

Construction IQ – A Smart Assistant for Diagnosing Risk on Construction Projects

Stella Xu, *Autodesk Inc.*

Matt Anderle, *AECOM*

Aaron Phillips, *Danis Construction*

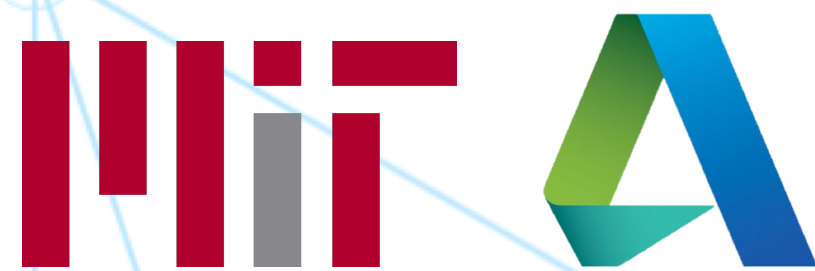


SPEAKERS



STELLA XU

Data Scientist
Autodesk



MATT ANDERLE

BIM Director B+P Americas
AECOM



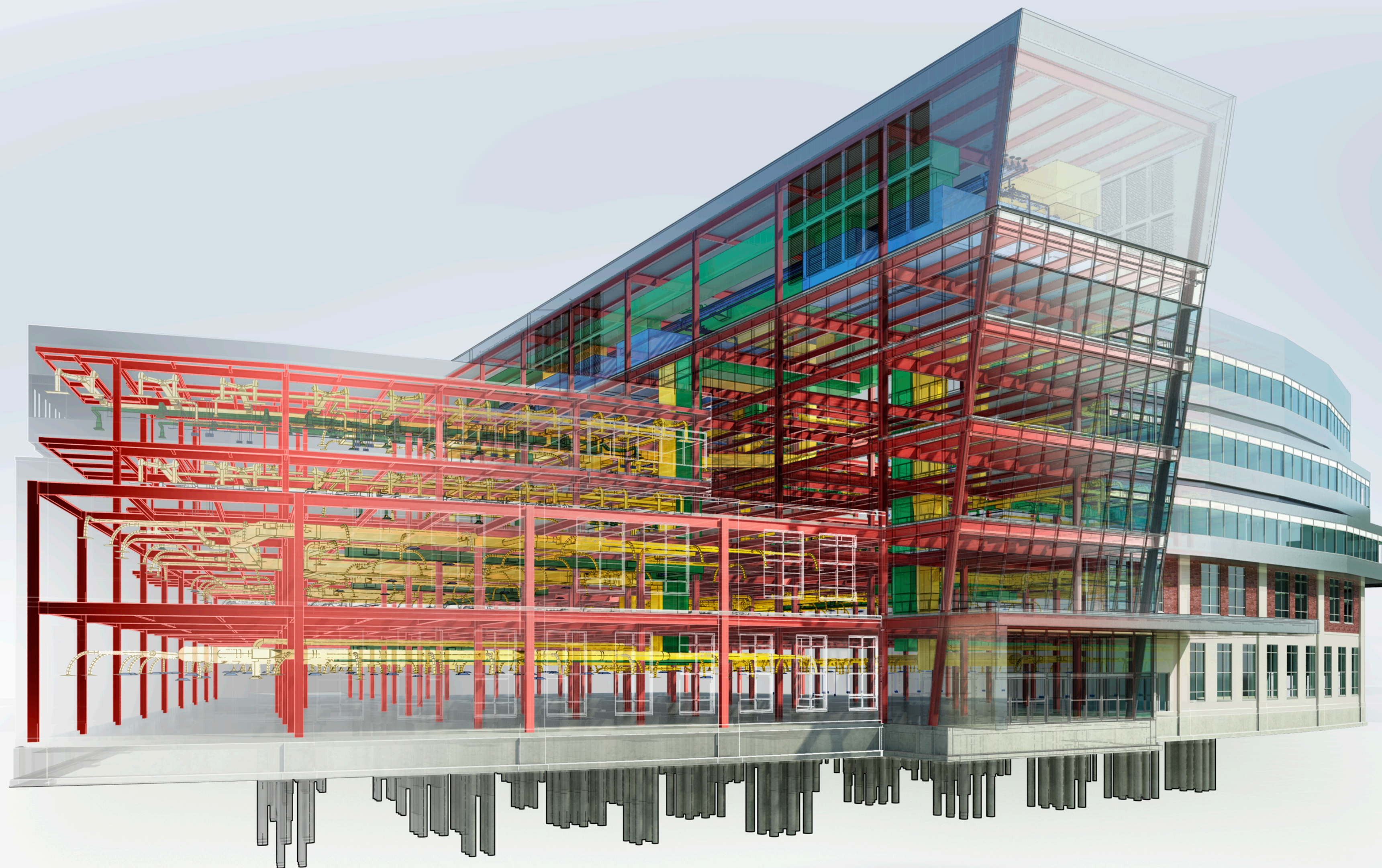
AARON PHILLIPS

Director of VDC
Danis



AGENDA

- Introduction
- AECOM point of view
- Danis point of view
- Diagnosing risk with Construction IQ
- Q & A











GAPS BETWEEN DESIGN AND CONSTRUCTION

- ❑ Missing dimensions/specifications
- ❑ Design conflicts/Constructability
- ❑ Unforeseen conditions



RFI

In most Construction Documents, it is inevitable that the agreement, drawings and specifications will not adequately address every single matter. Therefore, there may be gaps, conflicts or subtle ambiguities.

-- American Council of Engineering Companies of Kansas



◆-----◆
70% of a construction project's RFIs stem from design or documentation errors.¹

◆-----◆
A study from Engineers Daily estimated that **design errors accounted for 38%** of construction disputes.²



1 Autodesk Research

2 Engineers Daily

Design and Constructability Review



- Scope
- Budget and schedule
- **Completeness**
- Consistency**
- Coordination**
- Constructability**

Lack of audit and review processes is a **margin-killing** construction risk

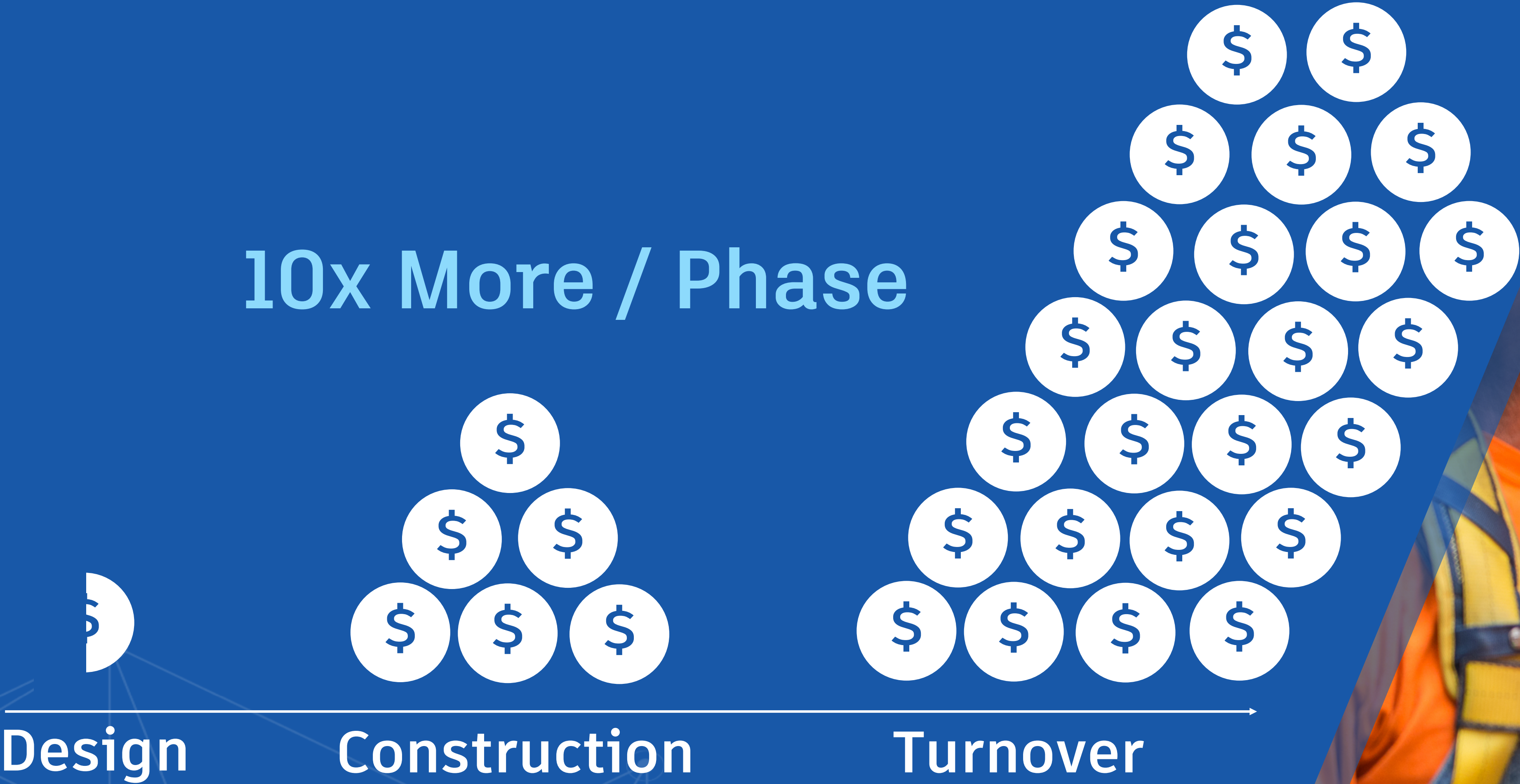
HOW DO WE MITIGATE
THE RISK?



Construction Industry Today

COST TO RESOLVE ISSUES

10x More / Phase





MITIGATING RISK

Pre-Construction

Construction

Design review

Project
management



Reduce or prevent RFIs

Industry point of view

Matthew Anderle

BIM Director B+P Americas

AECOM



About myself

Matthew Anderle, AECOM

Building Information Modeling (BIM) Director for the Buildings+Places Americas business line of AECOM. He is a BIM and technology evangelist with over 19 years of experience establishing global BIM workflows and standards around content, computational BIM, interoperability, and BIM consultation as a service. His experience spans over multiple market sectors with emphasis on large healthcare facilities, data centers, aviation, government projects, and science facilities. Mr. Anderle serves AECOM as a leader in the advancement and efficient implementation of BIM processes for a variety of project types. He manages and directs large distributed project teams to successfully implement BIM collaboration workflows, enabling global offices to work as one entity.



“In today's accelerated design and construction climate, information is the new paper, where printed drawings once conveyed our projects, going digital emphasizes data as the foundation of our design. We achieve program certainty and validate constructability by pairing data-centric design tools with risk analytics which positions us to achieve operational certainty.”

Matthew Anderle
AECOM

AECOM is...

The world's premier infrastructure firm,
delivering professional services throughout the
project lifecycle.

7 continents

87,000 employees

US\$20.2B full-year 2018 revenue

US\$6B market cap

#157 Fortune 500

Ranked #1 in Transportation and General
Building in Engineering

News-Record's 2019 "Top 500 Design Firms"

One of Fortune magazine's "World's Most
Admired Companies" for the fifth consecutive
year

AECOM Imagine it.
Delivered.



Challenges

- Global Presence
- Varied Project Markets
- Distributed Teams
- Complex Model Schemas



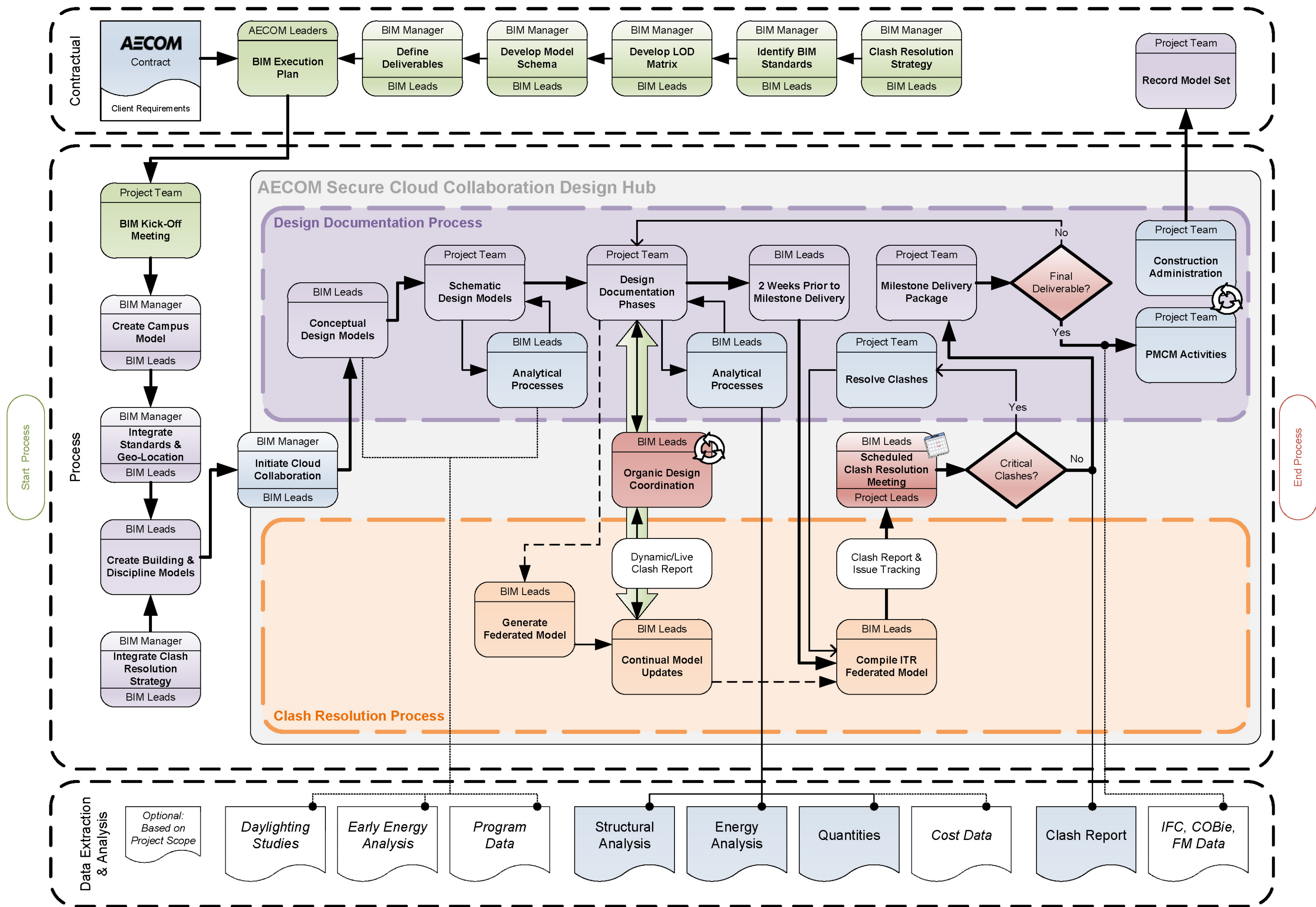


Data Strategy ➡ Design Certainty

- Geometric Certainty
- Data Certainty
- Cost Certainty

✓ Achieve Operational Certainty







Example Project Complexities

About the Project:

A Joint Venture Team Designing a Medical Center Campus

17
FIRMS

122
MODELS

12
BUILDINGS

04
**HOSTING
METHODS**



About the Project: A Joint Venture Team Designing a Medical Center Campus



Each with different levels of data exchange capabilities, model hosting and experience

300+ unique users including:

- Project Executives
- Discipline Leads
- Quality Managers
- Trade Specialists
- BIM Team
- Specification Writers
- Cost Estimators

A variety of file types including:

- Autodesk Revit
- Autodesk Civil 3D
- Autodesk AutoCAD
- Microsoft Excel
- Microsoft Word
- Adobe InDesign
- Adobe Acrobat
- Bluebeam
- Proprietary software



About the Project:

A Joint Venture Team Designing a Medical Center Campus



Model schema organized by:

CAMPUS

BUILDING

DISCIPLINE

SUB-DISCIPLINE

AGGREGATE MODELS



About the Project:
A Joint Venture Team Designing a Medical Center Campus

12
BUILDINGS

PARKING

Multiple Out Buildings

Multiple Out Buildings

GARAGE

Multiple Out Buildings

Multiple Out Buildings

MAINTENANCE BUILDING

HOSPITAL

Central Utility Plant

Laundry Facility Main Guard Station

GARAGE

PARKING

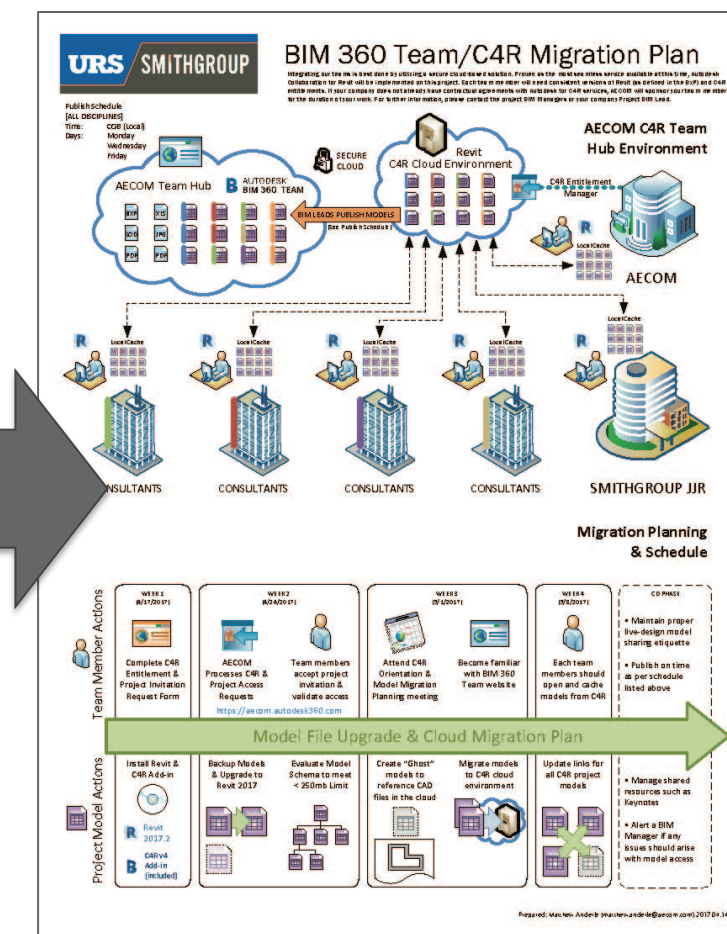
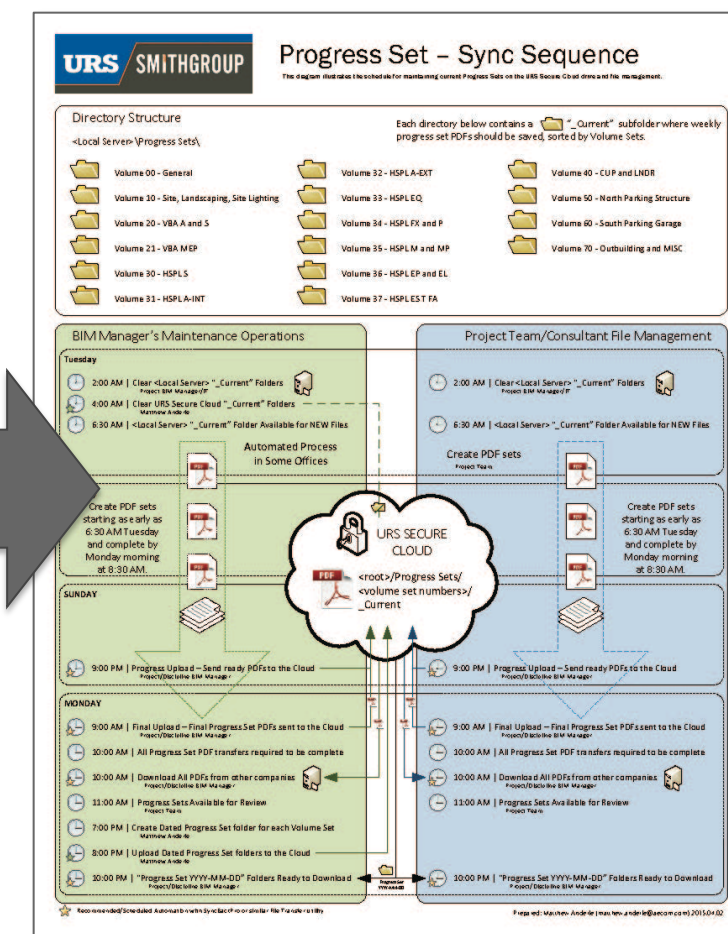
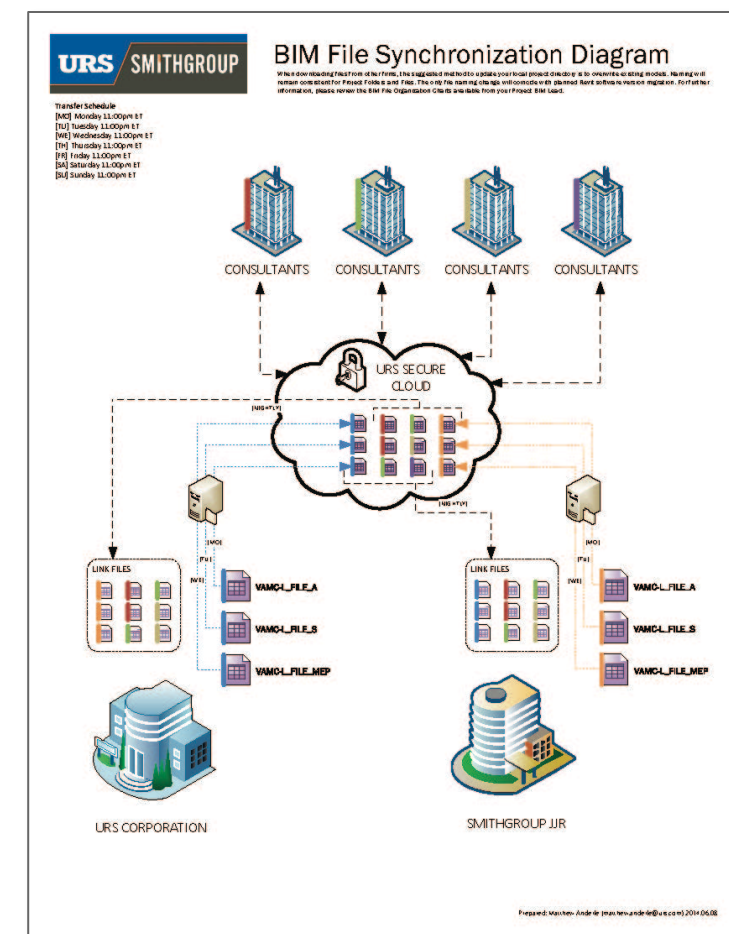
WATER TOWER

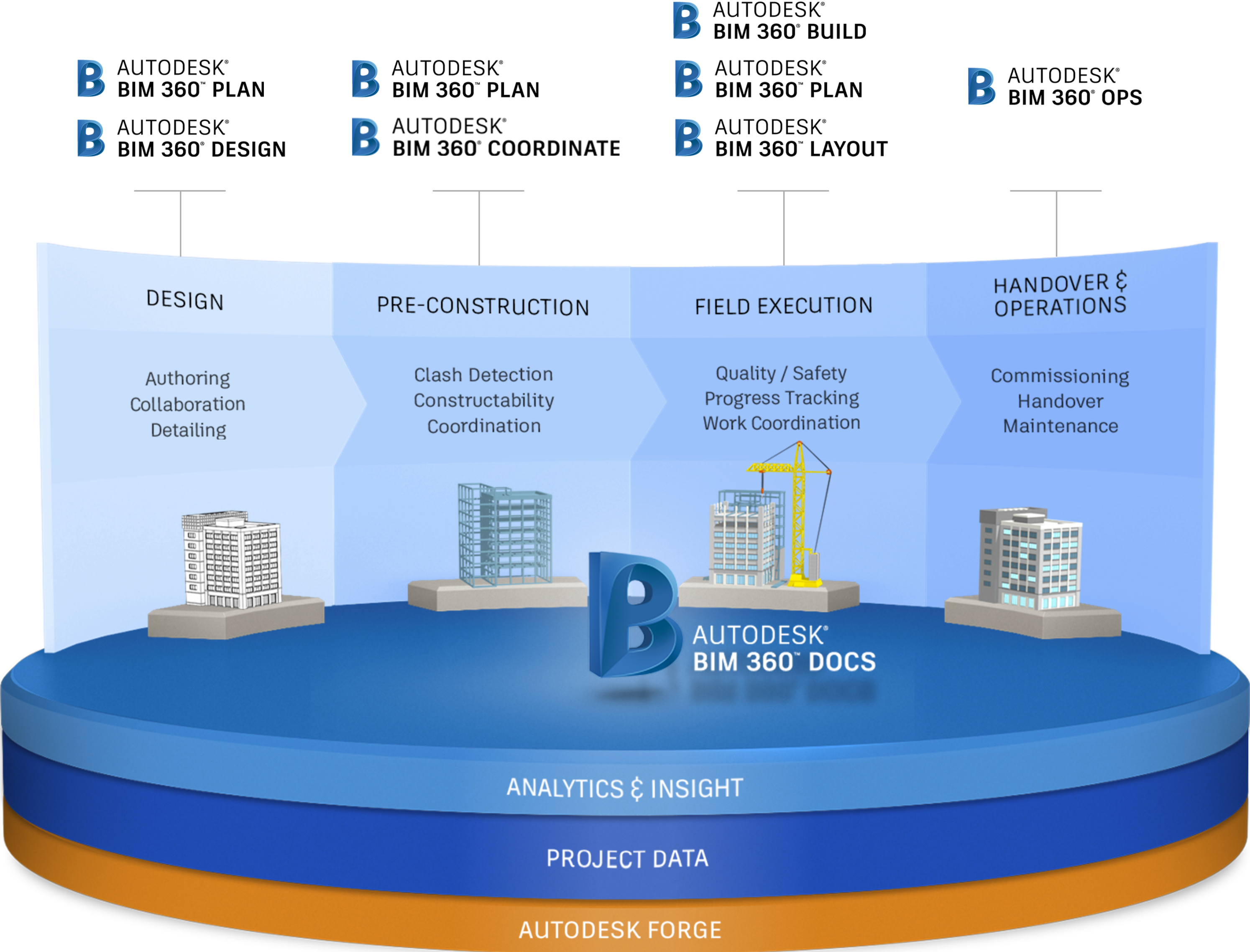


About the Project: A Joint Venture Team Designing a Medical Center Campus

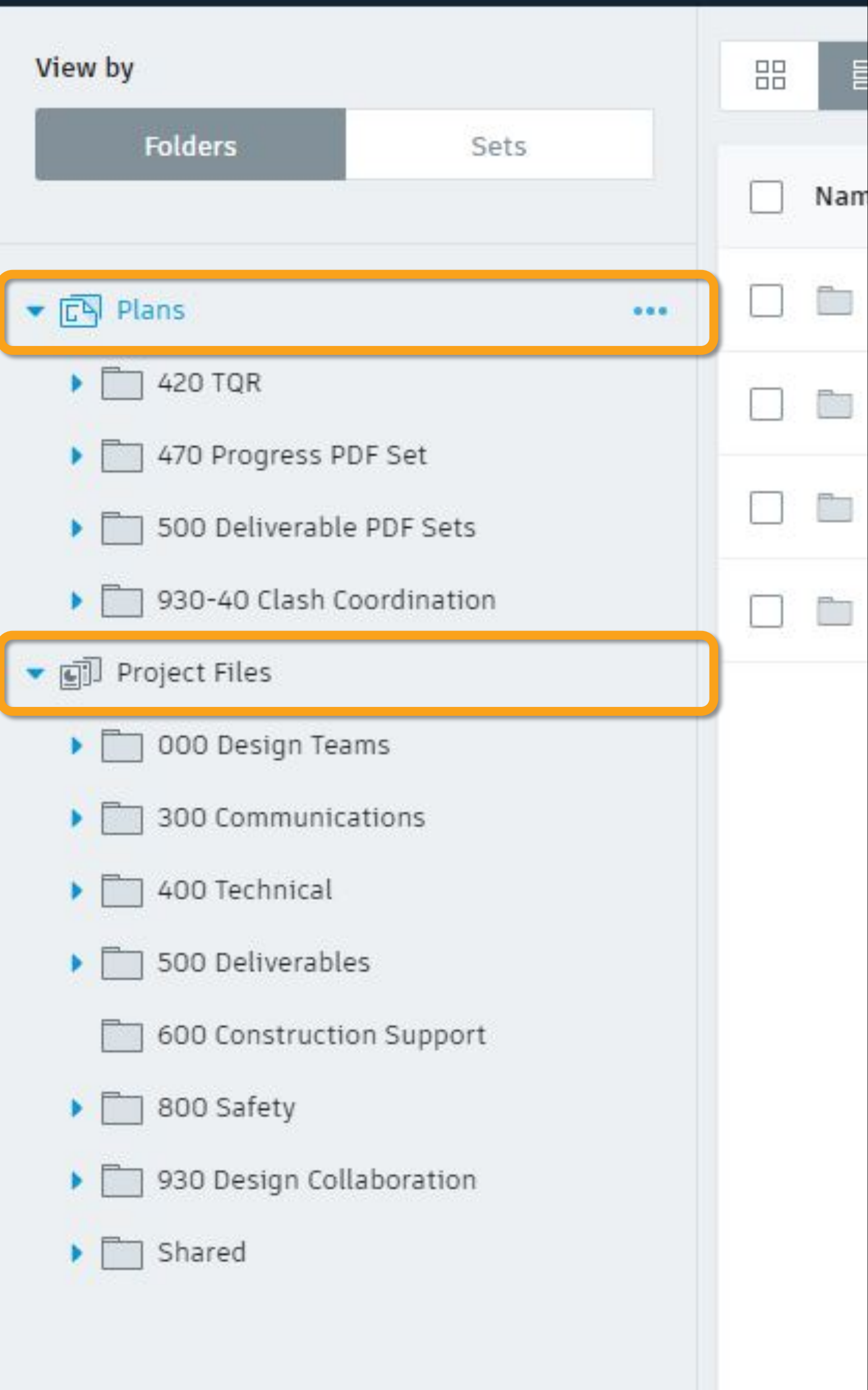
04 HOSTING METHODS

The duration of the project afforded us the opportunity to leverage several collaboration platforms which culminated in BIM 360 Design





Document Management



Plans vs Project Files

Plans Folder

- Leverage the advanced functionality which extracts their contents into individual views and/or sheets.
- Harvest metadata for review and validation
- Examples include:
 - **Revit Models:** extract into Views and Sheets within the Publish Sets
 - **DWG Files:** extract into model space and paper space views
 - **PDF Files:** extract into individual pages and can extract data

Project Files

- Central repository for Revit models and Microsoft Office 365 documents stored in this directory tree. The integration of both of these software packages allow for live editing in BIM 360 Docs.

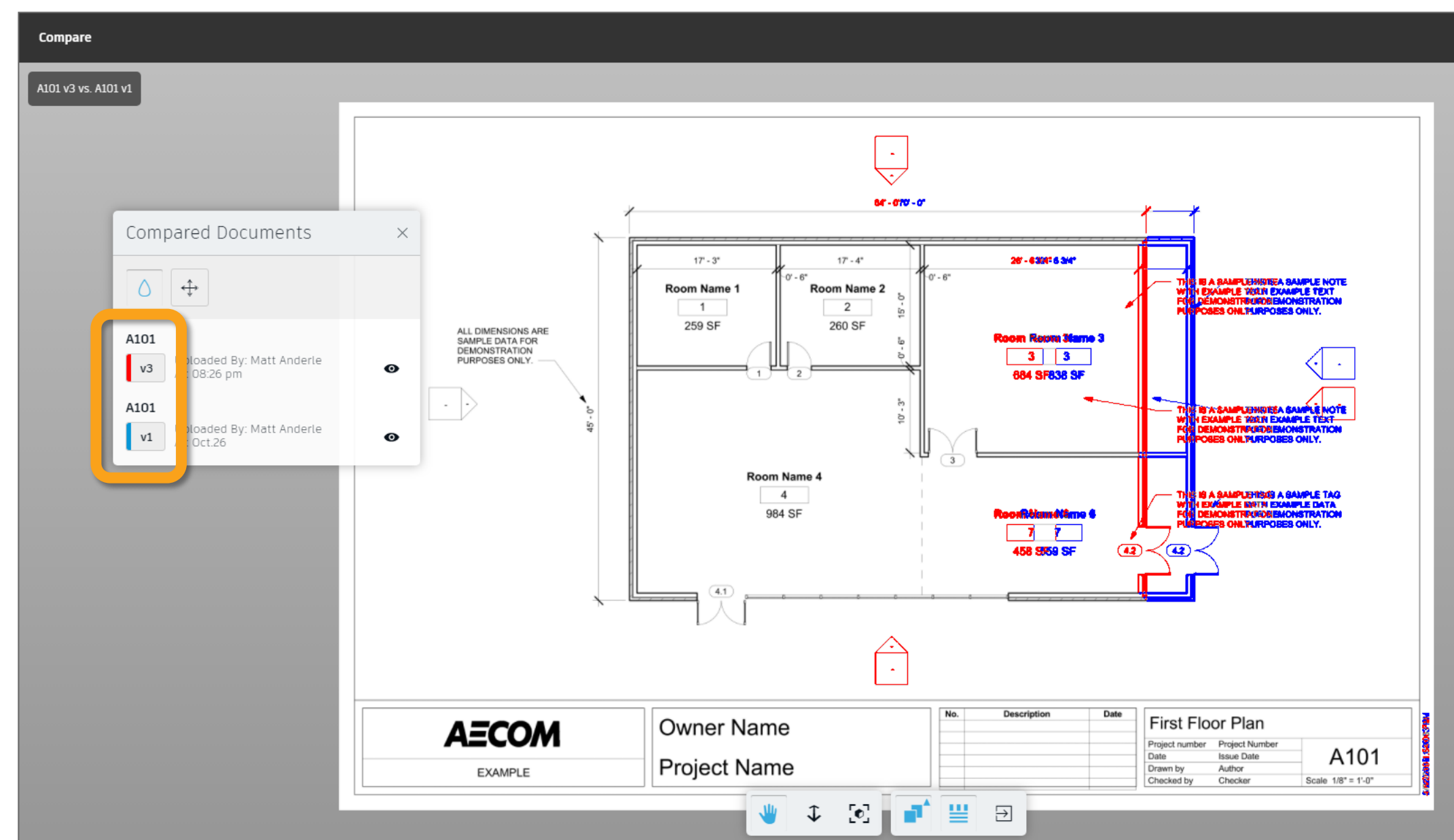
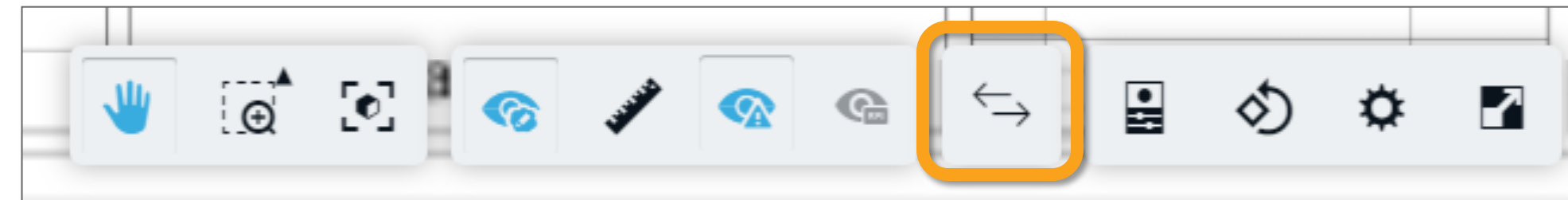


Design Review Tools

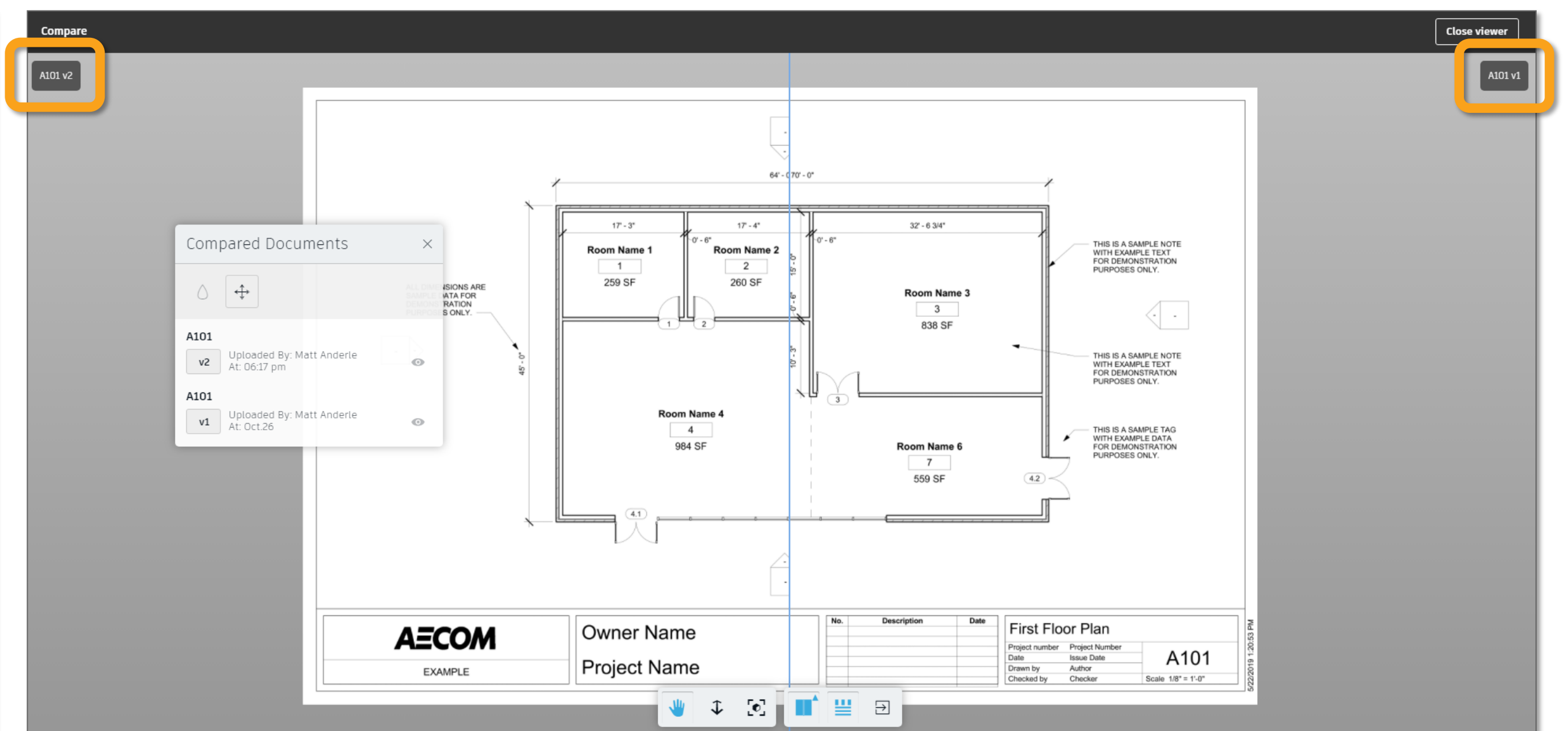
Version history is considered significant data

<input type="checkbox"/> Name ^	Title	Set	Version	Last updated
<input type="checkbox"/> A101	First Floor Plan	AU2019 Presentati...	V2	Nov 10, 2019 6:20 PM

Often comparing versions of information is important



Overlay

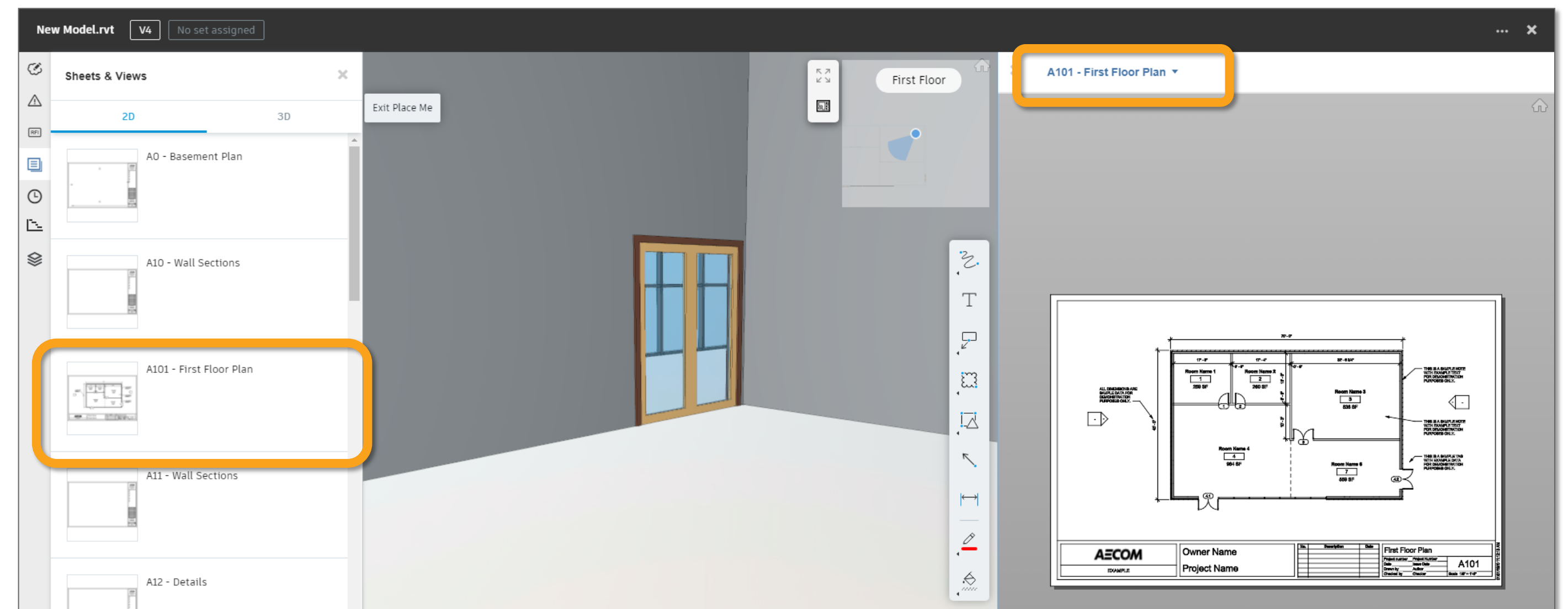
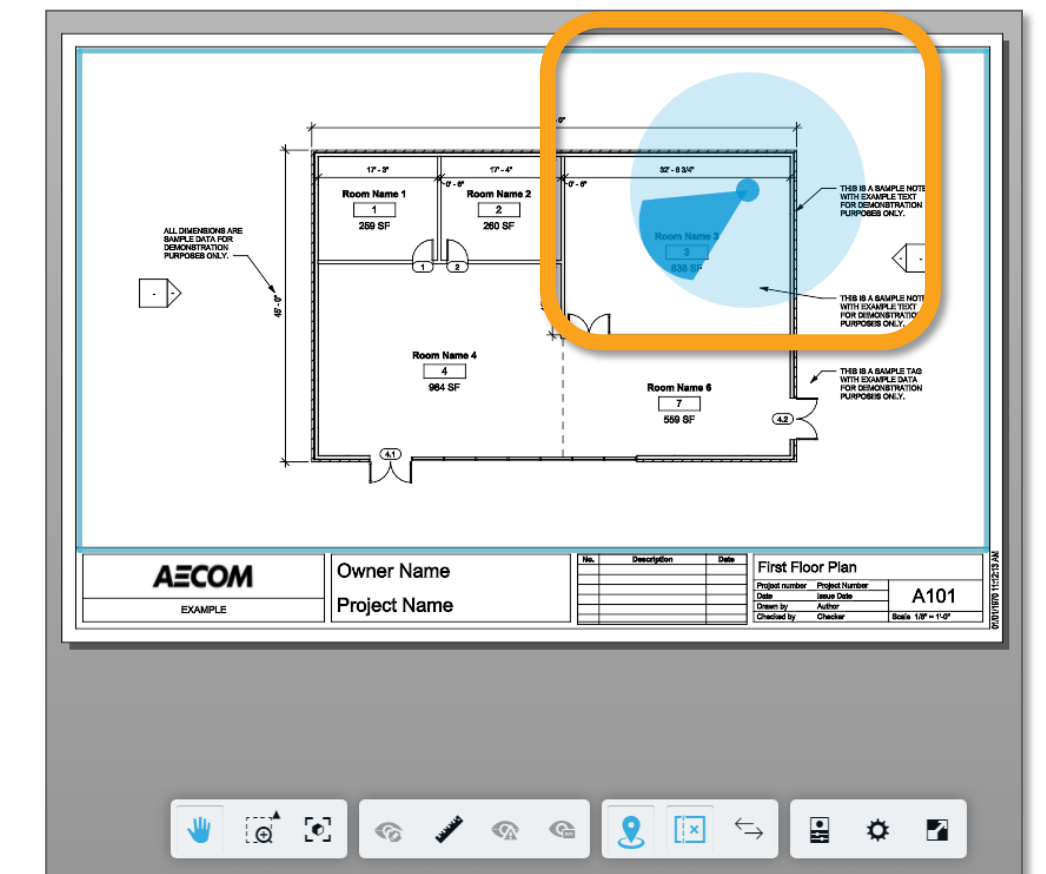
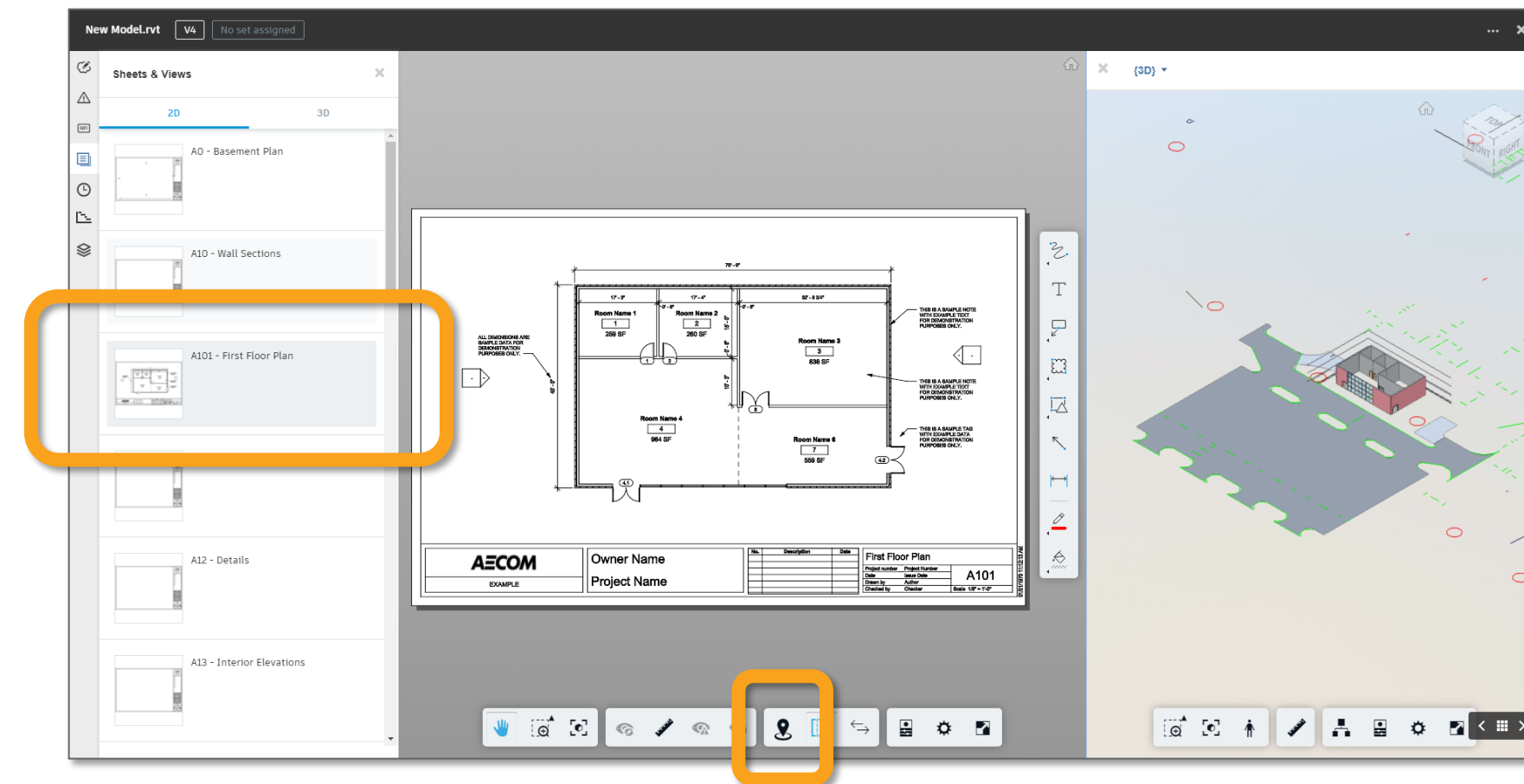


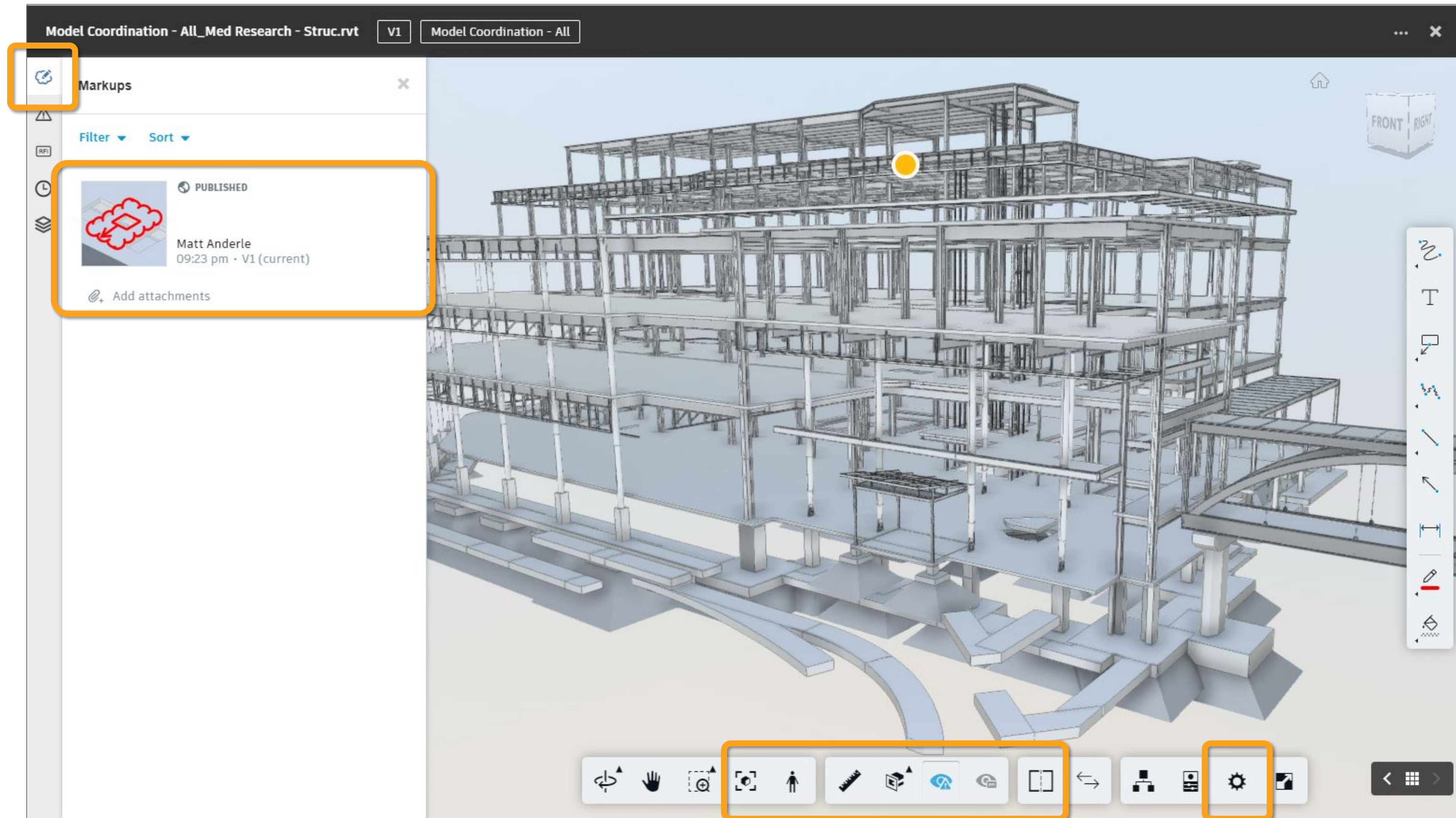
Side by Side

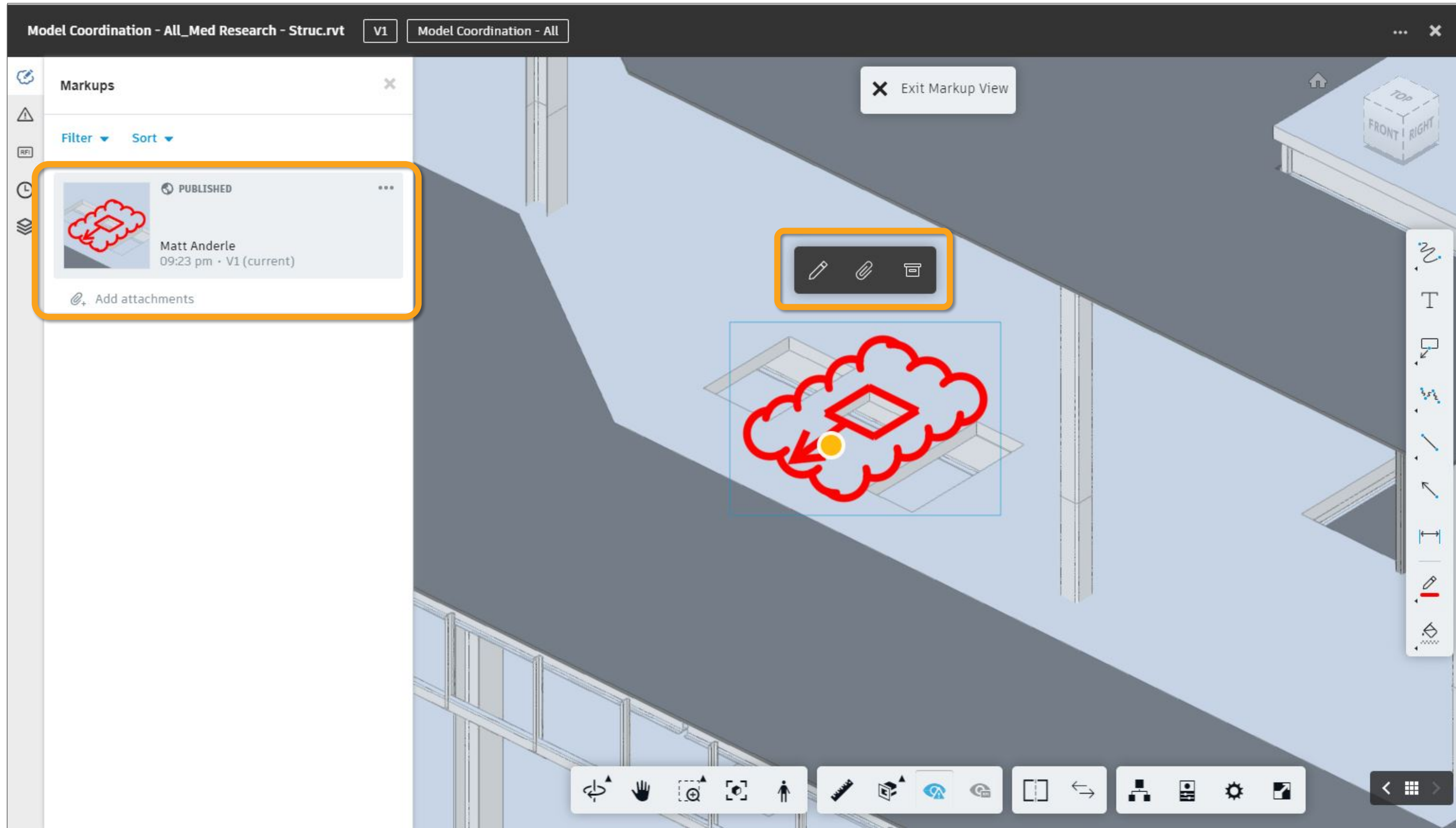


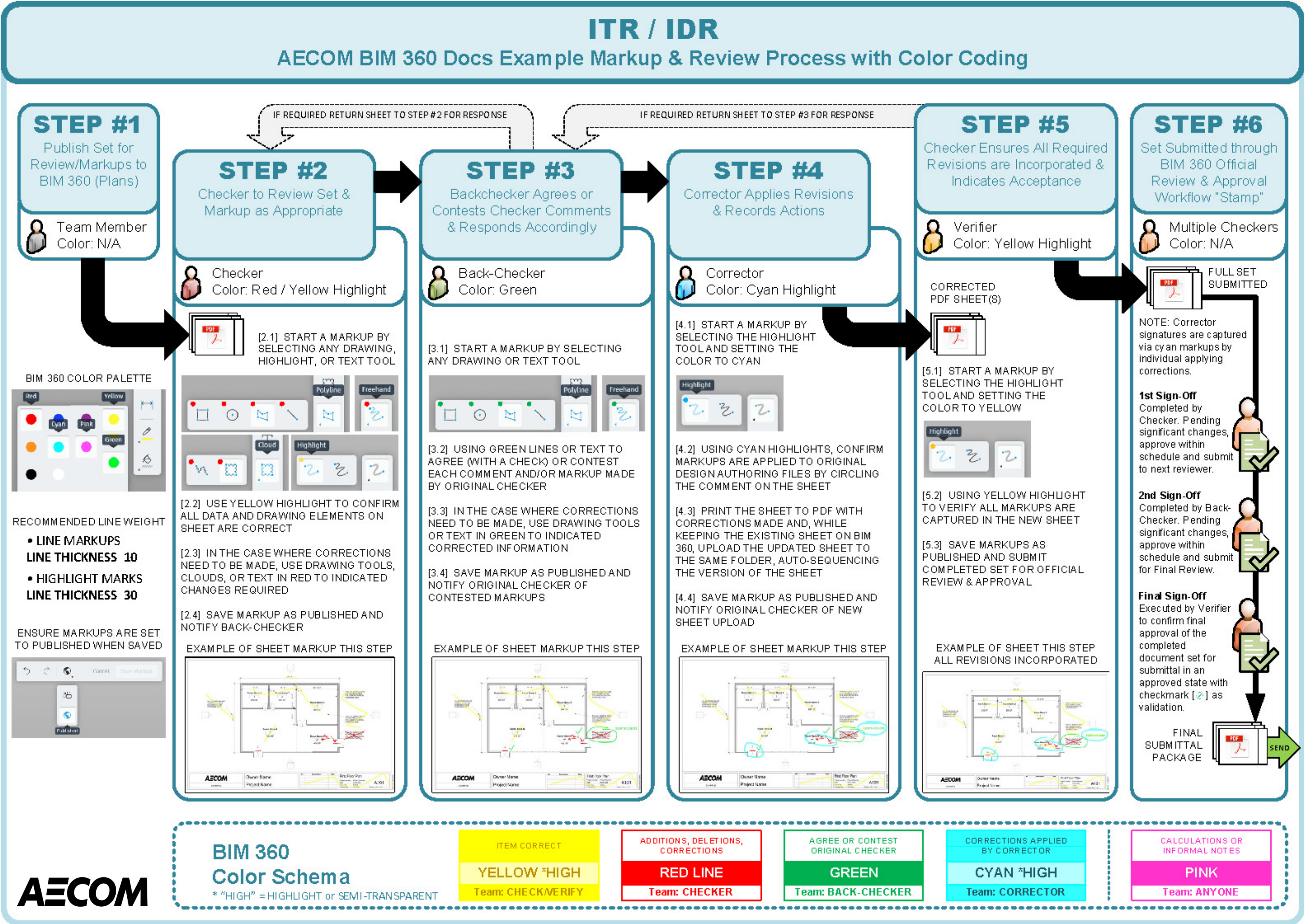
Design Review Tools

- Immersive visual reviews
- The user is placed into the 3D model in First Person Mode
- Provides opportunity to review multiple sources of data simultaneously









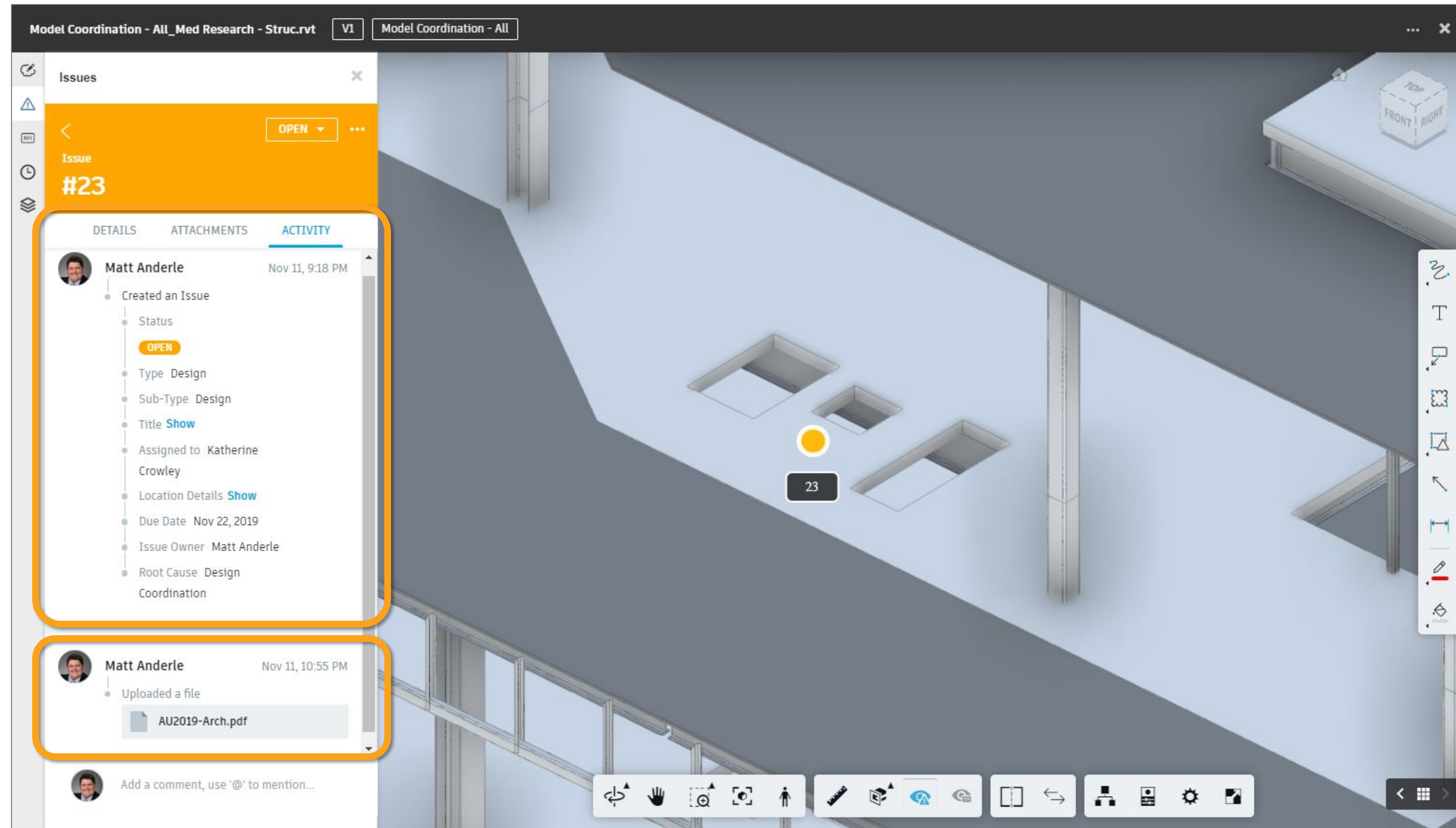
AUTODESK BIM 360 | AECOM | 00000000-AU2019

Document Management FOLDERS REVIEWS TRANSMITTALS ISSUES

Search Export Create Issue

ID	Type	Sub-type	Title	Location	Assigned to	Company	Due date	Linked document		
24	Design	Design	Column Size	-	Katherine Crowley	AECOM	Nov 22, 2019	Model Coord...c.rvt	0	0
23	Design	Design	Floor Opening Sizes	-	Katherine Crowley	AECOM	Nov 22, 2019	Model Coord...c.rvt	1	0
22	Design	Design	Check bridge ceiling ali...	-	Dennis McNeal	AECOM	Nov 22, 2019	Med Resear...t.rvt	0	0
21	Coordination	Clash	Clock [3158576] and Rn...	-	Matt Anderle	AECOM	-	Model Coord...E.rvt	0	0
20	Coordination	Clash	Clock [3051204] and Fle...	-	Matt Anderle	AECOM	-	Model Coord...E.rvt	0	0
19	Coordination	Clash	893-OB40 [3395147] an...	-	Matt Anderle	AECOM	-	Model Coord...E.rvt	0	0
18	Coordination	Clash	23 36 16_rnk - Terminal...	-	Matt Anderle	AECOM	-	Model Coord...h.rvt	0	0
17	Coordination	Clash	23 33 13_rnk - Damper ...	-	Matt Anderle	AECOM	-	Model Coord...h.rvt	0	0
16	Coordination	Clash	23 33 13_rnk - Damper ...	-	Matt Anderle	AECOM	-	Model Coord...h.rvt	0	0
15	Coordination	Clash	Pipe Clashes with duct	-	Matt Anderle	AECOM	-	Model Coord...e.rvt	0	0
14	Coordination	Clash	Elbow Reducing - Threa...	-	Matt Anderle	AECOM	-	Model Coord...e.rvt	0	0
13	Coordination	Clash	Pipe Types [2118423] a...	-	Matt Anderle	AECOM	-	Model Coord...e.rvt	0	0
12	Coordination	Clash	Pipe Types [2117917] an...	-	Matt Anderle	AECOM	-	Model Coord...e.rvt	0	0
11	Coordination	Clash	Shelvino [3829620] and...	-	Matt Anderle	AECOM	-	Model Coord...E.rvt	0	0

https://docs.b360.autodesk.com 1 of 1



The screenshot displays the Autodesk BIM 360 Project Admin interface. The top navigation bar includes the Autodesk BIM 360 logo, the project name 'AECOM > 00000000-AU2019', and a user profile icon. The main navigation menu on the left lists 'Overview', 'Issues' (highlighted with an orange box), 'Locations', 'Document Management', 'Project Management', 'Design Collaboration', and 'Model Coordination'. The top right navigation bar contains 'MEMBERS', 'COMPANIES', 'SERVICES' (highlighted with an orange box), and 'PROFILE'. Under the 'SERVICES' tab, the 'Custom Attributes' sub-tab is selected and highlighted with an orange box. Below this, there is a search bar labeled 'Find an attribute' and a 'Create new attribute' button (highlighted with an orange box). A table lists existing attributes:

Attribute Title	Type	Values	Description
Action Response	Dropdown	Concur, Non-Concur, F...	...



Custom Data Integration

Issue #23

OPEN

DETAILS

ATTACHMENTS

ACTIVITY

Linked document

Model Coordination - All_Med Research - Struc.rvt [V1, current]

Description

Add description

Response

Unspecified

Photos

Action Response

Select...

Concur

Non-Concur

For Information Only

Check and Resolve

Clear

AUTODESK BIM 360 | AECOM > 00000000-AU2019

Document Management

FOLDERSREVIEWSTRANSMITTALSISSUES

Search

Export

Create Issue

ID	Action Response	Type	Sub-type	Title	Location	Assigned to	Company	Due date	Linked document			
24	-	Design	Design	Column Size	-	Katherine Crowley	AECOM	Nov 22, 2019	Model Co...			
23	Check and Resolve	Design	Design	Floor Opening Sizes	-	Katherine Crowley	AECOM	Nov 22, 2019	Model Co...			
22	-	Design	Design	Check bridge ceiling ali...	-	Dennis McNeal	AECOM	Nov 22, 2019	Med Resi...			
21	-	Coordination	Clash	Clock [3158576] and Rn...	-	Matt Anderle	AECOM	-	Model Co...			
20	-	Coordination	Clash	Clock [3051204] and Fle...	-	Matt Anderle	AECOM	-	Model Co...			
19	-	Coordination	Clash	893-OB40 [3395147] an...	-	Matt Anderle	AECOM	-	Model Co...			
18	-	Coordination	Clash	23 36 16_rnk - Terminal...	-	Matt Anderle	AECOM	-	Model Co...			
17	-	Coordination	Clash	23 33 13_rnk - Damper ...	-	Matt Anderle	AECOM	-	Model Coor...h.rvt	0	0	
16	-	Coordination	Clash	23 33 13_rnk - Damper ...	-	Matt Anderle	AECOM	-	Model Coor...h.rvt	0	0	
15	-	Coordination	Clash	Pipe Clashes with duct	-	Matt Anderle	AECOM	-	Model Coor...e.rvt	0	0	
14	-	Coordination	Clash	Elbow Reducing - Threa...	-	Matt Anderle	AECOM	-	Model Coor...e.rvt	0	0	
13	-	Coordination	Clash	Pipe Types [2118423] a...	-	Matt Anderle	AECOM	-	Model Coor...e.rvt	0	0	

Showing 1 - 24 of 63 items

1 of 1

Search columns

Standard attributes

☐ Root cause

☐ Created by

☐ Created on

☐ Updated by

☐ Updated on

☒ Attachments

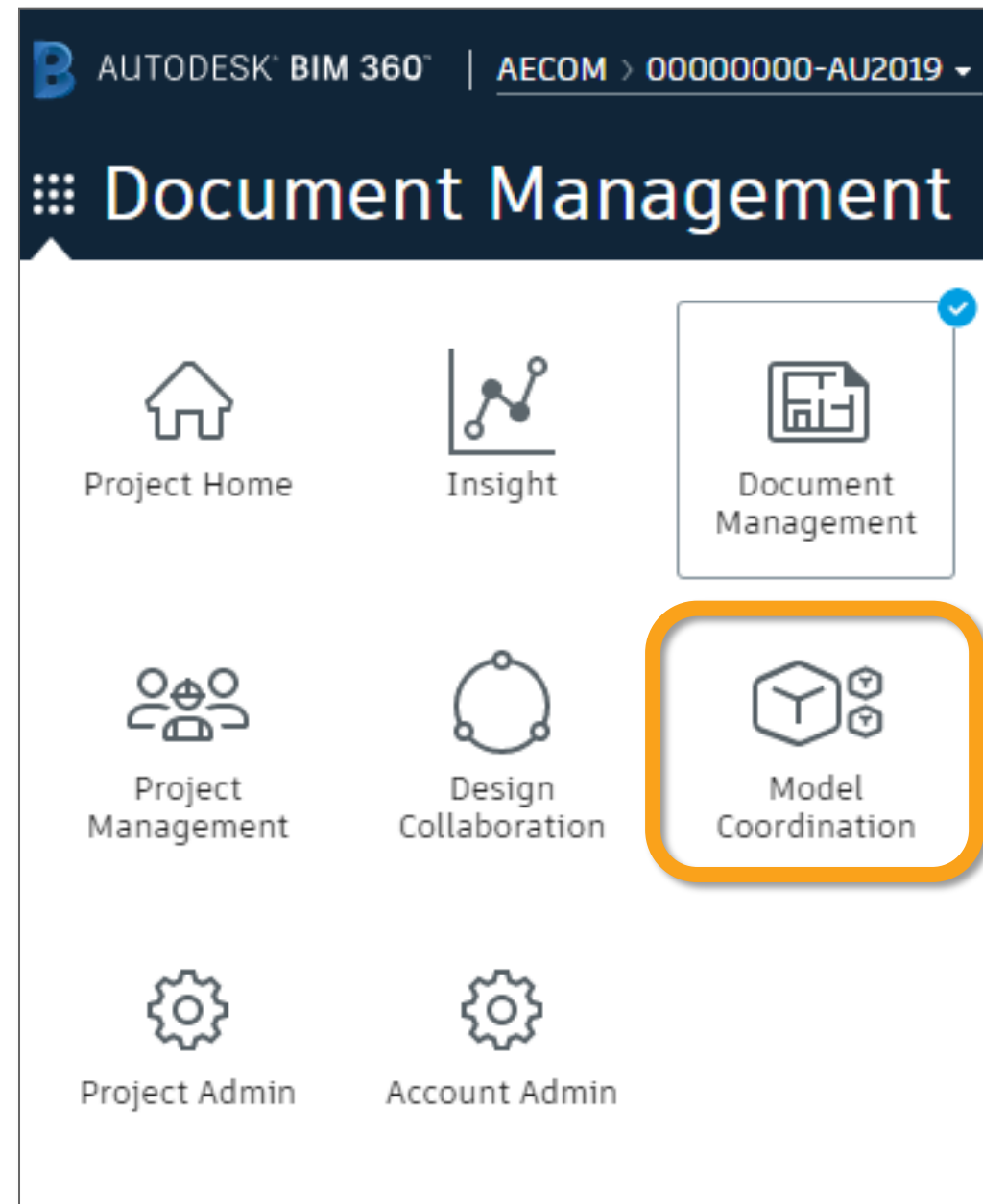
☒ Comments

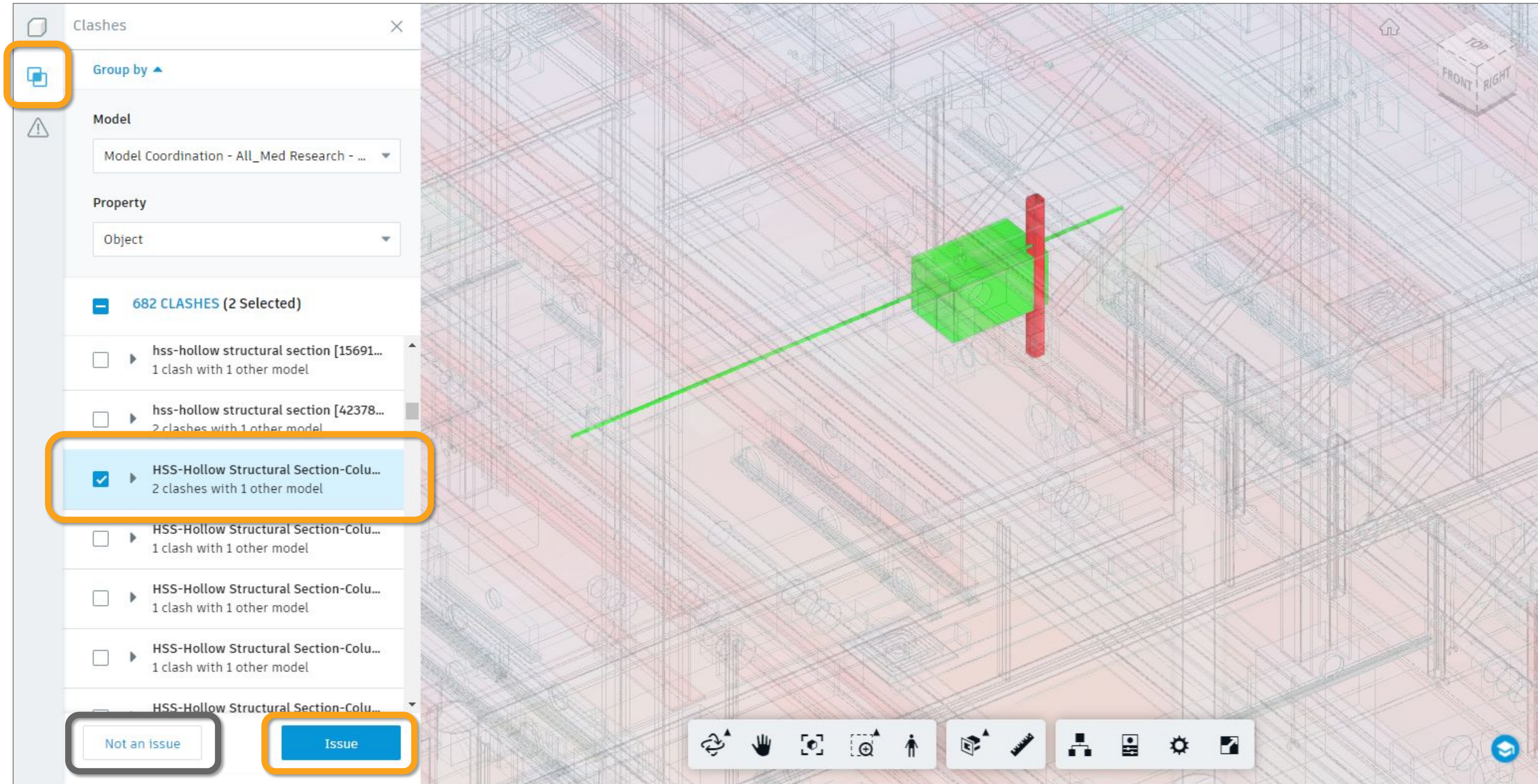
Custom attributes

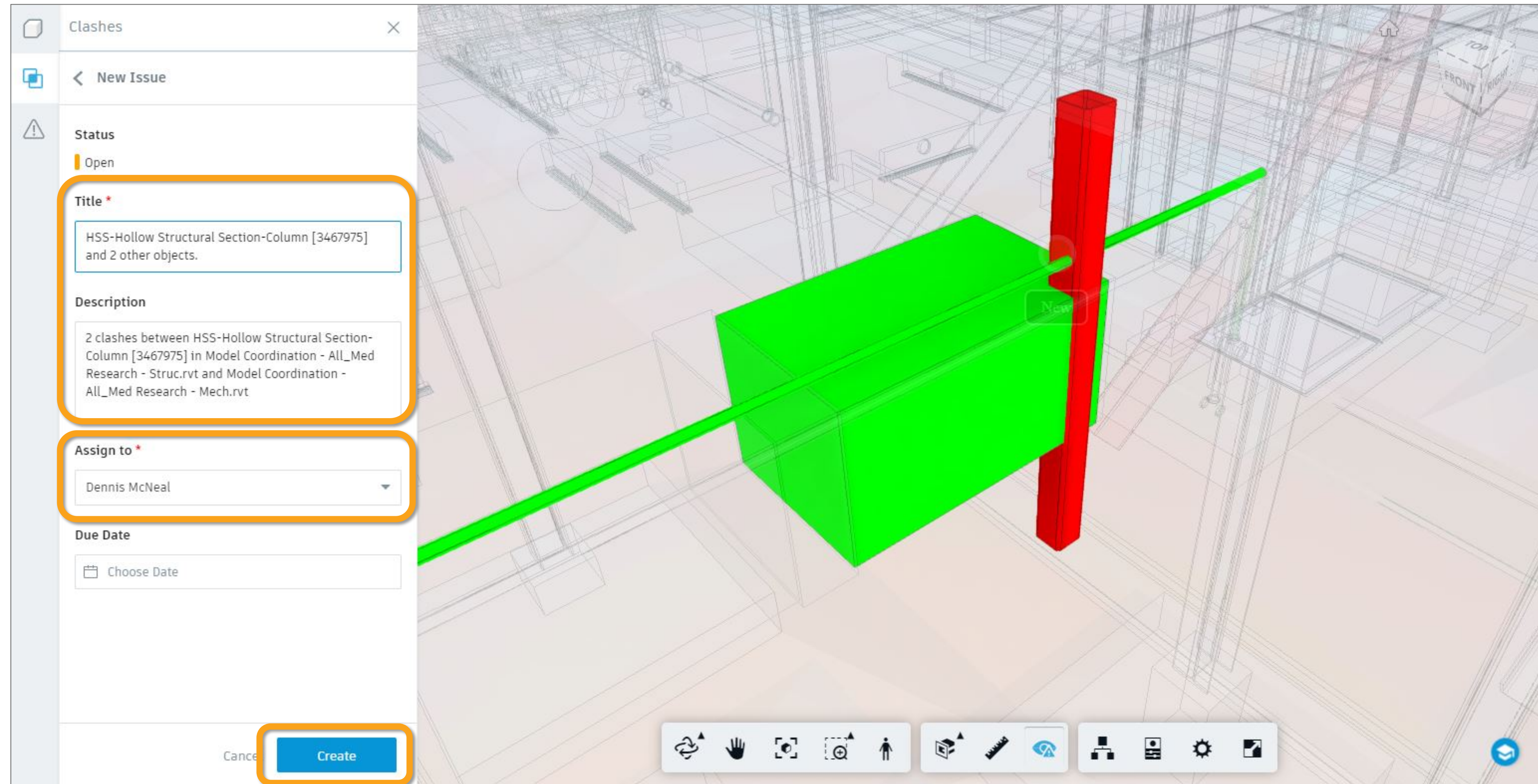
☒ Action Response



Design Coordination Tracking







Clashes

New Issue

Status
Open

Title *
HSS-Hollow Structural Section-Column [3467975] and 2 other objects.

Description
2 clashes between HSS-Hollow Structural Section-Column [3467975] in Model Coordination - All_Med Research - Struc.rvt and Model Coordination - All_Med Research - Mech.rvt

Assign to *
Dennis McNeal

Due Date
Choose Date

Create



Design Coordination Tracking

Upload Files

Showing 6 items

Search for documents

<input type="checkbox"/> Name	Title	Set	Version	Markup	Issue	RFI
<input type="checkbox"/> A101	Site Plan		V5	0	0	0
<input type="checkbox"/> A103	Elevations/Sections		V5	2	0	0
<input type="checkbox"/> A105	Elev./ Stair Sections		V5	1	1	0
<input type="checkbox"/> A001	Title Sheet		V6	0	0	0
<input type="checkbox"/> A104	Elev./Sec./Det.		V5	0	0	0
<input type="checkbox"/> A102	Plans		V5	4	0	0

Upload Files

Showing 6 items

Search for documents

<input type="checkbox"/> Name	Title	Set	Version	Markup	Issue	RFI	Sorting Parameter	Disclaimer
<input type="checkbox"/> A102	Plans		V5	4	0	0	8- 4.A1- A102	DOCUMENTS COM
<input type="checkbox"/> A103	Elevations/Sections		V5	2	0	0	8- 4.A1- A103	DOCUMENTS COM
<input type="checkbox"/> A105	Elev./ Stair Sections		V5	1	1	0	8- 4.A1- A105	DOCUMENTS COM
<input type="checkbox"/> A001	Title Sheet		V6	0	0	0	8- 1.A0- A001	DOCUMENTS COM
<input type="checkbox"/> A101	Site Plan		V5	0	0	0	8- 4.A1- A101	CONTRACT IN NO
<input type="checkbox"/> A104	Elev./Sec./Det.		V5	0	0	0	8- 4.A1- A104	DOCUMENTS COM

Upload Files

Showing 5 results

Search for documents

<input type="checkbox"/> Name	Title	Set	Version	Markup	Issue	RFI	Sorting Parameter	Disclaimer
<input type="checkbox"/> A101	Site Plan		V5	0	0	0	8- 4.A1- A101	CONTRACT IN NO
<input type="checkbox"/> A102	Plans		V5	4	0	0	8- 4.A1- A102	DOCUMENTS COM
<input type="checkbox"/> A103	Elevations/Sections		V5	2	0	0	8- 4.A1- A103	DOCUMENTS COM
<input type="checkbox"/> A104	Elev./Sec./Det.		V5	0	0	0	8- 4.A1- A104	
<input type="checkbox"/> A105	Elev./ Stair Sections		V5	1	1	0	8- 4.A1- A105	

5 Documents

A101

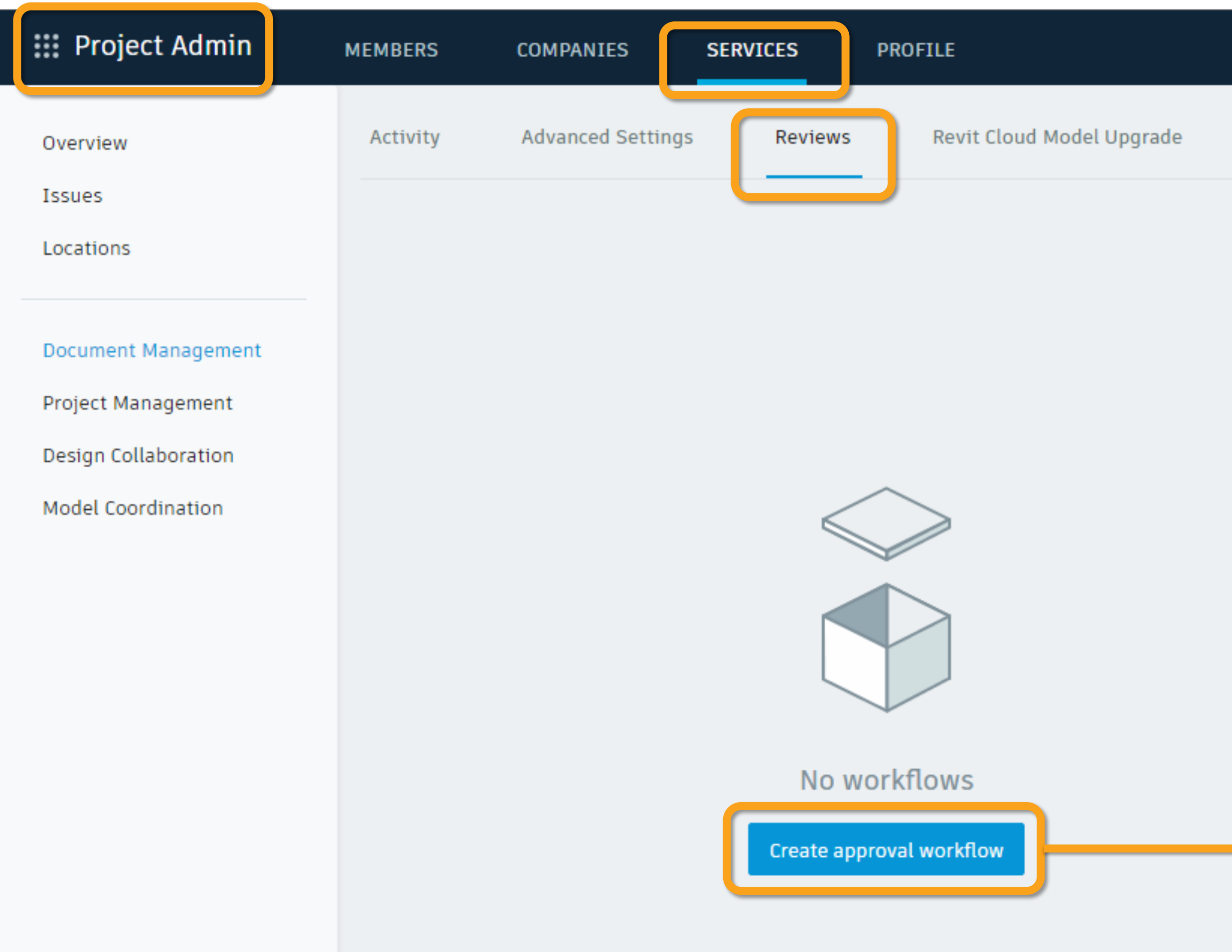
A102

A103

A104

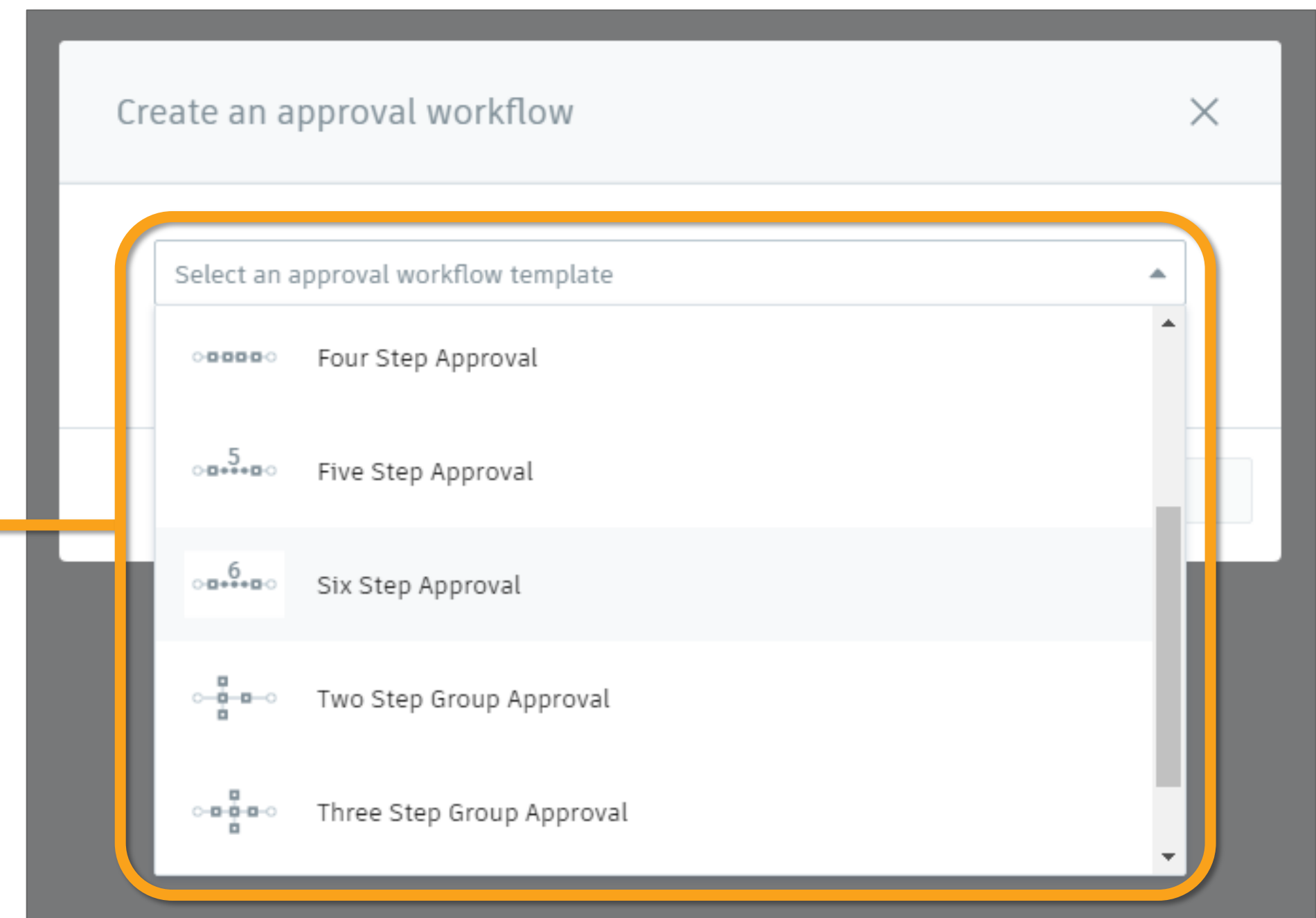
A105

< >



Approval Workflow

- BIM 360 Design provides a variety of workflows – including linear or group – to meet team needs
- Democratizing review process to improve team engagement with design



- Select documents to be submitted for review
- Click the [Submit for Review] button
- Select a Review Workflow



Approval Workflow

Document Management

FOLDERS

REVIEWS

TRANSMITTALS

ISSUES

Reviews > Review detail

OPEN #1 - Final Review ⌚ Time left: 3 days

Approval Workflow - SD

Submit review

Release task

Void entire review

Export Report



<input type="checkbox"/> Name ^	Title	Description	Version	Markup	Comments	Approval status	
<input type="checkbox"/> 01 - Entry Level		--	V2	0	No comments yet. Add	Approved	
<input type="checkbox"/> 01 - Entry Level - Area ...		--	V1	0	No comments yet. Add	Approved	
<input type="checkbox"/> 01 - Entry Level - Furnit...		--	V1	0	No comments yet. Add	Approved	
<input type="checkbox"/> 02 - Floor		--	V2	0	No comments yet. Add	Approved	
<input type="checkbox"/> 03 - Floor		--	V2	0	No comments yet. Add	Approved	
<input type="checkbox"/> New Construction_Arc...		--	V1	0	No comments yet. Add	Approved	
<input type="checkbox"/> Roof		--	V2	0	No comments yet. Add	Approved	
<input type="checkbox"/> Site		--	V1	0	No comments yet. Add	Approved	
<input type="checkbox"/> {3D}_Arch.rvt		--	V1	0	No comments yet. Add	Approved	

- Select... ▲
- Approved
- Rejected
- Approved w/ comme...

PROGRESS

Initiator Initial Review ^

Matt Anderle Nov 12, 12:19 AM
• <matthew.anderle@aecom.com>
• Submitted to Reviewer

Reviewer Initial Review v

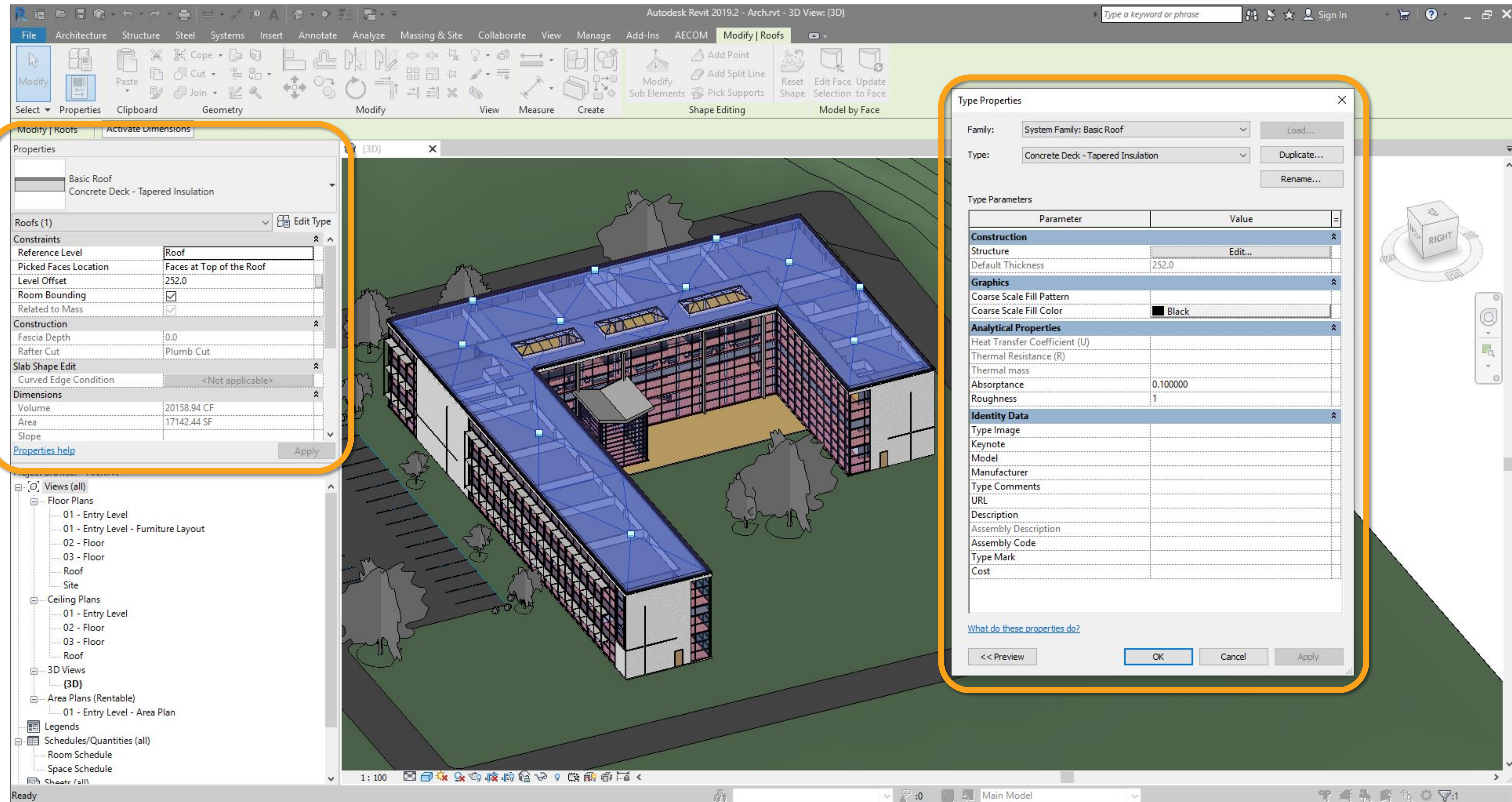
• Approver Final Review ^

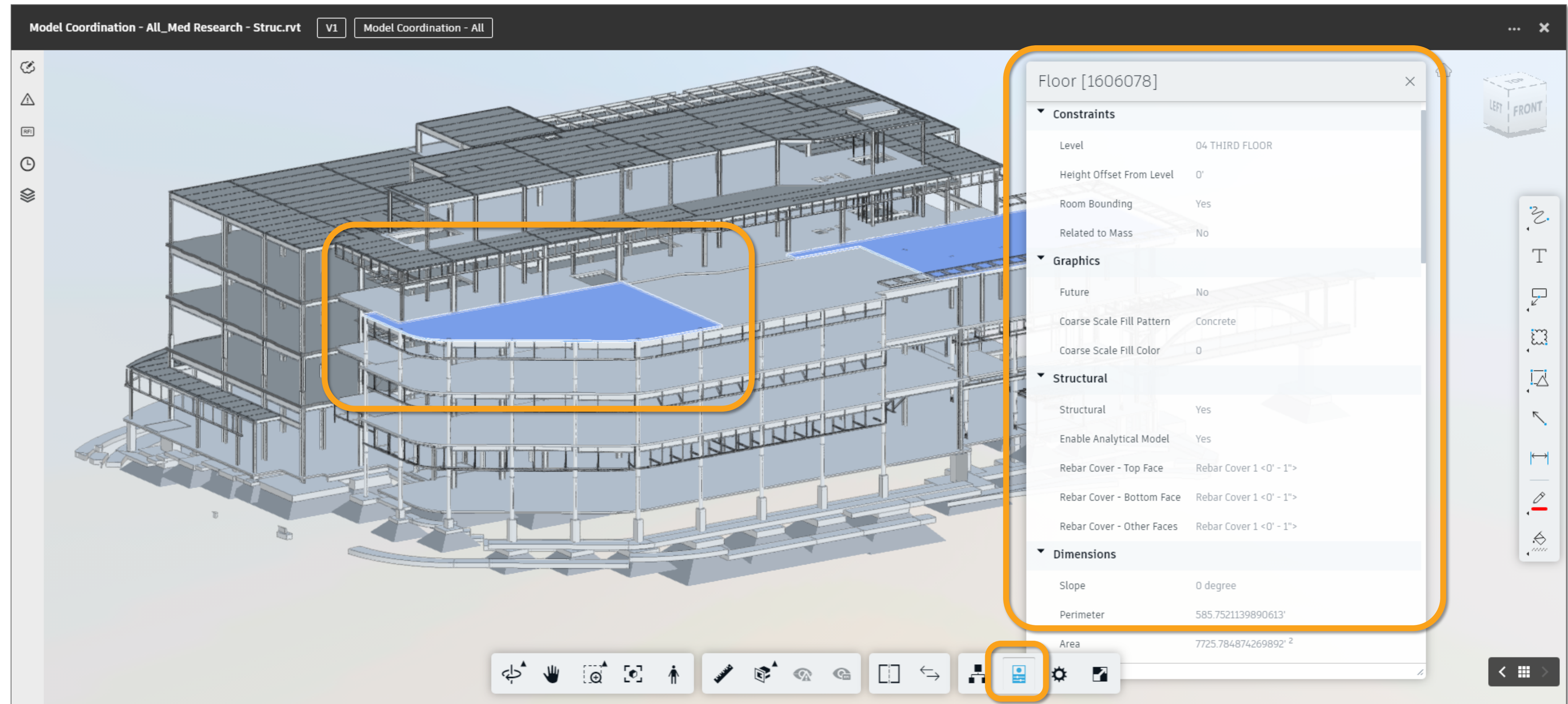
Matt Anderle [Send email notification](#)

Matt Anderle
• <matthew.anderle@aecom.com>

The screenshot shows the Autodesk BIM 360 Document Management web interface. The main content area displays a list of folders with columns for Name, Title, Set, Version, Last updated, and Updated by. An 'Add Attribute' dialog box is open in the foreground, allowing the user to add a new attribute. The dialog has fields for 'Name' (containing 'Printed Date') and 'Type' (set to 'Text Field'). A blue 'Add Attribute' button is highlighted with an orange box. In the top right corner, the 'RI' settings icon is also highlighted with an orange box. The left sidebar shows a tree view of project files, including folders like '420 TQR', '470 Progress PDF Set', '500 Deliverable PDF Sets', and '930-40 Clash Coordination'.

- We add Metadata to our folder list via custom attributes
- Information extracted directly from plan sheets brings forward data in a visible, searchable, and sortable review exercise





“Metadata is the
Rosetta Stone of
the 21st
century.”

Matthew Anderle, AECOM



AECOM

Imagine it.
Delivered.

AECOM

Transformative Successes

B AUTODESK®
BIM 360® DESIGN

R AUTODESK®
REVIT®

A AUTODESK®
CIVIL 3D®

I AUTODESK
INFRAWORKS 360

N AUTODESK®
NAVISWORKS®



ODBC



FORGE



Dynamo

AECOM Add-Ins

3rd Party Add-Ins



Transformative Successes



Primary Client Information

Name: Owner

Client Contract #:
Client Project #:
Client Project Manager:
Client BIM Manager:
Client Website:

Secondary Client Information

Name:

Client Contract #:
Client Project #:
Client Project Manager:
Client BIM Manager:
Client Website:

Contractor Information

Name:

Contractor Contract #:
Contractor Project #:
Contractor PM:
Contractor BIM Mngr:
Contractor Website:

Project Information

Project #: 00000000
Project Issue Date: 2019-01-02
Project Status: DEPLOYMENT
Project Address: GLOBAL

REVIT MODEL ANALYTICS

SAMPLE DATA

BIM Deliverables & Integration

Authoring Models
Clash Reports
COBie
Quantity Take-Offs

Facility Management Data
4D (Scheduling)
5D (Cost)
6D (As-Built)

Disclaimer

Owner of the Project understands and acknowledges that the DIGITAL MODEL FILES will continue to be modified and refined during the design process and the transferred DIGITAL MODEL FILES only represent a snapshot in time of the design process. Owner of the Project understands and acknowledges that the DIGITAL MODEL FILES developed by AECOM and its Subconsultants have been created for the purposes of developing and communicating the design intent of the Project. Therefore, AECOM makes no warranty, express or implied, that the DIGITAL MODEL FILES contain all architectural elements that may have an impact on the Referenced Uses nor that the DIGITAL MODEL FILES are absolutely coordinated with the two-dimensional construction documents. In the event of conflicts between the two-dimensional contract documents and the DIGITAL MODEL FILES, the contract documents take precedence.

The DIGITAL MODEL FILES have been prepared in accordance with the standard of care in the industry for similar projects under similar circumstances. While the DIGITAL MODEL FILES can be used to detect potential conflicts between elements, they may not accurately reflect all quantities, surface areas, and volumes, and may not accurately or completely describe all architectural elements that may have an impact on the Referenced Uses in the actual construction of the project.

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OWNER OF THE PROJECT AGREES, JOINTLY AND SEVERALLY, TO RELEASE, INDEMNIFY, HOLD HARMLESS AND DEFEND AECOM AND SUBCONSULTANTS, THEIR RESPECTIVE OFFICERS, SHAREHOLDERS, AND EMPLOYEES, COLLECTIVELY CALLED "INDENTITIES", FROM ANY AND ALL CLAIMS, DEMANDS, SUITS, LIABILITIES, LOSSES, DAMAGES, AND COSTS, INCLUDING BUT NOT LIMITED TO ATTORNEY'S FEES, EXPERT WITNESS FEES, AND COURT COSTS ARISING OUT OF OR IN ANY WAY CONNECTED WITH ANY USE OR DRAWING USES OF THE DIGITAL MODEL FILES PROVIDED BY AECOM AND/OR SUBCONSULTANTS PURSUANT TO THIS AGREEMENT.

OWNER OF THE PROJECT ACKNOWLEDGES THAT THE TRANSFER OF DIGITAL MODEL FILES IS A SERVICE AND SHALL NOT CONSTITUTE A SALE OF GOODS, AND AECOM MAKES NO WARRANTY, EXPRESS OR IMPLIED, OF MERCHANTABILITY OR FITNESS FOR ANY PURPOSE IN CONNECTION WITH THE SERVICE OF PROVIDING ACCESS TO, AND THE TRANSFER OF, THE DIGITAL MODEL FILES OR THAT THE DIGITAL MODEL FILES WILL BE USABLE OR ACCURATE, WHICH WARRANTIES AND REPRESENTATIONS ARE EXPRESSLY DISCLAIMED.

The issue of AECOM electronic format 3D models is made with the following conditions:

- 1. The documentation produced is uncontrolled and not subject to update.
- 2. The recipient is responsible for reviewing the status of the transferred information and should advise AECOM immediately upon receipt of any discrepancy.
- 3. 3D model information has been produced based on the available information at the time of documentation. AECOM assumes no responsibility for the accuracy and adequacy of the information, advises AECOM immediately upon receipt of any discrepancies contained within the files, including dimensional accuracy.
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- 6. The copyright and ownership of the files (including any embedded data and digital model files), and the intellectual property contained therein, remains with AECOM. The Recipient is granted a limited license to use the information solely for the purposes stated above.
- 7. The issue of these files does not relieve the Recipient from responsibility for checking the suitability of the files for the intended purposes, the accuracy and completeness.
- 8. If the information contained therein, and for coordination as necessary with your agents and subcontractors.
- 9. Unless AECOM are advised in writing to the contrary within 2 working days of transmittal of these files, we shall assume that the Recipient has fully accepted and shall abide by these conditions.
- 10. Should you not accept the above conditions, please advise AECOM immediately. The issued files should be deleted or returned to AECOM.

Conditions of Use - General

1. The issued files are to be used only for the purpose(s) stated above. They shall not be issued to any third party without permission of AECOM.
2. The Recipient accepts full responsibility for checking and satisfying themselves that the files are free of viruses and other malware. Although AECOM maintains anti-viral software, no warranty is made that these files are free from viruses or other defects. AECOM will not be held liable for any loss or damage resulting from the use of infected files.
3. Under no circumstances are the Recipient, their agents or subcontractors to make any alterations to the files.
4. The copyright and ownership of the files (including any embedded data and digital model files), and the intellectual property contained therein, remains with AECOM. The Recipient is granted a limited license to use the information solely for the purposes stated above.
5. The issue of these files does not relieve the Recipient from responsibility for checking the suitability of the files for the intended purposes, the accuracy and completeness.
6. If the information contained therein, and for coordination as necessary with your agents and subcontractors.
7. Unless AECOM are advised in writing to the contrary within 2 working days of transmittal of these files, we shall assume that the Recipient has fully accepted and shall abide by these conditions.
8. Should you not accept the above conditions, please advise AECOM immediately. The issued files should be deleted or returned to AECOM.

Conditions of Use - Building Information Model (BIM) Digital Model Files

1. Digital Model Files include embedded data, 2D/3D views, specifications, spreadsheets, reports, drawings and other information. All these are the intellectual property of AECOM, both during and after the completion of the project.

2. Digital Model Files are subject to continuous alteration, detectable or undetectable, intentional or unintentional, due to transmission, conversion, media degradation, software error and/or human alteration.

3. The Digital Model Files provided represent a transitory state and are intended for informational purposes only. They should not be viewed as an end product or as a record document. Any reliance thereon is deemed impractical and unenforceable. Only the signed and/or stamped two-dimensional contract documents are to be considered the true contract documents of record.

4. No data, images, sheets, parameter files, material libraries or model elements are to be extracted from the Digital Model Files without the explicit permission of AECOM.

5. The Recipient is tasked with preventing the unintentional transfer of the provided Digital Model Files or any of its parts to third parties.

6. Unless otherwise noted, the AECOM makes no warranty, expressed or implied, that the Digital Model Files:

- Contain all building elements,
- Allow the detection of all potential conflicts,
- Are absolutely coordinated with the two-dimensional contract documents,
- Accurately reflect actual quantities, surface areas and volumes and - where quantities are provided - follow industry norms or measurement conventions,
- Contain adequate levels of detail and/or simplifications,
- Include dimensional tolerances as required for construction or fabrication.

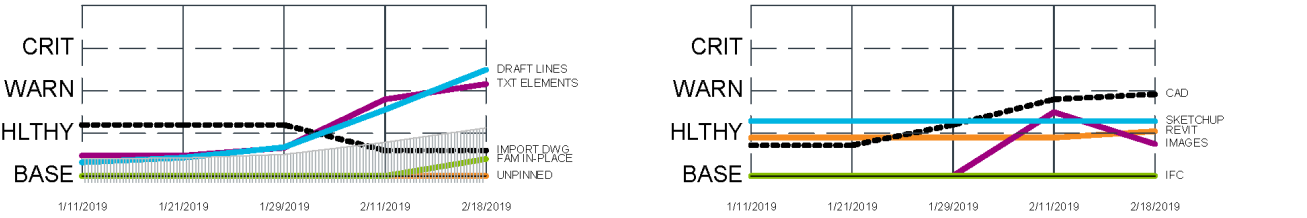
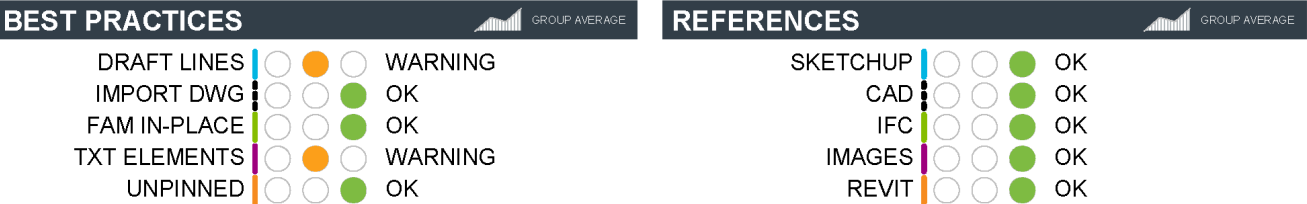
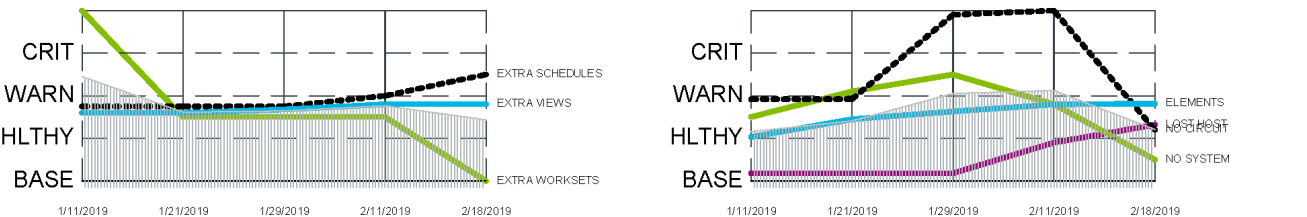
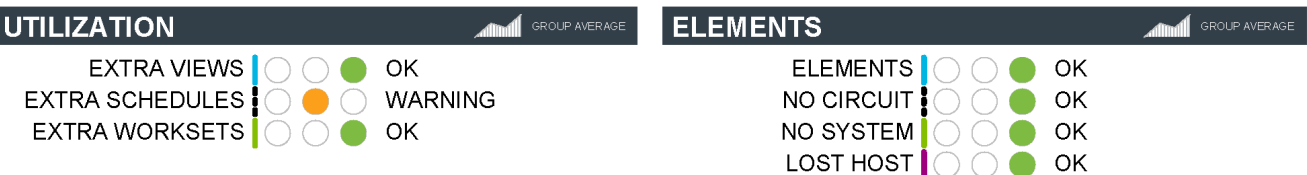
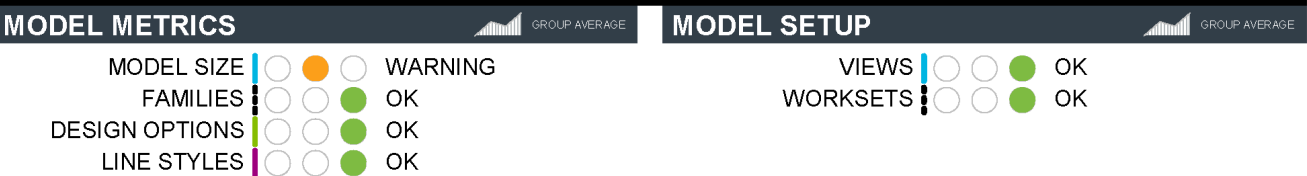
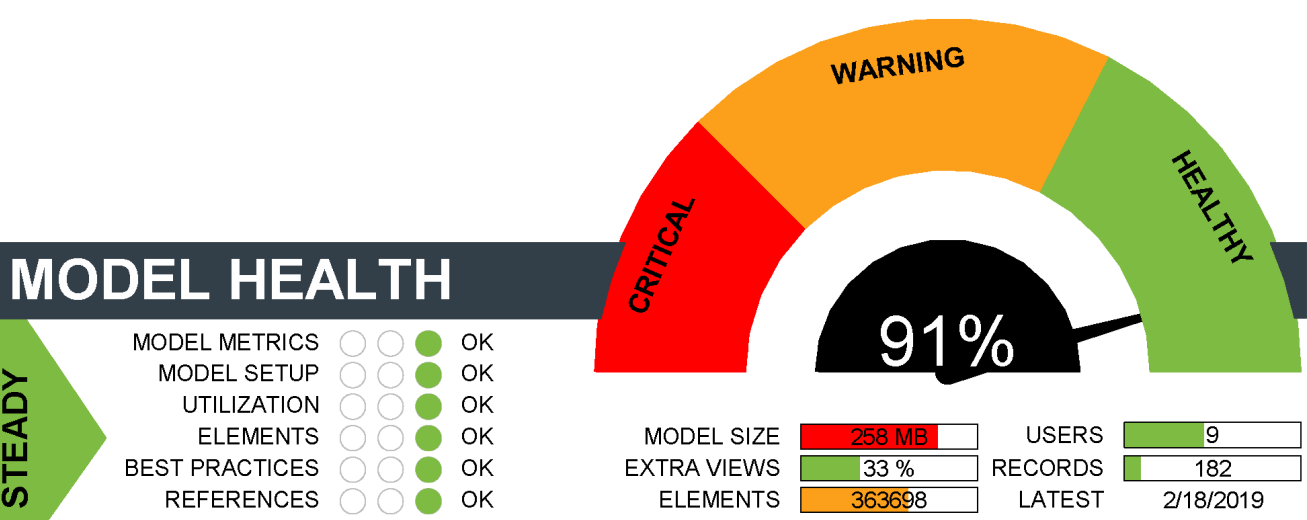
7. In the event of conflict between the two-dimensional contract documents and the Digital Model Files, the contract documents take precedence.

8. If the Recipient notices an error in the Digital Model Files or a conflict between the Digital Model Files and the two-dimensional contract documents, the Recipient should promptly notify AECOM who is then tasked with rectifying the error or conflict.

9. If the Digital Model Files include other linked Model Files developed by third parties:

- AECOM does not assume responsibility for these linked Model Files or any of their Model Elements. Each Model or Model Element author retains ownership of their respective Model File or Model Element. Subsequent use of these Models or Model Elements by the Recipient is only permitted to the extent agreed between the Recipient and the Model Element author.
- As necessary for the ongoing design and construction of the project.

Resource Links



Information presented on this dashboard is populated by the AECOM Model Analytics Add-in. The Add-in automatically runs in the background when you open, close, or save a model. You can selectively run intermittent updates to the database by running Analytics. Additional information is available on the Revit Metrics Dashboard which also populates the data presented in this view. Both are launched from the AECOM toolbar. All contents of this dashboard and the Revit Analytics Engine are proprietary to AECOM. Do not use, copy, reprint, or distribute (in part or whole) without permission from AECOM.



Transformative Successes

Leveraging Data

- Using Forge API to process the data in our BIM 360 hub
- Building data lakes rich with information harvesting everything from an element within a model up to a holistic view of projects across the company
- We present this data forward to the user in the form of dashboards and reports
- Developing Machine Learning strategies to better evaluate the data and improve our process and position our teams to achieve **Design Certainty**

Industry point of view

Aaron Phillips

Director of Virtual Design and Construction



Aaron Phillips

- 17 Years AE
- 6 Years @ Danis
- Design/Build
- Large Campus Owners
 - Indiana University BIM Guidelines & Standards
 - US Central Command BIM Guidelines & Standards
- Autodesk International BIM Experience Award



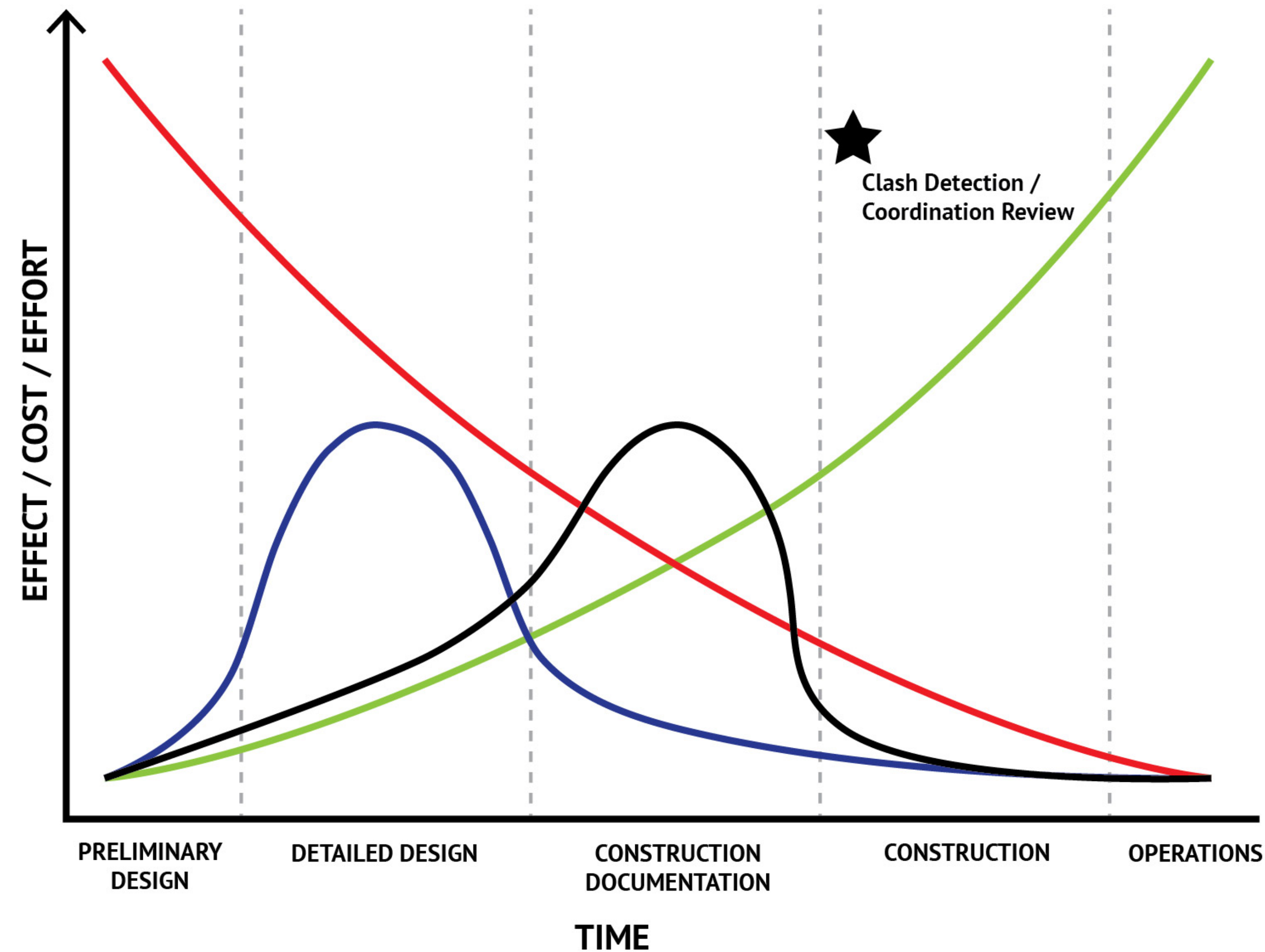


DANIS

- MIDWEST
 - Cincinnati, OH
 - Columbus, OH
 - Dayton, OH
- CAROLINAS
 - Raleigh, NC
- SOUTHEAST
 - Jacksonville, FL
- \$600MM Under Construction
- 600+ Employees (400+ Field Staff)
- Founded in 1916

CHALLENGES

TRADITIONAL - MACLEAMY CURVE



- Design timeline focused
- Doesn't represent newer project delivery models
- Delayed construction team involvement

CHALLENGES

- Cost and time of an RFI
- Understanding trends within the data
- Where are the real problems
- Reactive verse Proactive
- BIM 360 Field projects set up right before construction starts

DATA FROM BIM 360 FIELD

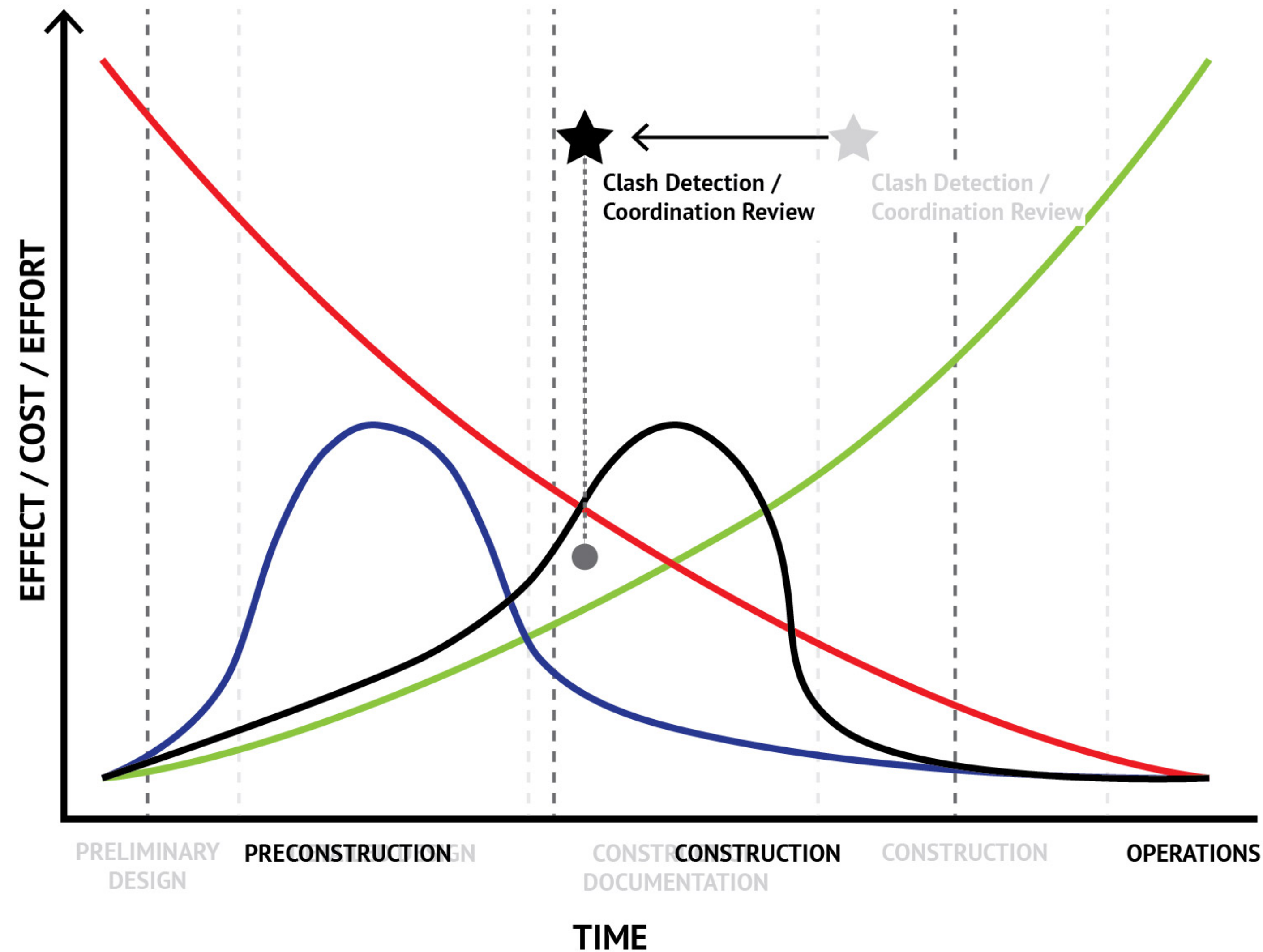
RFI 015	Elevator Numbering	Danis B
RFI 016	Top of Concrete Column ElevationsPlease review drawings S1.04, S1.05, and S1.06 containe	Danis B
RFI 017	Bottom of Base Plate ElevationsStructural drawings and sections do not provide enough inf	Danis B
RFI 018	Beam ReactionsSee attachment SK003 which contains drawings S1.04, S1.05, S1.06, S1.07, S1	Danis B
RFI 019	Elevations of Marked Platforms1) Structural sections do not provide top of steel elevation o	Danis B
RFI 020	Bearing Plate SizeRefer to drawings S1.04, S1.05, S1.06.....The typical bearing plate is called	Danis B
RFI 021	Thickness of End PlateReference Sheet S3.01Refer to Typical Beam Bearing Perpendicular D	Danis B
RFI 022	Lintel Sizes and Lintel NumbersPlease advise lintel sizes and lintel numbers for the cloude	Danis B
RFI 023	Bearing PL Underside & Clip L ConnectionsIf we follow the Typical Top of Concrete Column I	Danis B
RFI 024	Area L Grid LinesPlease provide dimensions in clouded areas on sheet S1.02 to locate Area	Danis B
RFI 025	Radius of Rolled TubesPlease see clouded areas on sheet S6.011) Provide the radius and th	Danis B
RFI 026	Roof Opening Sizes and LocationsOn the attached Sheet A1.04, please provided all clouded	Danis B
RFI 027	Unit Weight Requirements for Light Weight Concrete	Danis B
RFI 028	Door and Interior Windows at Garage Elevator Lobby 009	Danis B
RFI 029	Door Opening 112A	Danis B
RFI 030	Wood Door Finish Clarifications	Danis B
RFI 031	Wood Door Finish Clarifications	Danis B
RFI 032	Wood Door Finish Clarifications	Danis B

ANALYSIS OF BIM 360 FIELD DATA

Month	January					February				March			
Week Number	W 75	W 76	W 77	W 78	W 79	W 80	W 81	W 82	W 83	W 84	W 85	W 86	W 87
Week Start Date	12/31/17	1/7/18	1/14/18	1/21/18	1/28/18	2/4/18	2/11/18	2/18/18	2/25/18	3/4/18	3/11/18	3/18/18	3/25/18
Opened RFI's that Week	4	6	6	4	5	4	6	9	2	0	0	0	0
Open RFI's that Month	25					21				0			
Closed RFI's that Week	3	3	2	5	1	16	2	7	1	0	0	0	0
Closed RFI's that Month	14					26				0			
Total Active RFI's Open that Month	81					76				76			
that Month	81					76				76			

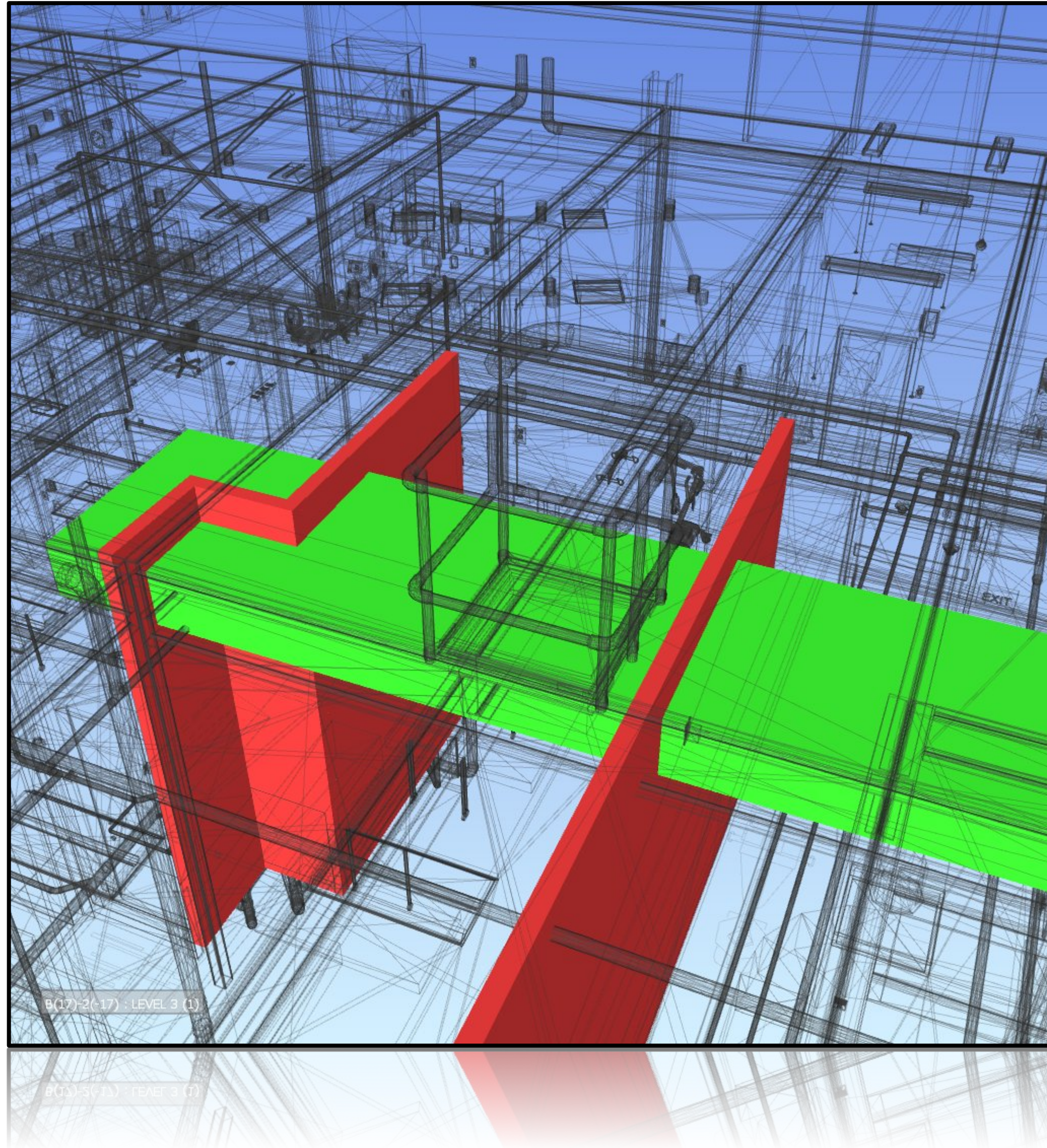
NEW NORM

CURRENT MARKET - MACLEAMY CURVE



- Preconstruction services
- Construction is phased & starts earlier
- Getting to a better place on the curve

EARLY DESIGN REVIEWS



- Design Development Review
- Formalized coordination with comments
- Early communication to design team
- Specifically tailored to VDC Lessons Learned

EARLY DESIGN REVIEWS

DANIS

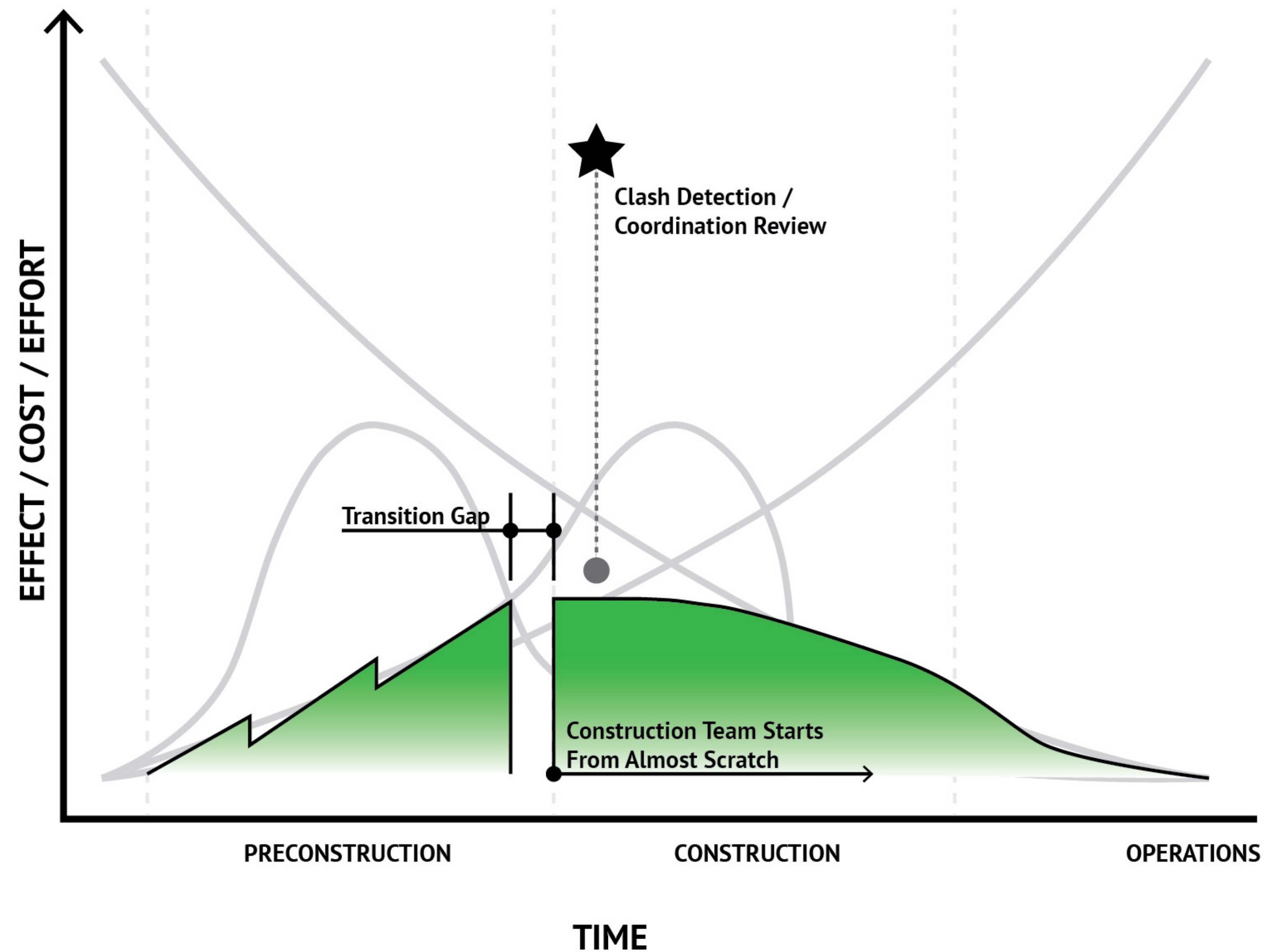
Constructability Review Checklist					
Project Name:	Mercy Enon Medical Center				
Project No.:	2018OH0083				
Project Phase:	Design Development				
Review Date:	8/22/2018				
Model Information					
Model Name	Discipline	Software	Version	Authoring Firm	
ENON-FSED-V19	Architectural	Revit	2019	Champlin	
19-180006-MH Enon FSED STRUCT	Structural	Revit	2019	Korda	
19-180006-MH Enon FSED MECH	Mech/Plumb	Revit	2019	Korda	
19-180006-MH Enon FSED ELEC	Electrical	Revit	2019	Korda	
Architectural Review					
Description	Yes	No	N/A	Comments	
Quickly glance over all sheets, spending no more than one minute per sheet to become familiar with the project	x				
Identify existence and names of worksets within the model	x			1). CORE AND SHELL 2). FINISH FLOOR 3). FITOUT 4). LANDSCAPE 5). Shared Levels and Grids 6). Z-Link-Elec 7). Z-Link-Mech 8). Z-Link-Structure	
Verify sections are properly linked within model	x			Sections are in development with what would be expected at a Design Development Level of information.	
				1). Level 1 (863'-0 3/4") 2). Level 2 (877'-8 3/4") 3). Level 3 (883'-8 3/4") 4). Level 4 (883'-0 3/4")	

Plan Check – Structural		
Identify existence and names of worksets within each model	x	1). Shared Levels and Grids 2). Workset1
Verify that column gridlines on structural and architectural match	x	Structural Model and Architectural Model have column line discrepancies. B.4 (Arch) = A.6 (Stru). Column Line 2.1 is in a different location between Arch and Stru. The Structural Model and the Architectural Model each have additional column lines that are not referenced in each other's model: C.5, D.1, & E.5 (Arch), C.7, C.9, D.3, E.2 (Struc)
Verify level names and elevations	x	1). Base (863'-0 3/4") 2). Entrance (873' - 10 3/4") 3). CANOPY (877' - 2 3/4") 4). Roof (877' - 6 3/4") 5). High roof (888' - 6 3/4") Base Level in the Structural Model aligns with Level 1 in the Architectural Model. The rest of the levels do not match up which is not uncommon. Levels that are at the same elevation that do not share the same name can lead to errors when coordinating between different disciplines.
Identify and verify model links with each individual model	x	1). Linked models: ENON-FSED.rvt Comment: Missing some of the other design team's models, including Plumbing and Electrical. This could lead to uncoordinated conditions as information from plumbing and electrical are not considered with the structural design.
Plan Check – Mechanical / Plumbing		

- Tracked in Excel spreadsheet
- Version tracking and sharing are Issues

PRECONSTRUCTION TO CONSTRUCTION

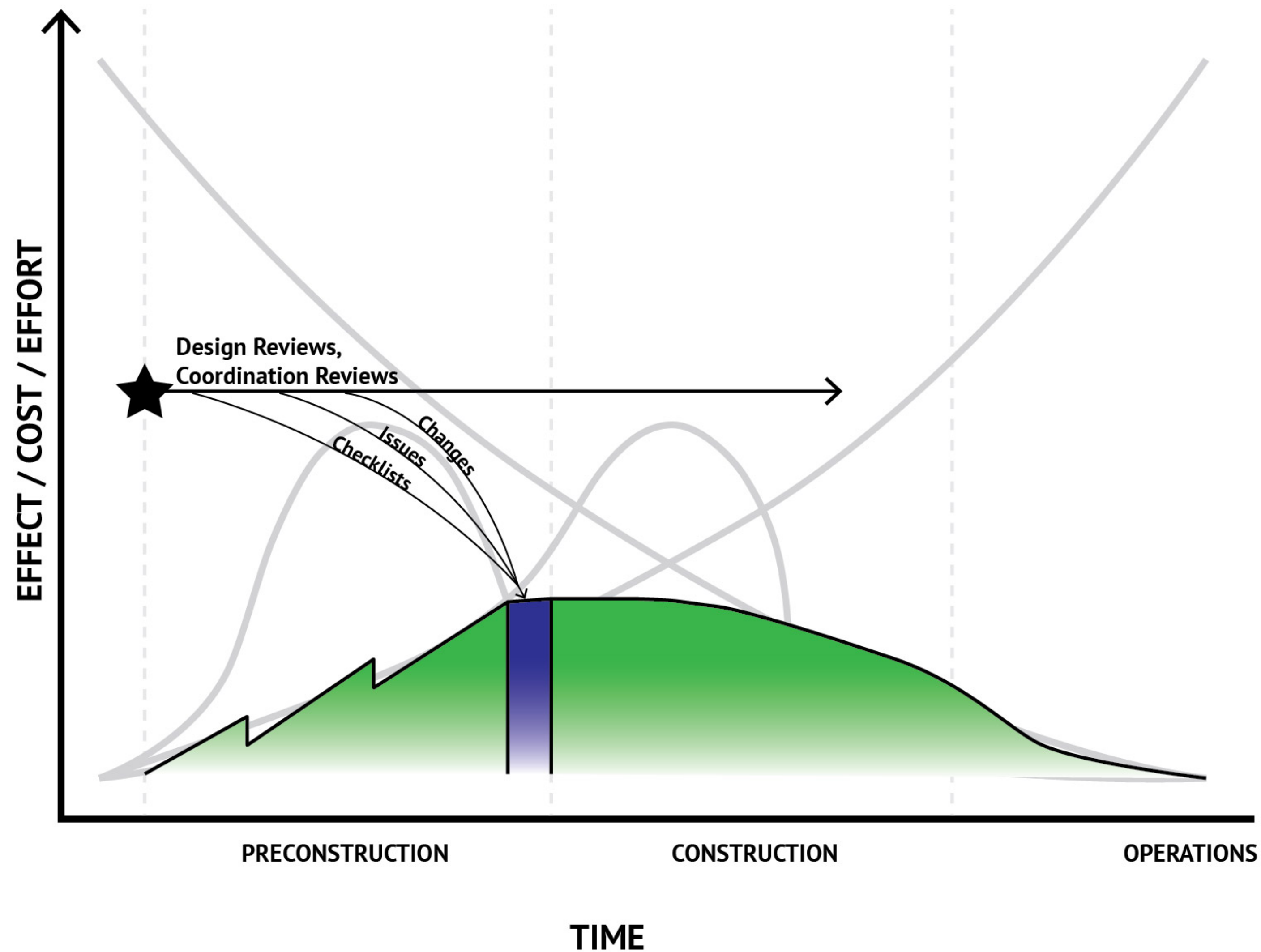
THE TRANSITION GAP



- Preconstruction group builds data & knowledge
- Onboarding construction team creates transition gap

PRECONSTRUCTION TO CONSTRUCTION

BIM 360 Design Review / Construction IQ



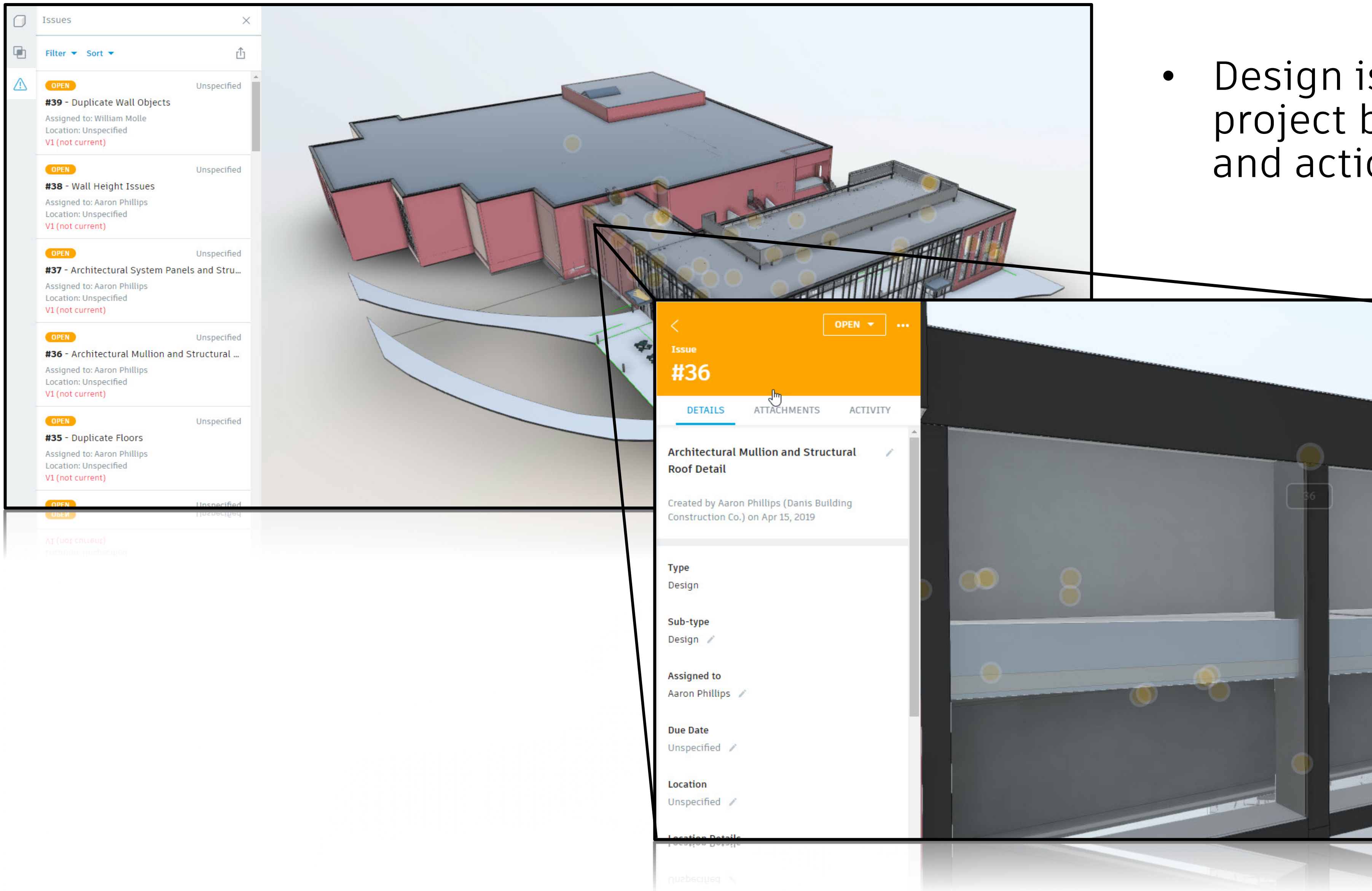
- Impactful issue tracking
- Creates early actionable information
- Everyone deals from the same deck

BRIDGING THE GAP – FORMALIZED DESIGN REVIEW

The screenshot displays the 'Field Management' software interface. The top navigation bar includes 'Field Management', 'TEMPLATES', 'CHECKLISTS', 'ISSUES', and 'DAILY LOGS'. The main header shows a 'Completed' status and the title 'Constructability Review'. On the left, a 'CHECKLIST OUTLINE' lists seven items: 1 General Information, 2 Architectural Model R..., 3 Structural Model Review, 4 Mechanical Model Review, 5 Plumbing Model Review, 6 Electrical Model Review, and 7 General Comments. Item 2 is selected and marked with a blue checkmark. The main content area is titled '2 Architectural Model Review' and includes a 'Done' button. It contains four sections: 2.1 Name of Model #1 (text input: 1885_CENTRAL_V19), 2.2 Name of Model #2 (Optional) (text input: 00000_Cedarville University_Arc_V19), 2.3 Quickly glance over all sheets within the model, spending no more than a minute per sheet to become familiar with the project. (radio buttons: Yes (checked), No, NA), and 2.4 Identify and document worksets within the model. (text input: Shared Template and Code Worksets). Each section has 'Issue', 'Note', and 'Photo' icons. A 'Note' box at the bottom of section 2.2 states 'Note: Not used in construction model'. Navigation arrows at the bottom allow moving between sections 1, 2, and 3.

- Constructability Reviews occur in BIM 360
- Issues are tracked and always stay with the project
- Creates a record review that can be referenced later in the project

BRIDGING THE GAP – CREATE EARLY UNDERSTANDING



- Design issues early in the project become trackable and actionable

BRIDGING THE GAP – TRACK AND MEASURE

- Create issue types and subtypes that support your internal teams

▼ Bid RFI's	✓ Active	Basic
Bid RFI's	✓ Active	Basic
BP #1	✓ Active	Basic
BP #2	✓ Active	Basic

▼ Preconstruction	✓ Active	
Architectural	✓ Active	
Civil	✓ Active	
Electrical	✓ Active	
Fire Protection	✓ Active	
HVAC	✓ Active	
Plumbing	✓ Active	
Preconstruction	✓ Active	
Structural	✓ Active	

Document Management								
FOLDERS REVIEWS TRANSMITTALS ISSUES								
Search								
Status	ID	Type	Sub-type	Title	Location	Assigned to	Company	
Open	24	Bid RFI's	BP #1	Fiber Optic Cable	-	Joel Hinderliter	Heapy En	
Answered	23	Bid RFI's	Bid RFI's	Fire Door for Building S...	-	Kyle Slone	Danis Bu	
Answered	22	Bid RFI's	Bid RFI's	Fire Door for Building S...	-	Kyle Slone	Danis Bu	
Answered	21	Bid RFI's	Bid RFI's	Von Fire Door Requirem...	-	Kyle Slone	Danis Bu	
Closed	20	Preconstruction	Preconstruction	Metal Panel ACM-3	-	Doug Steward	Danis Bu	
Closed	19	Bid RFI's	Bid RFI's	Above Millwork Detail i...	-	Katie Jerome	Danis Bu	
Closed	18	Bid RFI's	BP #2	Under slab Gravel Thick...	-	-	-	
Closed	17	Preconstruction	Architectural	Verify Correct Wall Type	-	Alexander Bochenek	Danis Bu	
Open	16	Preconstruction	Architectural	Fire Rating of IT Closets	-	Joel Hinderliter	Heapy En	

High risk design review issues

Which issues do I focus on first?

DANIS									
Constructability Review Checklist									
Level 1									
Level 1 Collisions are reported collisions that are considered critical to the design and construction process. These collisions have been assigned the highest priority and should be rectified within the model as soon as possible.									
Mech. Ductwork / Piping v. Arch. Ceilings									
Plum. Piping v. Arch. Ceilings									
Mech. Ductwork / Piping & Plum. Piping v. Arch. Rated Walls (For coordination of dampers and other mechanical equipment needs)									
Mech. Ductwork / Piping & Plum. Piping v. Stru. Framing									
MEP Equipment & Fixtures v. Arch. Walls									
MEP Equipment & Fixtures v. Stru. Framing									
MEP Equipment, Fixtures & Devices v. MEP Equipment, Fixtures & Devices									
Mech. Ductwork / Piping v. Plum. Piping									
Level 2									
Level 2 Collisions are reported collisions that are considered important to the design and construction process. These collisions have been assigned a greater priority and should be rectified during project meetings during design.									
Stru. Framing v. MEP Equipment, Fixtures & Devices									
Mech. Ductwork / Piping & Plum. Piping v. Elec. Equipment, Fixtures & Devices									
Mech. Ductwork / Piping v. Arch. Floors & Stru. Floors									
Arch. Casework v. Elec. Equipment, Fixtures & Devices									
Arch. Furnishings v. Elec. Equipment, Fixtures & Devices									
Stru. Framing v. Arch. Specialty Equipment									
Level 3									
Level 3 Collision are reported collisions that while are considered important to the correctness of the model will generally be changing on a regular basis throughout the design and construction process. These collisions have been assigned a lower level of priority and should be rectified before the phase submission of the models.									
ADA Clearance v. Arch. Doors, Furnishings, Walls, & Casework									
Plum. Piping vs. Elec. Equipment, Fixtures & Devices									
Plum. Piping vs. Mech. Equipment, Fixtures & Devices									
Arch. Casework v. Arch. Walls & Stru. Walls									
Arch. Casework v. Arch. Walls & Stru. Walls									
Plum. Piping vs. Mech. Equipment, Fixtures & Devices									

- Priorities are set by lessons learned efforts from past projects
- Project type dictates high design risk issues



“

We see that our investments in technology are paying off as we are able to deliver higher quality projects, leading to stronger relationships with our clients, said ***Troy Erbes, Senior Vice President at Danis.*** Our next step is to utilize the data generated from all of our technology to further improve efficiency and safety across all of our projects.

”

CONSTRUCTION IQ

Design Risk Management



LEARNING FROM PAST & APPLY TO FUTURE



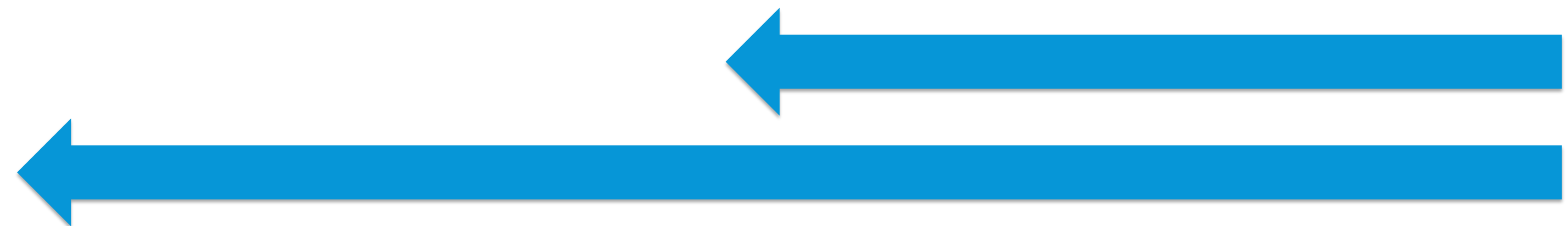
Design



Pre-construction



Construction



Push knowledge learned from data upstream


DESIGN RISK MANAGEMENT

Harness the power of machine learning to predict high risk

- Code Compliance Design Issues
- Critical Building Components
- Document Errors and Omissions

Insight

RISKDESIGNPROJECT CONTROLSCOSTQUALITYSAFETYREPORTS





United Construction


Pacific Center Campus


Project Dates: Tue Oct 17 2017 - Fri Oct 29 2021


Design Review Risk Factors

 4 Code Compliance

 6 Critical Components

 12 Documentation Incomplete

 75 Overdue Issues

 7 Overdue Reviews

Status	ID	Title	Root Cause	Building Components	Location	Assigned To	Company	Due Date
OPEN	255	Need ADA spec to verify design meets c...	Code Compliance		North Bar, Men's R...	Unassigned	Unassigned	Jan 12, 2019
OPEN	275	Elevator Shaft Clearance	Documentation In...					OPEN
ANSWERED	347	Ceiling Material Change Requested	Code Compliance	Cei				
OPEN	29	Need stair spec	Code Compliance, ...	Sta				

Issue #275

Elevator Shaft Clearance

Please check and make sure shaft clearance is sufficient per manufacturer's specs.

Created by Laurie Spitler on Feb 14, 2019

Assigned ToLaurie Spitler

Due DateFeb 20, 2019

TypeDesign

Location

B Construction IQ - PREVIEW

Don't Agree? If you don't agree with root cause or building component, you can change it. Changes immediately update the issue list and issue details. Learn more about [Construction IQ](#)

Building Components

Select...

Root Cause

☐ Design Coordination

☐ Constructability

☐ Documentation Conflict

☒ Code Compliance

☒ Documentation Incomplete

☐ Other


[View in Document Management](#)


DESIGN RISK MANAGEMENT


Take immediate action to resolve overdue issues & reviews


- Overdue Issues
- Overdue Reviews


Design Review Risk Factors

4 Code Compliance

6 Critical Components

12 Documentation Incomplete

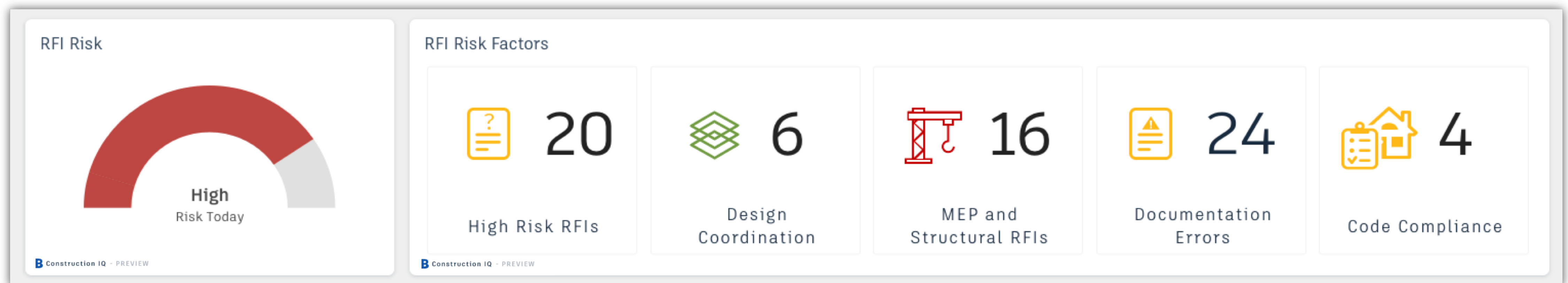
75 Overdue Issues

7 Overdue Reviews

Status	ID	Review Name	Workflow	Initiated By	Next Action By	Next Action Due	Documents	Approved	Rejected
OPEN	3	S1 Issued for Coordination	S1 Issued for Coordination	David Sanchez	Andy Thelwell	Sep 10, 2018	39		
OPEN	35	One Step Approval	One Step Approval	Joan Allen	Project Manager	Apr 16, 2019	8		
OPEN	34	S4 Issued for Construction Approval	S4 Issued for Construction	Joan Allen	Hansen Liu	Apr 19, 2019	6		
OPEN	37	One Step Approval	One Step Approval	Emma Thompson	Mike Woods	May 4, 2019	3		
OPEN	39	Internal Review - Issuance to Owner	Internal Review - Issuance to Owner	Joan Allen	BIM Manager, Documentation	Jun 14, 2019	3		
OPEN	40	S1 Issued for Coordination	S1 Issued for Coordination	Joan Allen	Hansen Liu	Jun 22, 2019	5		
OPEN	36	S1 Issued for Coordination	S1 Issued for Coordination	Joan Allen	Project Manager	Aug 16, 2019	357		

PROJECT MANAGEMENT: PRIORITIZE RFIs & PREVENT COST

- What disciplines drive RFIs in my project?
- What are the Root Causes of RFIs in my projects?



<asdfas>

- `<asdfasdf>`

United Construction > Bayfront Arena

RISK
QUALITY
SAFETY
PROJECT CONTROLS
REPORTS

United Construction

Bayfront Arena

Project Dates: Fri Sep 30 2016 - Sat Oct 31 2020

Customize

RFI Risk Factors

20
High Risk RFIs

6
Design Coordination

16
MEP and Structural RFIs

24
Documentation Errors

4
Code Compliance

Status	ID	Title	Risk	Root Cause	Disciplines	Building Componets	Location	Assigned to	Due Date
OPEN	12	Id vestibulum, pede posuere.	High	Code Compliance	Architectural	Ceiling	Floor 1	Ahmad Nazeri	Oct 14, 2018
OPEN	13	Nam porttitor, mauris luctus, velit aliquam tempor.	High	Unforeseen Condition	Concrete	Foundation	Floor 1	Boon-mee Yao-Yun	Oct 14, 2018
OPEN	14	Rutrum aliquet lectus.	High	Documentation Incomplete	Plumbing	HVAC System	Floor 1	Lungelo Ngcaba	Oct 14, 2018
OPEN	15	Nibh gravida, lacus hymenaeos tincidunt, semper commodo.	High	Code Compliance	Mechanical	Fire Protection Systems	Floor 1	Nonkosi Joyi	Oct 15, 2018
OPEN	16	Nisl ut.	High	Documentation Conflict	Other	Fire Protection Systems	Floor 1	Olivia Evans	Oct 16, 2018
OPEN	17	Ipsum tellus, sodales turpis mauris.	High	Documentation Conflict	Interior/Finishes	Ceiling	Floor 2	Sang Young-Il	Oct 17, 2018
OPEN	18	Tincidunt ornare, fermentum suscipit.	High	Unforeseen Condition	Architectural	Elevator	Floor 2	Sidnee Gye	Nov 1, 2018
OPEN	19	Amet erat dis, tortor vestibulum, nulla leo.	High	Design Coordination	Civil/Site	Foundation	Floor 2	Sofie Hubert	Nov 3, 2018
OPEN	20	Quam sagittis suspendisse.	High	Design Coordination	Electrical	Escalator	Floor 2	Tao Yi	Nov 8, 2018
OPEN	21	Lorem ipsum dolor sit amet, pellentesque hendrerit vulputate.	High	Documentation Incomplete	Landscaping	Site Elements	Floor 3	Veerle de Bree	Nov 10, 2018

MORE ON CONSTRUCTION IQ @ AU 2019

- **CS321348 - Construction IQ for Design Review: Reducing RFIs and costly issues in Construction**
Time: Thursday, Nov 21, 8:00 - 09:00AM **Location:** San Polo 3404, Level 3
- **CS324010 - Industry Panel: Forge, Connected Data, Machine Learning, and Predictive Insights**
Time: Thursday, Nov 21, 8:00 - 09:00AM **Location:** Marcello 4503, Level 4
- **CS323692 - Autodesk Construction Solutions: Managing Risk Through Prediction and Analytics**
Time: Tuesday, Nov 19, 10:30 - 12:00PM **Location:** Delfino 4103, Level 4
- **CS322274 - From Fee Erosion to Fee Enhancement: Manage Your RFIs Using AI**
Time: Tuesday, Nov 19, 8:00 - 09:00AM **Location:** Lando 4205, Level 4
- **Idea Exchange - Using AI to Enhance Measurements within Drawings**
Time: Wednesday, Nov 20, 3:30-6PM **Location:** Idea Exchange Booth - T03-E



Visit the BIM 360
Resource Center

<https://qrgo.page.link/h8ytU>





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