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Bringing ISO 19650 to Silicon Valley – BIM Challenges on the BART Extension

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About the speaker

Peter Starnes

I work for global engineering firm Mott MacDonald and my role involves championing the use of BIM processes and providing leadership and guidance for collaborative working. I act as information manager on BIM projects working towards ISO 19650 and I devise and monitor suitable workflows for BIM processes, tailored to the needs of the project.

I'm responsible for ensuring consistent quality and on-time delivery of technical models, coordinating a multidisciplinary team across multiple locations, organizations and time zones.

About the speaker

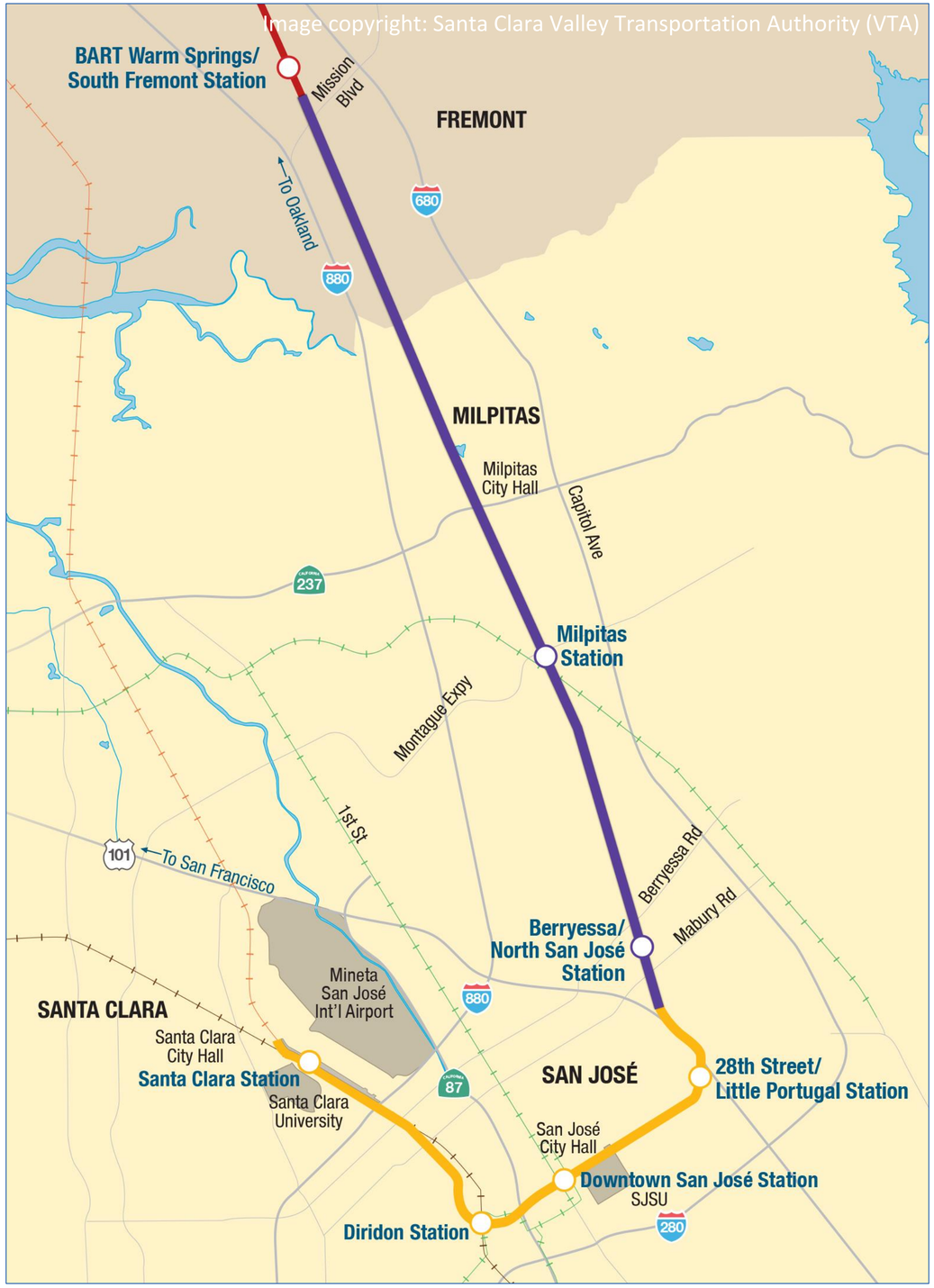
Brindusa Dumitrascu

Senior Digital Delivery Specialist with Mott MacDonald. Learned the ins-and-outs of document management and project delivery by holding a few different roles in the company and by working on some milestone projects.

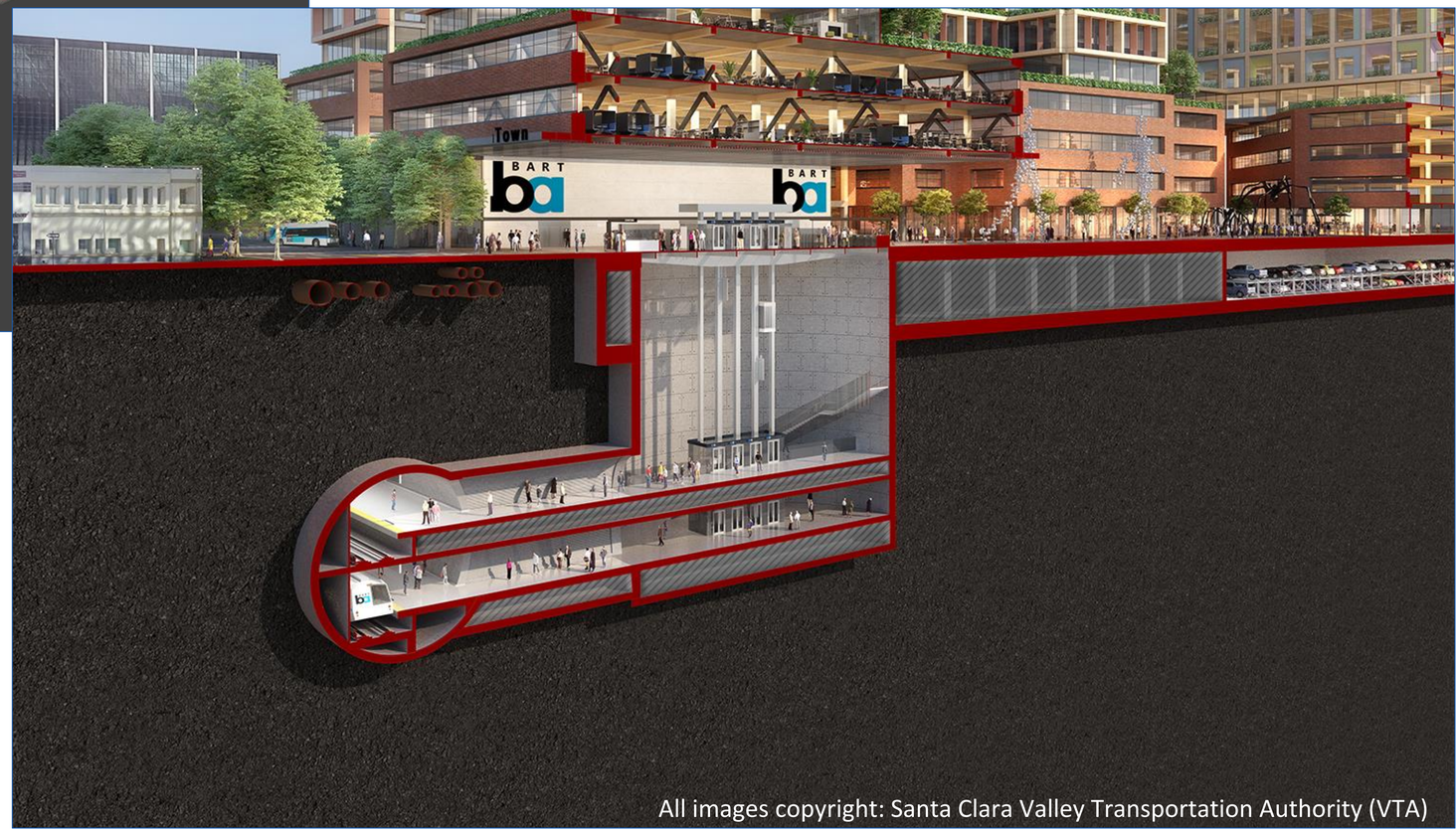
Experienced in Revit, Navisworks, BIM 360, ProjectWise, SharePoint, BIM Track.

Project Overview

- **The BART to Silicon Valley (“BSV”) Program will extend the San Francisco Bay Area Rapid Transit (BART) system from the city of Fremont in Alameda County through the cities of Milpitas, San Jose and Santa Clara, in Santa Clara County.**
- **The 16-mile BART extension to Santa Clara County is being implemented in multiple phases.**
- **Phase II of the Program is a 6-mile, 4-station extension from the under-construction Berryessa Station to Santa Clara (BSVII), and it includes:**
  - Approximately 5-mile long tunnel through Downtown San Jose
  - Three below-ground stations (28th Street / Little Portugal Station, Downtown San Jose Station, Diridon/Arena Station)
  - One at-grade station (Santa Clara Station)
  - Maintenance yard and associated works.



BART to Silicon Valley Phase II



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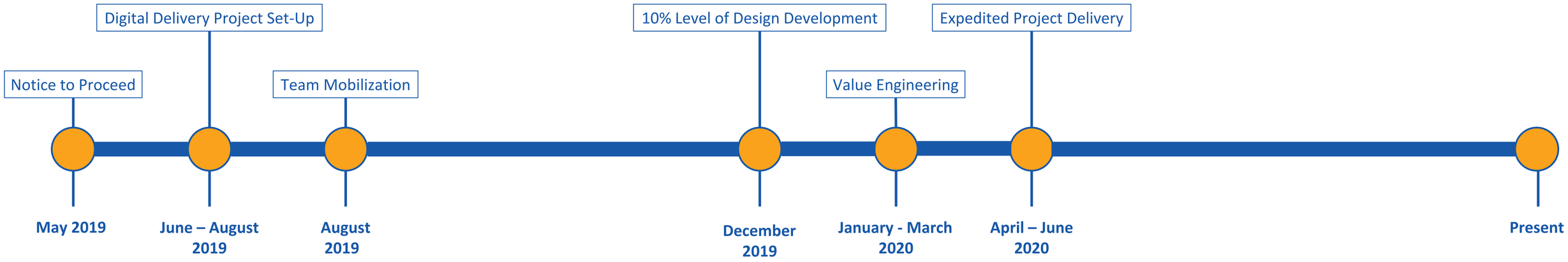
Project Timeline



Delivery Phases

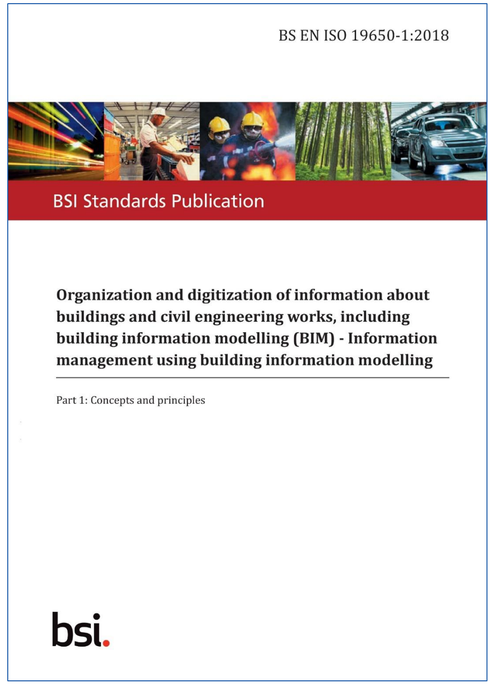
Client BIM Goals for the Project

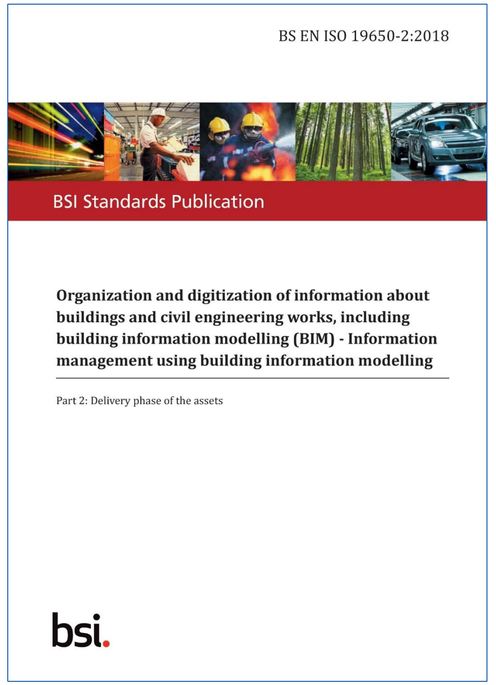
- Common working environment for **collaboration**
- Mitigate project risk through **connected** data and models
- Use new and **innovative** technologies where appropriate
- Enhance ability to make **informed** and timely decisions
- Increase **confidence** and predictability of cost and schedule
- Simulate construction to identify risks in a **virtual** environment
- Enhance **productivity** and deliver work efficiently

ISO 19650

BSVII project adopts the principles of BIM as set out in ISO 19650:

- **Confirm the BIM execution plan**
- **Establish the digital delivery environment**
- **Establish the list of deliverables**
- **Mobilize resources**
- **Establish the processes for the review, approval, and sharing of information**



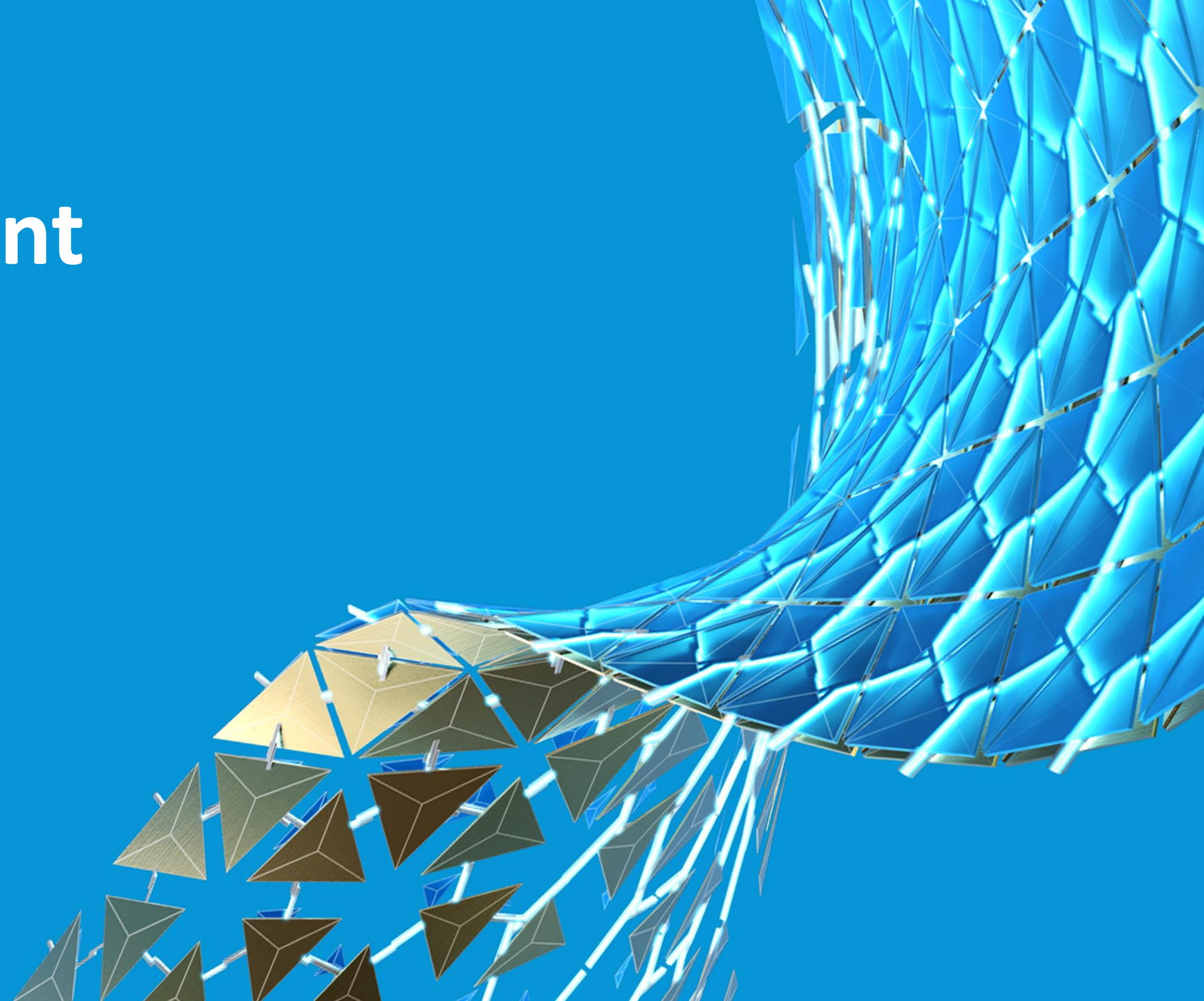


Outcome Oriented Targets (Lean Engineering)

"Begin with the end in mind"

- **Reduce waiting and searching for information**
- **Avoid over production of information with no defined use**
- **Eliminate defects and re-work through better coordination**
- **Re-use models and look for interchange opportunities**
- **Build confidence into models**
- **Reduce time and cost**

Appointment

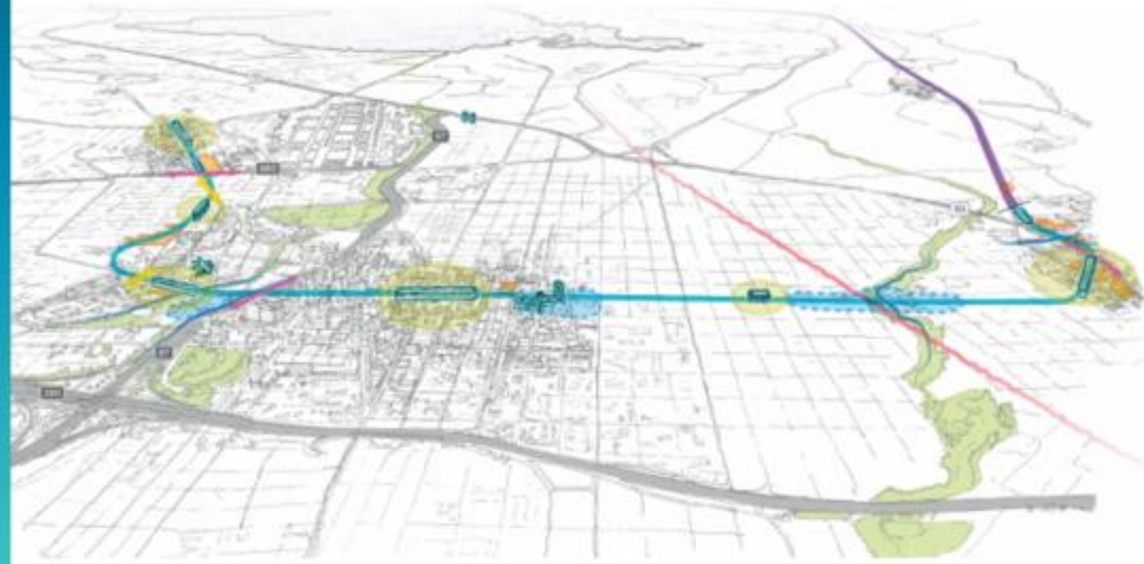


BIM Execution Plan

- Digital delivery
- Building information modeling
- BIM execution plan details
- Key roles and responsibilities
- Project BIM objectives and goals
- File sharing / document management
- Software and training
- BIM / CAD modeling guidelines
- QA / QC and model coordination
- Final deliverables

VTA's BART Silicon Valley Phase II Extension Project

General Engineering Consulting Services



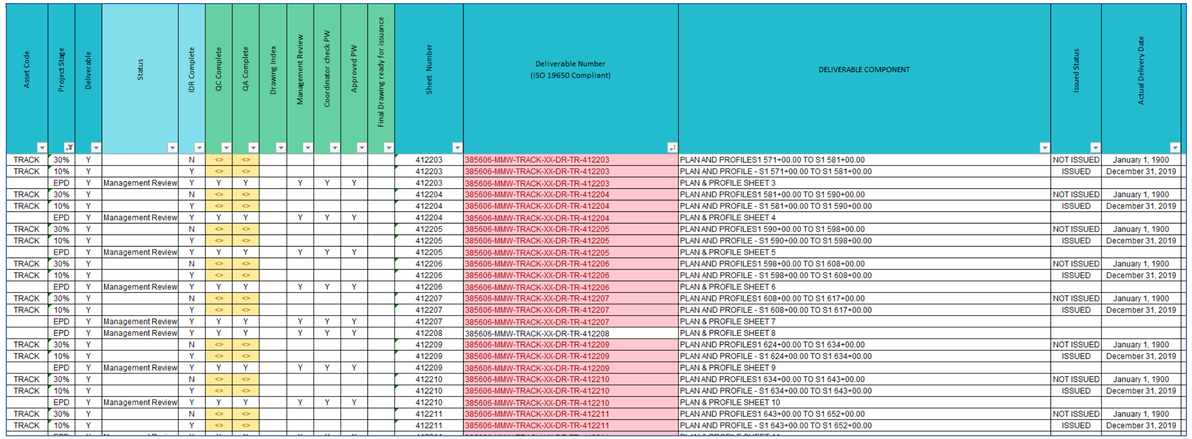
BIM Execution Plan

30% Design Phase
Revision P03
June 22, 2020

MMW TEAM
MOTT MACDONALD
WONG ENGINEERING

MIDP

- Master Information Delivery Plan
- Master file detailing document names by discipline, asset and contract
- Discipline teams responsible for maintaining drawing lists in the MIDP
- BIM team responsible for maintaining model lists (MPDT – Model Production Delivery Table) in the MIDP
- Tracking the completion of files in Power BI



Asset Code	Project Stage	Deliverable	Status	IDR Complete	QC Complete	QA Complete	Drawing Index	Management Review	Coordinator check PW	Approved PW	Final Drawing ready for issuance	Sheet Number	Deliverable Number (ISO 19650 Compliant)	DELIVERABLE COMPONENT	Issued Status	Actual Delivery Date
TRACK	30%	Y		N	<>	<>						412203	385606-MMW-TRACK-XX-DR-TR-412203	PLAN AND PROFILES1 571+00.00 TO S1 581+00.00	NOT ISSUED	January 1, 1900
TRACK	10%	Y		Y	<>	<>						412203	385606-MMW-TRACK-XX-DR-TR-412203	PLAN AND PROFILE - S1 571+00.00 TO S1 581+00.00	ISSUED	December 31, 2019
	EPD	Y	Management Review	Y	Y	Y		Y	Y	Y		412203	385606-MMW-TRACK-XX-DR-TR-412203	PLAN & PROFILE SHEET 3		
TRACK	30%	Y		N	<>	<>						412204	385606-MMW-TRACK-XX-DR-TR-412204	PLAN AND PROFILES1 581+00.00 TO S1 590+00.00	NOT ISSUED	January 1, 1900
TRACK	10%	Y		Y	<>	<>						412204	385606-MMW-TRACK-XX-DR-TR-412204	PLAN AND PROFILE - S1 581+00.00 TO S1 590+00.00	ISSUED	December 31, 2019
	EPD	Y	Management Review	Y	Y	Y		Y	Y	Y		412204	385606-MMW-TRACK-XX-DR-TR-412204	PLAN & PROFILE SHEET 4		
TRACK	30%	Y		N	<>	<>						412205	385606-MMW-TRACK-XX-DR-TR-412205	PLAN AND PROFILES1 590+00.00 TO S1 598+00.00	NOT ISSUED	January 1, 1900
TRACK	10%	Y		Y	<>	<>						412205	385606-MMW-TRACK-XX-DR-TR-412205	PLAN AND PROFILE - S1 590+00.00 TO S1 598+00.00	ISSUED	December 31, 2019
	EPD	Y	Management Review	Y	Y	Y		Y	Y	Y		412205	385606-MMW-TRACK-XX-DR-TR-412205	PLAN & PROFILE SHEET 5		
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TRACK	10%	Y		Y	<>	<>						412206	385606-MMW-TRACK-XX-DR-TR-412206	PLAN AND PROFILE - S1 598+00.00 TO S1 608+00.00	ISSUED	December 31, 2019
	EPD	Y	Management Review	Y	Y	Y		Y	Y	Y		412206	385606-MMW-TRACK-XX-DR-TR-412206	PLAN & PROFILE SHEET 6		
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TRACK	10%	Y		Y	<>	<>						412207	385606-MMW-TRACK-XX-DR-TR-412207	PLAN AND PROFILE - S1 608+00.00 TO S1 617+00.00	ISSUED	December 31, 2019
	EPD	Y	Management Review	Y	Y	Y		Y	Y	Y		412207	385606-MMW-TRACK-XX-DR-TR-412207	PLAN & PROFILE SHEET 7		
	EPD	Y	Management Review	Y	Y	Y		Y	Y	Y		412208	385606-MMW-TRACK-XX-DR-TR-412208	PLAN & PROFILE SHEET 8		
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	EPD	Y	Management Review	Y	Y	Y		Y	Y	Y		412210	385606-MMW-TRACK-XX-DR-TR-412210	PLAN & PROFILE SHEET 10		
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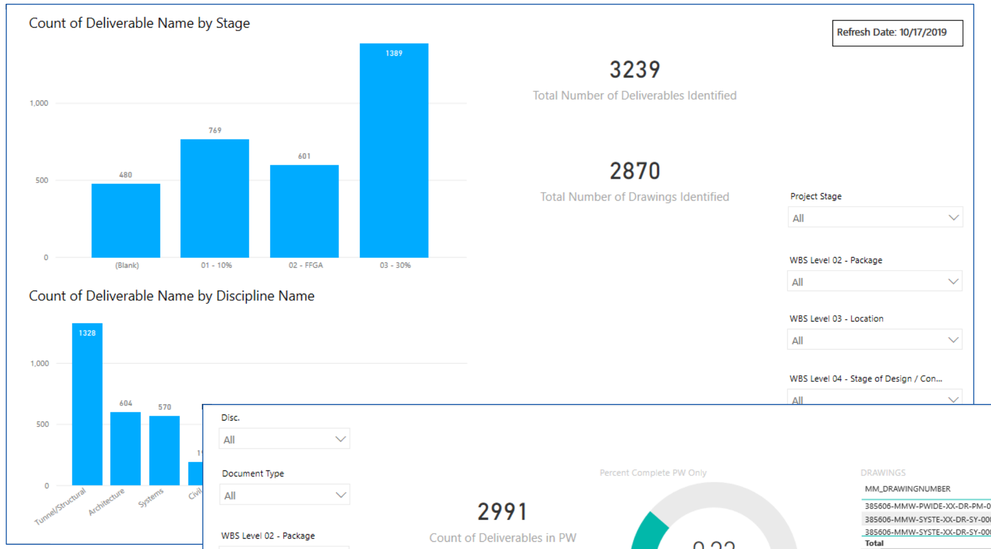
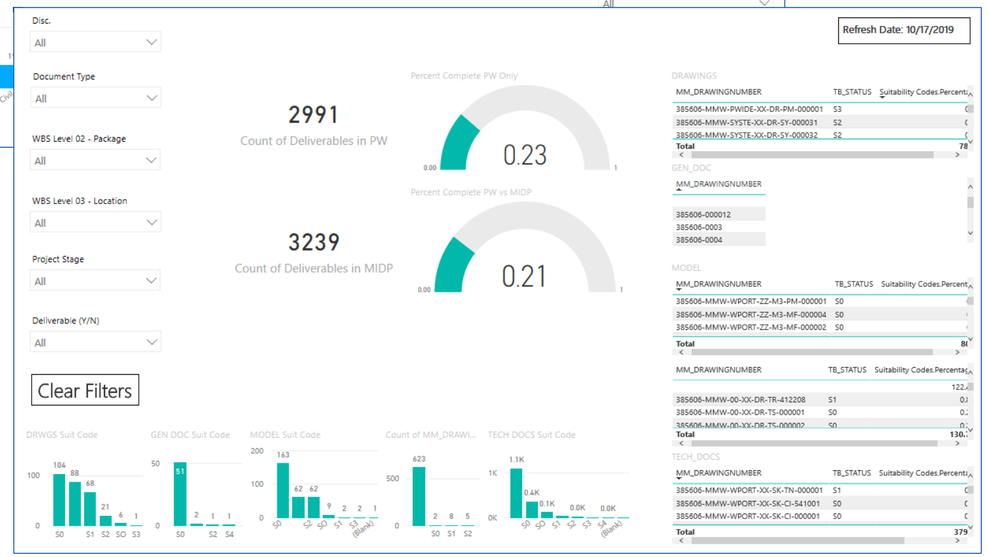
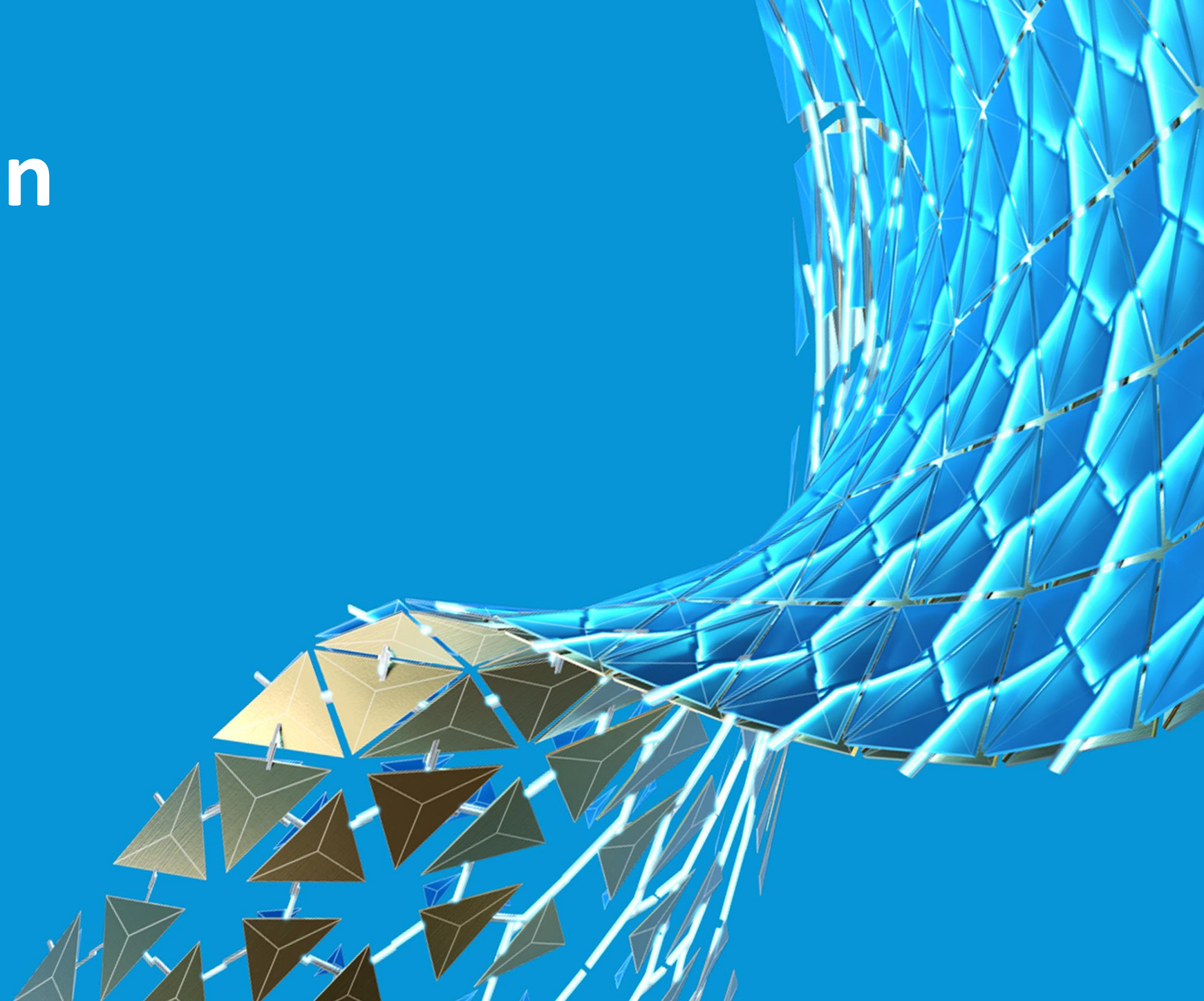
TRACK	10%	Y		Y	<>	<>						412211	385606-MMW-TRACK-XX-DR-TR-412211	PLAN AND PROFILE - S1 643+00.00 TO S1 652+00.00	ISSUED	December 31, 2019

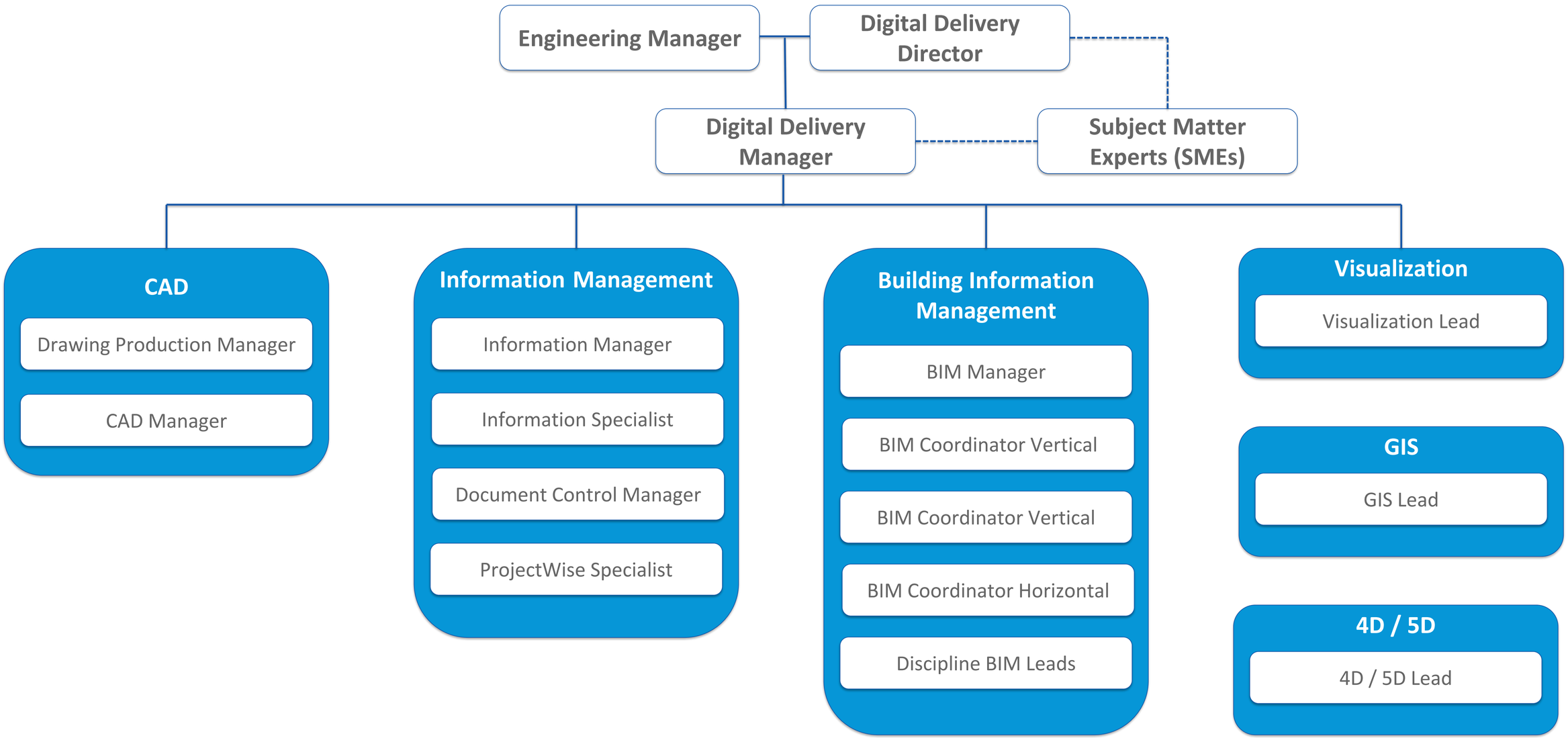




Mobilization Resources



Digital Delivery Team



Mobilization of Team

460
MOBILIZED STAFF

49
LOCATIONS

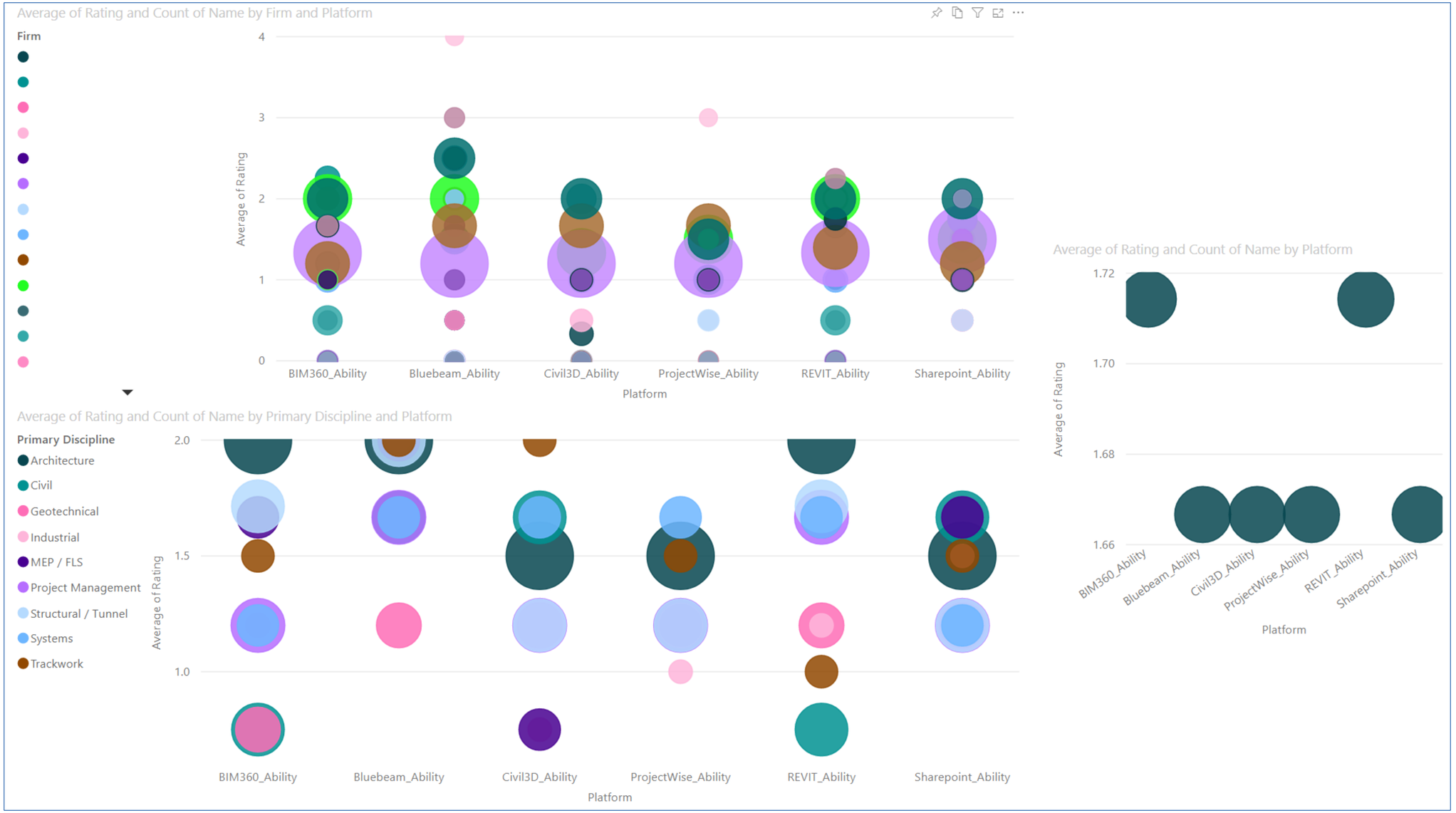
25
FIRMS

10
DISCIPLINES

One

Team
Way of Working
Combined Vision

Skills Survey



Training and Support

Classroom / Online

Instructional Videos

Printed Materials

Initial Training

Information Management Team Support

Surgeries

Ongoing Support

Champions

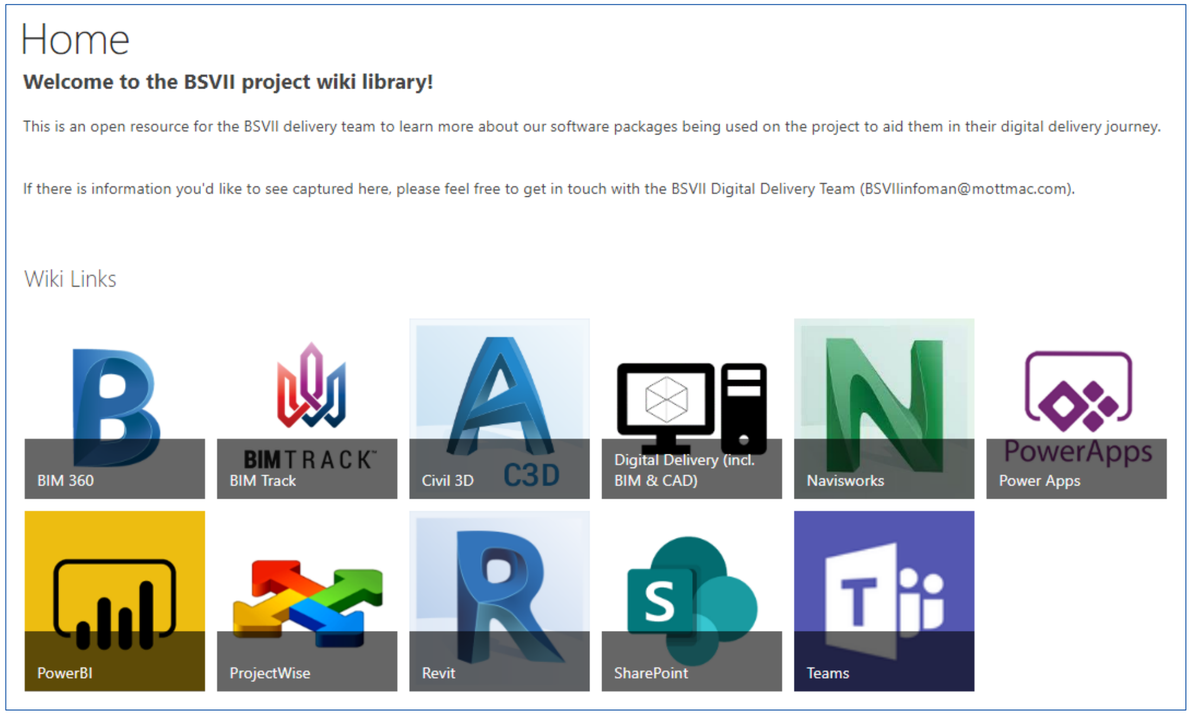
Peer Support

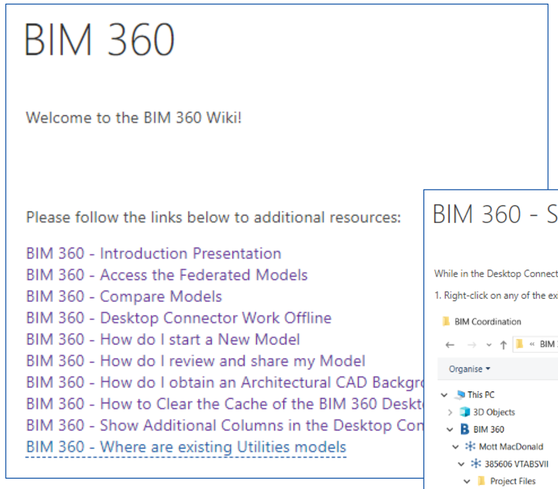
Self-Sufficiency

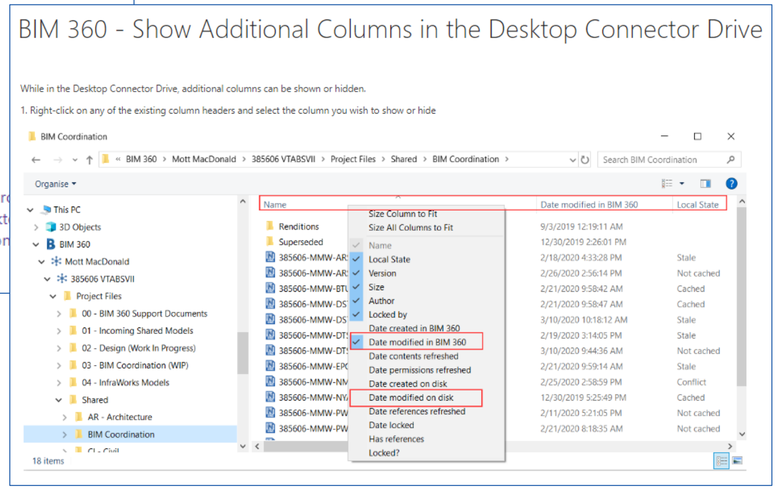
Project Maturity

Project Wiki

- **Step-by-step work instructions**
- **Training videos**
- **Training presentations**







TRUST

1 Create information **once** and store correctly.

2 Actively **share** information. Understand ISO 19650 and respect the **workflow**.

3 Seek, support and share training **knowledge** with your colleagues.

4 Send links instead of attachments – keep the **single source of truth**.

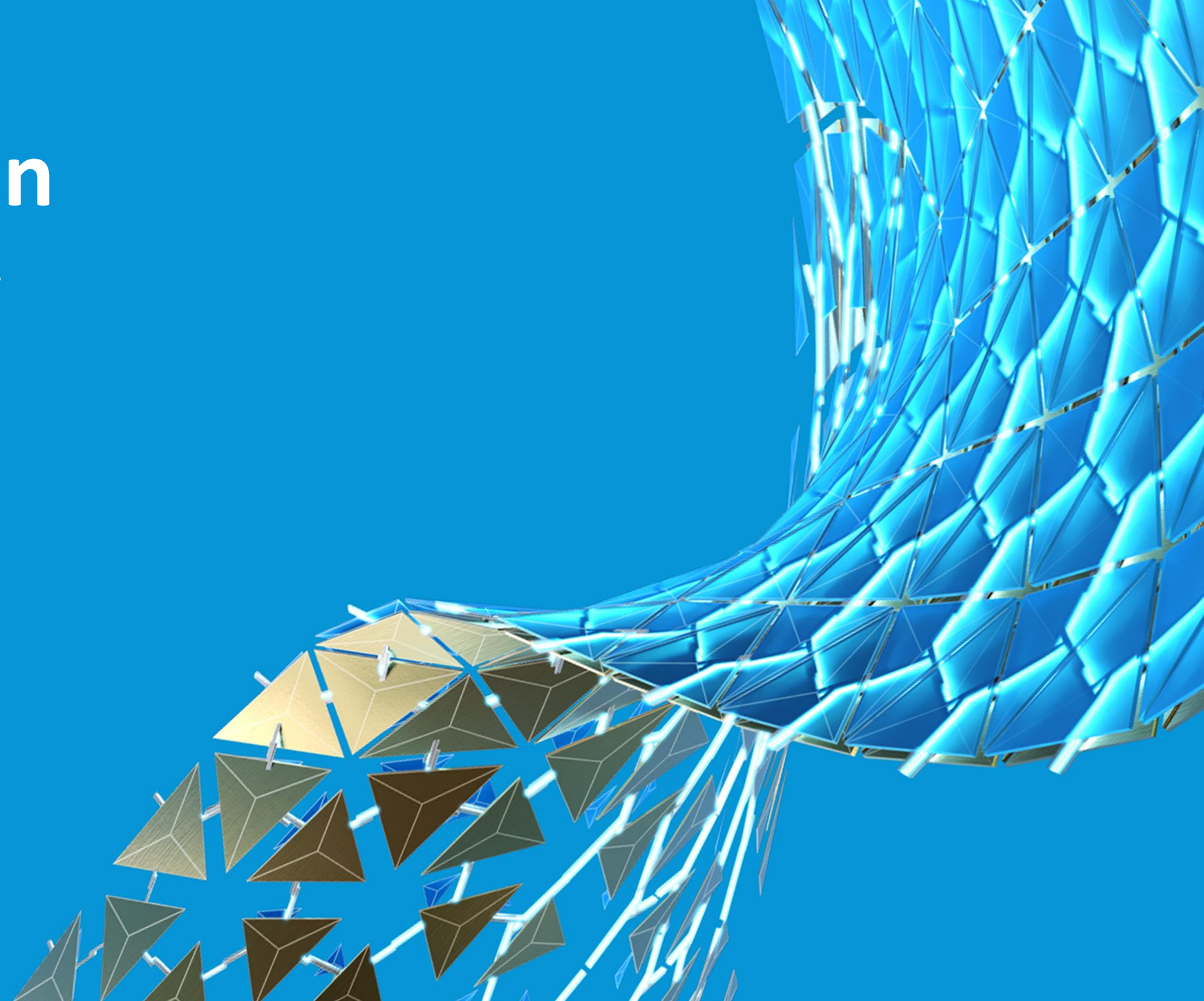
5 Be clear and concise – **communication** will be a challenge.

6 **Don’t be afraid** of the models.

7 Only design and model to the required **scope and level of detail**.

8 **Sharing is caring** – help others and seek help.

Mobilization Technology



Robust Digital Framework

BIM 360

Revit

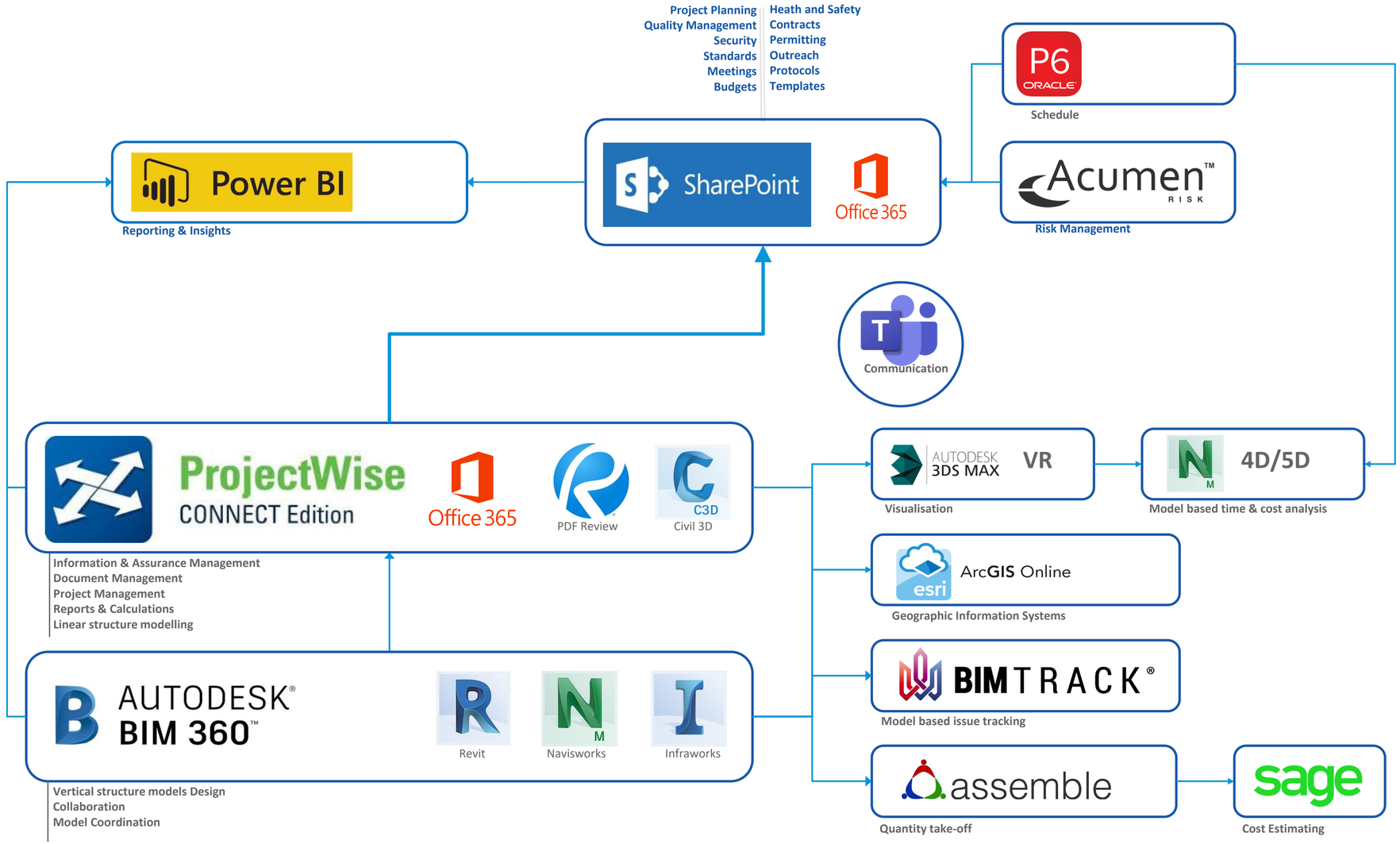
Civil 3D

Navisworks

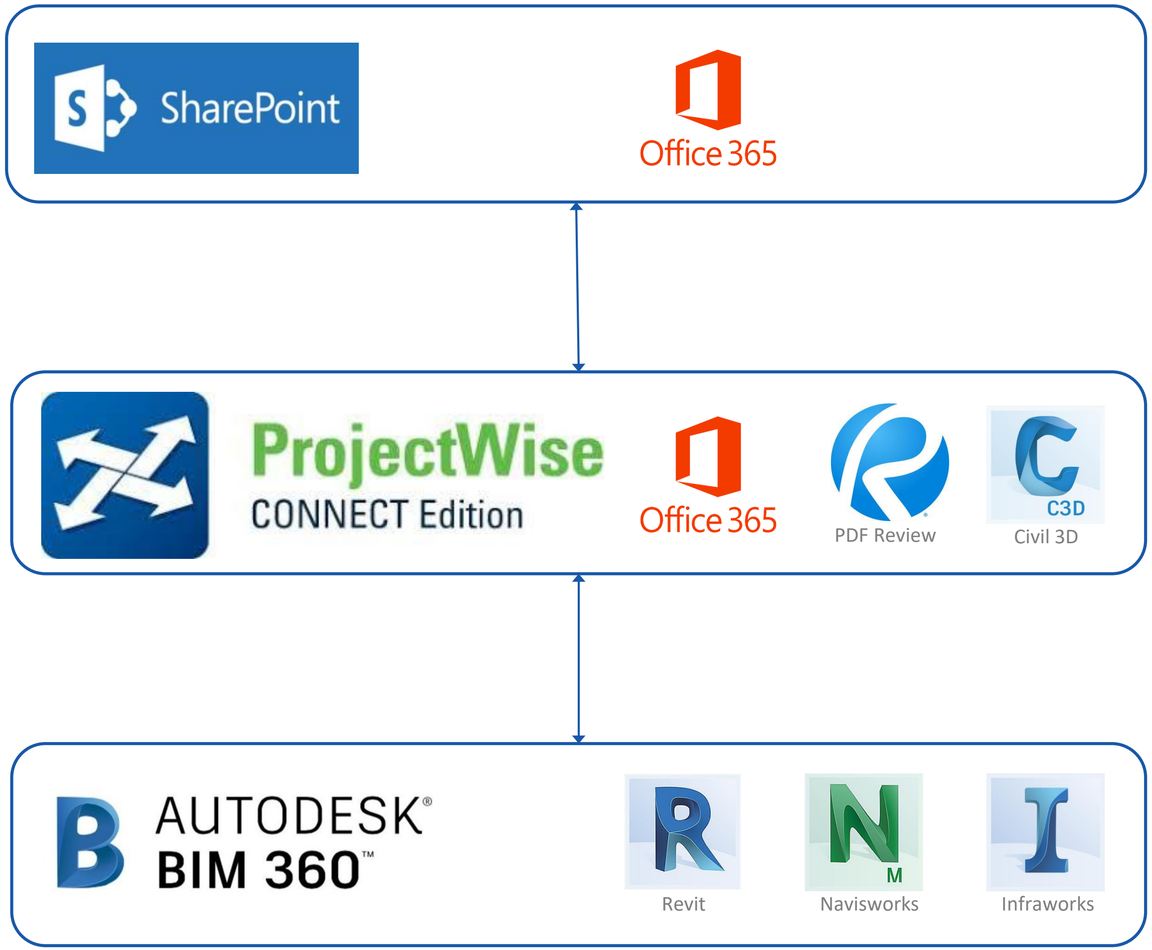
Infraworks

3ds Max

Digital Delivery Environment



Common Data Environment



Project Planning
Quality
Management
Security
Standards
Meetings
Budgets

Heath and Safety
Contracts
Permitting
Outreach
Protocols
Templates

Information and Assurance
Management
Document Management
Project Management
Reports and Calculations
Linear structure modelling

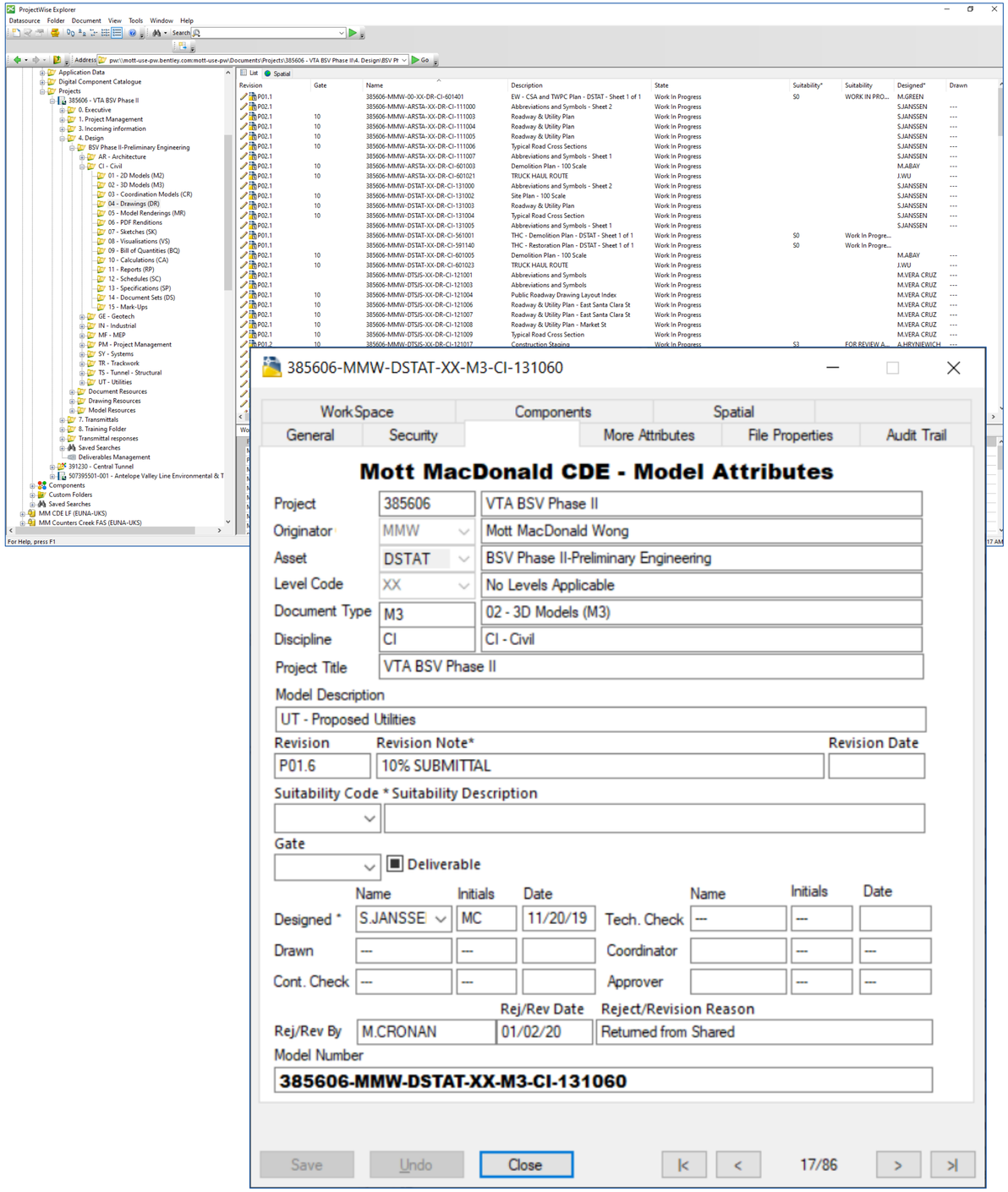
Vertical structure models
Design Collaboration
Model Coordination

SharePoint

- Non-delivery information
- GEC project control and management
- Onboarding and training material
- Links, templates and commonly used files

ProjectWise

- Primary CDE for all deliverables
- ISO 19650 structure including file naming, state and suitability codes
- Embedded workflows for file sharing and validation
- Customizable metadata for enhanced analysis
- Title block integration for DWG files
- PDF renditions



BIM 360

- CDE for all Revit models and federated models
- Applied ISO 19650 environment
- Enhanced model visibility

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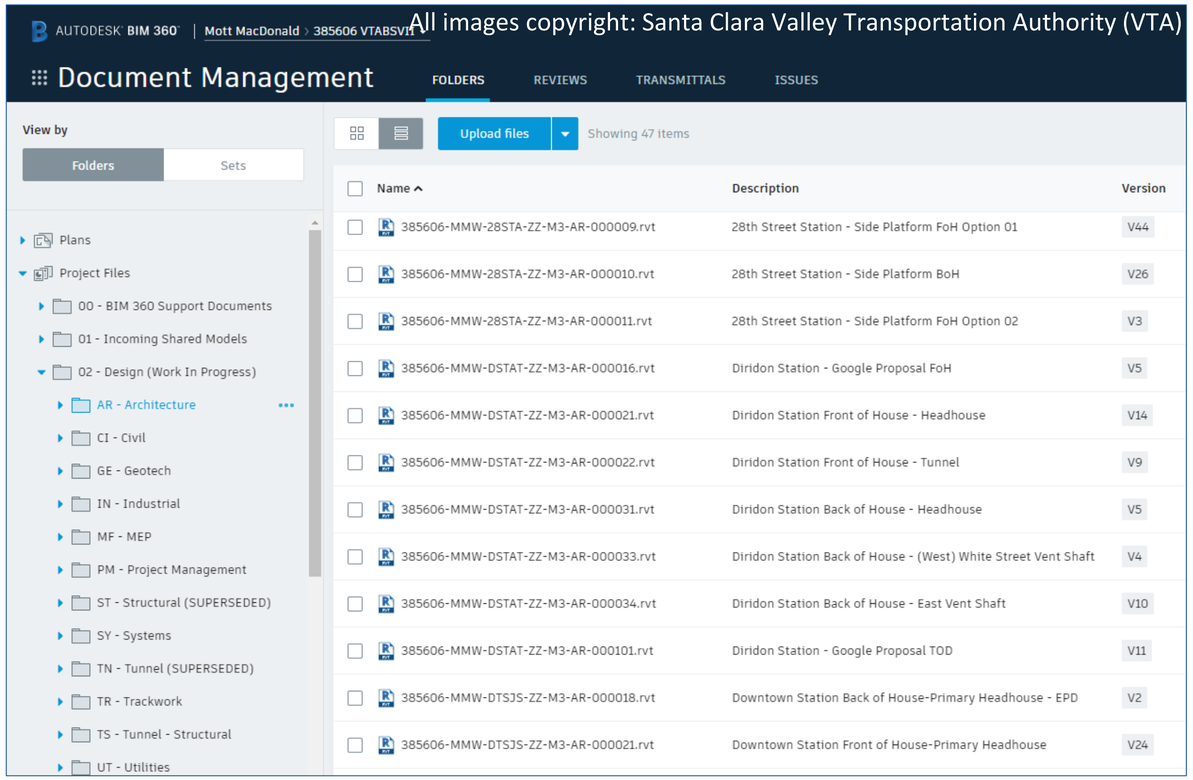
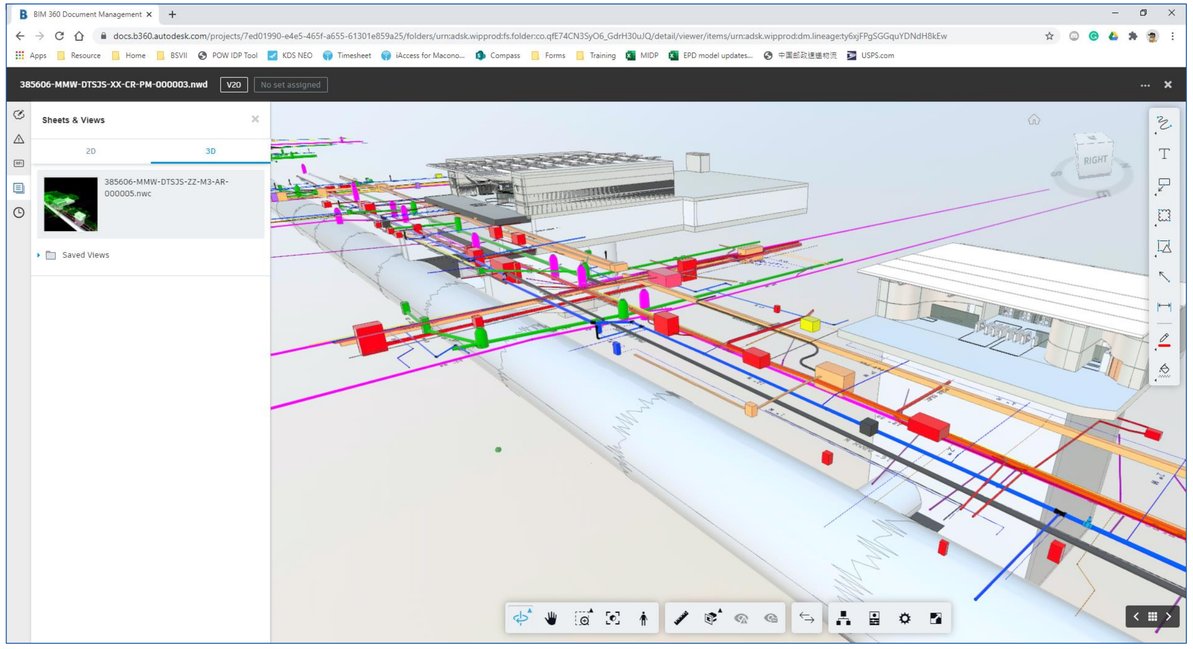
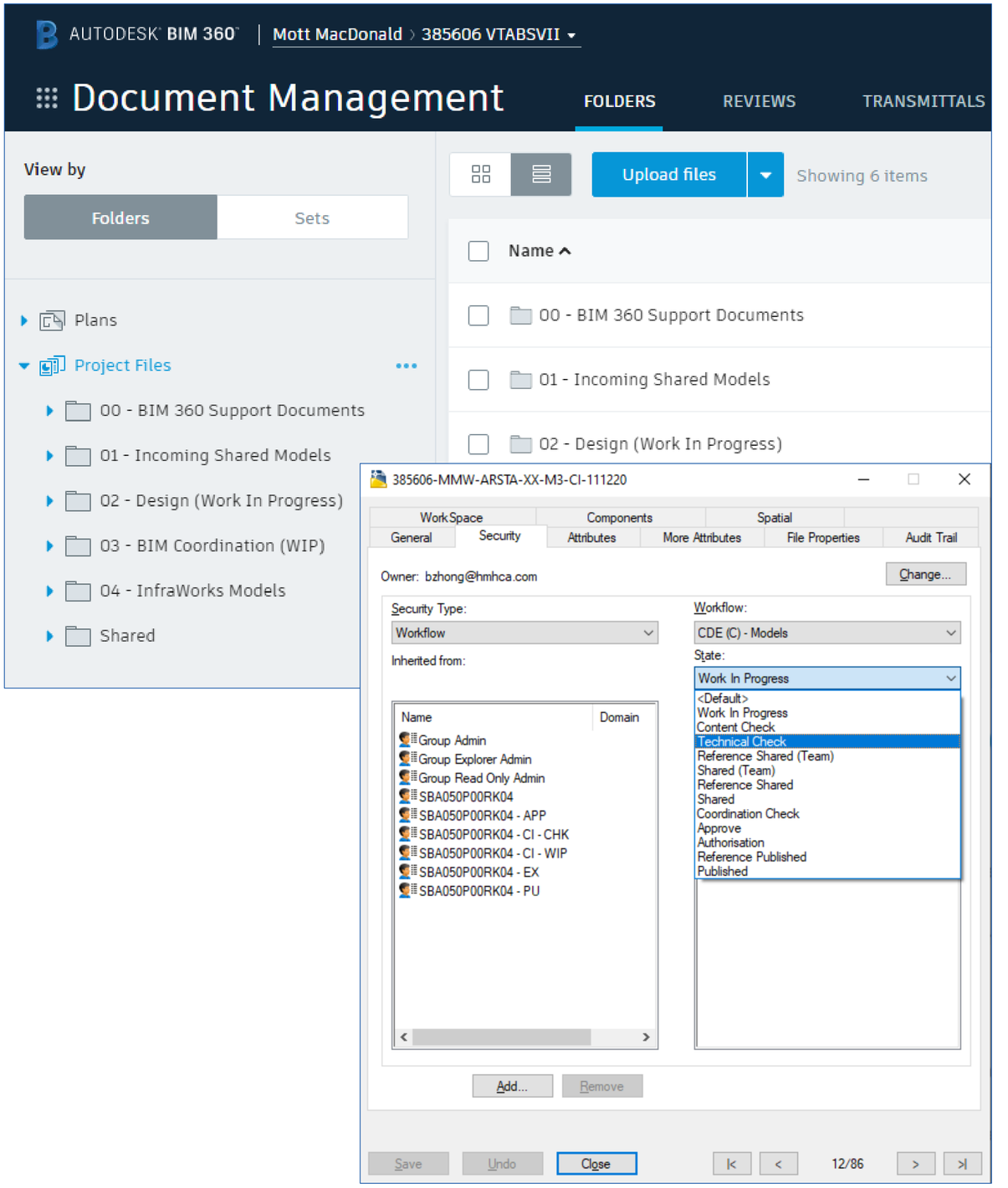




Information Sharing Workflows

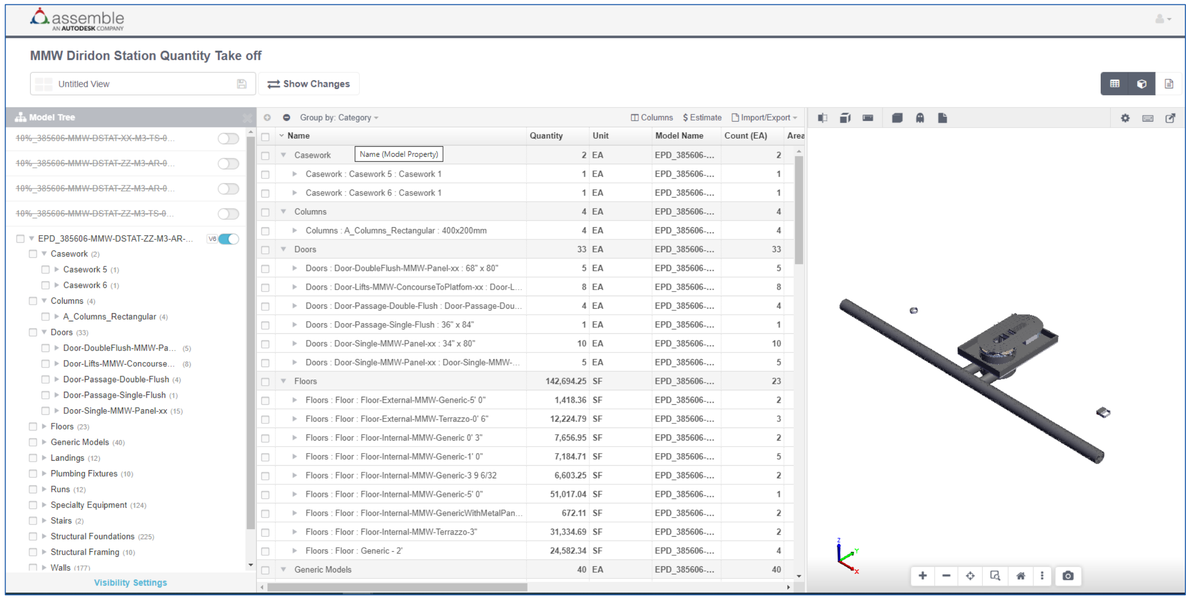
- **BIM 360**
  - Manual set-up of WIP and Shared folders
  - Manual set-up of approval workflows
  - Approved version of the models copied to the Shared folder
  - Custom attributes for suitability code and state

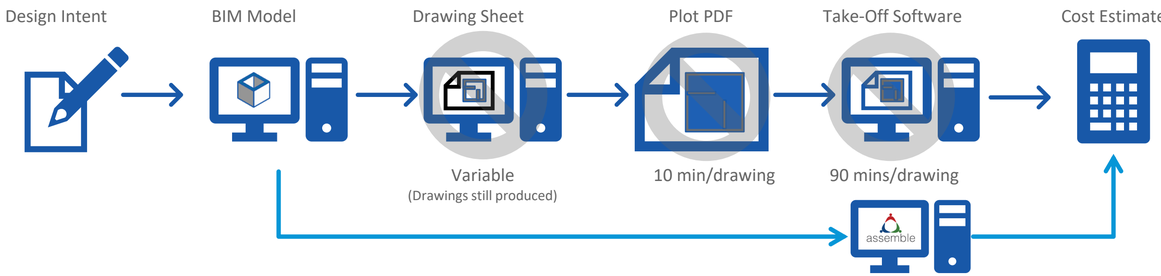
- **ProjectWise**
  - Automated workflows for the review and approval processes
  - Files shared through suitability codes and states



Assemble

- **Typical Quantity Take-Off Process:**
  - Requires high resolution PDFs (higher resolution = higher accuracy)
  - Elements are traced to obtain areas
  - Design intent can be misunderstood
    - Material types
    - Construction methodology
- **Assemble Quantity Take-Off Process:**
  - Models can be directly imported for material take-off
  - Accurate extraction of areas and volumes
    - No tracing or calibration of scales required
    - Eliminates requirement of specific 1ft PDF drawing plots
    - Less opportunity for design intent to be misunderstood
    - Time and cost savings





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BIM Track

- Issue tracking (not just clashes)
- Integrates with main design software
- Accessible online for non-technical staff
- Record and monitor issues
- Bridge the gap between 2D and 3D teams with hyper-modelling
- All parties access

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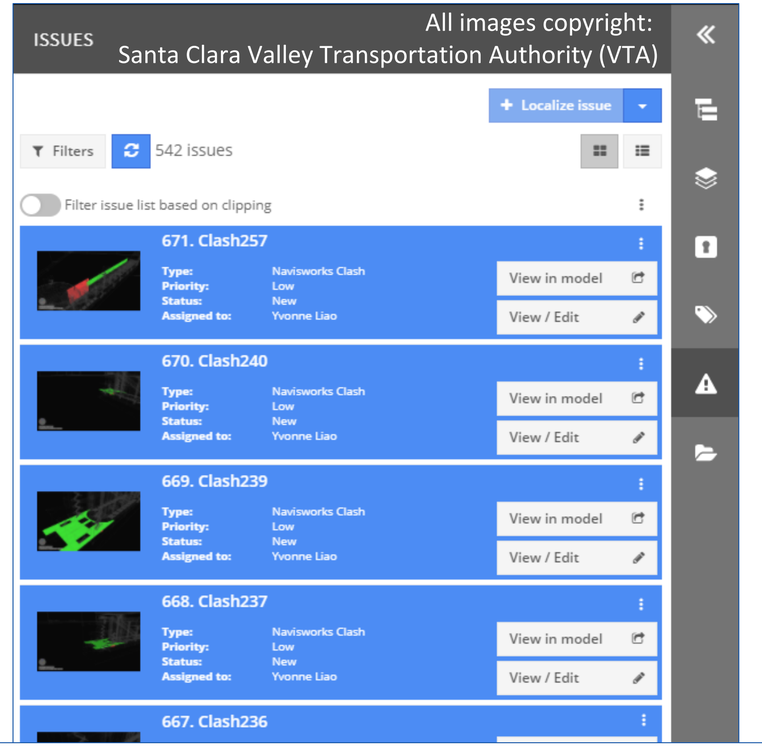
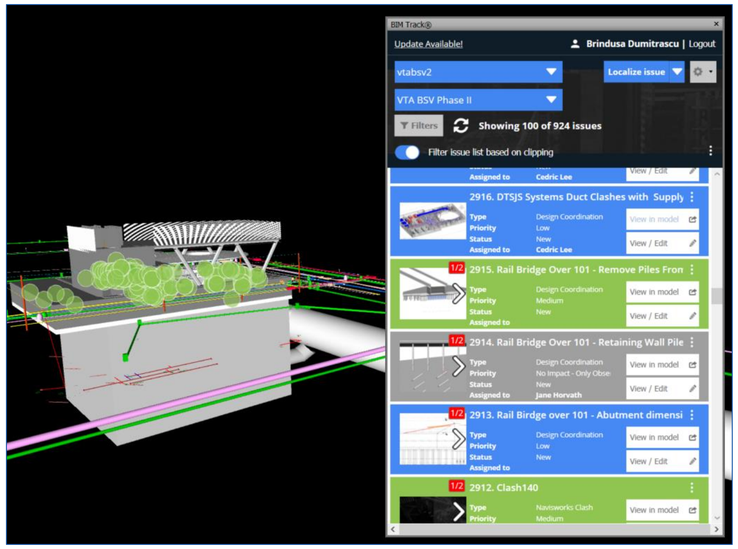
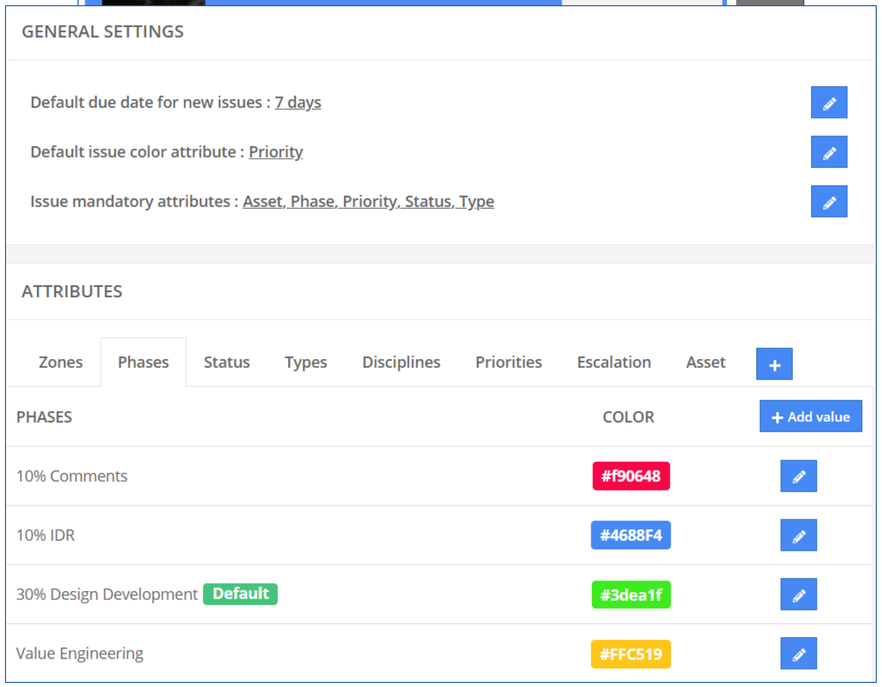
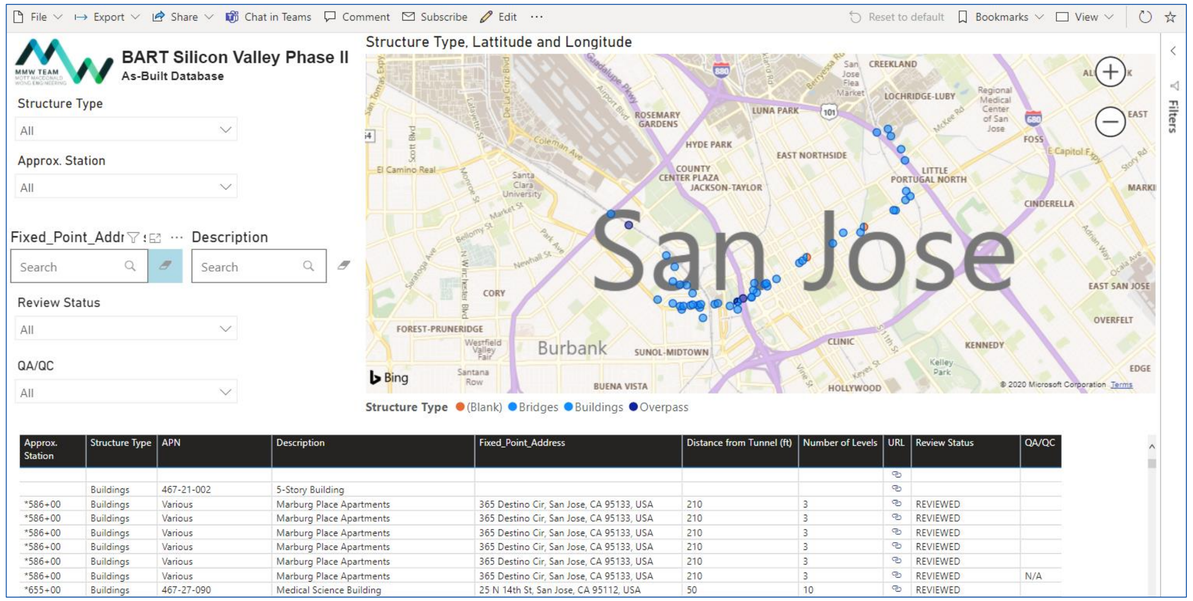


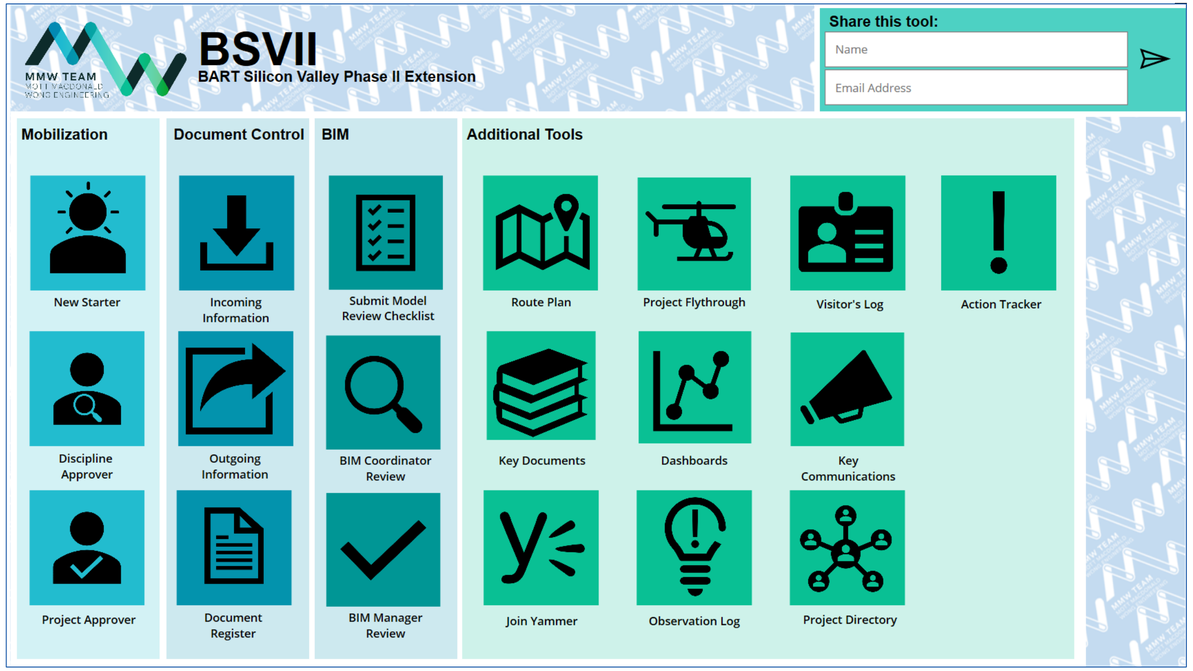




Power BI & Power Apps

- Tracking as-built information through to models
- Monitor and report QC of Civil 3D and Revit models
- Visualize data from BIM 360 and ProjectWise
- Geotechnical – GIS dashboard for boreholes and water levels
- Budget reporting
- RFCs and submittals reporting
- Management performance reporting
- Change analysis and earned value reporting
- Project App for automation of common tasks:
  - Mobilization
  - Document control
  - Project directory
  - Key info
  - Etc.
- Staffing Plan





Virtual Reality

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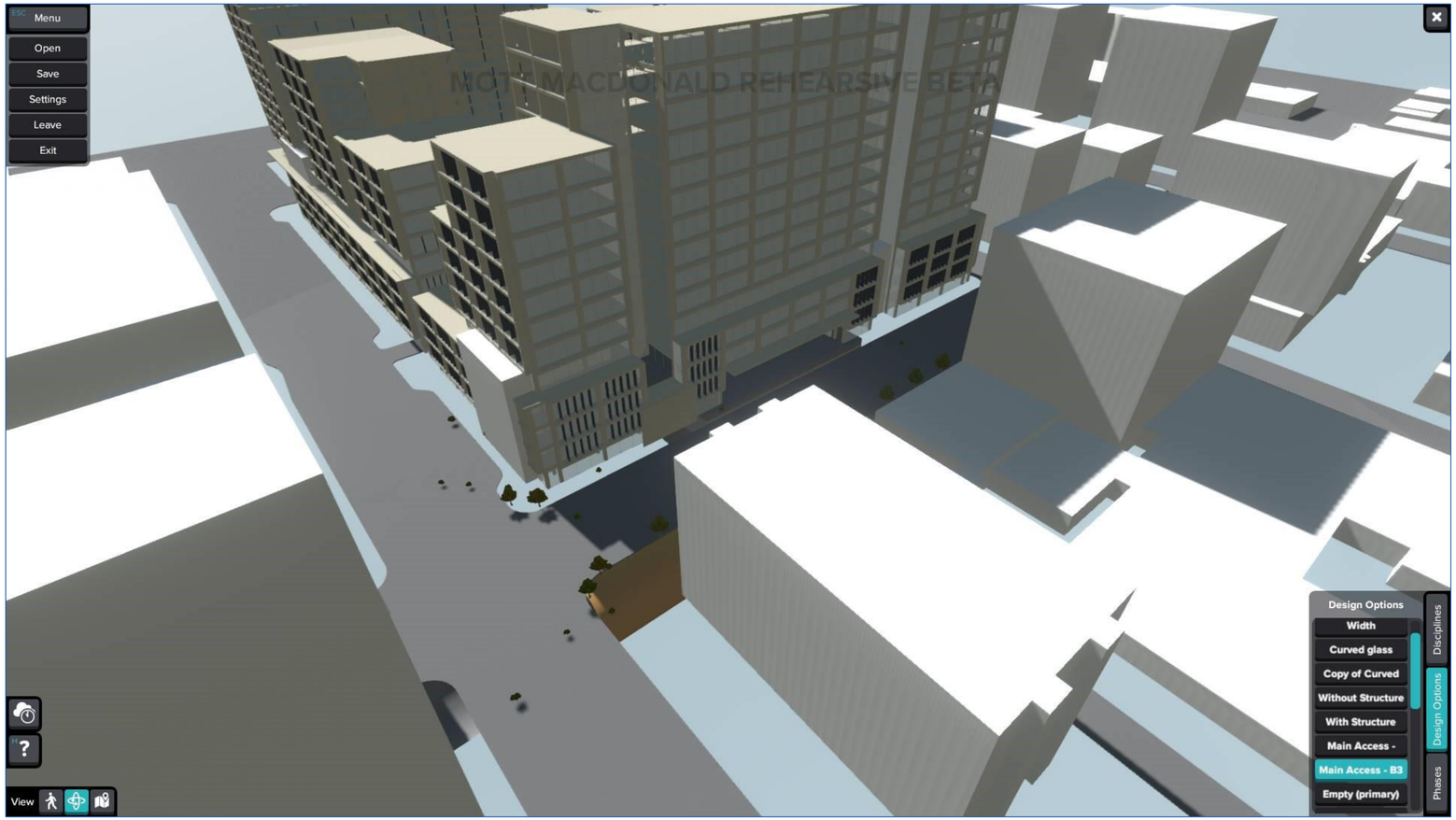
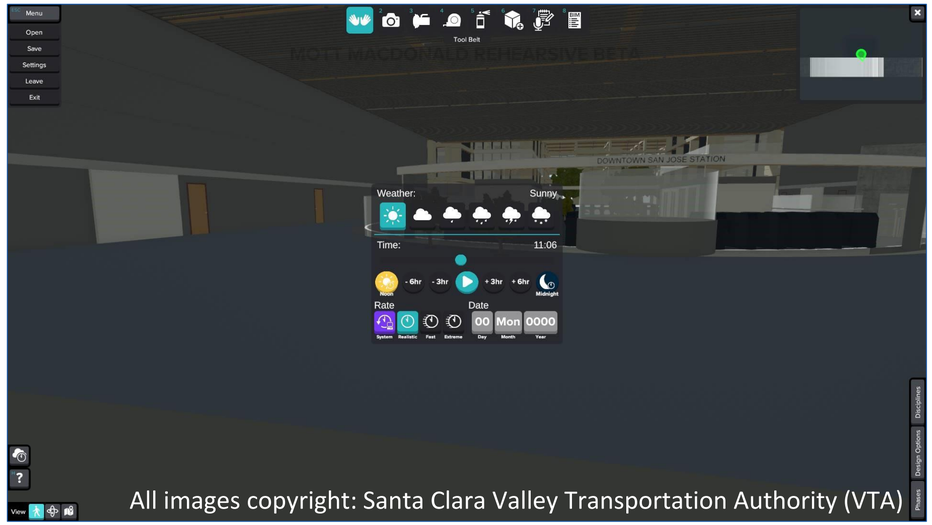
www.Rehearsive.io





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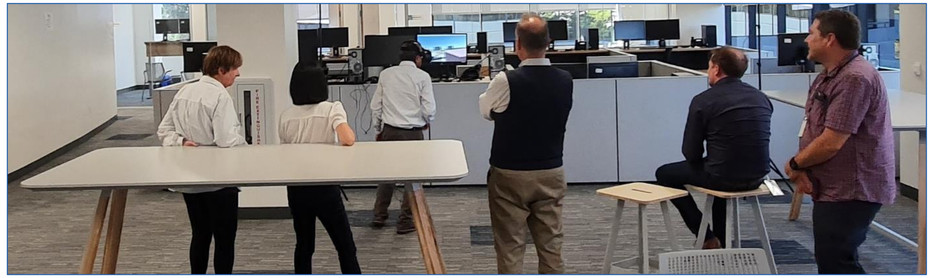
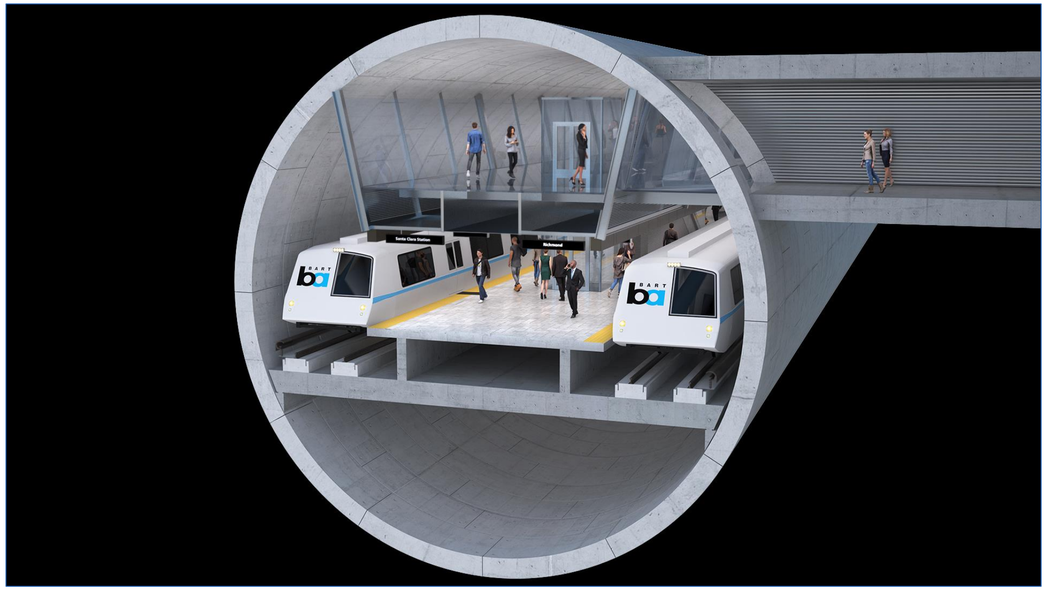
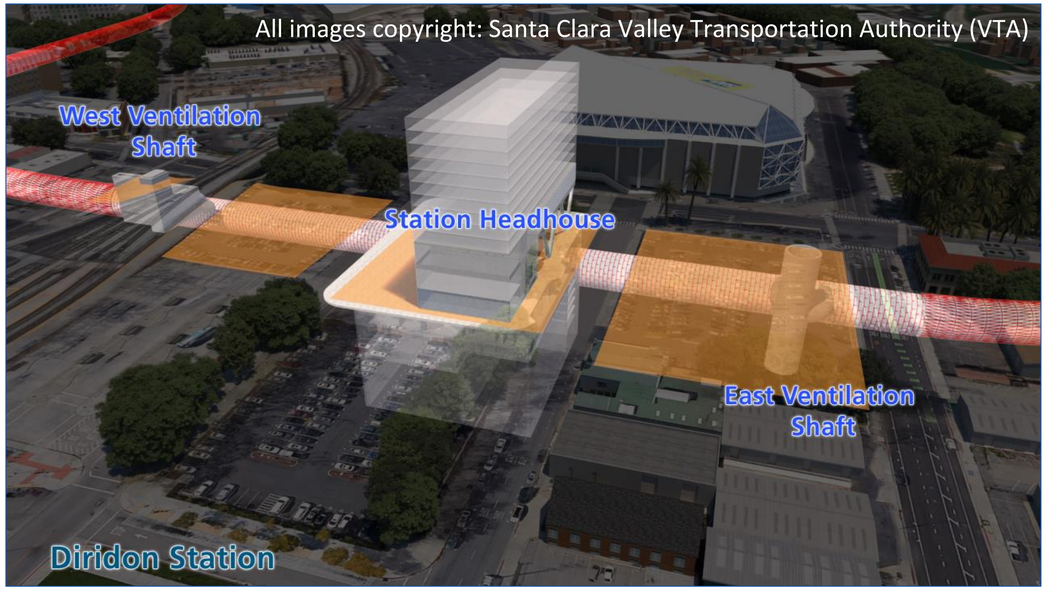
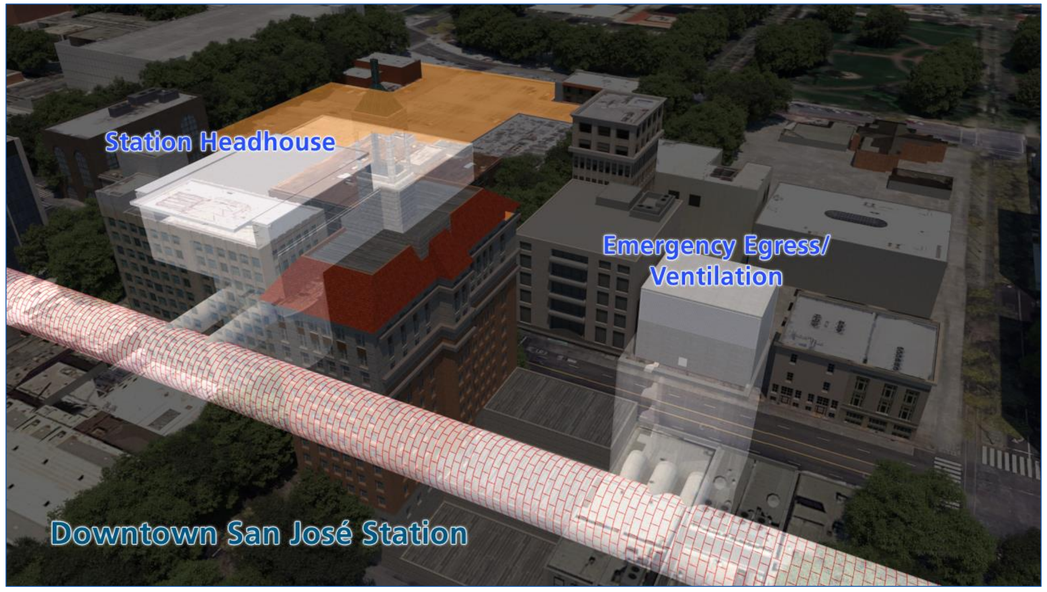


Visualization

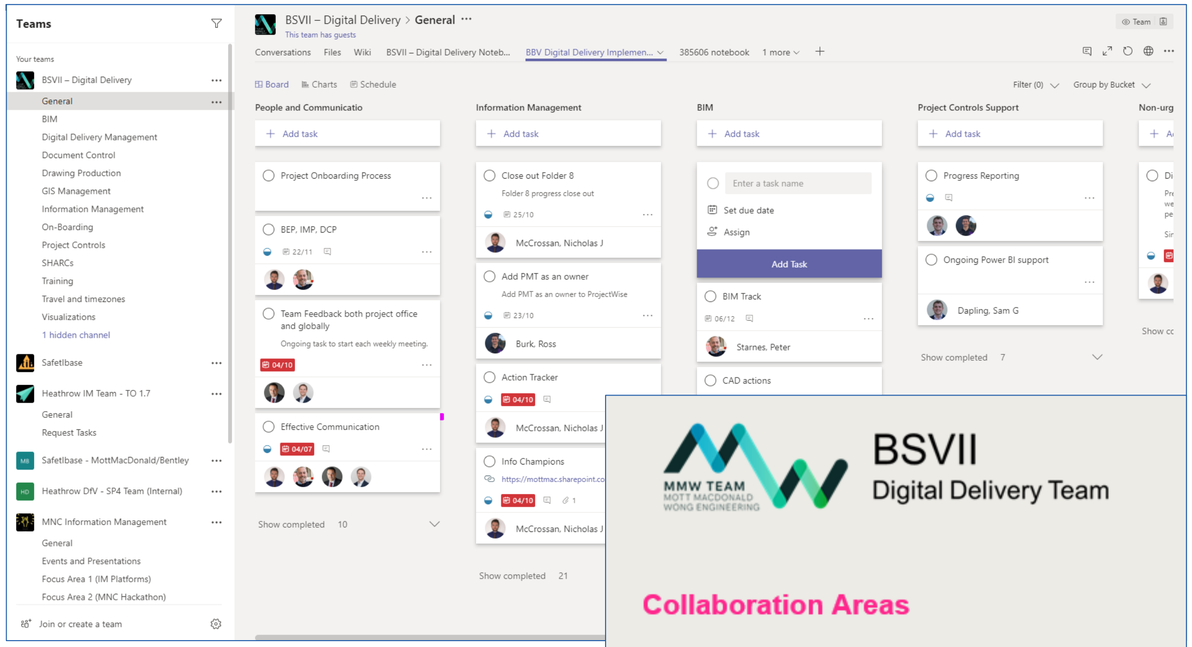


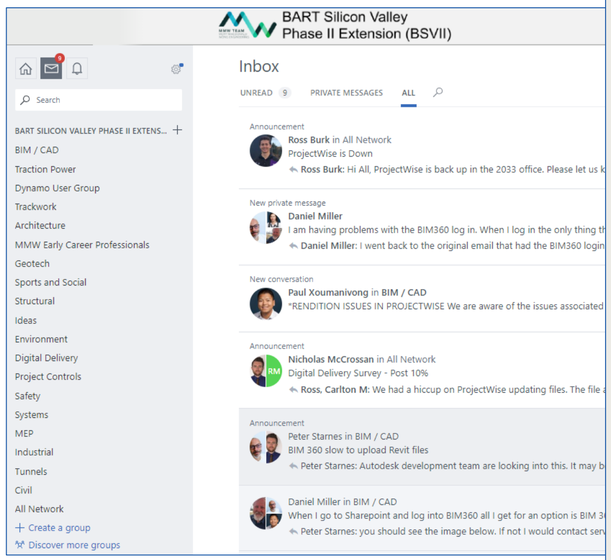


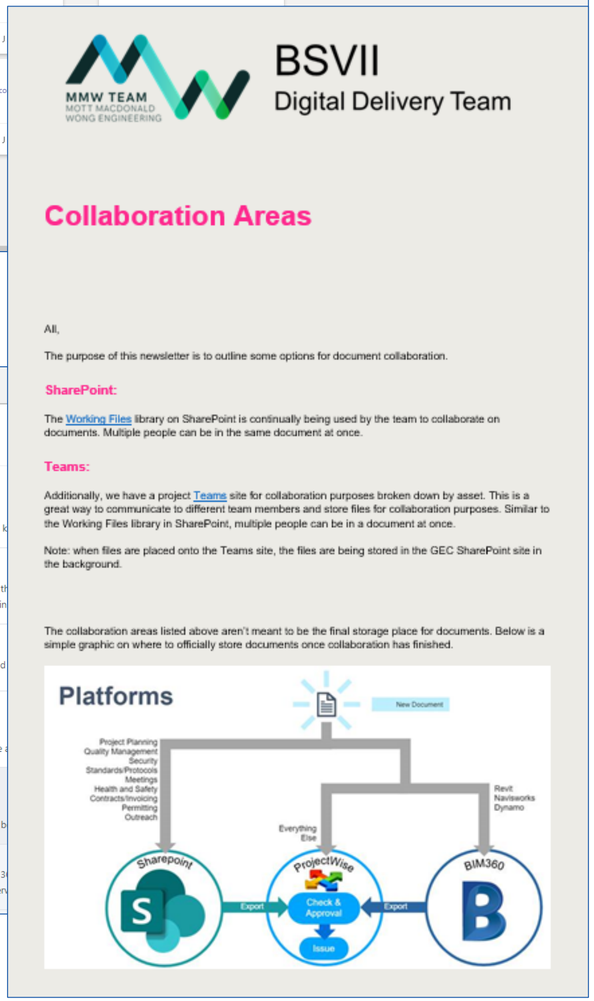


Communication

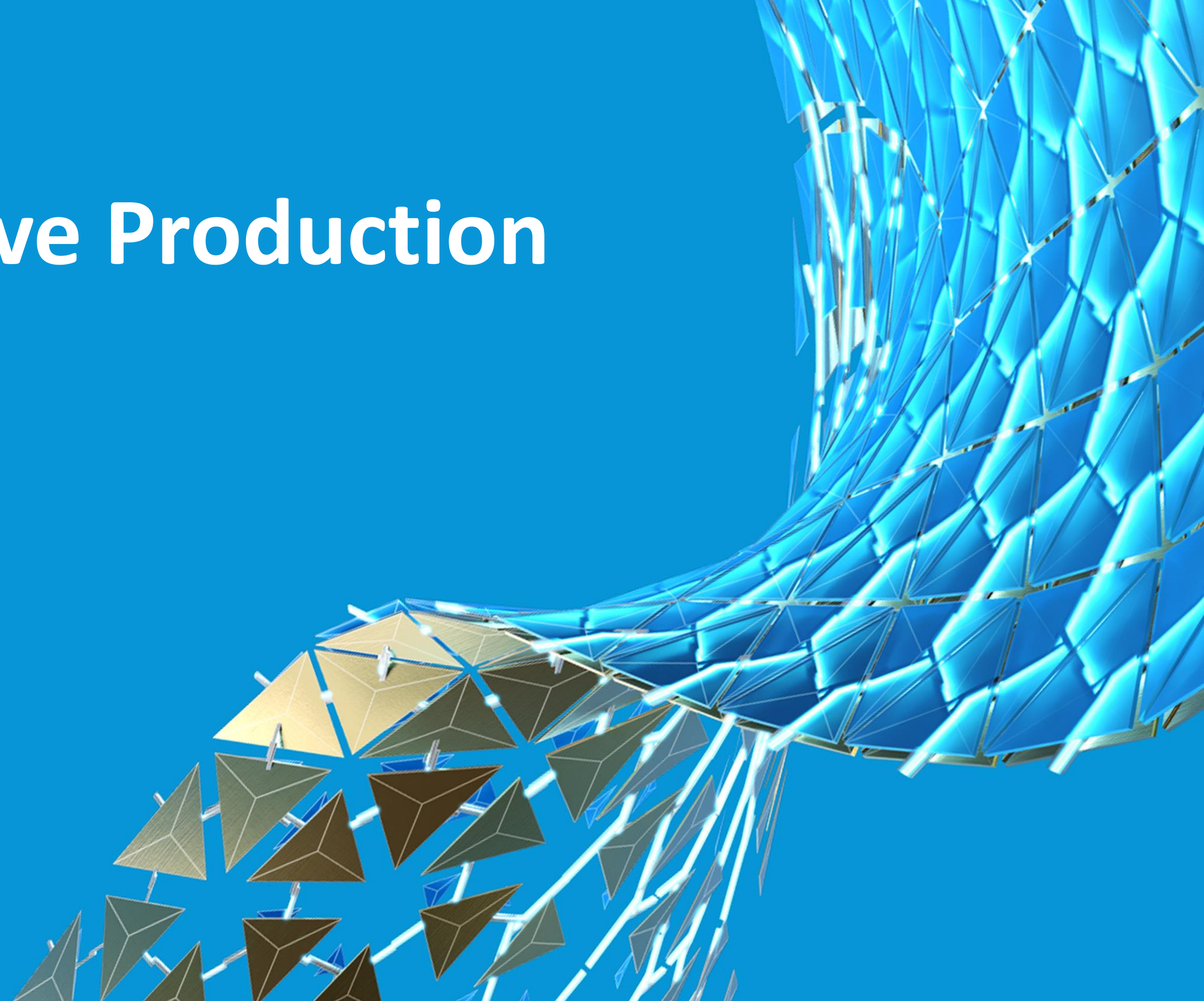
- **Teams**
  - Instant messaging
  - Screen sharing
  - Meetings
  - File sharing
  - OneNote
  - Planner
- **Yammer**
  - Open communication
  - Reduced email communication
  - Increased collaboration
  - Team engagement
- **Newsletters**
  - Various information management topics
- **Project BIM Meetings**
  - Standard updates
  - Tips and tricks
  - Round Robin



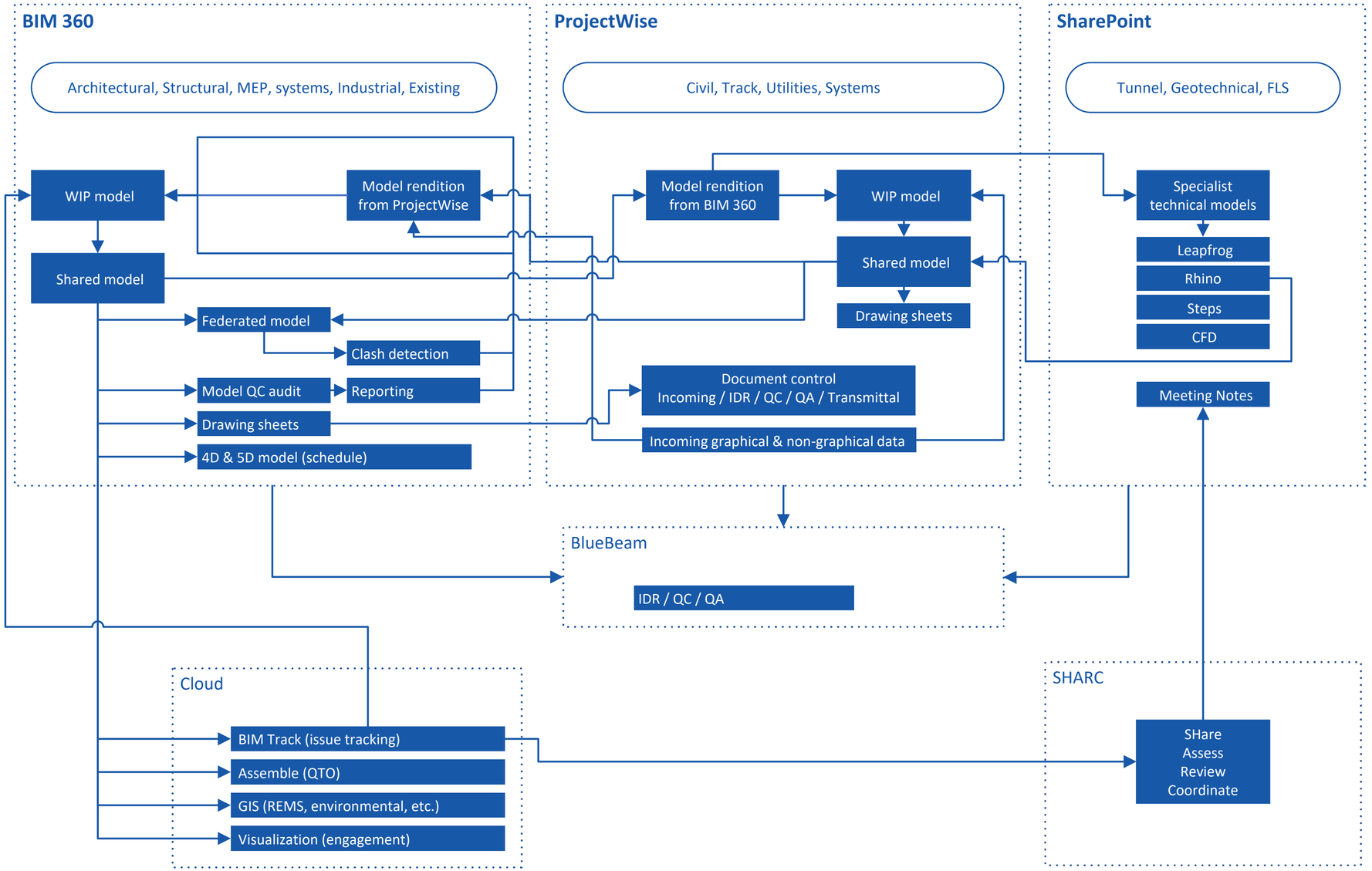




Collaborative Production

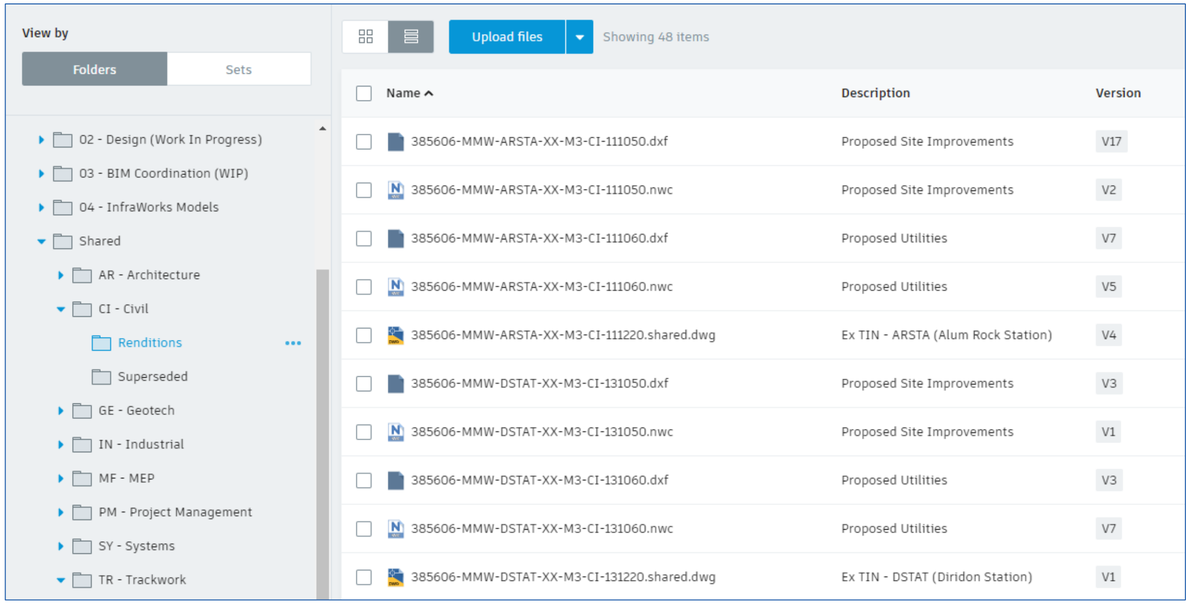


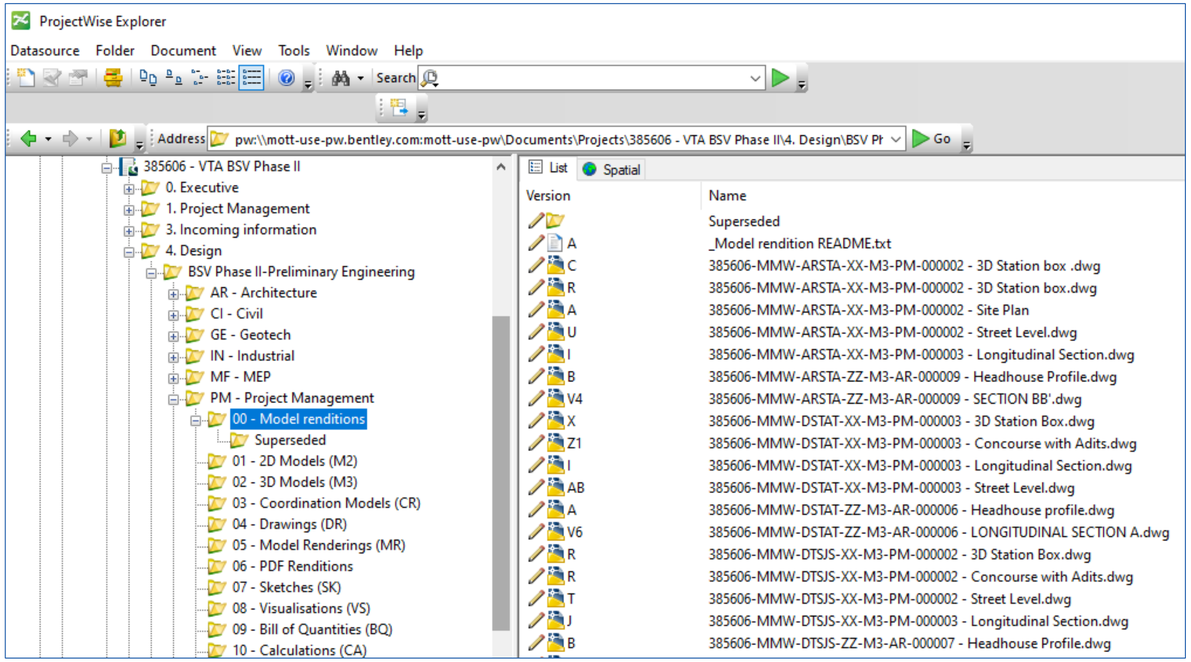
Data Connections



Renditions

- **Link two graphical CDEs (BIM 360 and ProjectWise)**
- **Manually created**
- **Monitored through version control and reporting**
- **BIM 360 -> ProjectWise**
  - Notification from BIM 360 when a model is shared
  - Spreadsheet to keep track of the renditions
    - Date of shared model
    - Date of rendition
- **ProjectWise -> BIM 360**
  - Email notification when a ProjectWise model is shared
  - Custom attribute in BIM 360 for the corresponding ProjectWise shared version
  - Power BI:
    - Manual export weekly from ProjectWise with the state and date of files
    - Comparison against the renditions in BIM 360





Suitability Codes

Work In Progress (WIP)
Unchecked Native Data

Suitable For Coordination
Shared for other disciplines to reference.

Suitable For Information
Data shared purely for others' awareness.

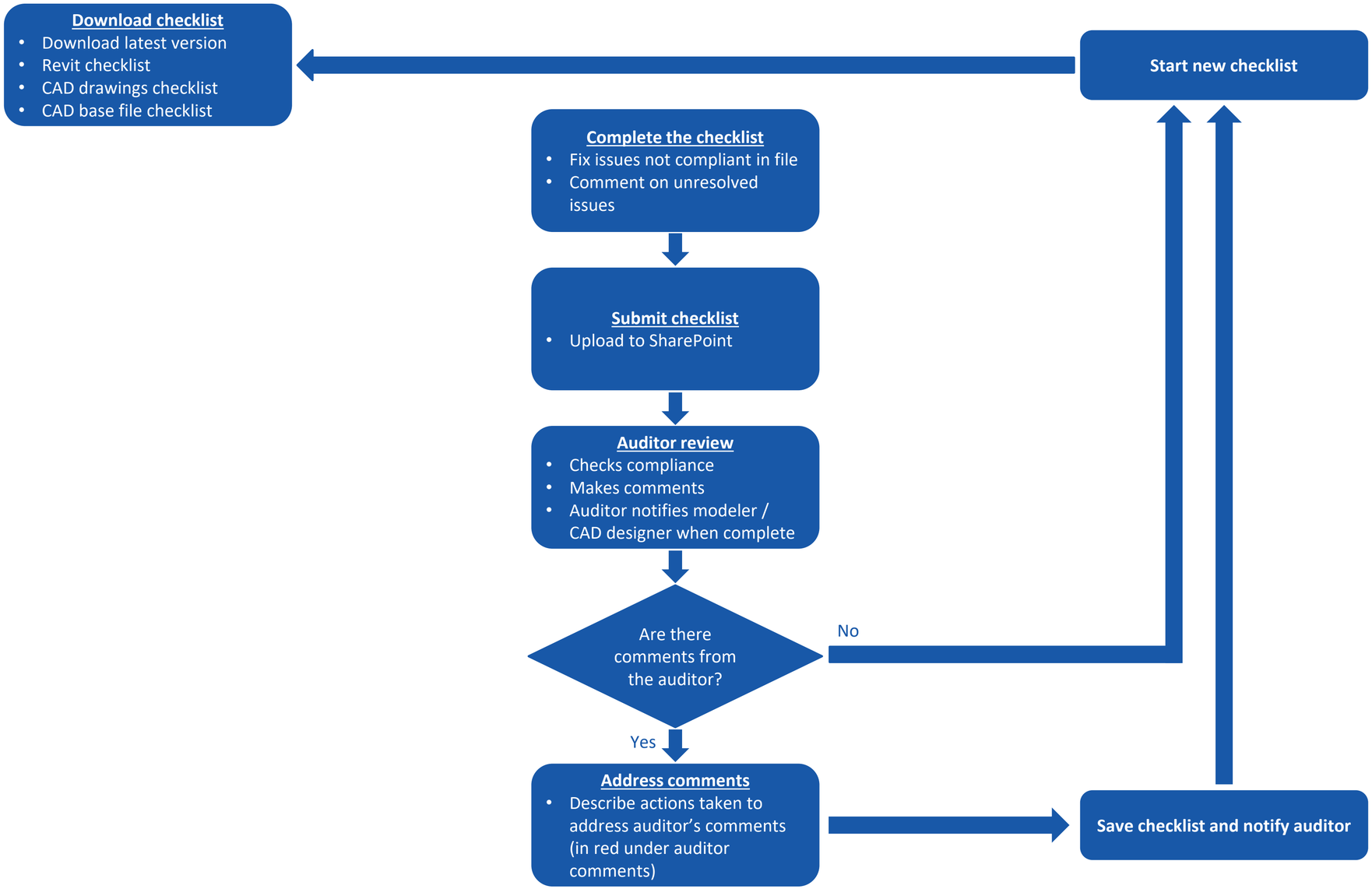
Suitable For Review & Comment
Data ready for other parties to provide feedback on.

Suitable For Stage Approval
Data ready for Client approval.

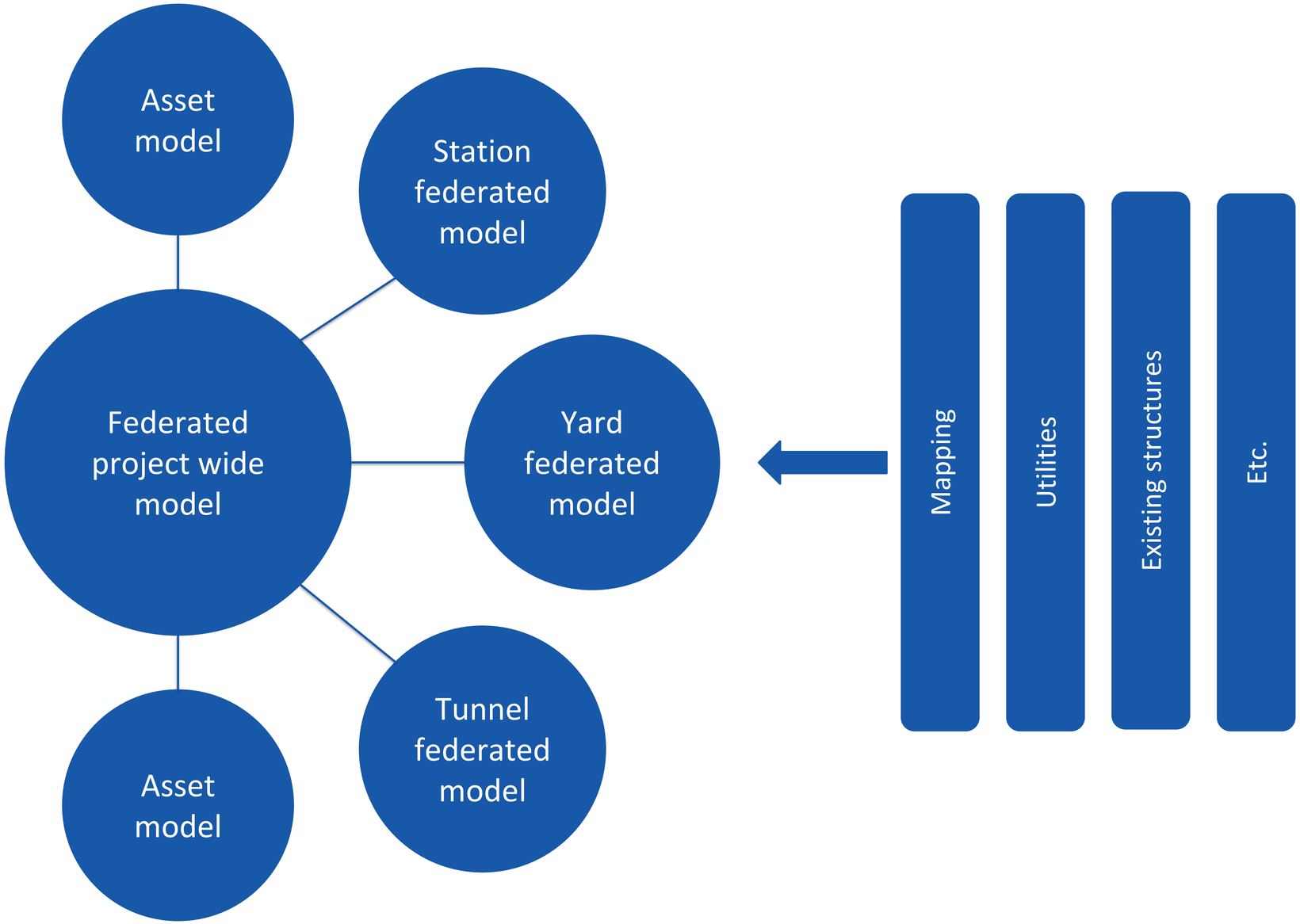
States

ISO 19650 State	ISO 19650 Description	ProjectWise Workflow State	Visible To
Work In Progress	Information in development by the Discipline Team. Not visible by any other discipline.	Work In Progress	Discipline
Check / Review / Approve Transition	Discipline Data compared against agreed standards, methods and procedures by the Discipline Team.	Content Check Technical Check	Discipline
Shared	Constructive and collaborative development of the data through inter-disciplinary coordination. Non-editable and visible to other disciplines.	Shared (Team) Shared	Discipline MMW Team Design Stakeholders
Review / Authorize	All data compared against information requirements for coordination, completeness and accuracy. This separates data that can be relied on for the next stage of delivery from that which is subject to change.	Coordination Check Approve Authorization	Discipline MMW Team Design Stakeholders PMT / VTA
Published	Data that is authorized for use.	Published	Discipline MMW Team Design Stakeholders PMT / VTA

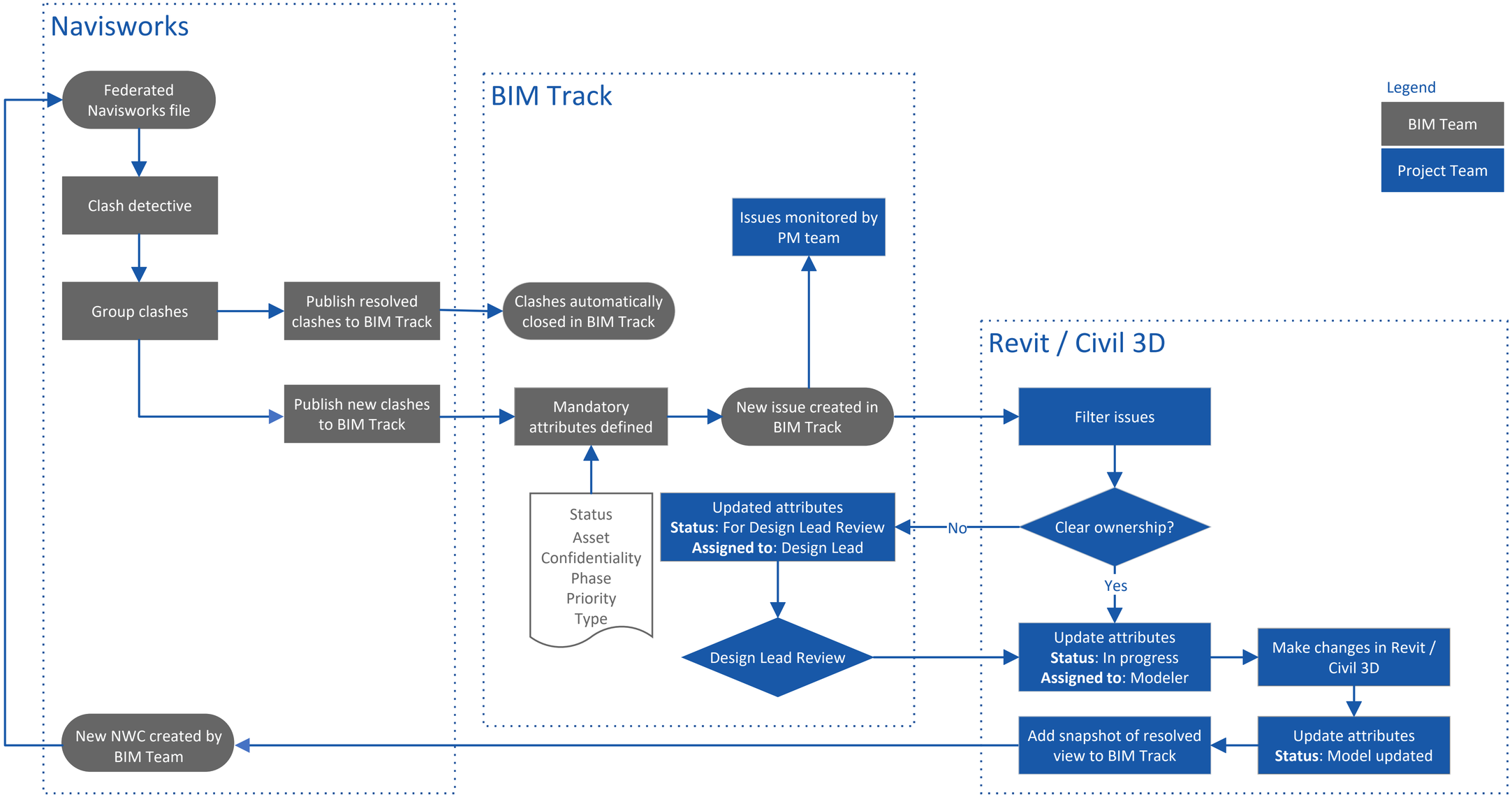
CAD / Revit QA / QC



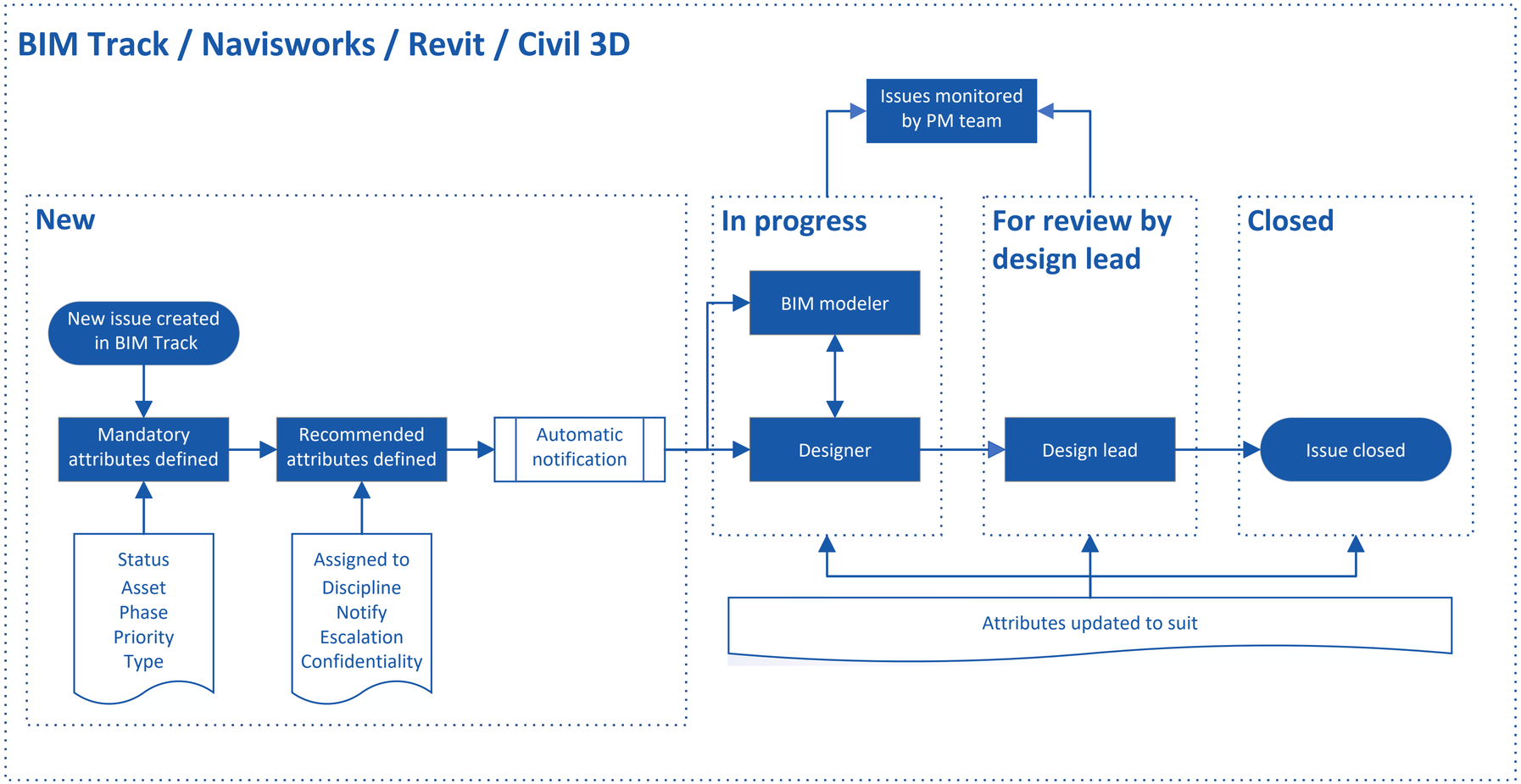
Model Federation



Clash Resolution Process

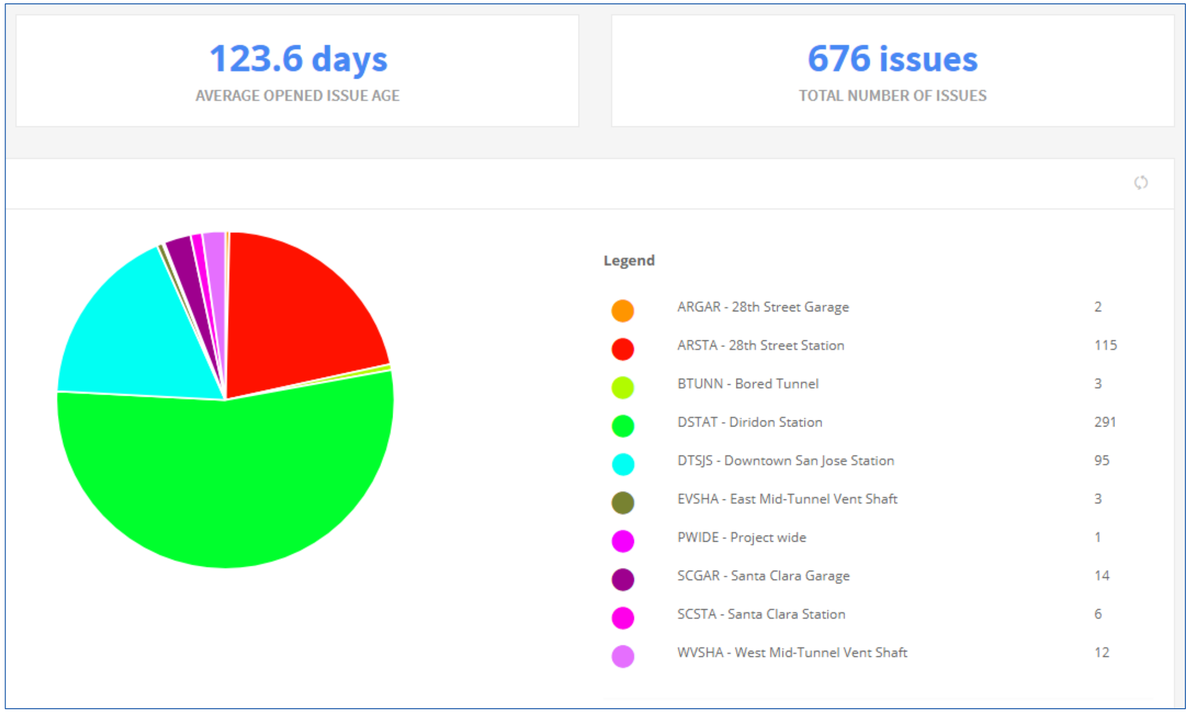


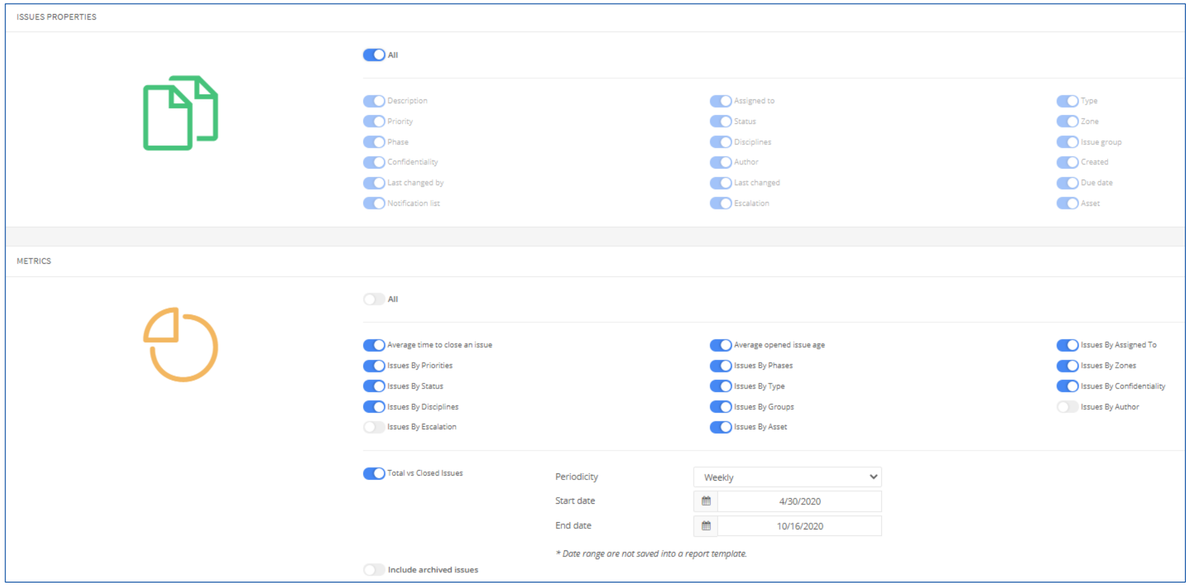
Issue Tracking Process



Issue Reporting

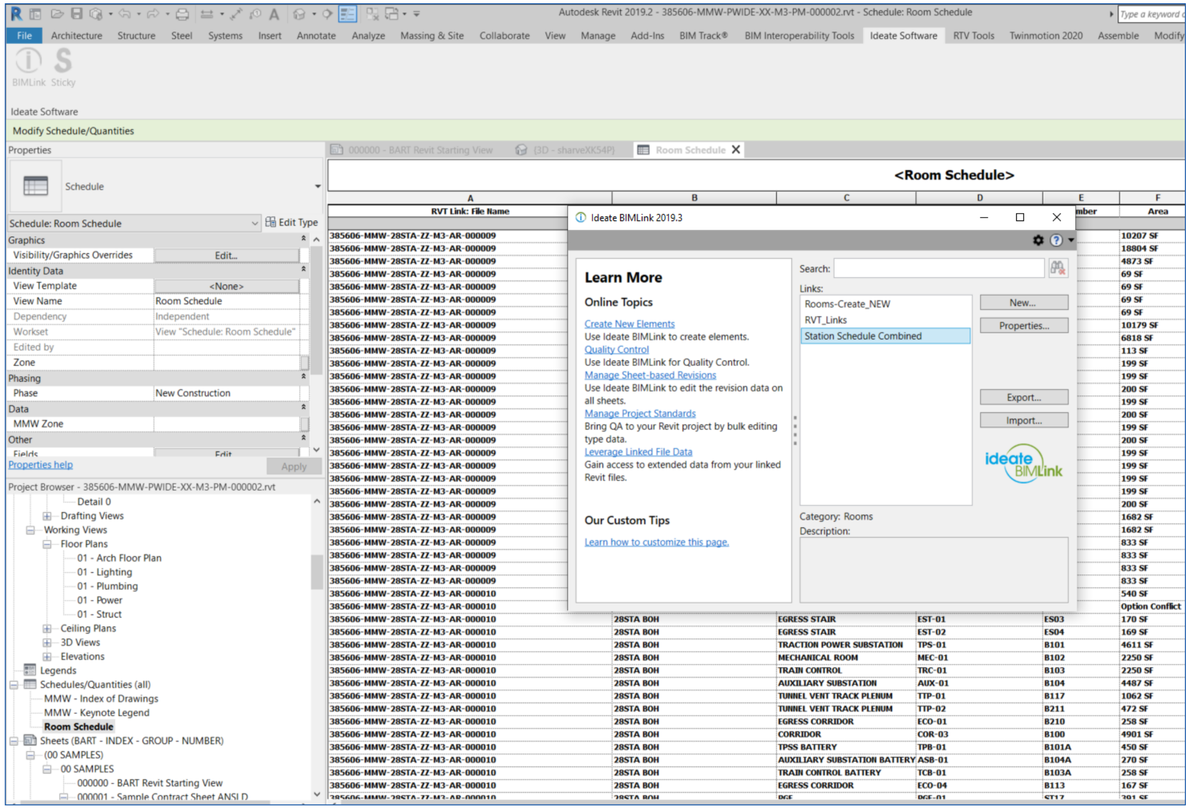
- **Interactive project metrics: instant overview of project coordination performance**
- **Report templates:**
  - Personal
  - Shared
- **Scheduled reports:**
  - Daily basis
  - Every week
  - Every month
- **Customizable report metrics**





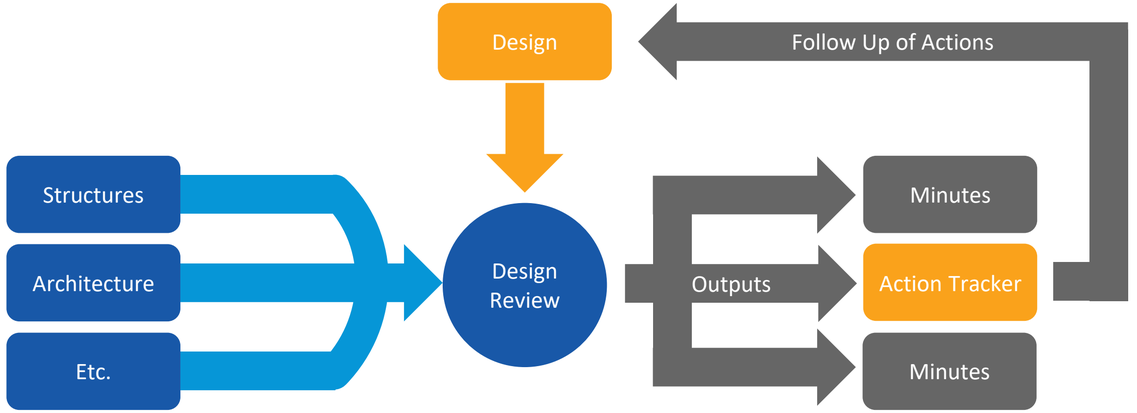
Room Criteria

- **Discrepancies on room numbers and names across the different stations**
- **Standard room types not complying with the BART facility standard requirements**
- **Using Ideate BIMLink:**
  - Publish room data from federated model to Excel
  - Comparison table of existing room data against the BFS template



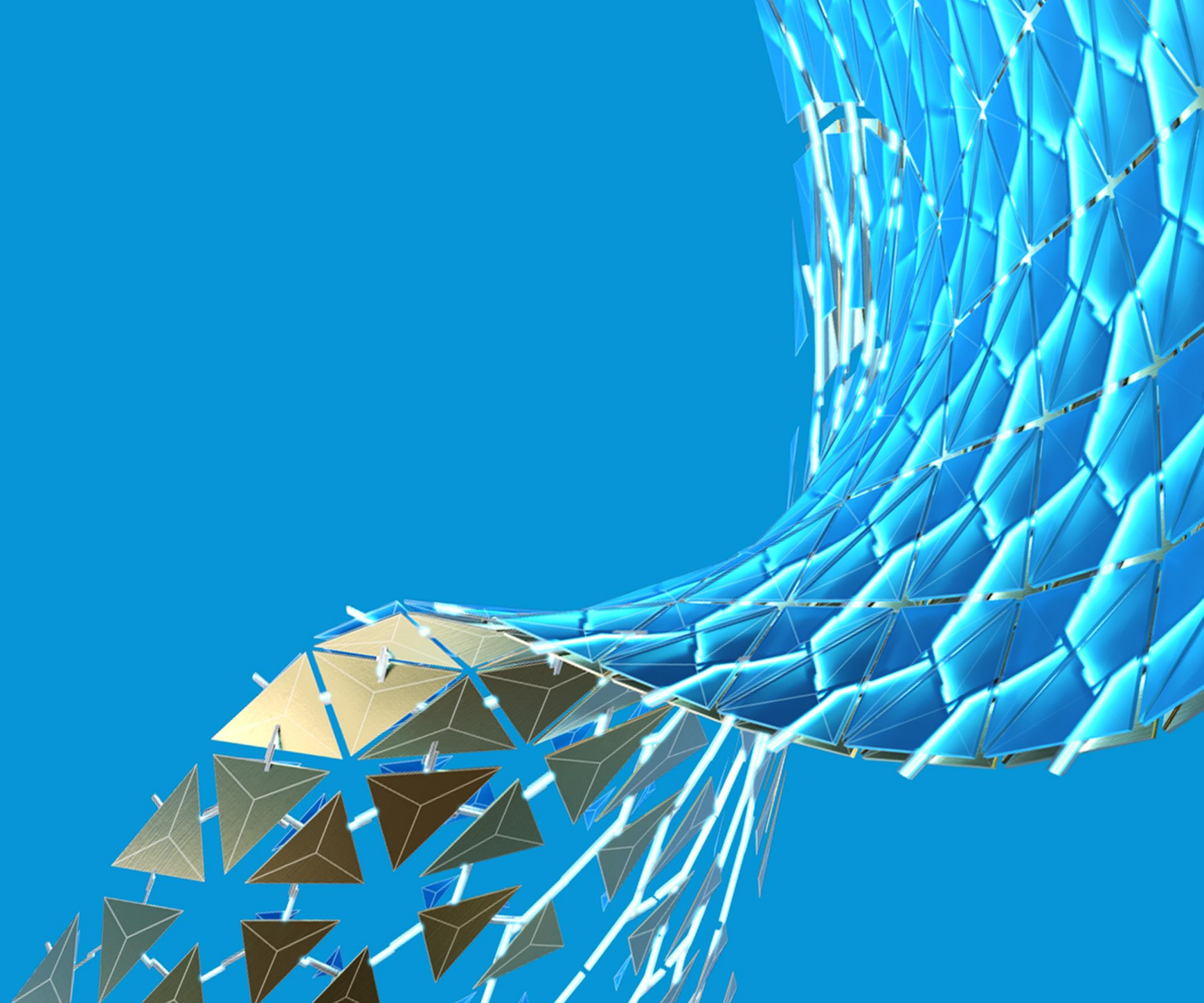
COMBINED STATION NAME	COMBINED ROOM NAME	COMBINED ROOM ID	COMBINED ROOM #	COMBINED REQ'D AREA (SF.)	COMBINED ROOM LENGTH	COMBINED ROOM WIDTH	CEILING HEIGHT	BIM MODEL OWNERSHIP	REFERENCE STATION
28STA BOH	EGRESS STAIR	0	ES13	262.79	19' 0"	13' 10"	9' -0"		
28STA BOH	EQUIPMENT ACCESS HATCH	0	ST21	120.01	11' 12"	10' 0"	14' -0"		
DTSJS BOH-MEXICO BAKERY	ANCILLARY ROOM	0	AS54	156.00	13' 0"	11' 12"	20' 8 3/7"		
MID TUNNEL EAST VENT SHAFT	MID TUNNEL GAP BREAKER STATION	0	162	1123.60	61' 7 1/3"	18' 2 5/6"	16' 9 3/4"		
MID TUNNEL EAST VENT SHAFT	BATTERY ROOM	0	167	96.00	11' 12"	7' 12"	7' 12"		
MID TUNNEL EAST VENT SHAFT	SERVICE STAIR	0	181	0.00	0' 0"	0' 0"	#DIV/0!		
MID TUNNEL WEST VENT SHAFT	BATTERY ROOM	0	185	106.44	15' 5"	6' 10 5/6"	8' 0"		
MID TUNNEL WEST VENT SHAFT	MID-TUNNEL GAP BREAKER	0	186	465.97	41' 9 4/5"	11' 1 5/7"	17' 7"		
MID TUNNEL WEST VENT SHAFT	MID TUNNEL GAP BREAKER STATION	0	190	465.97	41' 9 4/5"	11' 1 5/7"	17' 5 7/9"		
MID TUNNEL WEST VENT SHAFT	BATTERY ROOM	0	200	106.44	15' 5"	6' 10 5/6"	8' 0"		
0 - TEMPLATE	JANITOR'S ROOM	JAN-00	(by floor)	240.00	20'	12'	8' ?	Local Architect	Milpitas Station
28STA BOH	JANITOR'S ROOM	JAN-01	B107	85.50	9' 6"	9' 0"	14' 0"		
DSTAT BOH-HEADHOUSE	JANITOR'S ROOM	JAN-01	B122	147.00	13' 12"	10' 6"	26' 2"		
DTSJS BOH-HEADHOUSE	JANITOR'S ROOM	JAN-01	AS43	28.42	5' 8 1/5"	4' 12"	33' -0"		
DTSJS BOH-JOHNNY V	JANITOR'S ROOM	JAN-01	AS44	64.00	17' 1 3/5"	3' 8 5/6"	8' 0"		
DTSJS BOH-MEXICO BAKERY	JANITOR'S ROOM	JAN-01	LPL	0.00	0' 0"	0' 0"	#DIV/0!		
28STA BOH	JANITOR'S ROOM	JAN-02	B205	101.14	11' 0"	9' 2 1/3"	10' 0"		
DTSJS BOH-MEXICO BAKERY	JANITOR'S ROOM	JAN-02	LPL	114.11	11' 3 4/7"	10' 1 1/5"	8' 0"		
DSTAT BOH-EAST VENT SHAFT	JANITOR'S ROOM	JAN-03	PL25	110.00	11' 0"	10' 0"	10' 0"		
DSTAT BOH-WHITE STREET VENT SHAFT	JANITOR'S ROOM	JAN-04	PL35	132.06	12' 6"	10' 6 7/9"	11' 5 7/8"		
DTSJS BOH-HEADHOUSE	BROCHURE STORAGE ROOM		AS48	214.95	17' 8 1/3"	12' 1 7/9"	8' 0"		
DTSJS BOH-HEADHOUSE	TUNNEL VENT PLENUM		B127	1336.68	110' 7 3/7"	12' 1"	7' 12"		
DTSJS BOH-HEADHOUSE	TUNNEL VENT PLENUM		B129	681.12	42' 8"	15' 11 1/2"	8' -0"		
0 - TEMPLATE	AC SWITCHGEAR ROOM	ACS-00	(by floor)	600.00	30'	20'	8' ?	Local Architect	Size to be Confirmed by Systems
DSTAT BOH-HEADHOUSE	AC SWITCHGEAR ROOM	ACS-01	ST36	605.00	30' 3"	20' 0"	9' 12"		
0 - TEMPLATE	AREA OF REFUGE	AOR-00	(by floor)	1 per 200 calculated occupant load	NA	NA	NA	Local Architect	CBC 1009.6
0 - TEMPLATE	ARMORY	ARM-00	(by floor)	35.00	6'-8"	5'-6"	8' ?	Local Architect	Part of Police Zone Facility (where occurs) / Warm
0 - TEMPLATE	AUXILIARY SUBSTATION BATTERY ROOM	ASB-00	(by floor)	430.00	TBD	TBD	8' ?	Local Architect	Size to be Confirmed by Systems
28STA BOH	AUXILIARY SUBSTATION BATTERY ROOM	ASB-01	B104A	270.21	22' 6 1/5"	11' 12"	25' 0"		
DSTAT BOH-HEADHOUSE	AUXILIARY SUBSTATION BATTERY ROOM	ASB-01	B135	502.25	24' 6"	20' 6"	26' 2"		
DTSJS BOH-HEADHOUSE	AUXILIARY SUBSTATION BATTERY ROOM	ASB-01	B119	283.12	21' 0"	13' 5 3/4"	8' 0"		
MID TUNNEL EAST VENT SHAFT	AUXILIARY SUBSTATION BATTERY ROOM	ASB-01	160	120.00	15' 0"	7' 12"	7' 12"		
MID TUNNEL WEST VENT SHAFT	AUXILIARY SUBSTATION BATTERY ROOM	ASB-01	180	120.00	11' 12"	10' 0"	7' 12"		
DTSJS BOH-HEADHOUSE	AUXILIARY SUBSTATION BATTERY ROOM	ASB-02	B121	283.14	21' 0"	13' 5 3/4"	7' 12"		
0 - TEMPLATE	AUXILIARY SUBSTATION	AUX-00	(by floor)	80 180	TBD	TBD	18'-0" Clear	Local Architect	Size TBD by Systems per each station design
28STA BOH	AUXILIARY SUBSTATION	AUX-01	B104	4486.77	99' 8 1/2"	44' 12"	23' 3 1/2"		
DSTAT BOH-HEADHOUSE	AUXILIARY SUBSTATION	AUX-01	B132	5509.33	113' 4 4/5"	48' 7"	26' 2"		
DTSJS BOH-HEADHOUSE	AUXILIARY SUBSTATION ROOM	AUX-01	B115	6258.42	128' 11 2/3"	48' 6 2/7"	8' 0"		
28STA BOH	EMERGENCY LIGHTING BATTERY ROOM	BAT-01	B110	226.63	20' 0"	11' 4"	14' -0"		
0 - TEMPLATE	BIKE PARKING	BIP-00	(by floor)	Furnish per projected ridership	10'-9"	9'	8' ?	Local Architect(AIA) or F+P	Furnish per projected ridership demand per station
DSTAT FOH-HEADHOUSE	BIKE PARKING	BIP-01	ST53	3529.84	71' 8"	49' 6 3/7"	8' 0"		

SHARC Meetings



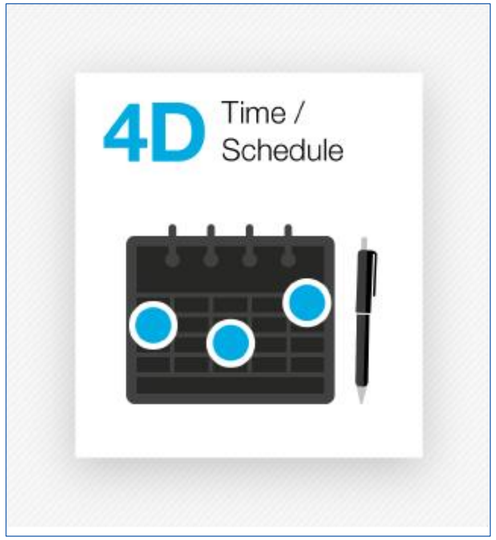
- **SHARC: SHare, Appraise, Review and Cooordinate**
- **Discuss and resolve issues that arise during design development**
- **Present and discuss complete or partially complete elements of the design**
- **Led by package managers and design unit leads**
- **Held on a regular basis, usually weekly**
  - General overview
  - Specific workgroups
- **Model based suitable**
- **Organized through the Design Integration Manager**

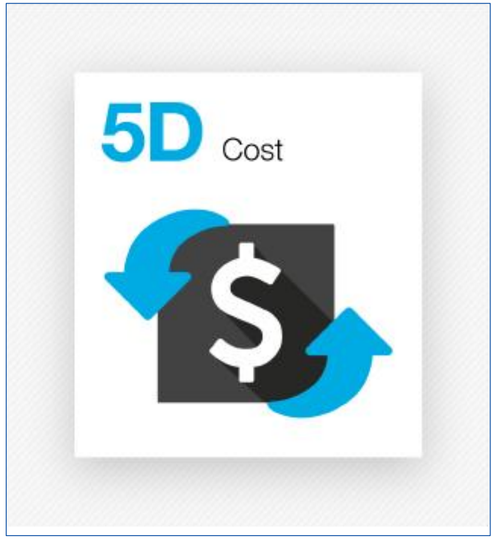
Next Steps



4D and 5D

- **Requirements defined in the BIM Execution Plan**
- **4D federated Navisworks model with all elements linked to the client’s P6 construction WBS activities in timeline**
- **5D federated Navisworks model with all elements linked to their respective project WBS items in the Navisworks quantification catalogue**





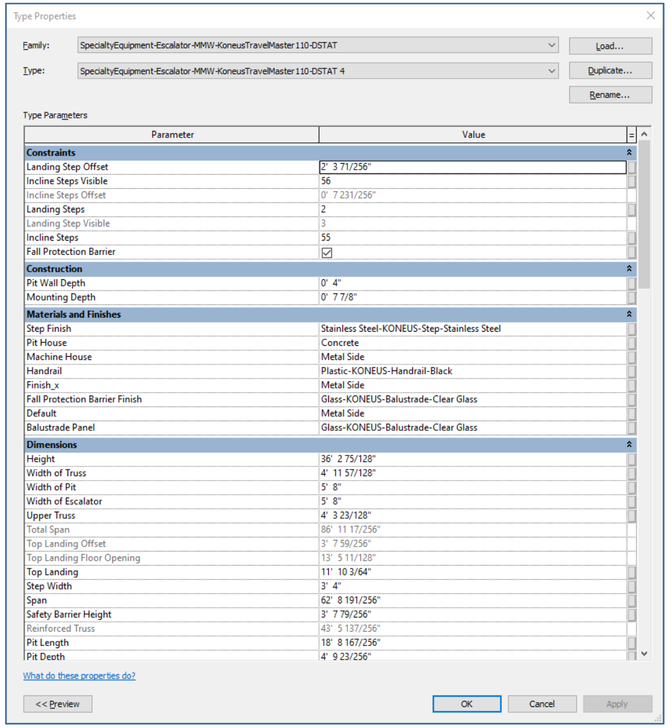
Level of Development

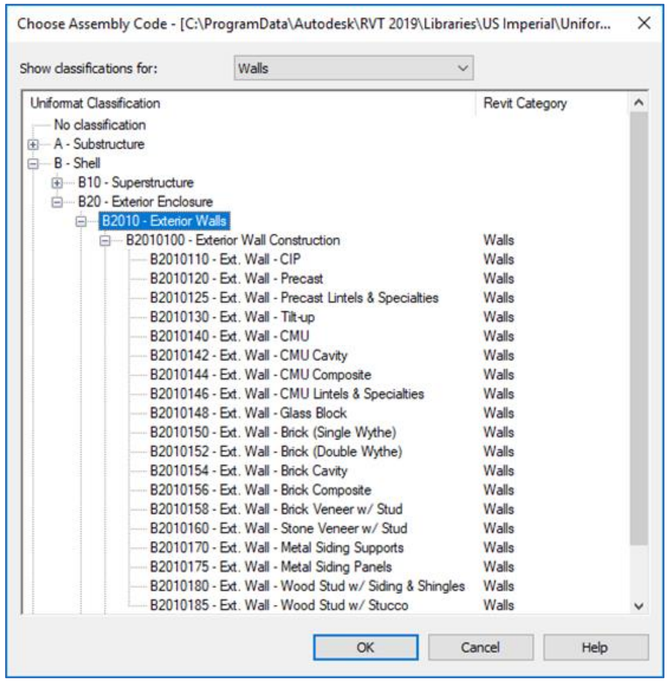
- **Requirements defined in the BIM Execution Plan**
- **Each stage of the project requires a specific level of development (LOD)**
- **LOD 300 for 30% deliverable**
- **Discipline leads to record the appropriate LOD in the Model Production Delivery Table (MPDT)**

Level of Development	Description
LOD 100	The model element may be graphically represented in the model with a symbol or other generic representation but does not satisfy the requirements for LOD 200. Information related to the model element (e.g., cost per square foot, tonnage of HVAC) can be derived from other model elements.
LOD 200	The model element is graphically represented within the model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the model element.
LOD 300	The model element is graphically represented within the model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the model element.
LOD 350	The model element is graphically represented within the model as a specific system, object or assembly terms of quantity, size, shape, location, and orientation, and interfaces with other building systems. Non-graphic information may also be attached to the model element.
LOD 400	The model element is graphically represented within the model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the model element.
LOD 500 (as-builts)	The model element is a field verified representation in terms of size, shape, location, quantity, and orientation. Non-graphic information may also be attached to the model elements.

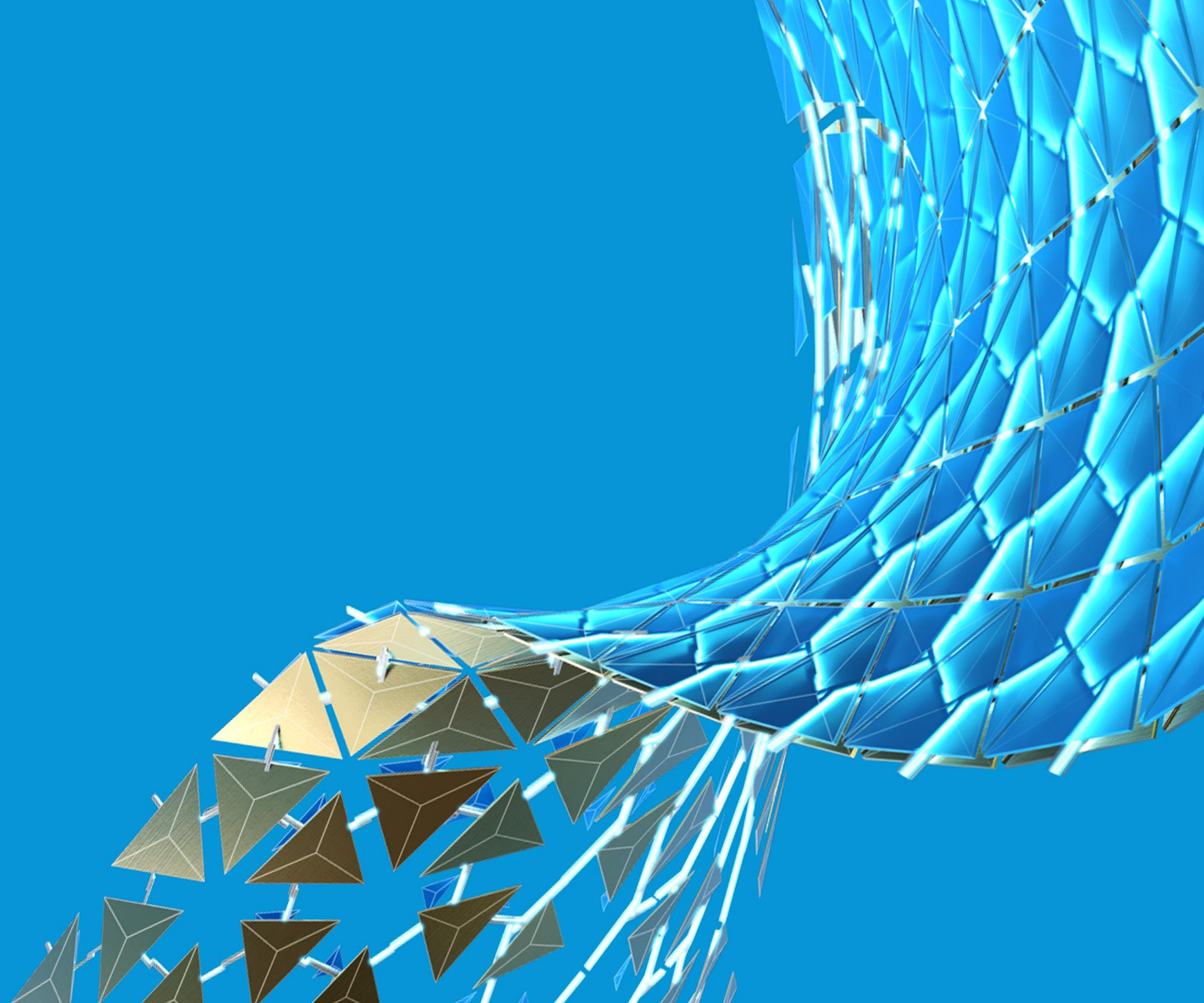
Asset Information

- Requirements defined in the BIM Execution Plan
- Non-graphical information attached to the model elements
- CSI 2010 Uniformat II classification system



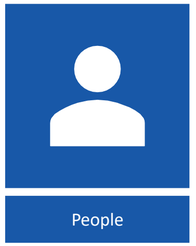


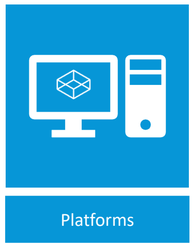
Outcome

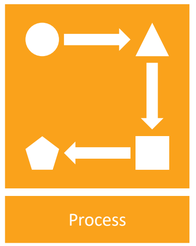


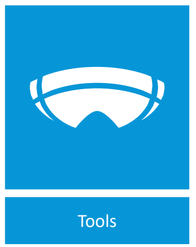
Challenges

- **ISO 19650:**
  - Awareness of ISO standard
  - ISO workflow different between ProjectWise, BIM 360, SharePoint in order to achieve same aim
- **Inertia to change**
- **Drip feed mobilization of teams**
- **Technology platforms**
- **Processes**
- **Tools**
- **Feedback**









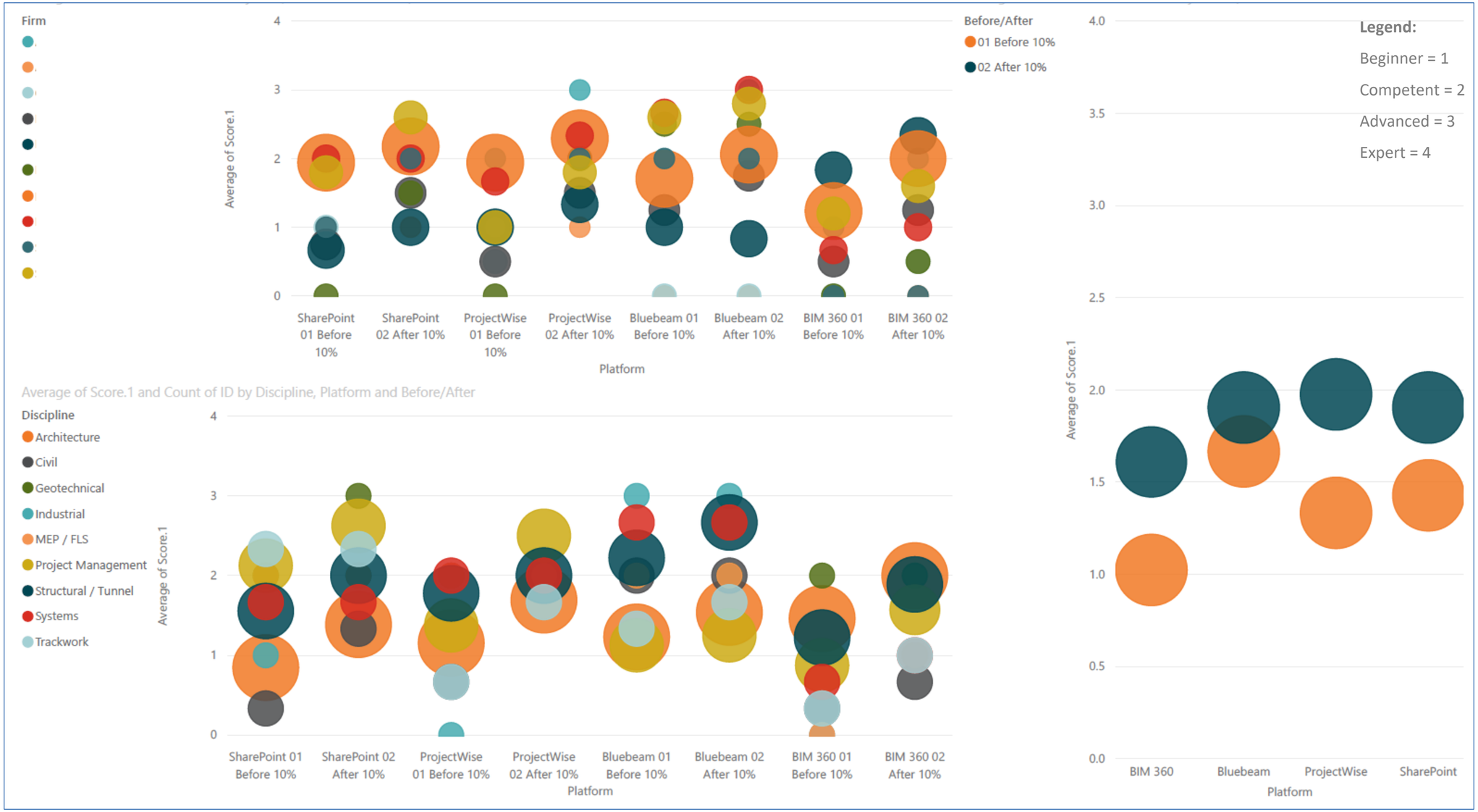
Successful Delivery of First Phase of Project

920
FILES SUBMITTED

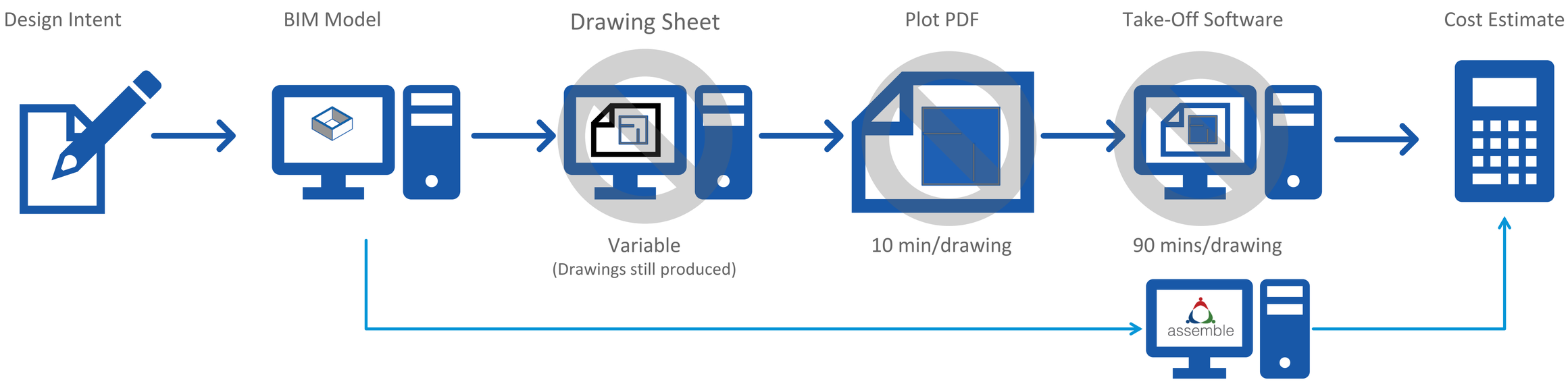
199
3D MODELS

1835
INCOMING FILES

Upskilling of Whole Team

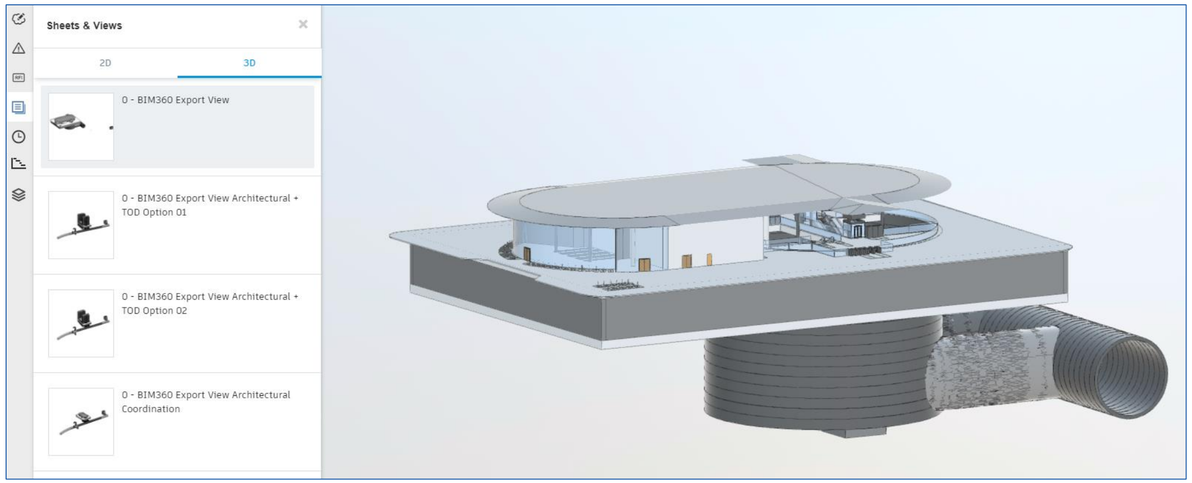


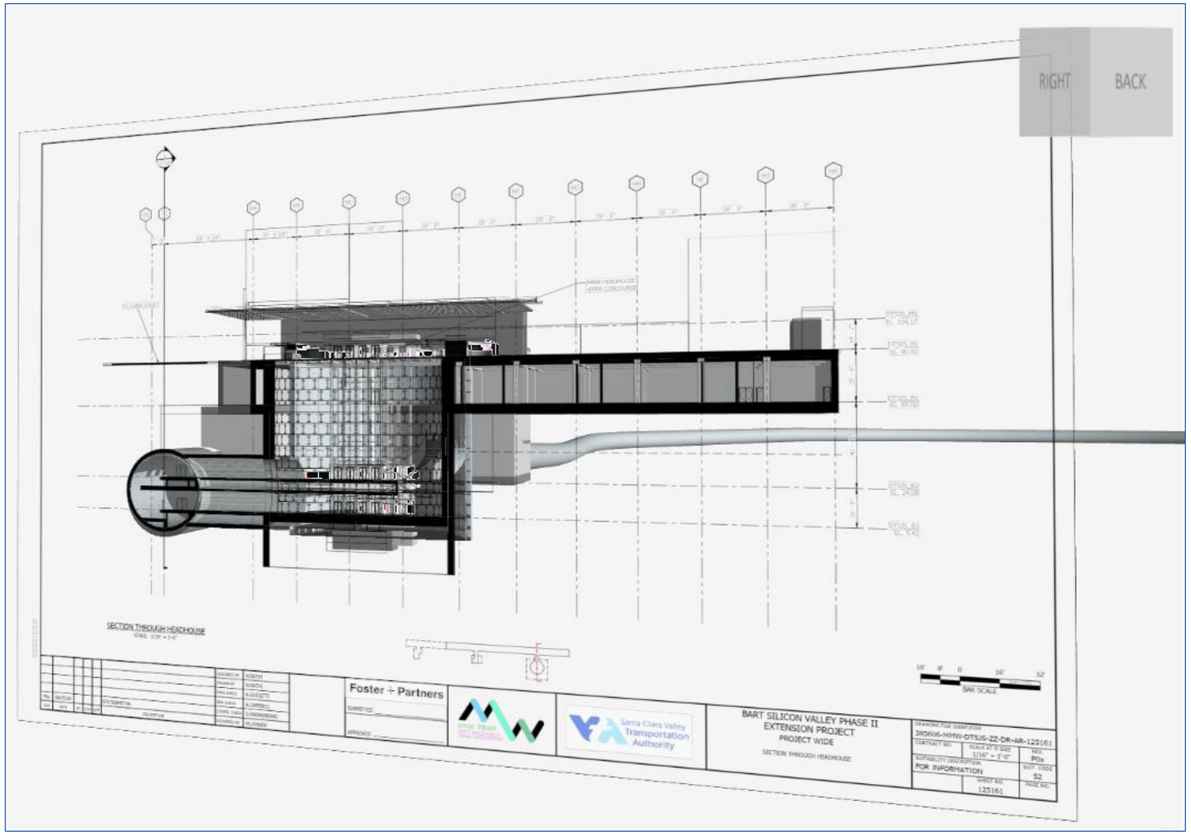
Assemble


Design Intent
BIM Model
Drawing Sheet
Plot PDF
Take-Off Software
Cost Estimate
Variable
(Drawings still produced)
10 min/drawing
90 mins/drawing
assemble

Models Visibility

- **BIM 360 Viewer**
  - Individual models shared on a regular basis
  - Navisworks federated models for the individual assets and Projectwide
  - Used in the asset coordination meetings
  - Visible to all design team members
- **BIM Track**
  - Models published to BIM Track on a regular basis
  - Sheets hyper-modeled
  - Used for issue tracking
  - Visible to all team (including client)





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Did We Establish ISO 19650?

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