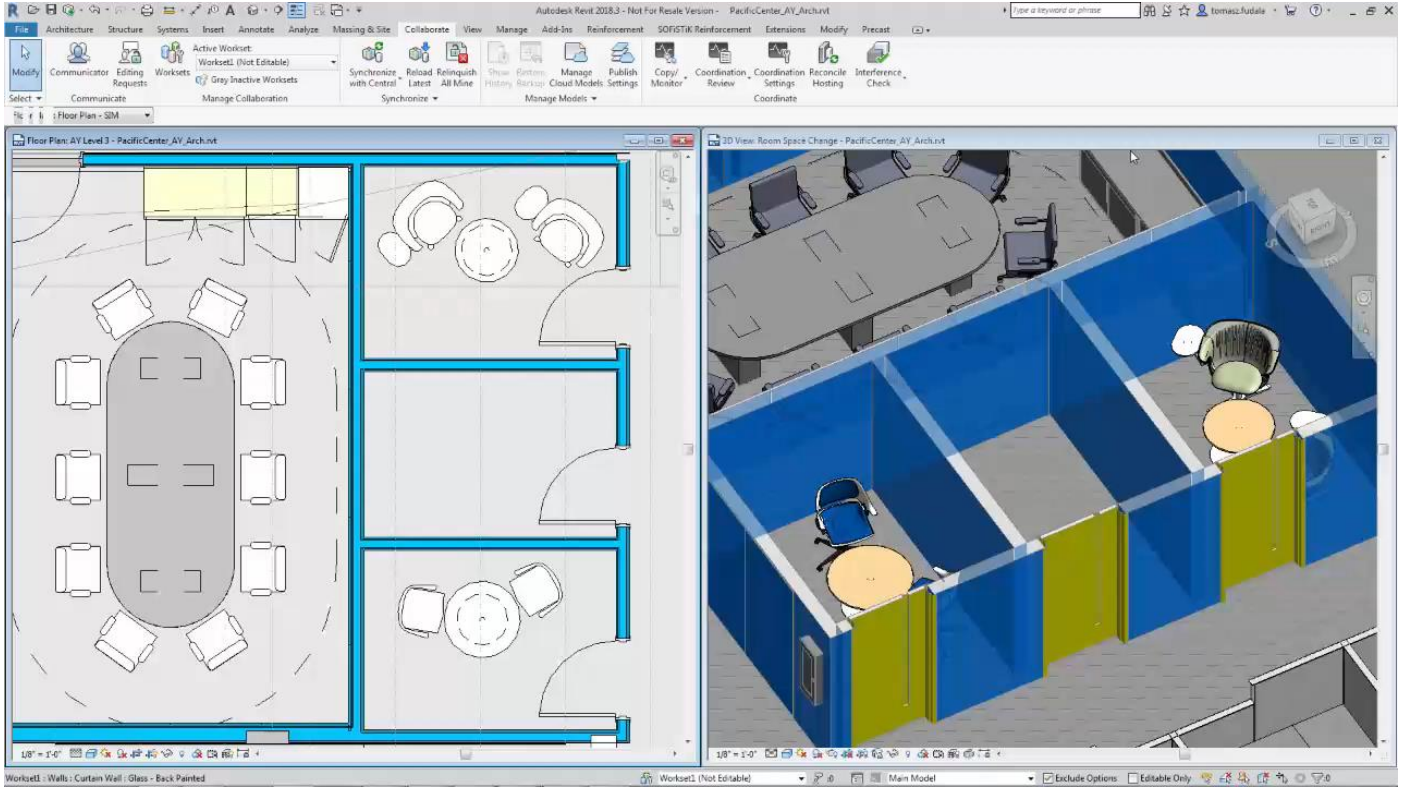
Collaboration with Multi-Disciplinary Teams

Architects team edits & updates model to BIM 360



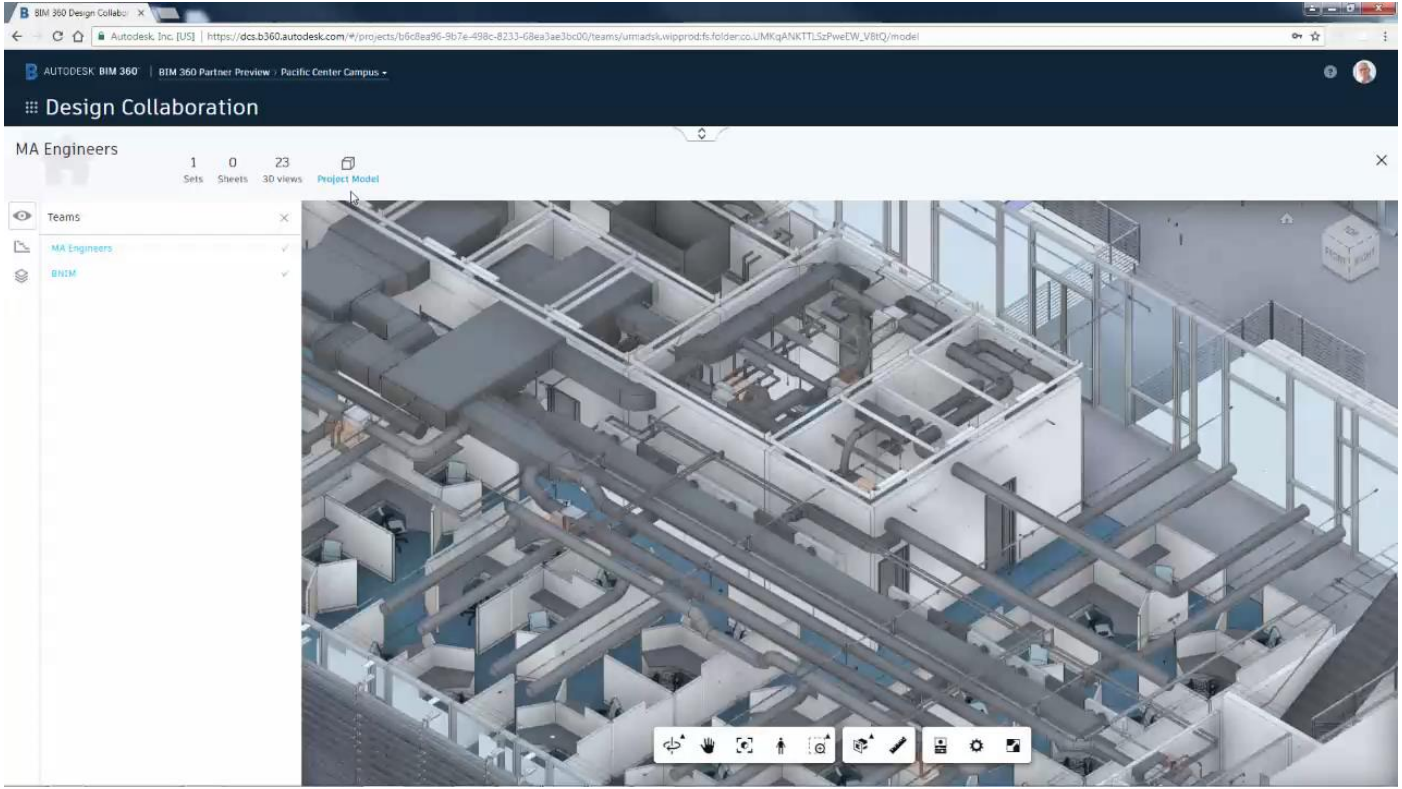
Collaboration with Multi-Disciplinary Teams

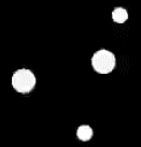
Communication of changes between teams



Collaboration with Multi-Disciplinary Teams

Engineers team reviews changes





CONNECTING INSIGHT

Integration of BIM and analysis

Connecting Insight - Workflow 3

Creates physical model, including analytical properties

1

Tomasz Fudala

Structural Designer

2

Share model with structural engineer

Performs structural analysis and optimization on the building

3

Paul Sanderson

Structural Engineer

4

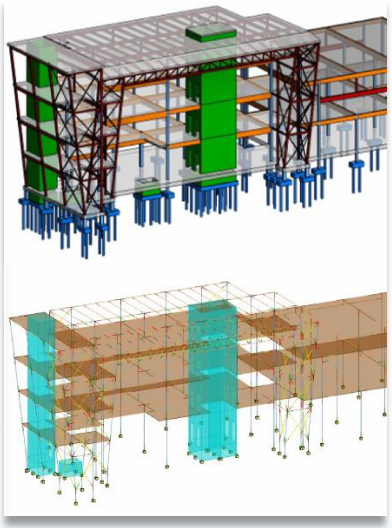
Update the model
Share with designer

5

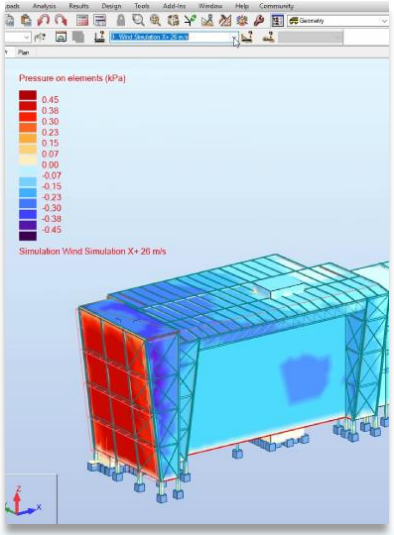
Compares changes

Integration of BIM and analysis

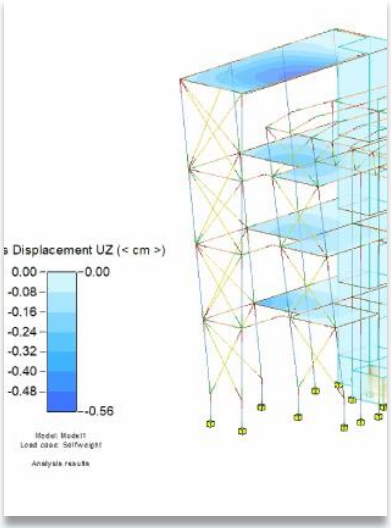
AUTODESK® REVIT®



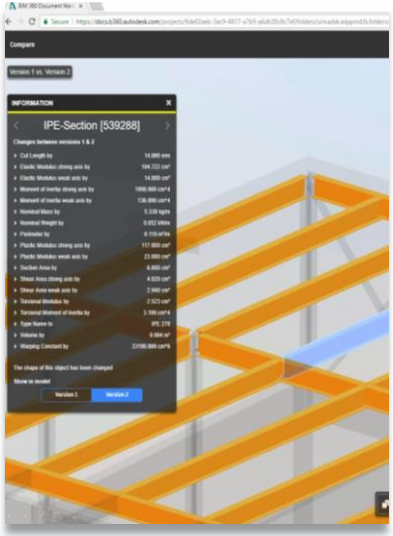
AUTODESK® ROBOT™ STRUCTURAL ANALYSIS PROFESSIONAL



AUTODESK® REVIT®



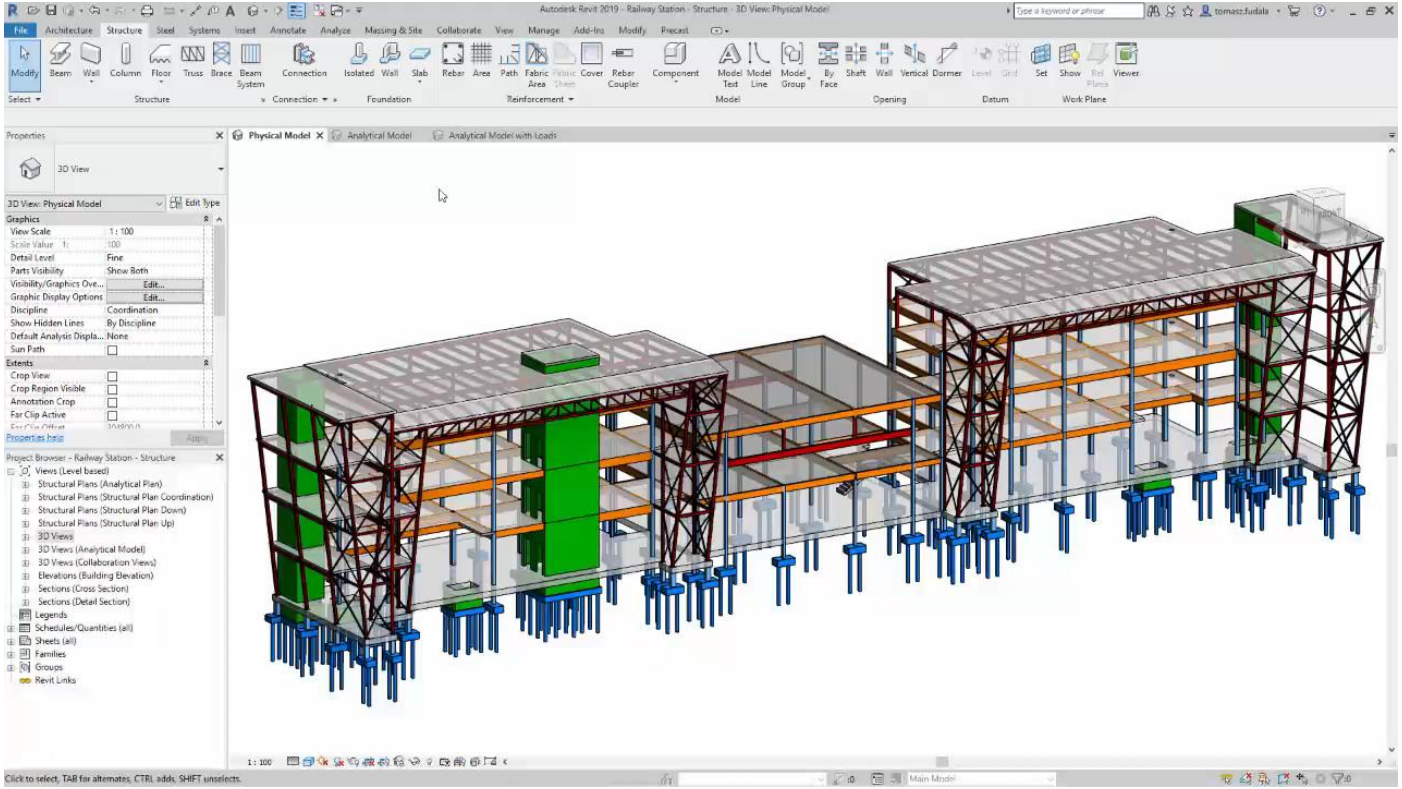
AUTODESK® BIM 360™ DOCS



Structural Model → Structural Analysis → Review Final Engineering Model → Compare Changes

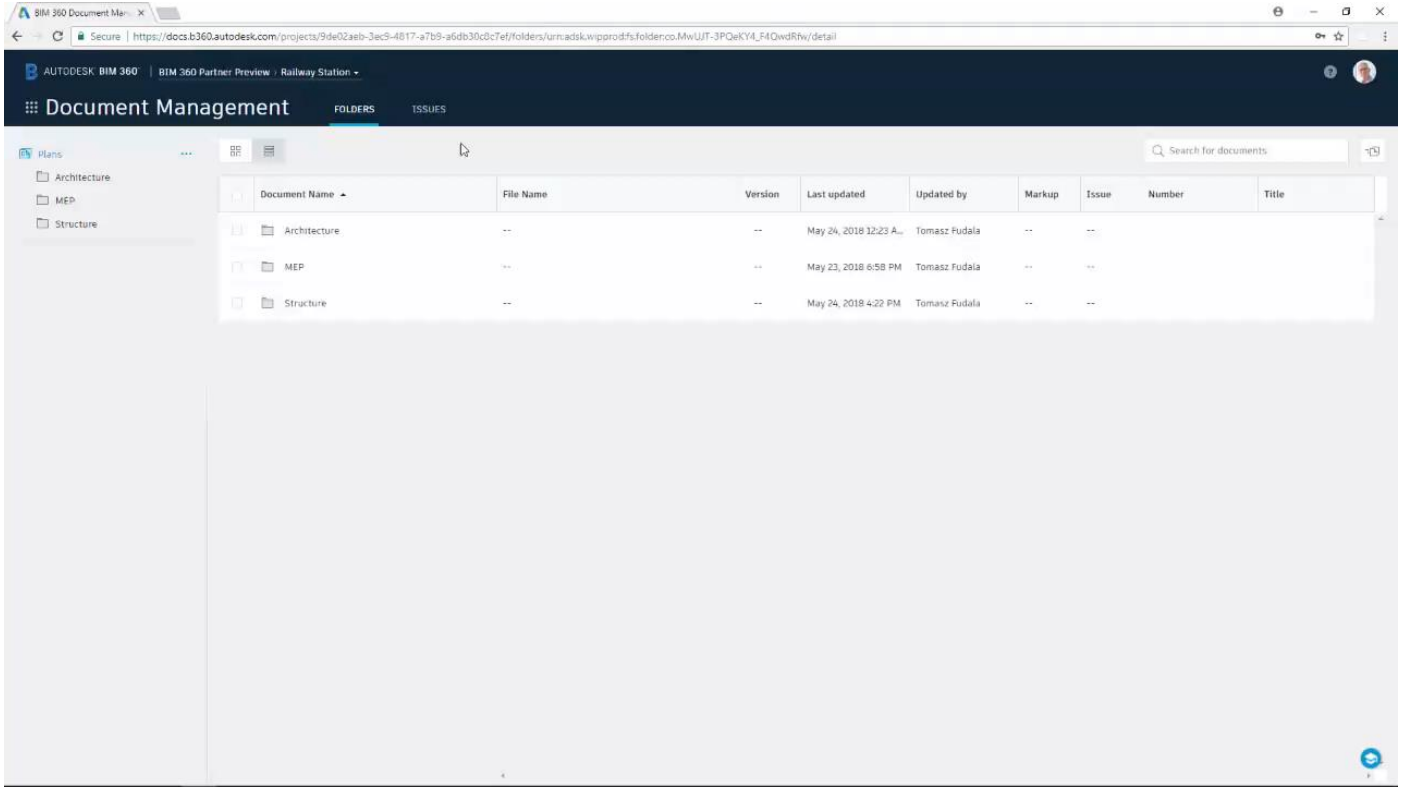
Integration of BIM and analysis

Creation of structural model: physical and analytical



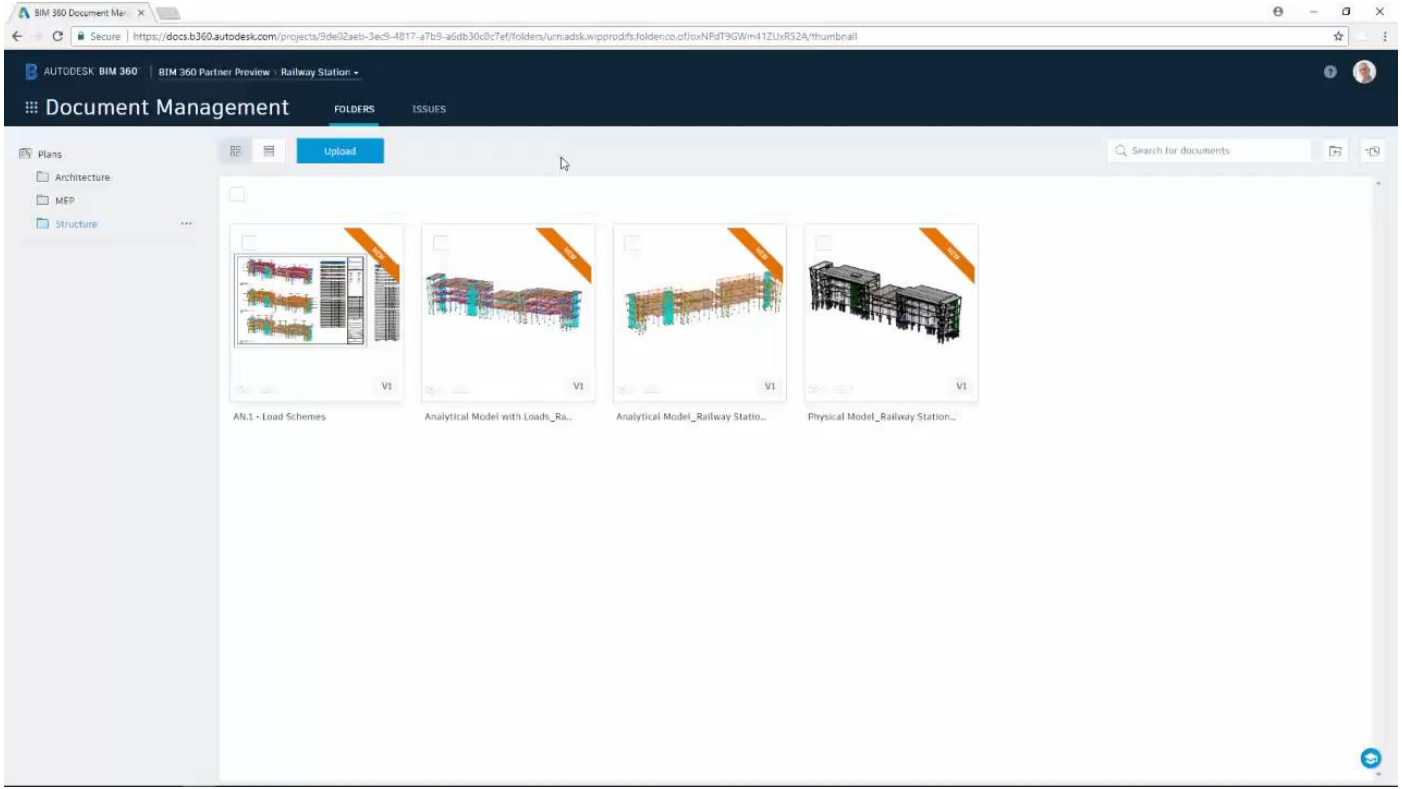
Integration of BIM and analysis

Structural analysis by the engineers



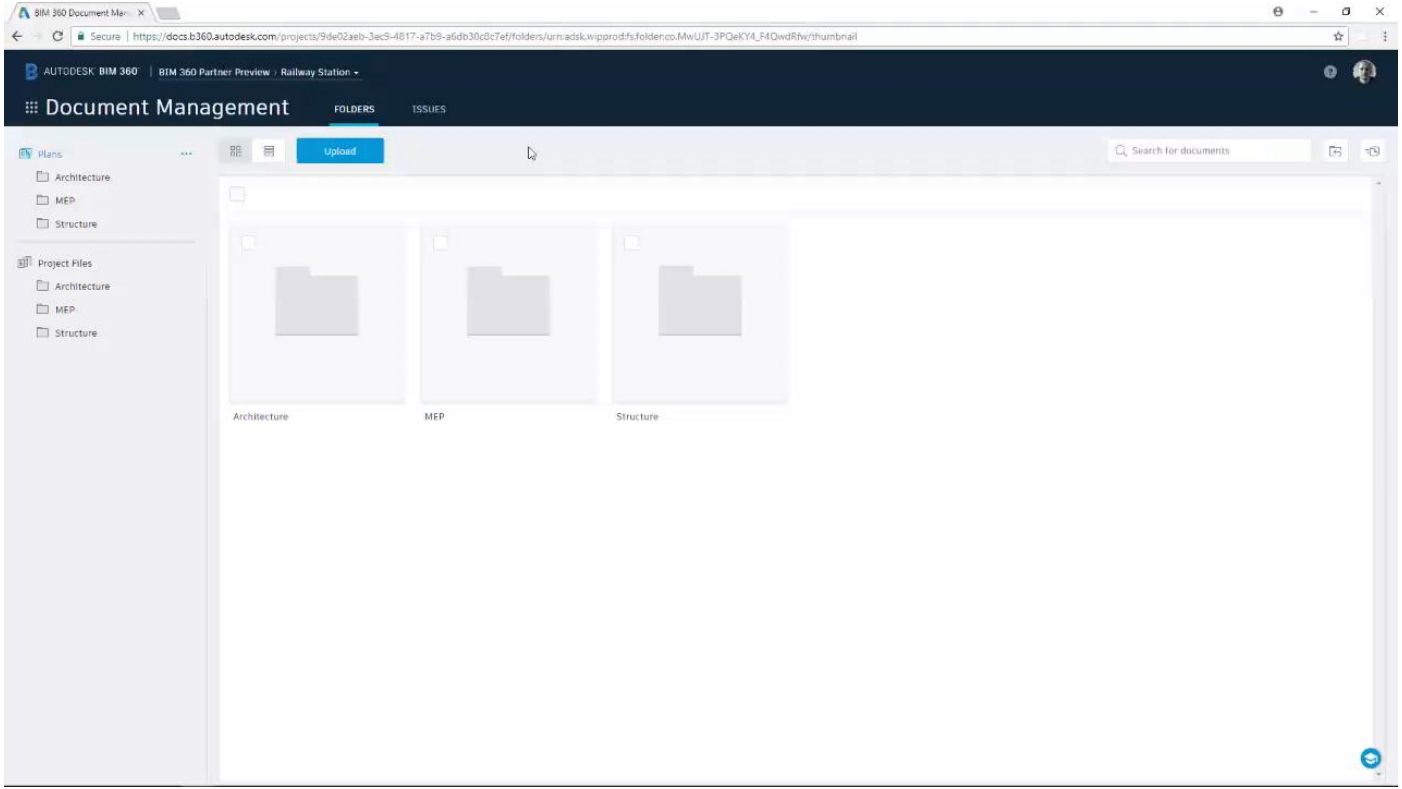
Integration of BIM and analysis

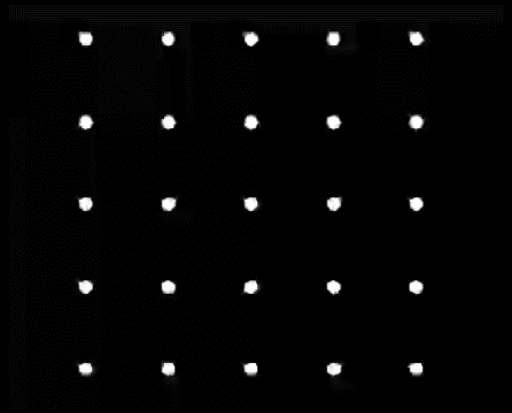
Review final engineering model



Integration of BIM and analysis

Compare changes after engineering updates



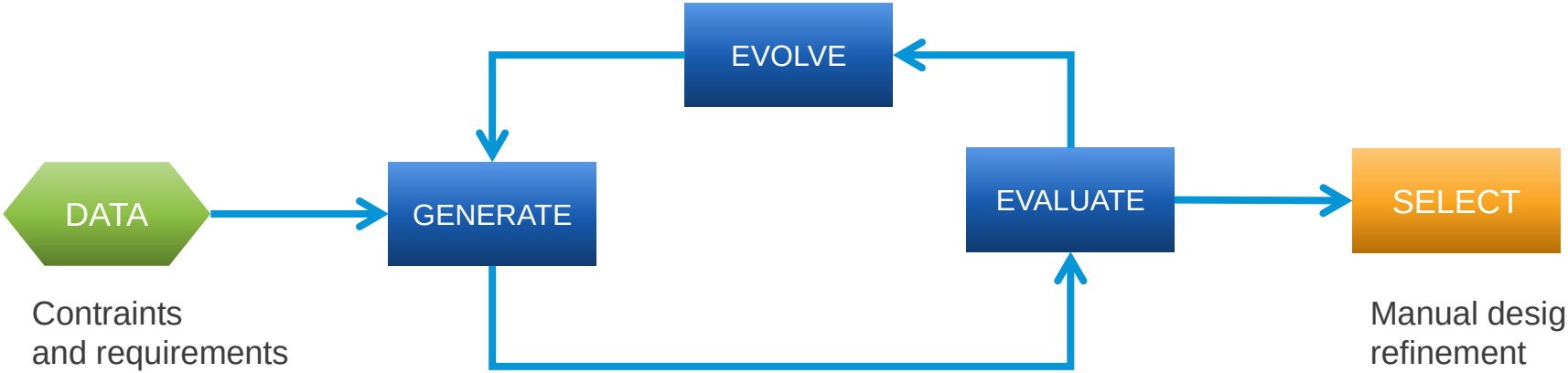


CONNECTING OUTCOMES

Structural Optimization of Constructions

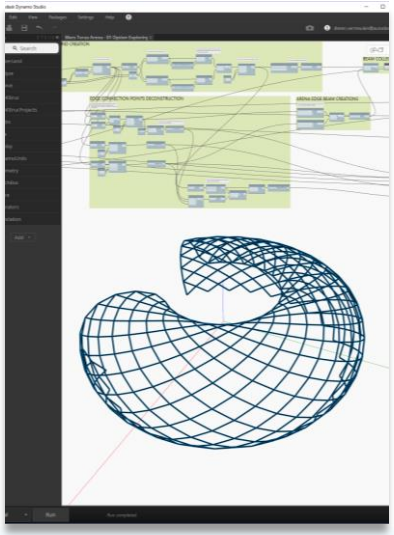
Connecting Outcomes – Workflow 4

Initialization | Generative Design | Post-Processing

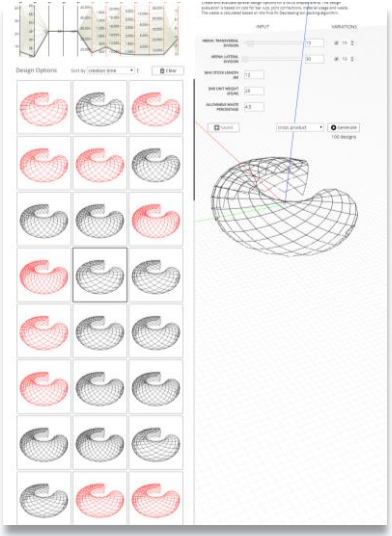


Structural Optimization of Constructions

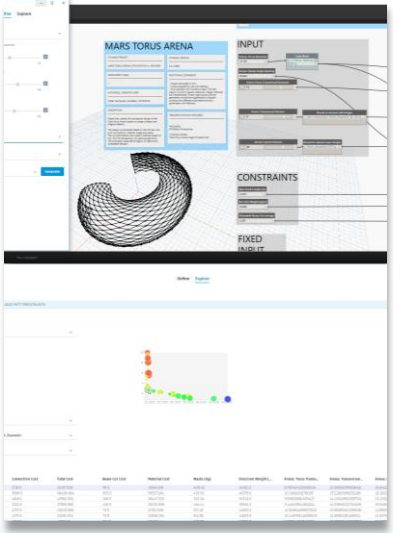
AUTODESK® DYNAMO STUDIO



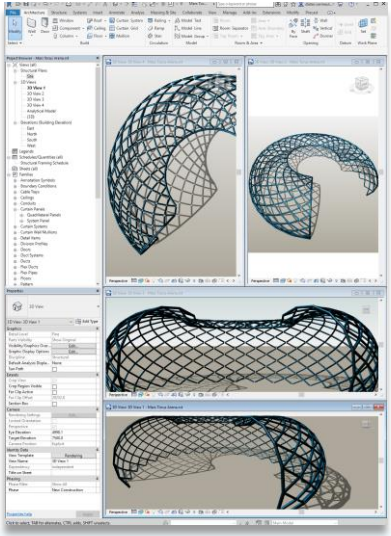
PROJECT FRACTAL



AUTODESK® DYNAMO STUDIO



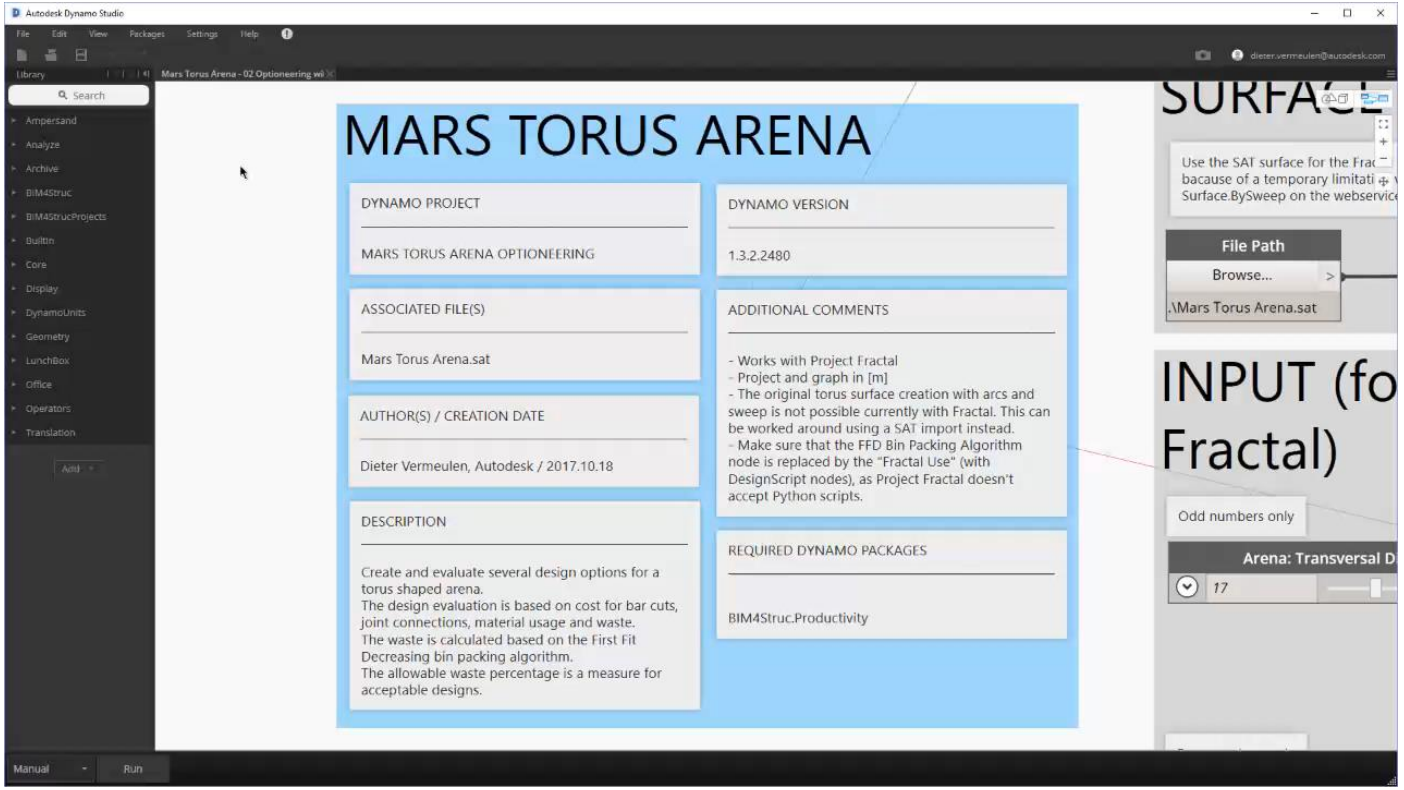
AUTODESK® REVIT®



Computational Model → Option Generation → Optimization with Refinery → Connect to structural model

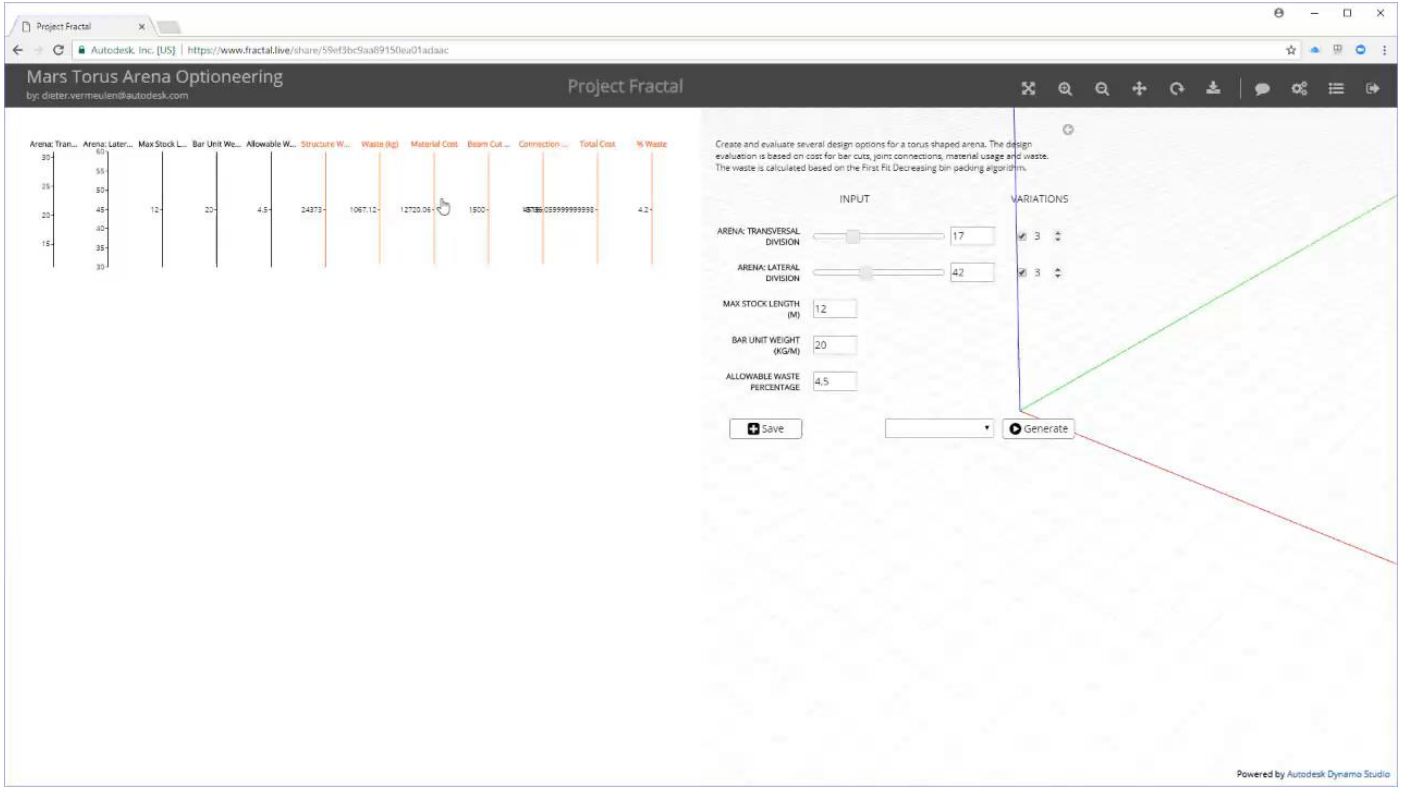
Structural Optimization of Constructions

Definition of computational model with Dynamo



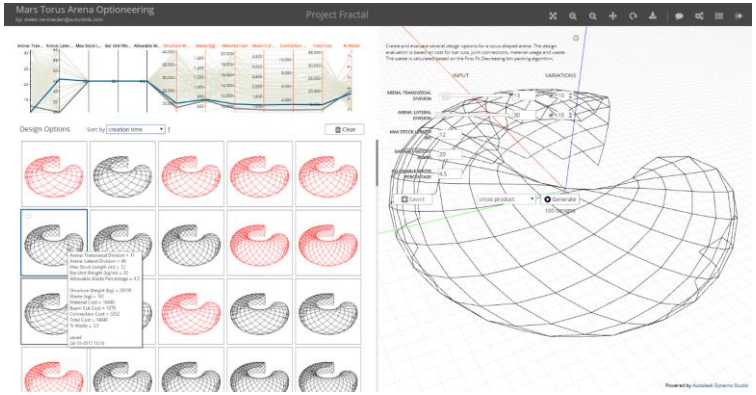
Structural Optimization of Constructions

Generation of options with Project Fractal



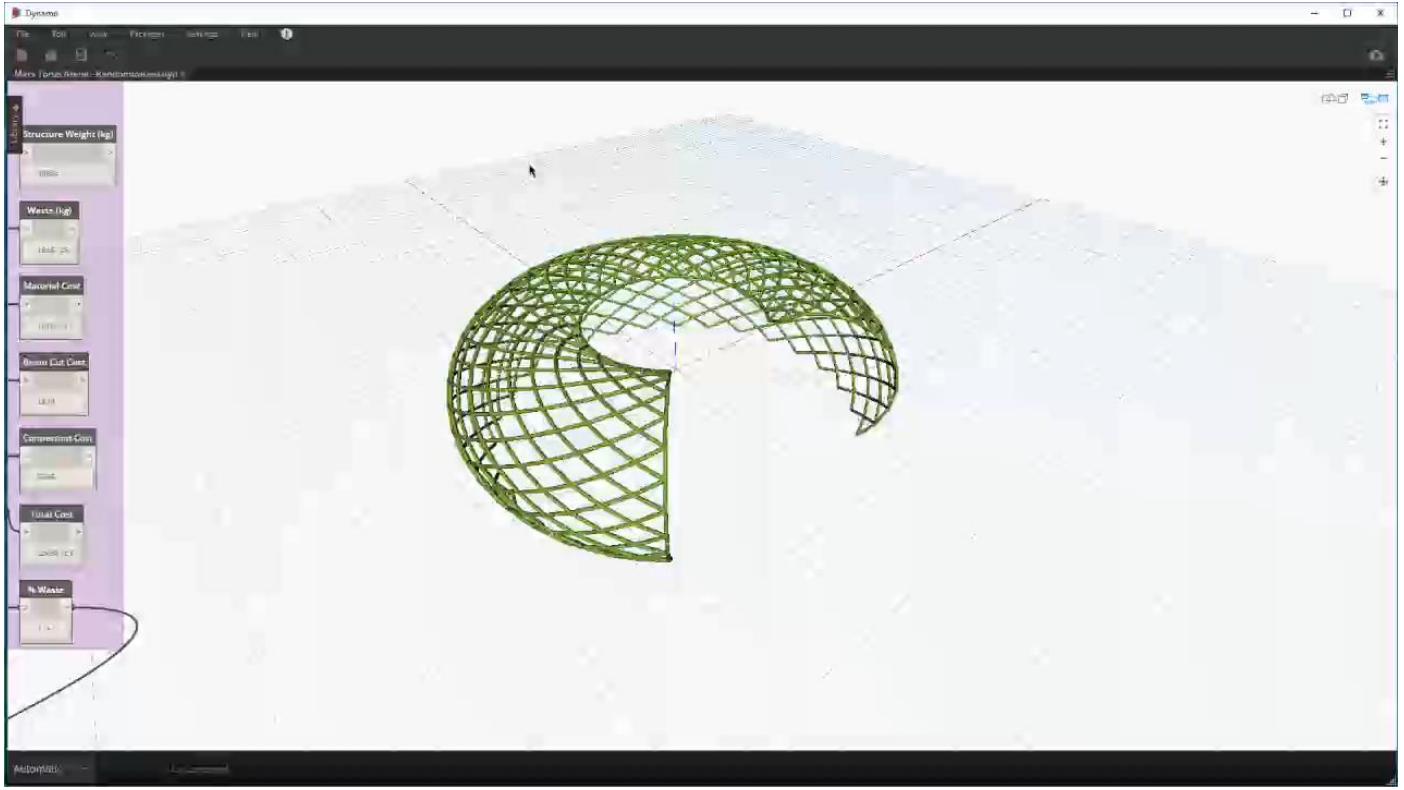
Beta Preview: Project Fractal

- Not a commercial service or product
- Only for testing purposes / feedback gathering
- Connects with Dynamo Studio
- Design Exploration software that supports optioneering workflows
- Request access through this link: https://home.fractal.live/



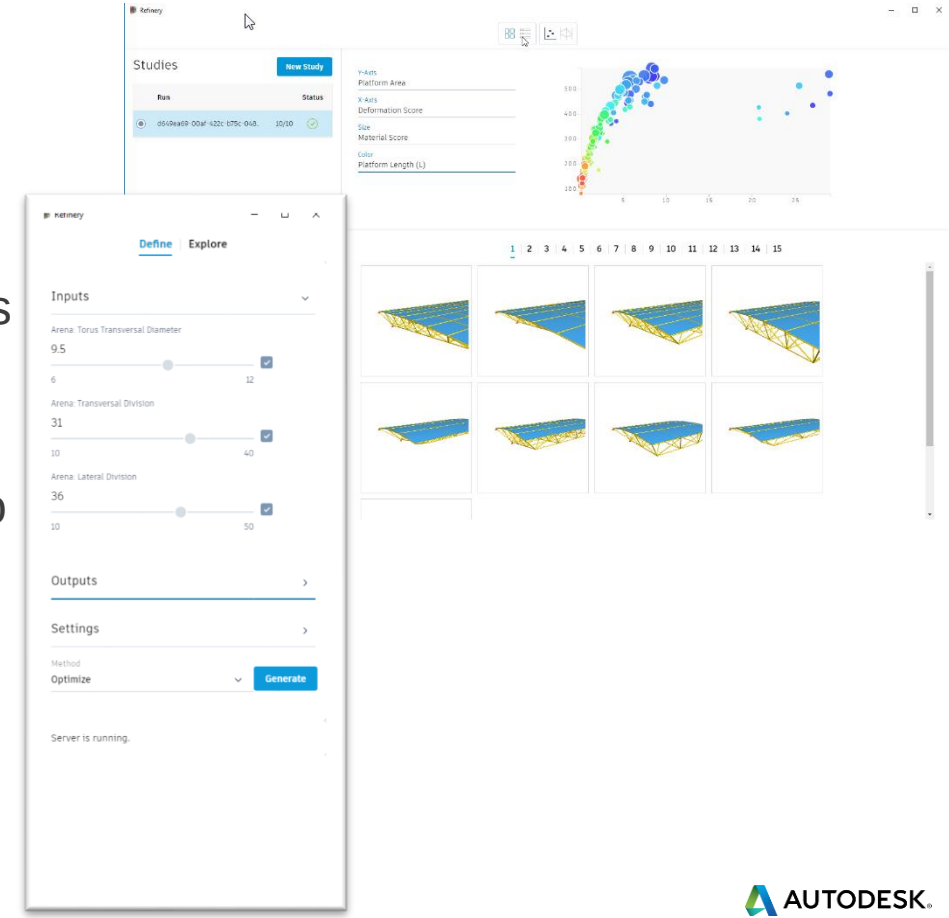
Structural Optimization of Constructions

Finding the optimal solution with Refinery



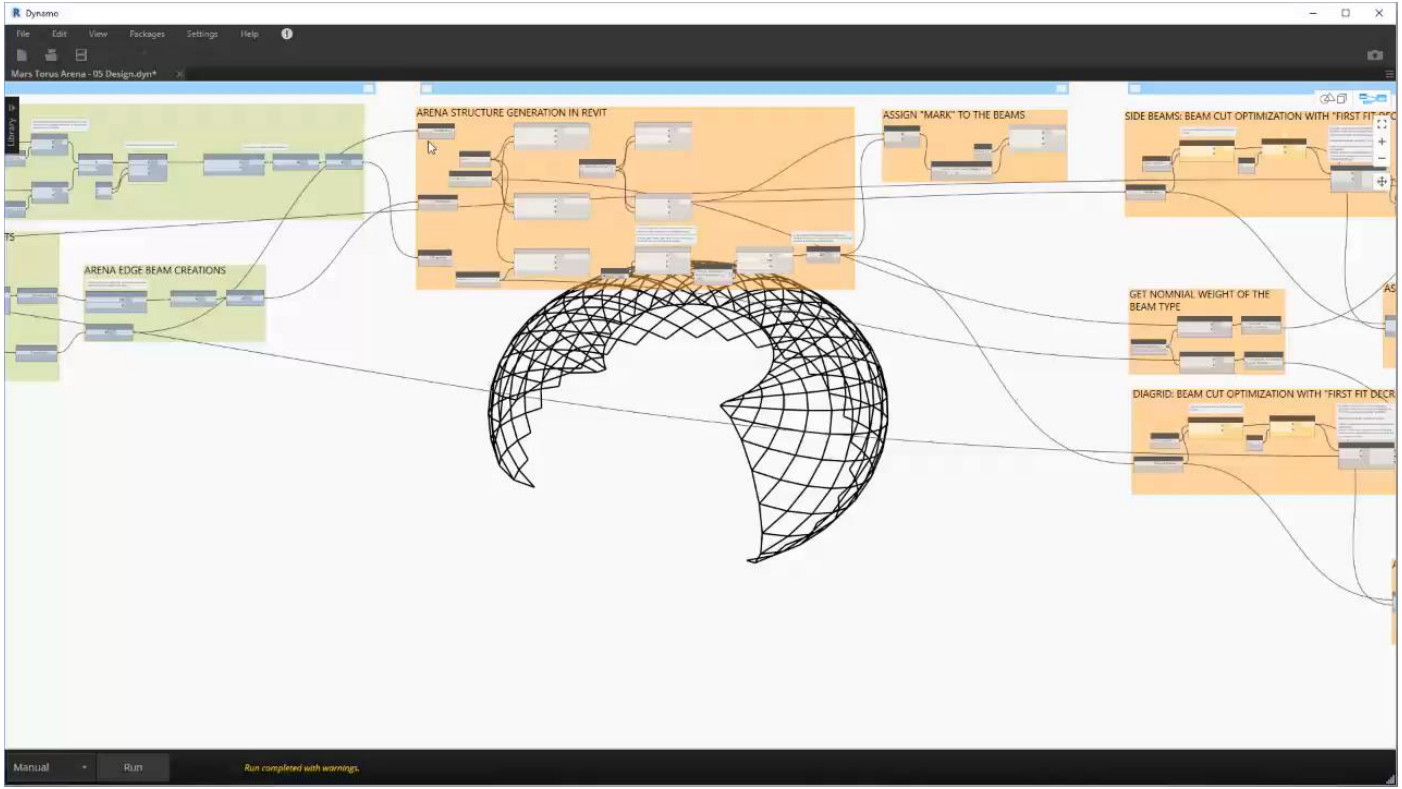
Preview: Optimization with Refinery

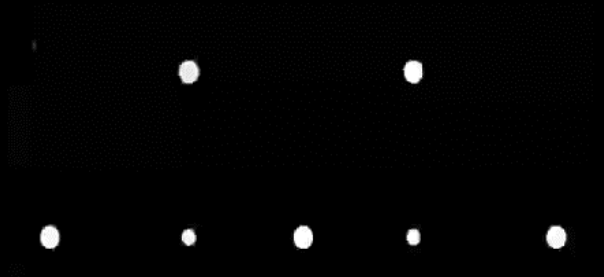
- Connects with Dynamo 2.0
- Design Exploration software
- Optioneering and Optimization workflows
- Advanced results display
- Syncing selected option back to Dynamo
- Request access through this link: https://beta.autodesk.com/key/refinery



Optimization of Structures

Generating Structural Model





CONNECTING DELIVERY

Connect Design to Fabrication

Connecting Delivery – Workflow 5

Tomasz Fudala

Structural Engineer

1 Defines steel connection design intent based on engineering results

2 Share design intent

Philippe Bonneau

Steel Detailer

3 Creates steel connections detailed drawings

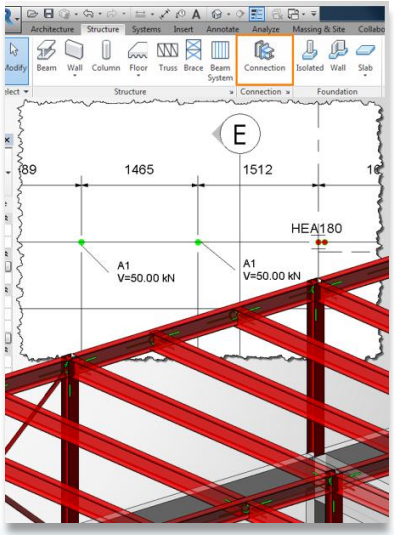
4 Shared with fabricator for the creation of fabrication deliverables

Paula White

Fabricator

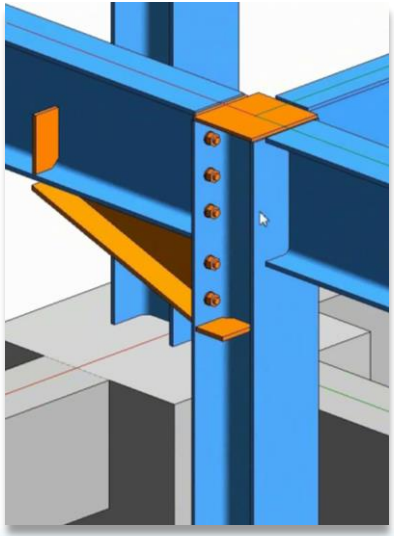
Connect Design to Fabrication

AUTODESK® REVIT®



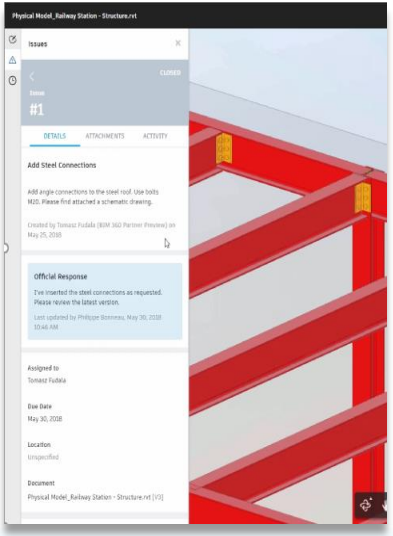
Steel Connection Design Intent

AUTODESK® REVIT®



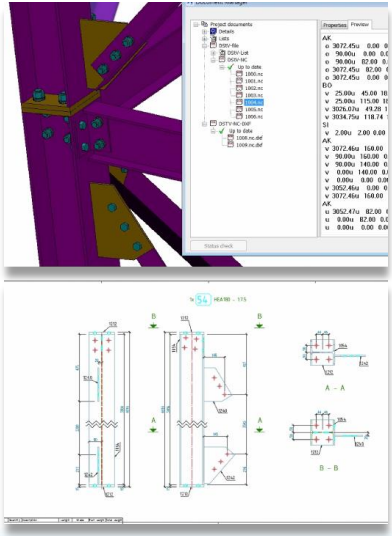
Steel Connection Detailing

AUTODESK® BIM 360™ DOCS



Communication of Design Intent

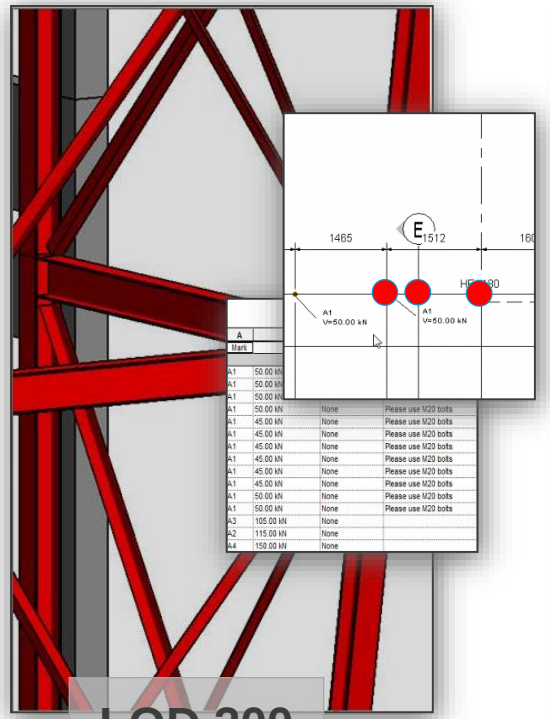
AUTODESK® ADVANCE STEEL



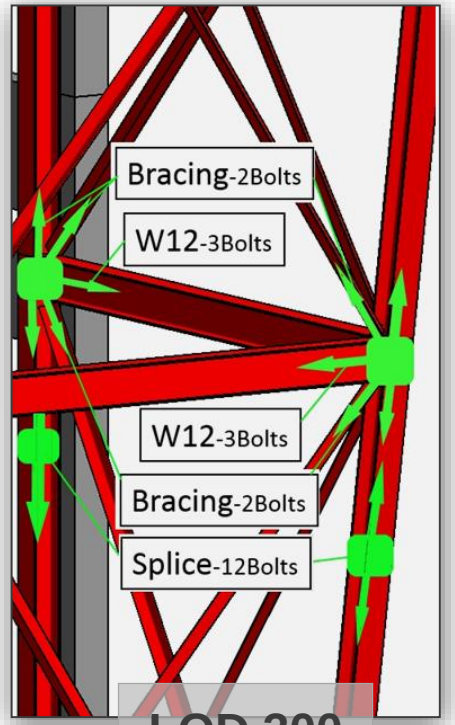
Fabrication Deliverables

Connect Design to Fabrication

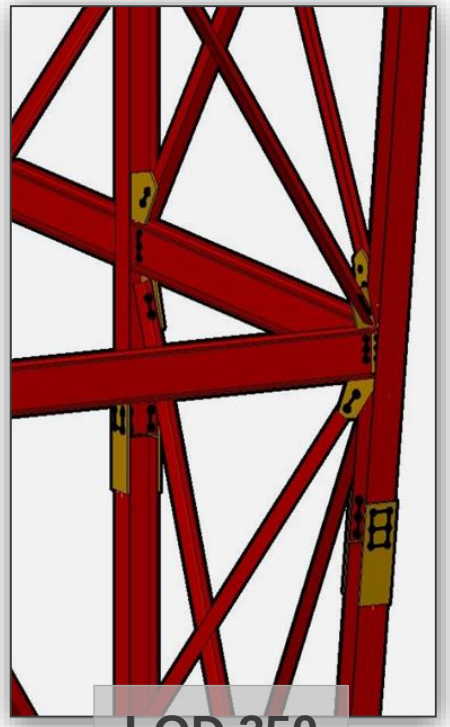
Increasing LOD for Steel Connections



LOD 200



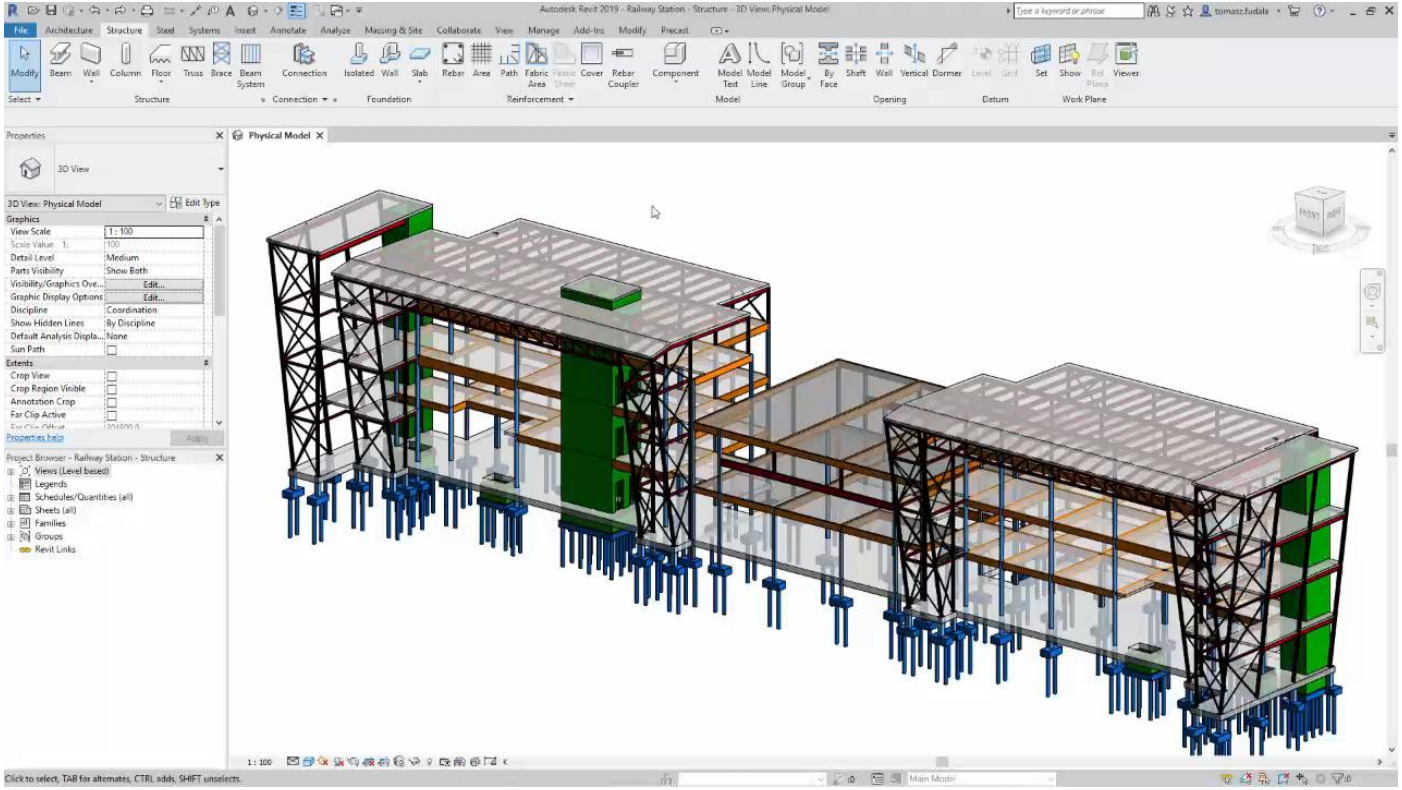
LOD 300



LOD 350

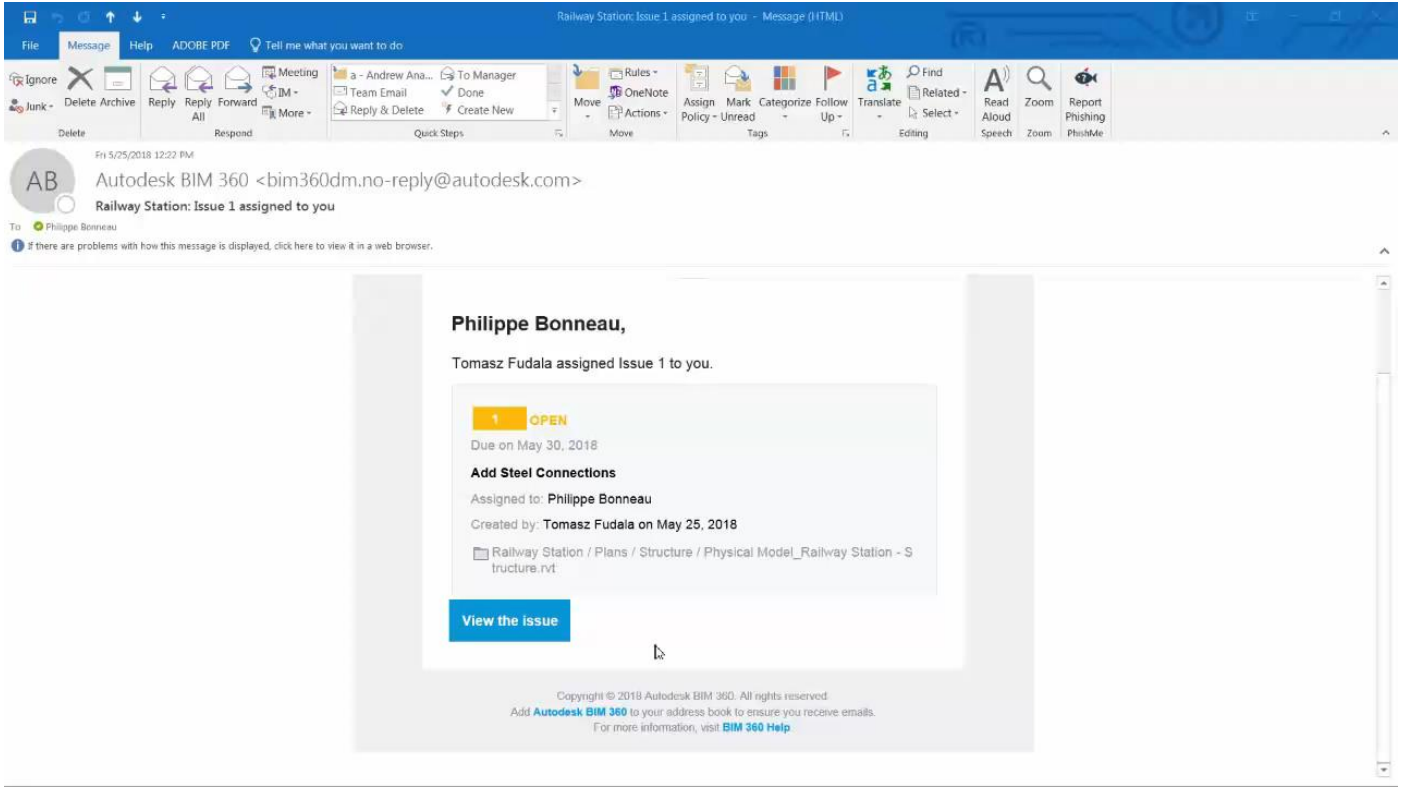
Connect Design to Fabrication

Steel Connection Design Intent based on Engineering



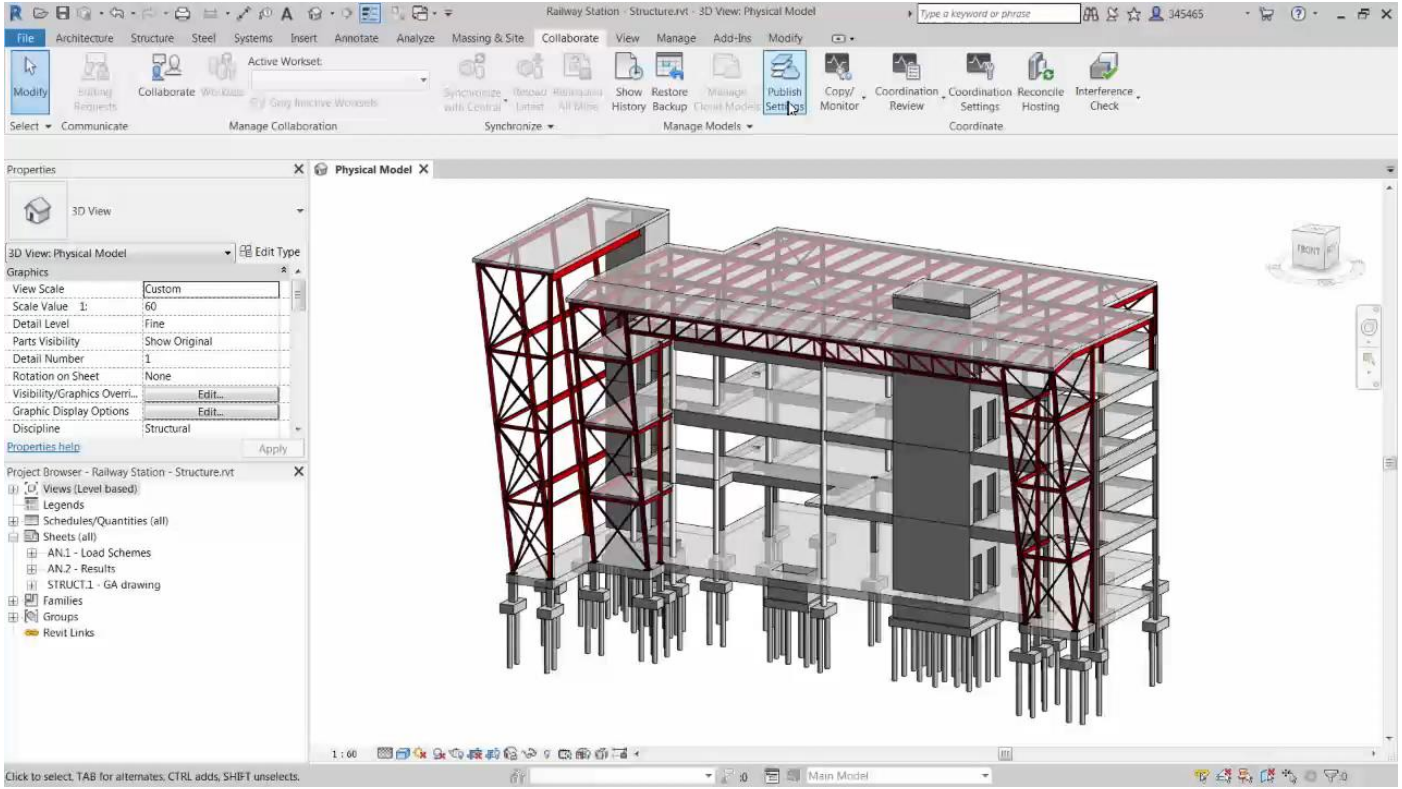
Connect Design to Fabrication

Steel Connection Detailing in Revit



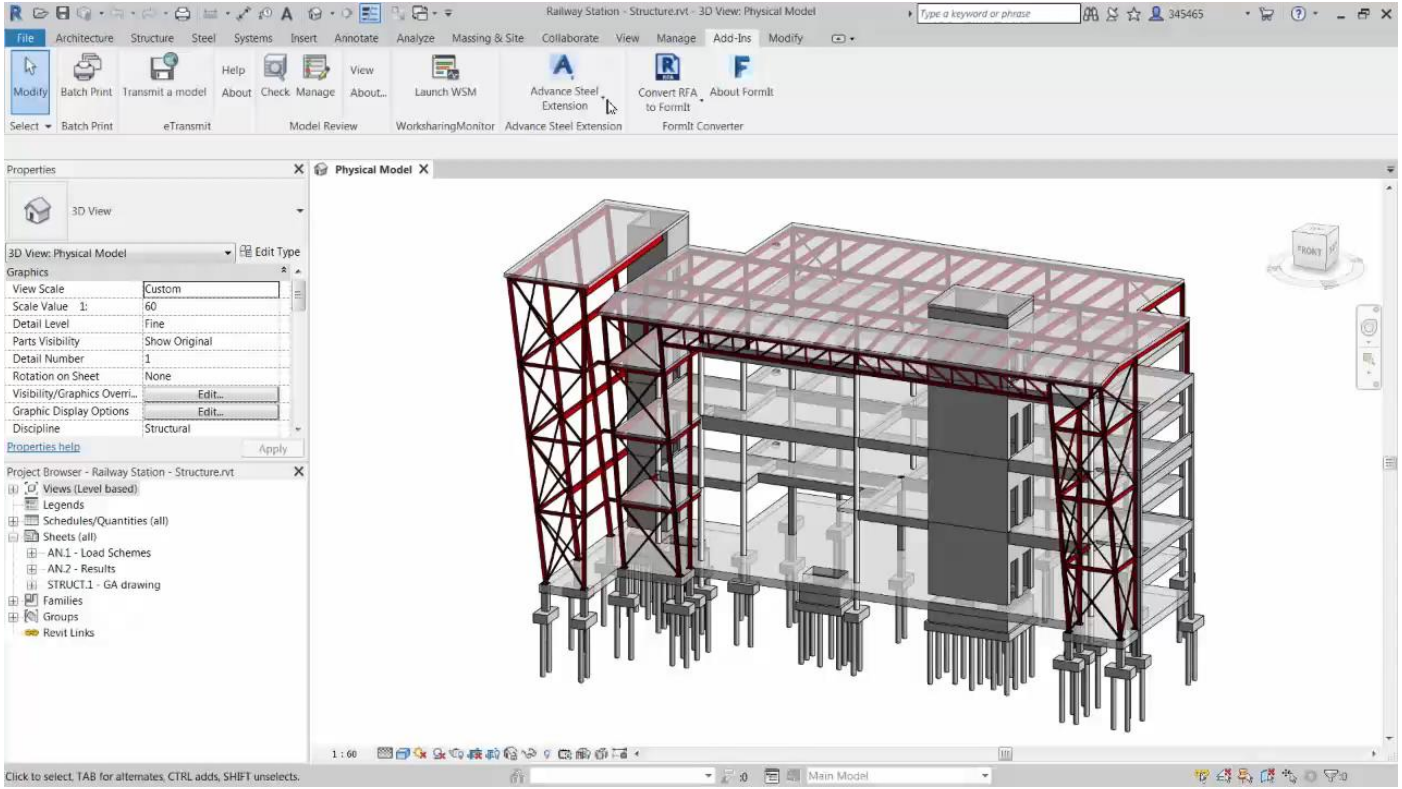
Connect Design to Fabrication

Communication of design intent with BIM 360 Docs



Connect Design to Fabrication

Steel connection fabrication deliverables with Advance Steel



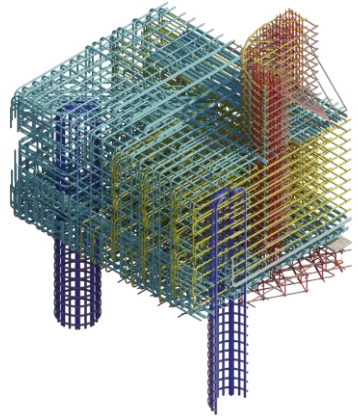
Business values of the AEC Collection

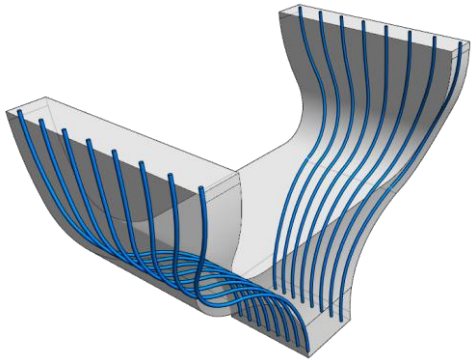
Value Propositon of AEC Collections

Structural Rebar Design & Detailing

AUTODESK® REVIT®

BENEFITS	• Create detailed and accurate 3D reinforcement designs • Create shop drawings and bending schedules • Check collisions between reinforcements • Design to Detailing workflow • Collaborate in a multi-user and multi-disciplinary 3D model environment • Interoperability with Infraworks for concrete bridge detailing
BUSINESS VALUES	• Reduce clashes both in the preconstruction and site execution phases • Deliver accurate 3D models, 2D drawings and schedules • Minimize model rework through better collaboration in design • Working in a collaborative environment • Reduce waste and field issues



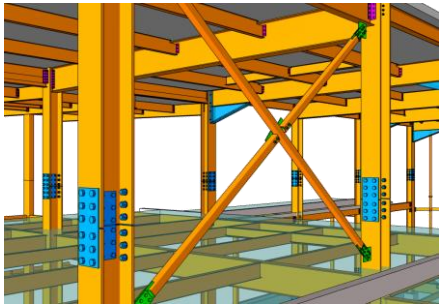


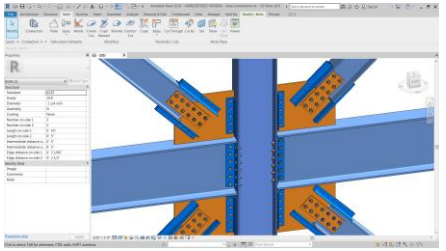
Value Propositon of AEC Collections

Structural Steel Design

AUTODESK® REVIT®

BENEFITS	• BIM-centric steel design & detailing • Physical and associated analytical model are created concurrently • Views and schedules are direct presentation of the underlying database • Cloud based analysis from within the product • Structural design creates main connections • Export connections to fabrication software • Connect Design with Construction
BUSINESS VALUES	• Lower costs and increase margin by reducing rework • Saving time with automation • Minimize errors and omissions with deliverables • Win more work by extending service offerings • Better coordinate and manage design changes



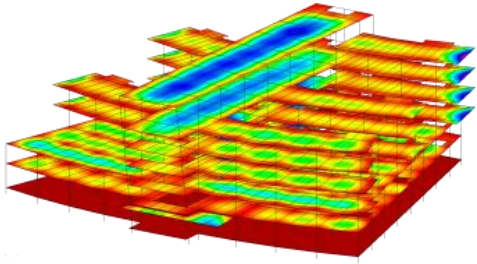


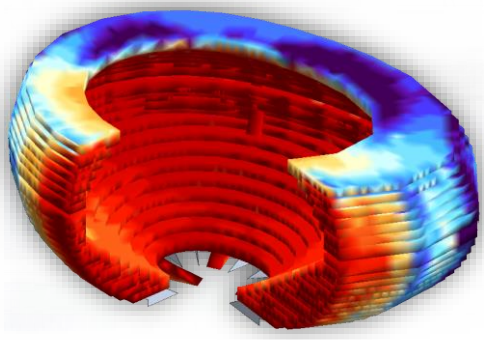
Value Propositon of AEC Collections

Structural Analysis

AUTODESK® ROBOT™ STRUCTURAL ANALYSIS PROFESSIONAL

BENEFITS	• Use bidirectional links with Autodesk Revit • Embrace Building Information Modeling (BIM) • Minimize inefficiencies with better analysis and design • Powerful analysis with finite element auto-meshing capabilities • More efficient nonlinear and dynamic algorithms • Design codes and capabilities for widely used structural materials • Delivers more flexibility for a broad range of structures
BUSINESS VALUES	• Faster calculation and simulation of complex models • Minimizes inefficiencies by enabling analysis and design to stay synchronized • Enhances collaboration and structural workflows from design to analysis



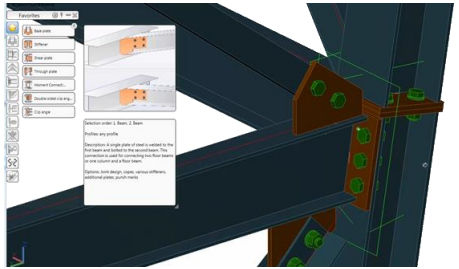


Value Propositon of AEC Collections

Structural Steel Detailing & Fabrication

AUTODESK®
ADVANCE STEEL

BENEFITS	• Integrates tightly with Revit • Familiar AutoCAD based platform • Extends Revit LOD for engineers • Direct interface with CNC machines • Automated connection detailing • Publish fab models to Navisworks
BUSINESS VALUES	• Lower costs and increase margin by reducing rework • Saving time with automation • Minimize errors and omissions with deliverables • Win more work by extending service offerings • Better coordinate and manage design changes



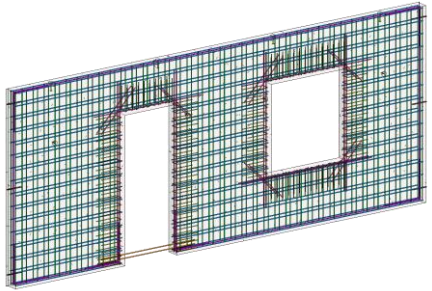
Value Propositon of AEC Collections

Structural Precast Detailing

AUTODESK® REVIT®

AUTODESK® STRUCTURAL PRECAST EXTENSION FOR REVIT®

BENEFITS	• Support for multiple stages of the precast workflow • Applicable for planar building elements • Automated rule based model segmentation • Fabrication focused authoring tools • Shop drawing generation • Connect to Fabrication automation with CNC
BUSINESS VALUES	• Precast modeling in a single BIM Authoring tool • More effective collaboration and interaction based on workflows and project requirements • Coordination between design and fabrication model • Reduce modeling and detailing time

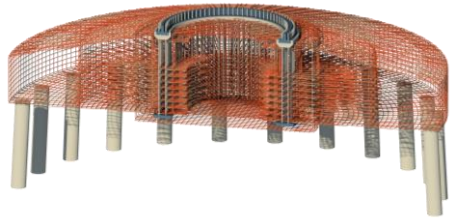


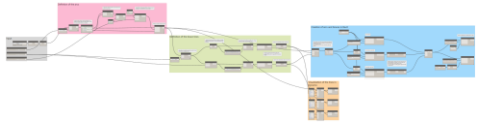
Value Propositon of Computational Design

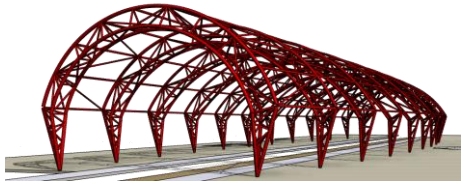
Dynamo for Revit

AUTODESK® REVIT® DYNAMO FOR REVIT®

BENEFITS	• Enables BIM-connected computational design (link with Revit) • Extend and customize BIM-connected model behavior in a simple environment • Quickly explore parametric design concepts • Solve complex geometric problems from simple data, logic and analysis • Evaluate designs and analyze geometry
BUSINESS VALUES	• Study more design options in less time • Manage risk by exposing tradeoffs and understanding systems and connections at the conceptual phase • Gain more projects with a high degree of complexity • Greater design insight with less manual effort • Gain time by automating repetitive tasks • Communicate your work easily and efficiently with project teams with shareable content



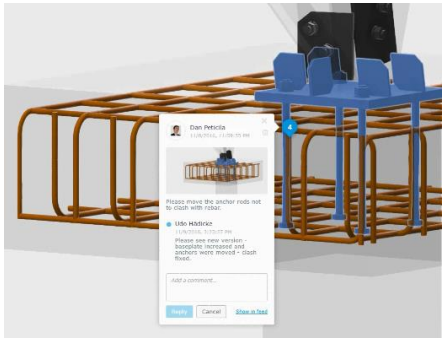




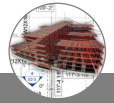
Value Propositon of Collaboration for Engineering

BIM 360 Design & BIM 360 Docs

	AUTODESK® BIM 360® DESIGN	AUTODESK® BIM 360™ DOCS
BENEFITS	• Centralized access to project data for all team members • Use latest and correct version of documents and plans • Audit trail • In-context communication • BIM 360 Integration for better team collaboration • Connect external team members and project contributors • Collaborative viewing, markup and issue management • Web and mobile access to all project plans, models and docs	
BUSINESS VALUES	• Minimize complex and costly IT setup and maintenance • Save time and reduce risk • Eliminate errors in construction projects • Access to your data anytime and anywhere	



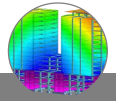
Benefits of the Structural Solutions Portfolio



Structural Model

+ Create multi-material structural models
+ Automate tasks and design workflows
+ Explore parametric conceptual designs
+ Collaborate with other design stakeholders
+ Keep all designs within the same design environment

Designer



Analyze & Verify

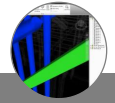
+ Seamless connection between design and analysis
+ Conduct advanced analysis
+ Easily visualize detailed analysis results
+ Pull quantities and value engineer from the design model
+ Optimize structure running code checking
+ Guarantee safety and human comfort

Engineer

Detailing

+ Carry engineering intent from design to detailing
+ Optimize design around constructability factors
+ Merge design changes with better accuracy and keep documentation up to date
+ Model structural details
+ Automate shop drawings, NC files and reports

Detailer



Fabricate & Install

+ Drive workshop processes using model data
+ Plan construction sequencing
+ Perform clash detection
+ Verify field as-builts, track materials with BIM 360
+ Share as-built model with contractor and owner
+ Use point data from the model to drive field layout (with robotic instruments)

Fabricator Contractor

How did we do ?

- Your class feedback is critical. Fill out a **class survey** now.
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- Give feedback after each session.
- AU speakers will get feedback in real-time.
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Q&A

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