[CES468335]

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

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Learning Objectives

- Identify and navigate the challenges of applying ISO 19650 principles to a project.
- Develop technical solutions for a structured data environment.
- Manage and integrate various design platforms for project success.
- Change behavioral attitudes to technology and process changes.

Description

The presentation focuses on the challenges encountered in implementing a structured ISO 19650 approach to BIM and data management for the BART to Silicon Valley Phase II Project (BSVII) located in Northern California. During conceptual and preliminary design, the management of data across the 25 firms, 10 disciplines and 49 locations was critical to the successful delivery of the first milestone submission. Traditional workflows were challenged, and digital solutions introduced to integrate software from Autodesk (Revit, Civil 3D, Navisworks, Assemble), Bentley (ProjectWise), Microsoft (SharePoint, Power BI), BIM Track and various other applications (Leapfrog, Rhino).

This class will cover bringing these programs together with efficient and manageable processes and workflows; collecting, integrating, validating, and sharing data across teams; and using behavioral aspects in providing guidance and support to those new to a “one team” philosophy of digital collaboration.

Speaker(s)

Peter Starnes works for the global engineering firm Mott Macdonald and his role involves championing the use of BIM processes and providing leadership and guidance for collaborative work. Peter is acting as information manager on BIM projects to ISO 19650 and he devises and monitors suitable workflows for BIM processes, tailored to the needs of the project.

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

Brindusa Dumitrascu (aka Brin) is a Senior Digital Delivery Specialist with Mott MacDonald. She started with the company in Vancouver/Canada in 2008 and moved to Los Angeles in 2014. Brin 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.

Brin's favorite Autodesk software is Revit, but she is also familiar with Navisworks, Civil 3D, and her expertise also includes platforms such as BIM 360, SharePoint, ProjectWise, BIM Track.

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Project Overview

The BART to Silicon Valley (“BSV”) Program, previously called the Silicon Valley Rapid Transit (“SVRT”) 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.

Phase II of the Program is a 6-mile, 4-station extension from Berryessa Station to Santa Clara including an approximately 5-mile long tunnel through Downtown San Jose. BART Silicon Valley II (BSVII) is planned to include three below-ground stations (28th Street / Little Portugal Station, Downtown San Jose Station, and Diridon/Arena Station) and one at-grade station (Santa Clara Station). The project currently in a preliminary design phase, preparing documentation for Design & Build contracts. Phase II is currently anticipated to be operational in 2030.

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FIGURE 1: BSVII ALIGNMENT MAP

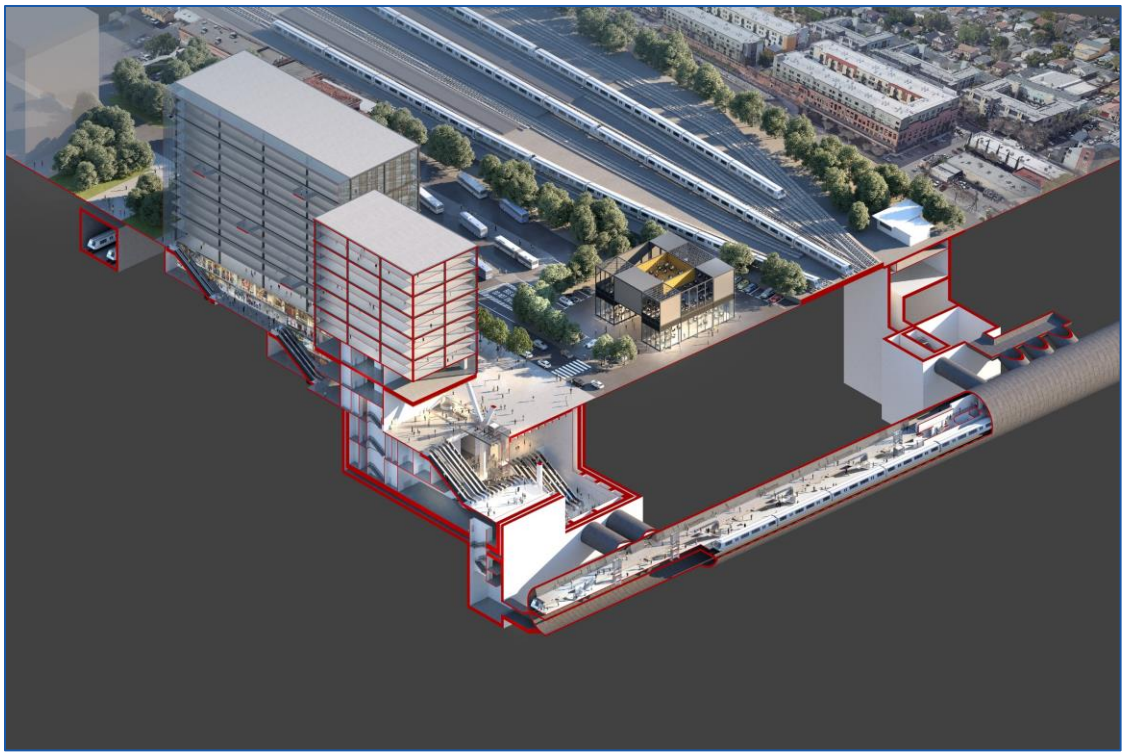

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FIGURE 2: UNDERGROUND STATION CONCEPT VISUALISATION

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FIGURE 3: TUNNEL PLATFORM CONCEPT VISUALISATION

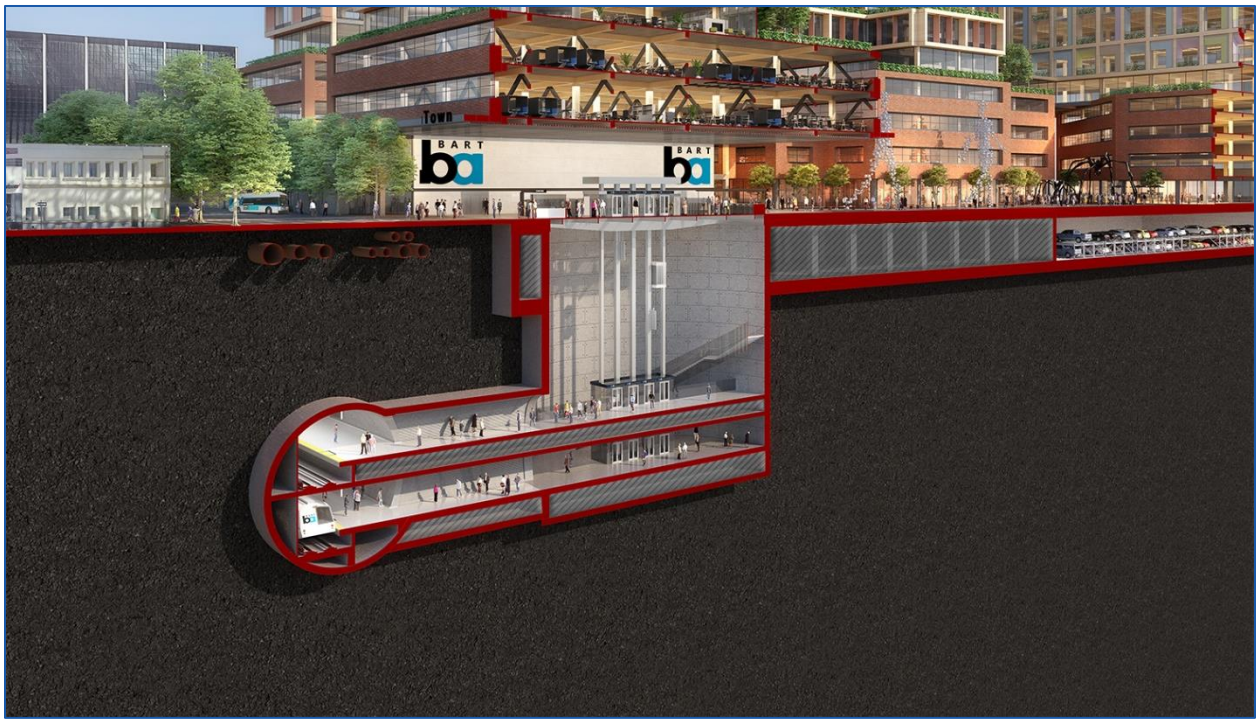

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FIGURE 4: UNDERGROUND STATION CONCEPT VISUALISATION

Project Timeline

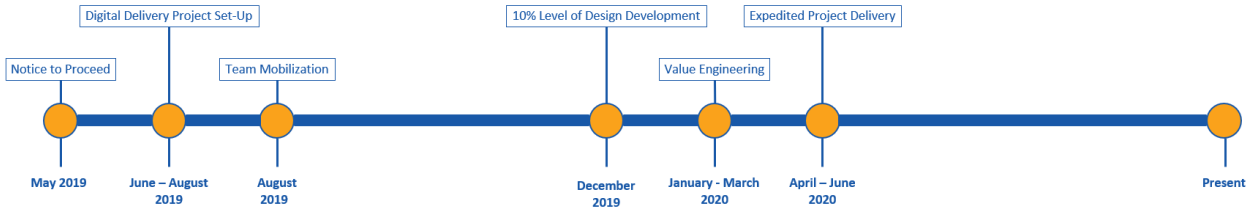

FIGURE 5: PROJECT TIMELINE

The project started in May 2019. We had a 3-month period of collecting information and setting up the digital platform for the project, followed by team mobilization. We then worked towards a 10% level of design development milestone, which took place in December 2019. The 10% submittal was followed by a value engineering exercise at the beginning of the year, that culminated with an expedited project delivery milestone in June 2020. And now the team is working towards the contract procurement phase. We are now 18 months into what is likely to be a 10-year project.

ISO 19650 Delivery Phases

We are going to talk about our experience in applying ISO 19650 Part 2, which is the Delivery Phase of a Project Lifecycle, and what we also think is BIM best practice for the BSVII project. It is worth pointing out that our involvement started at the appointment stage through mobilization, collaborative information production, and the information model delivery phases that are identified in the ISO so those are the ones that we're going to be concentrating on.

We might touch on some of the other phases and any information that we have about that but it's worth again just reiterating that initially we're working to produce a combination of design bid build and design build contract documentation.

As we step through the handout, we are going to use these delivery phases as a guide.

FIGURE 6: ISO 19650 DELIVERY PHASES

Client BIM Goals for the Project

Prior to the award, the client had identified what their goals were:

- Common working environment for **collaboration**
- Mitigate project risk through **connected** data and models
- Use new **innovative** technologies where appropriate
- Enhance the 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 Principles

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)

We, as a team, wanted to add some targets of our own:
“Begin with the end in mind”

- Reduce waiting and searching for information
- Avoid over production of information with no defined us
- 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

Next, we will be talking about some tasks at the appointment stage. We were acting as an appointed party at this point so there was more activity on the client side than for us, but we want to start off with a couple of documents that are critical to a project.

BIM Execution Plan

Probably one of the most crucial Documents when you're starting a BIM project is the execution plan. It's important to try and spend some time and make sure this is right and it can be hard to do at the start of the project. We had a BIM execution plan template that was provided to us that was part prescriptive, part open to interpretation, and we found it quite difficult to adapt to how we thought that we would be delivering the project. We had a large team made up of multiple companies and we knew that we had to have a cohesive document to pull everyone together into a single way of working.

The BIM execution plan went through several major revisions over the first period and it’s worth pointing out that it is a dynamic document and it's important that you do review and update that BIM execution plan on a regular basis. We were doing minor revisions as we were going along and every couple of months or so we would do a review across the whole of the BIM execution plan and have a major revision, get it agreed with the client and then push it out to the team.

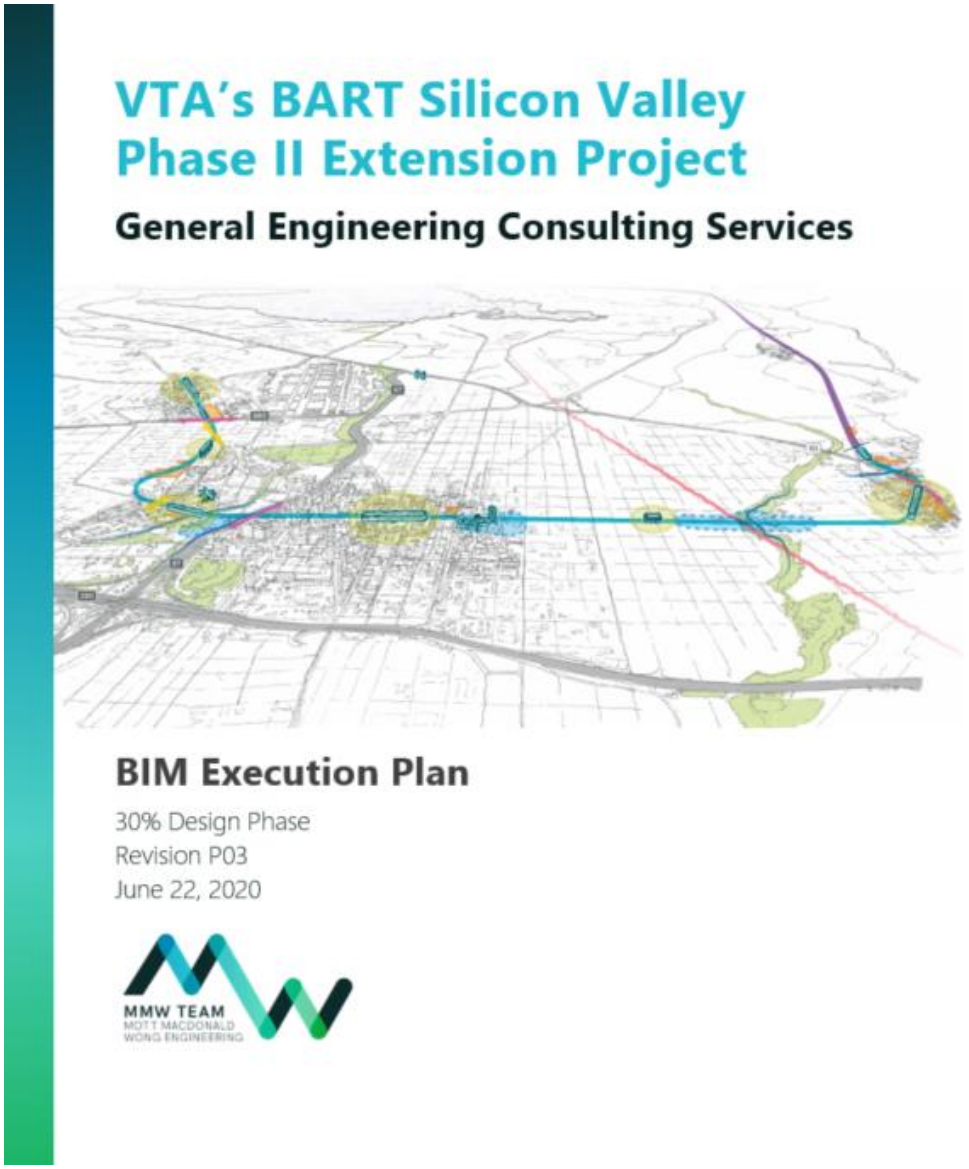

FIGURE 7: BIM EXECUTION PLAN COVER PAGE

Master Information Delivery Plan (MIDP)

The second principal document for BIM is the MIDP, or your deliverables list. Depending on the size of the project, the MIDP might be broken down into task information delivery plans (TIDP). For our project, the TIDPs were broken down by discipline and each of the disciplines produced a TIDP for each major asset and then those TIDPs were brought together into a single master information delivery plan.

We used Excel for this and at the phase of the project that we were at that point, Excel was fine and did the job. When you get into the detailed stages of a job like this, which is a five or six billion dollars project, you may well need to start looking at databases that would be able to handle the much larger quantity of information that you would require.

One of the things we did was make the information as visible as possible, by pulling the information from Excel and running that through Power BI. That has allowed us to really slice and dice the information very quickly and give everybody and especially the management teams a good visual indication of where the work was happening. When we got to milestones, we were able to link progress into the MIDP Dashboard.

Associated with the MIDP or your deliverables list is the model production delivery table, MPDT. Since we have a couple of platforms hosting the BIM models and drawings sheets, we were pulling that information from the different locations and combining it into a central location where we were making sure that we knew which models were being used for which phase and which purpose, which were the current models, and which were no longer actively being developed. The MPDT is another great resource to make sure similar information is not being developed by in different places or different teams.

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		
TRACK	30%	Y		N	<>	<>						412206	385606-MMW-TRACK-XX-DR-TR-412206	PLAN AND PROFILES1 598+00.00 TO S1 608+00.00	NOT ISSUED	January 1, 1900
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		
TRACK	30%	Y		N	<>	<>						412207	385606-MMW-TRACK-XX-DR-TR-412207	PLAN AND PROFILES1 608+00.00 TO S1 617+00.00	NOT ISSUED	January 1, 1900
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		412209	385606-MMW-TRACK-XX-DR-TR-412209	PLAN & PROFILE SHEET 9		
TRACK	30%	Y		N	<>	<>						412210	385606-MMW-TRACK-XX-DR-TR-412210	PLAN AND PROFILES1 634+00.00 TO S1 643+00.00	NOT ISSUED	January 1, 1900
TRACK	10%	Y		Y	<>	<>						412210	385606-MMW-TRACK-XX-DR-TR-412210	PLAN AND PROFILE - S1 634+00.00 TO S1 643+00.00	ISSUED	December 31, 2019
	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

FIGURE 8: MIDP

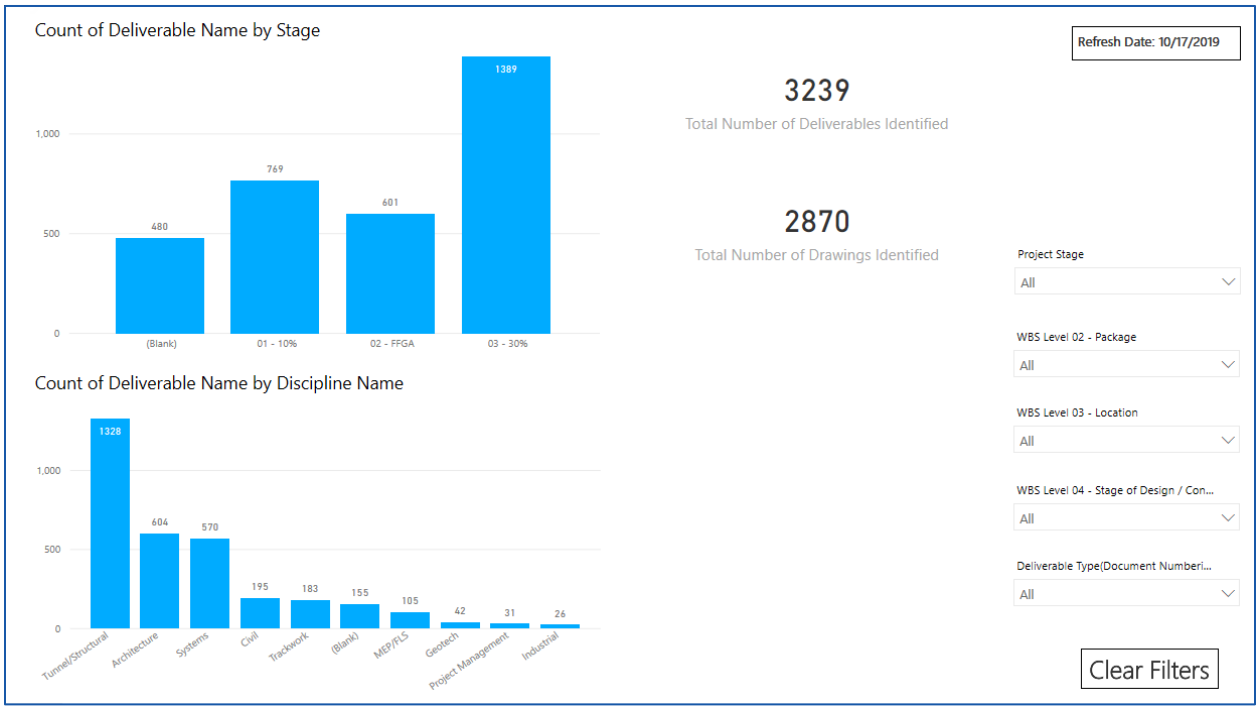


FIGURE 9: POWER BI MIDP DASHBOARD

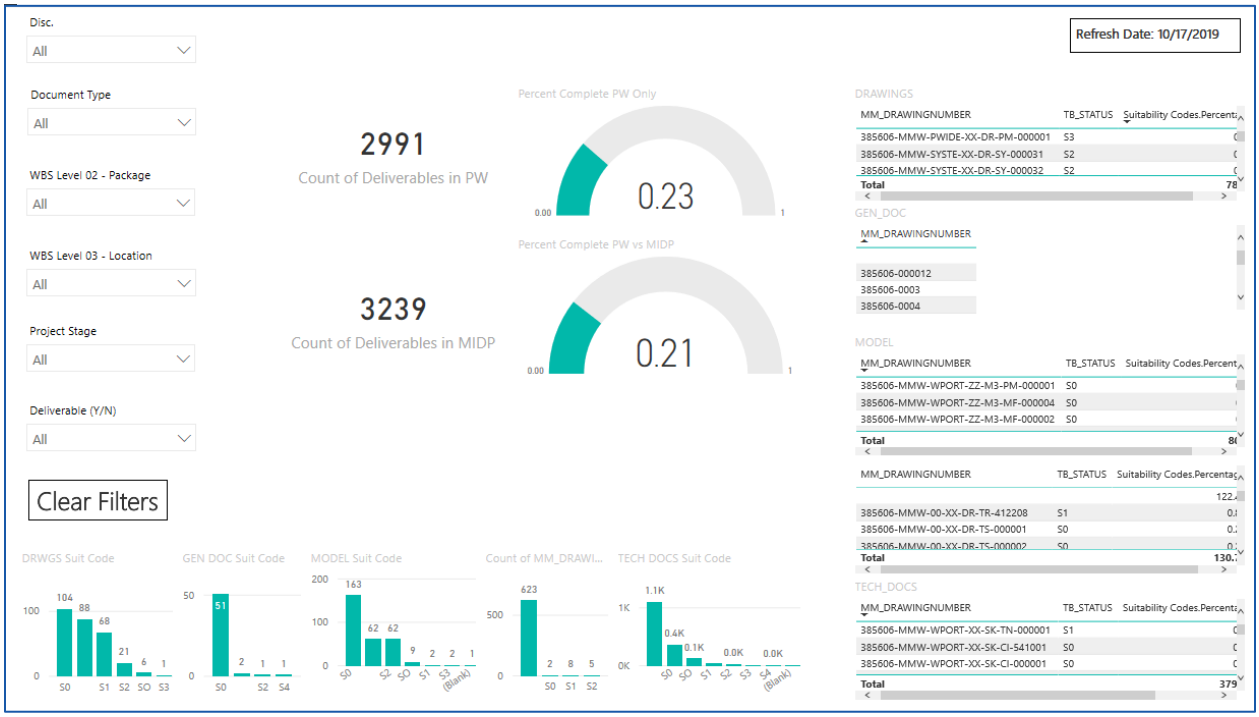


FIGURE 10: POWER BI MIDP DASHBOARD

Mobilization

Next, we will focus on the mobilization phase, which is split into Resources and Technology.

Resources

Digital Delivery Team

A team of digital delivery experts was put together and was tasked with setting up the digital environment for the project, and that included the platforms, tools, processes, training. This team included Mott MacDonald experts from all over the world: Australia, UK, United States.

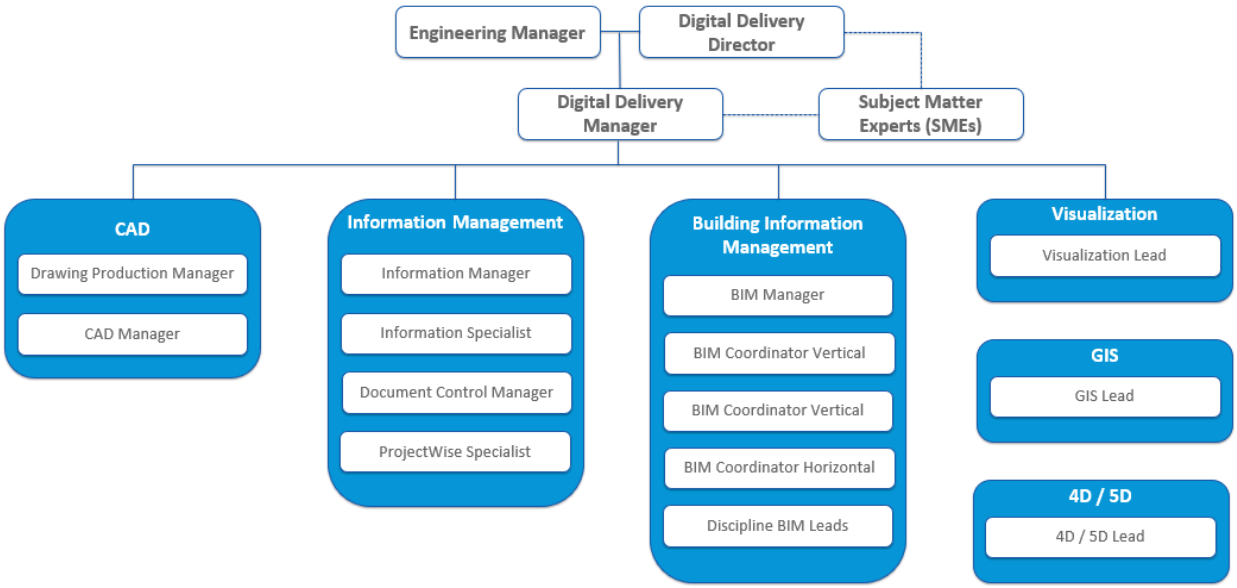


FIGURE 11: DIGITAL DELIVERY TEAM STRUCTURE

Mobilization of Team

We then started mobilizing the rest of the team. Throughout the first phase of the project we mobilized 460 staff, working out of 49 locations across the world, part of 25 firms, and covering 25 disciplines.

With so many different firms working on the project, it was important to instill the concepts of one team, one way of working, one combine vision.

Skills Survey

Once the larger team was mobilized, we needed to assess the team members' skill level in the CDE platforms we were planning on using, and we also needed to know their skill level in the main software used on the project. A survey was included in the mobilization on-boarding process, and the mobilization wasn't fully completed without the skills survey being completed. We then used Power BI to analyze the data and asses the team's knowledge.

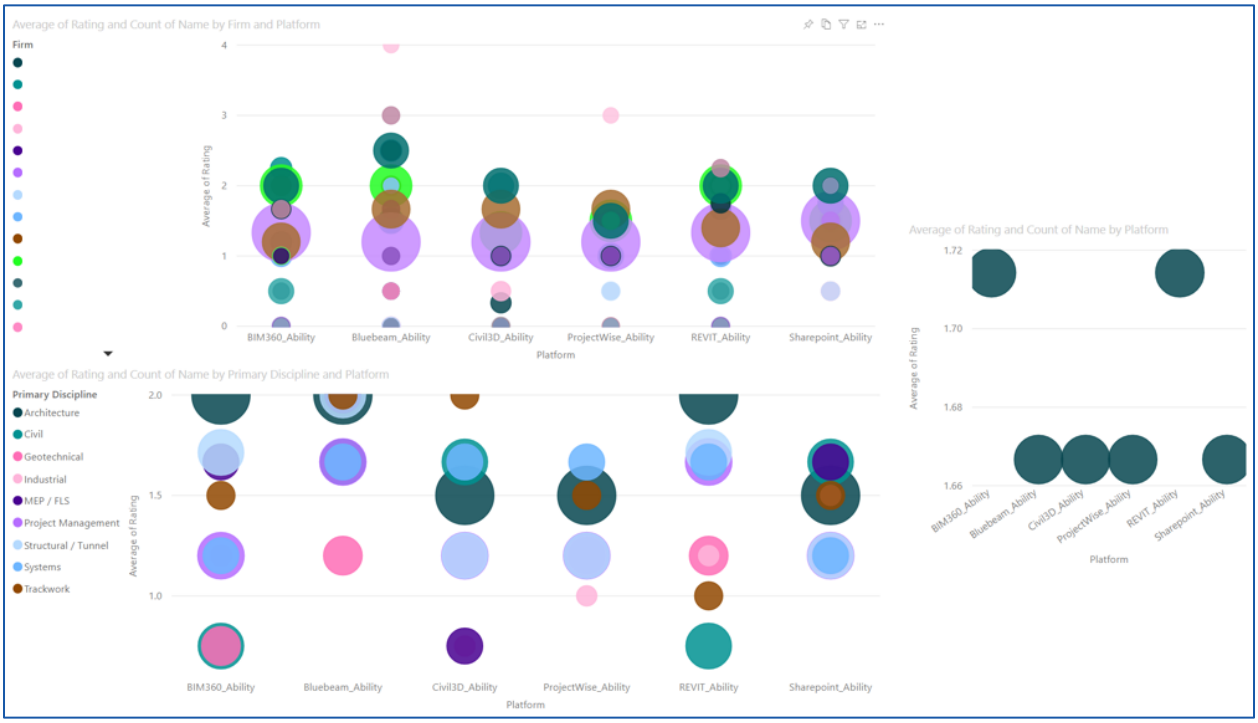


FIGURE 12: SKILLS SURVEY POWER BI DASHBOARD

Training and Support

Following the skills survey, we realized that there was a need for quite a bit of training. ISO 19650 was new to most people on the team, not to mention the CDE platforms used on the project. Some of the smaller firms needed training even in some of the basic software, such as Revit, Civil 3D, Navisworks.

We held issue training to start with, covering the topics that were new to everyone, plus additional training for the teams that needed a bit more hand holding. We recorded the training sessions and made them available to the team, and especially to the new members that were joining later.

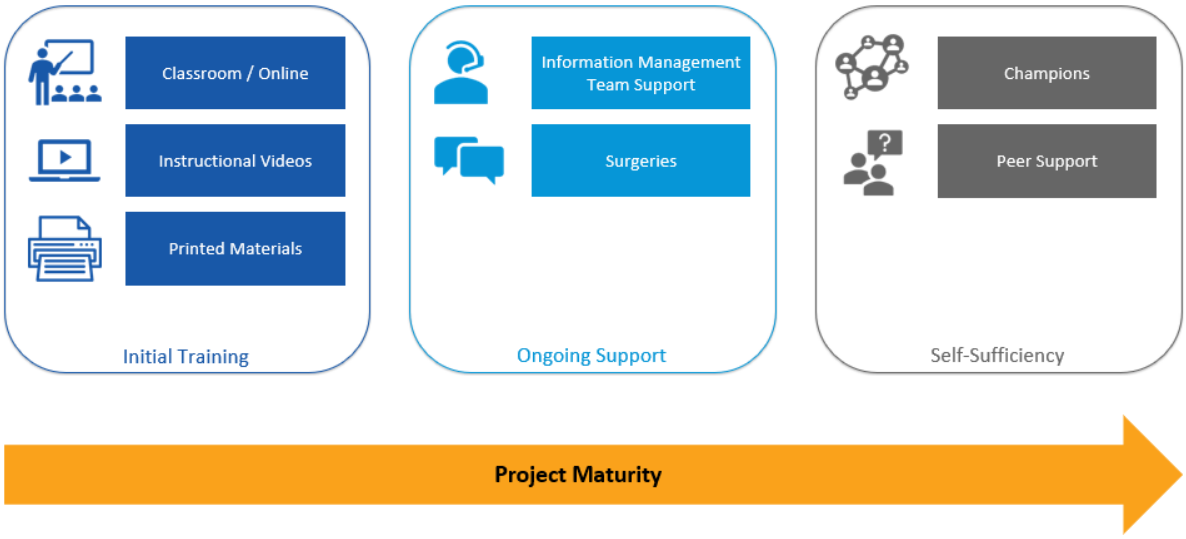


FIGURE 13: TRAINING AND SUPPORT PROCESS

Project Wiki

We also put together what we call a Project Wiki, hosted in SharePoint, that has step-by-step instructions on topics we realized the team needed help with.

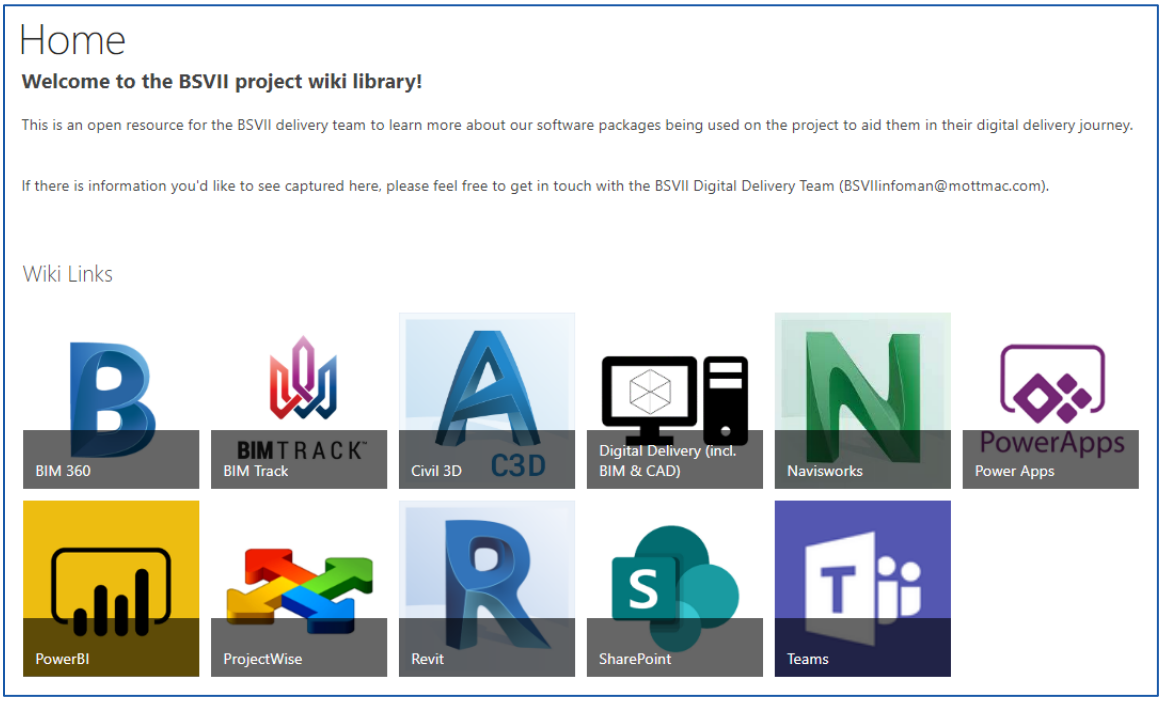


FIGURE 14: PROJECT WIKI HOME PAGE

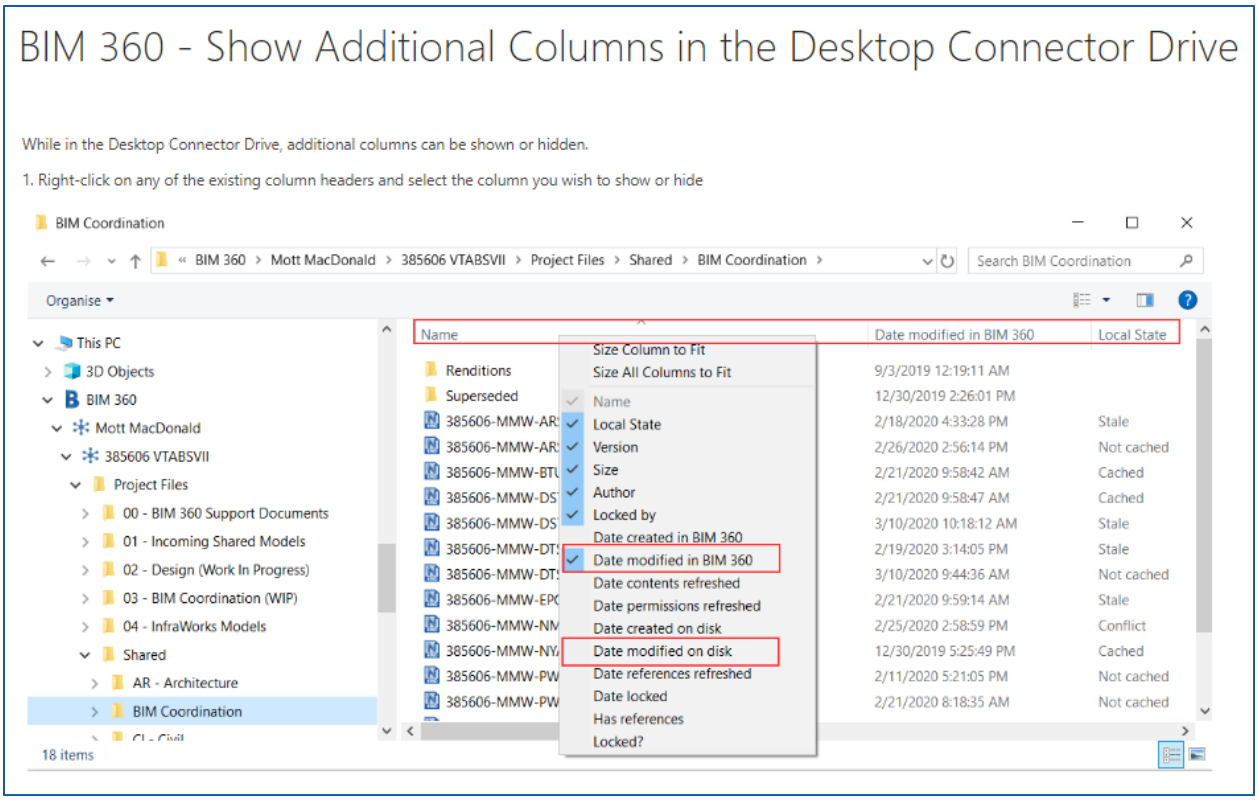


FIGURE 15: WIKI STEP-BY-STEP EXAMPLE

Trust

One of the biggest challenges at the beginning of the project was to get everyone to trust the information each team was producing, trust the systems and the workflows put in place. We produced the below digital charter and we made a habit of reminding everyone of it any chance we got.

- Create information **once** and store correctly.
- Actively **share** information. Understand ISO 19650 and respect the **workflow**.
- Seek, support and share training **knowledge** with your colleagues.
- Send links instead of attachments – keep the **single source of truth**.
- Be clear and concise – **communication** will be a challenge.
- **Don't be afraid** of the models.
- Only design and model to the required **scope and level of detail**.
- **Sharing is caring** – help others and seek help.

Technology

Robust Digital Framework

The core BIM tools for the technology framework all come from the Autodesk suite. This is mostly tried and tested technology that we were familiar with. BIM 360 being the youngest product and undergoing rapid development was the biggest unknown, with much of the functionality available now not part of the system when we were setting up the project in the summer of 2019. We knew that many of the processes would be new to the team, which itself was made up of many companies and individuals that were working together for the first time, so we wanted to make sure we were not also introducing too much new technology at once.

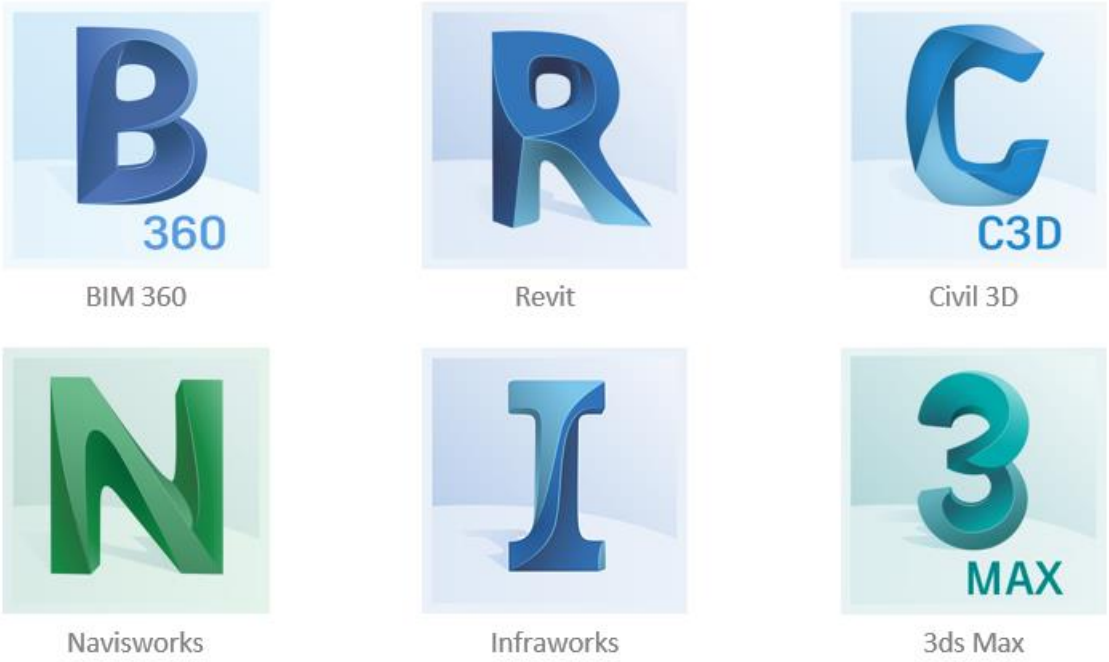


FIGURE 16: ROBUST DIGITAL FRAMEWORK

Digital Delivery Environment

Below there's a simplified model of our digital environment. We have three Common Data Environments: SharePoint, ProjectWise, BIM 360, each with well-defined document types and functions. Linked to whose we have several software applications that run from their own database or cloud storage.

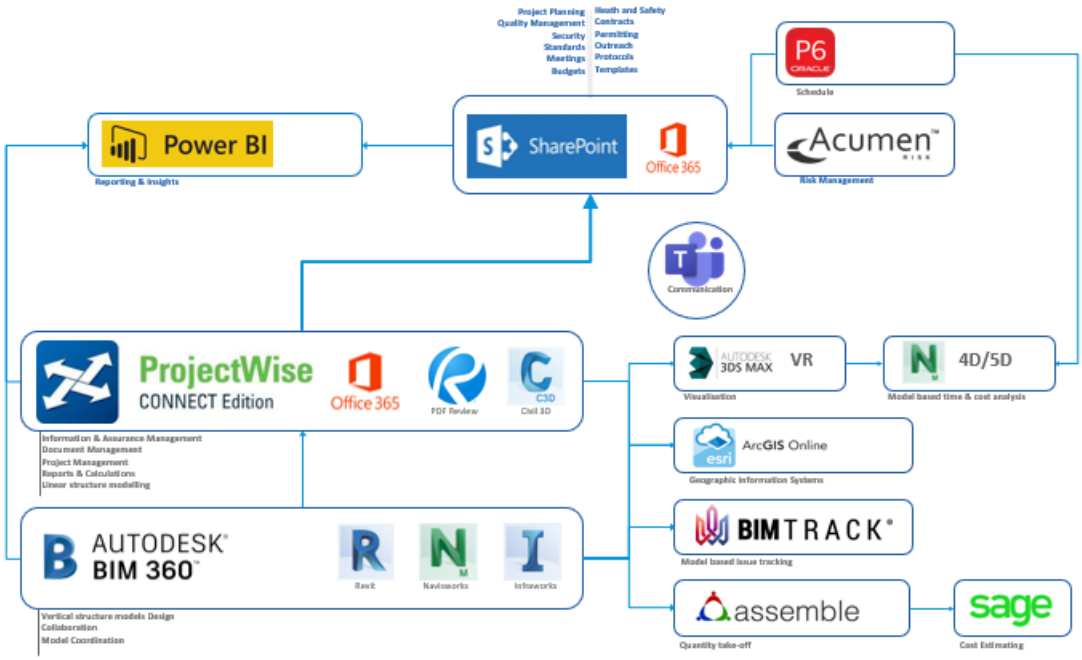


FIGURE 17: DIGITAL DELIVERY ENVIRONMENT

Common Data Environment

As much as we would have liked, we couldn't find a Common Data Environment (CDE) platform that as capable to do everything we wanted:

- Integration with all the Autodesk platforms and tools used on the project
- Embedded ISO 19650 numbering system and workflows
- Co-authoring capabilities
- Etc.

As such, we decided to go with three platforms, each of them brining their own set of features and strengths.

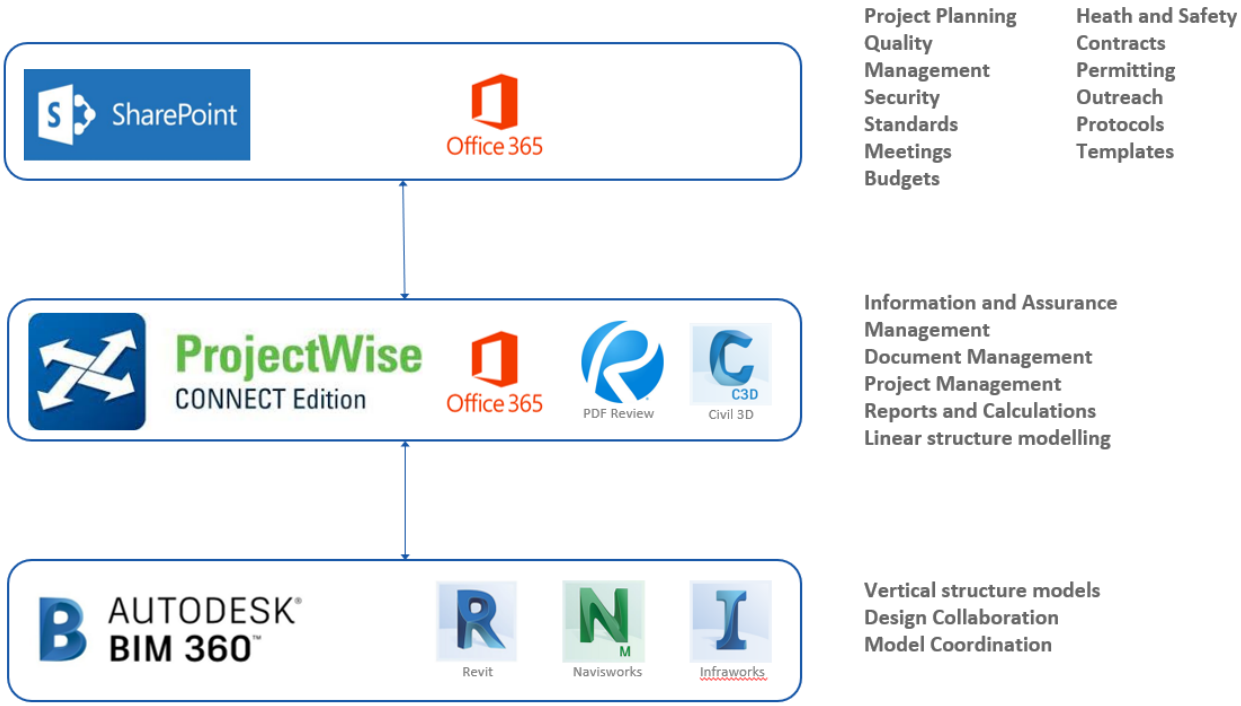


FIGURE 18: COMMON DATA ENVIRONMENT

SharePoint

SharePoint is the platform chosen for non-delivery information, like project control and project management information, onboarding and training material, links, templates and commonly used files. And if you are familiar with SharePoint, you most likely love the co-authoring feature, same as we do. We tried as much as possible to move away from folder structure to libraries of documents with attached metadata so that we have more control over how the information is used.

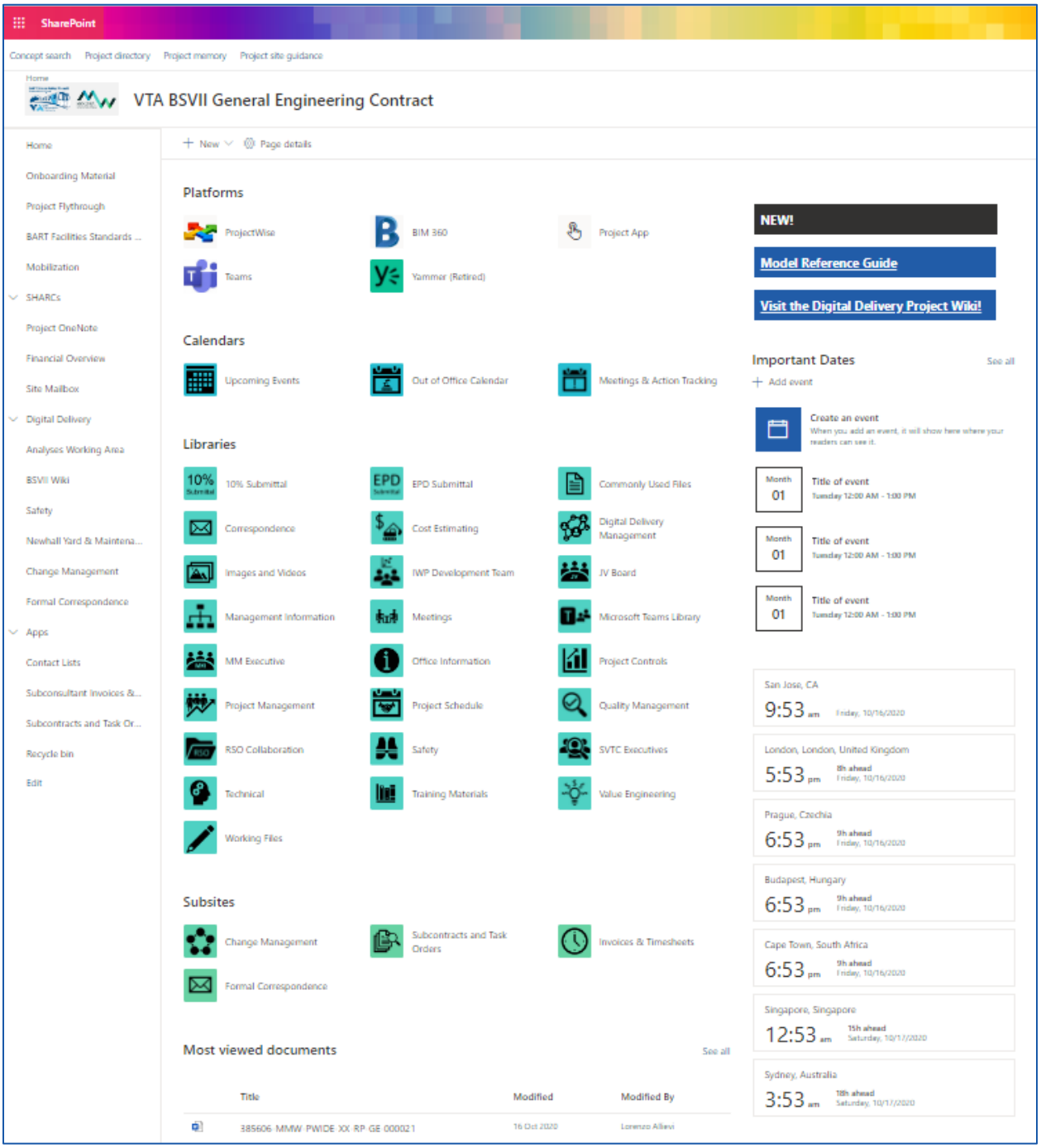


FIGURE 19: SHAREPOINT HOME PAGE

ProjectWise

ProjectWise is the platform used for all deliverables, mainly due to its ISO 19650 capabilities. Mott MacDonald customized it to include ISO 19650 file naming, state and suitability codes, embedded workflows for file sharing and validation, customizable metadata for enhanced analysis. Other features that make ProjectWise invaluable for the project are the title block integration for DWG files and the PDF renditions.

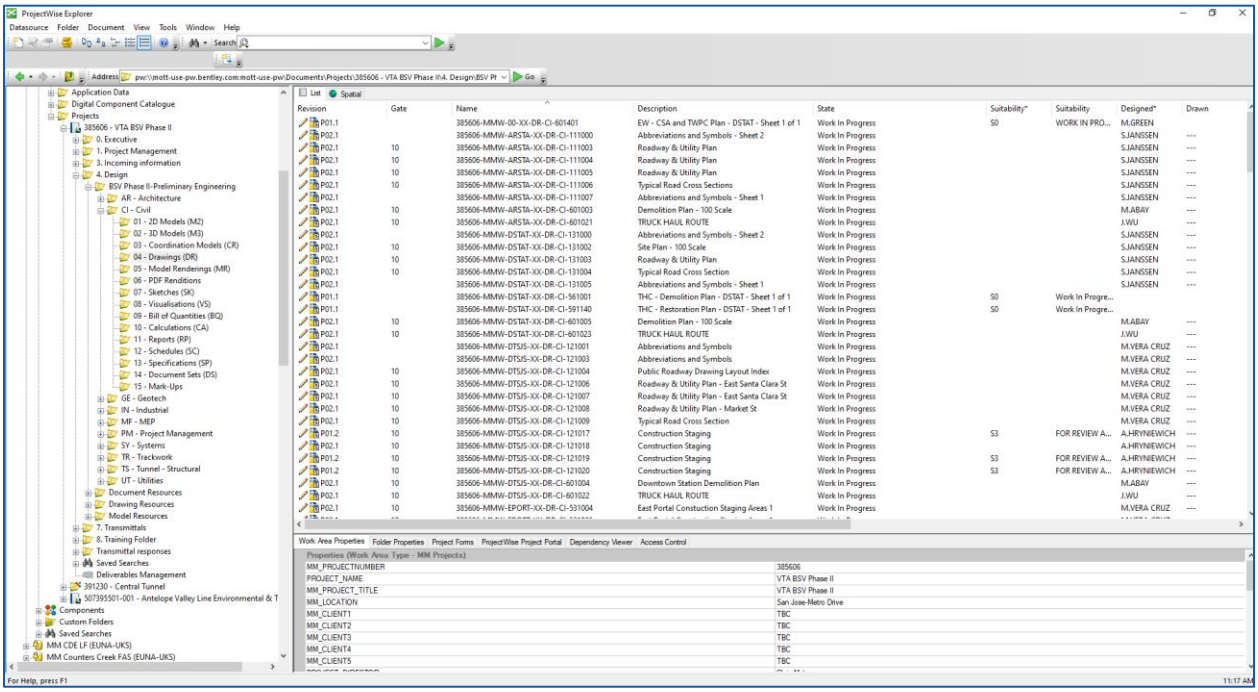


FIGURE 20: PROJECTWISE STRUCTURE

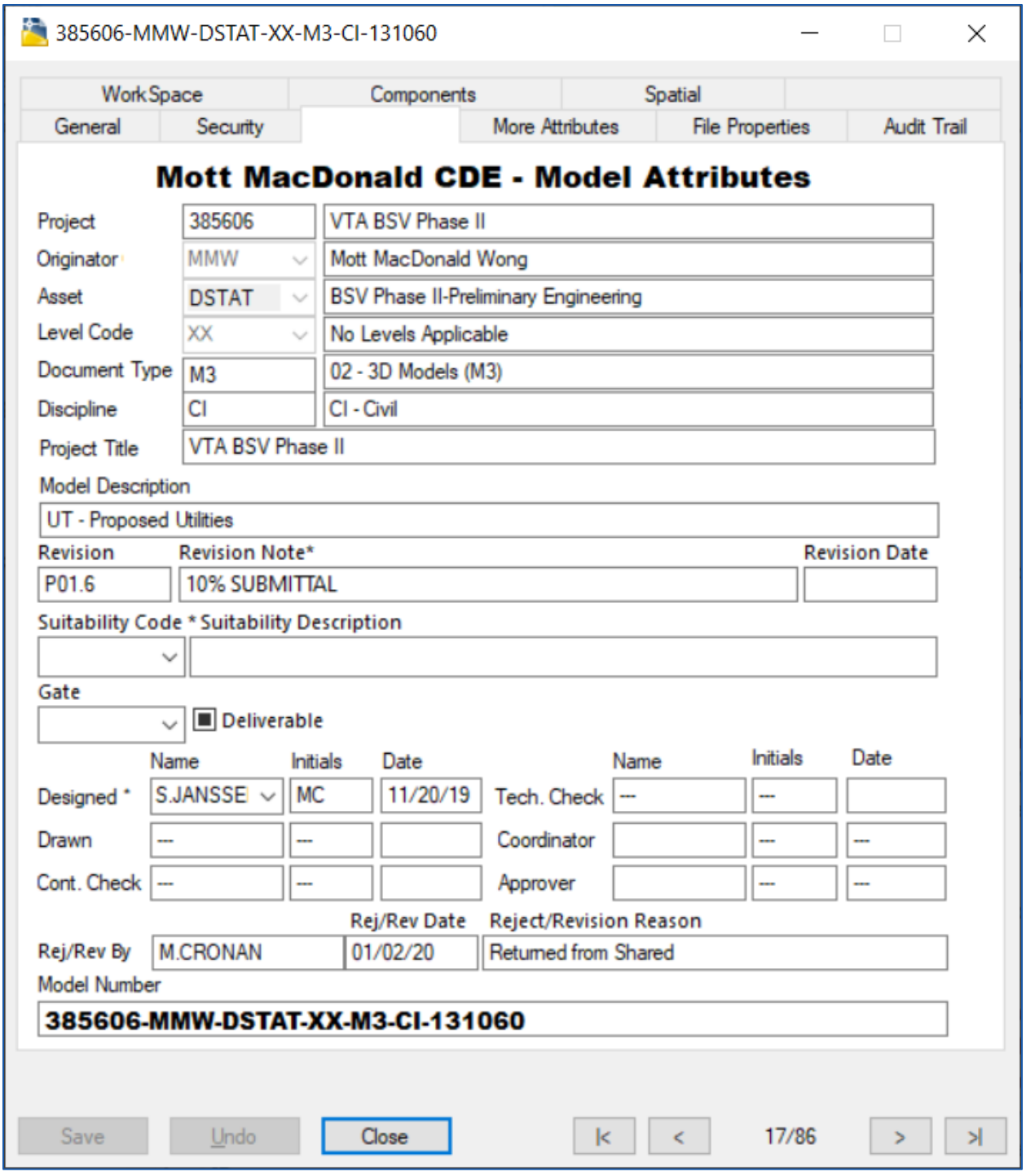


FIGURE 21: CDE MODEL ATTRIBUTES

BIM 360

BIM 360 is the platform used for all Revit models and federated models, be them Revit or Navisworks. BIM 360 doesn't come with a fully integrated ISO 19650, so we had to mimic that. But one of its greatest features is enhanced model visibility and we use that constantly.

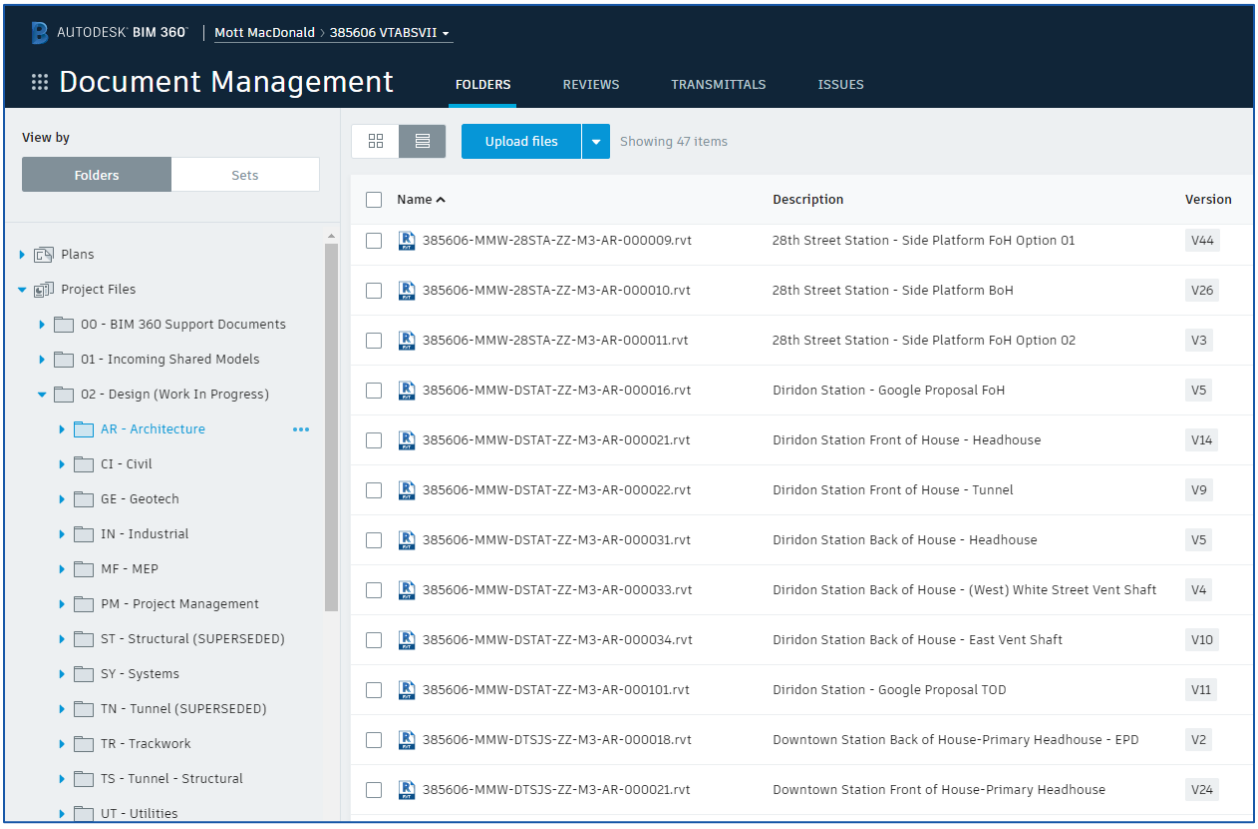


FIGURE 22: BIM 360

Information Sharing Workflows

In BIM 360 we had to manually set-up Work in Progress and Shared folders, as well as approval workflows. Approved versions of the models are copied to the Shared folder, where we have set-up custom attributes for suitability code and state.

ProjectWise, on the other hand, comes with automated workflows for the review and approval processes. The files are being shared through suitability codes and states, without copies created in other folders.

Assemble

In early design, the station design teams were producing drawings at a scale which didn't work for the estimators when they were importing them in their software. All the lines were grainy, and they couldn't do a proper quantity take-off. Producing drawings at an appropriate scale, on short notice, was a huge task to undertake across several models, just for the estimating purposes.

We had to come up with another solution, and that was to use Assemble, which was new to most of us. By publishing the models to Assemble, the estimators have a way of not only viewing the model, thereby improving their understanding of the proposed design, but also extract quantities very easily and save time and money in the process.

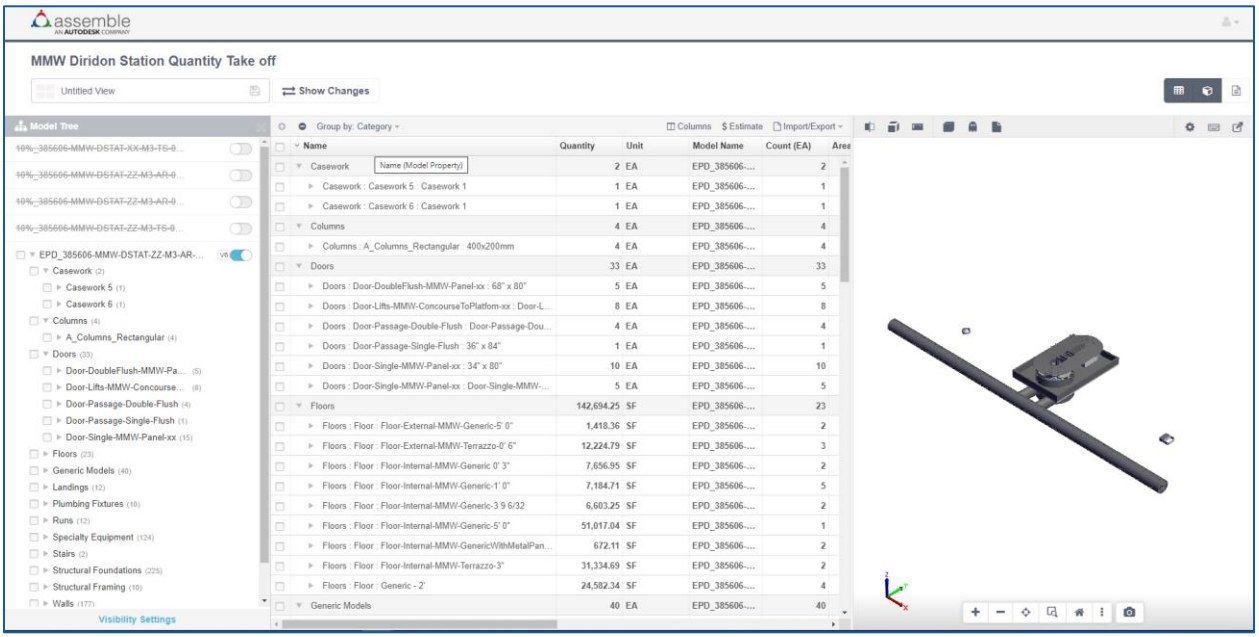


Image copyright: Santa Clara Valley Transportation Authority (VTA)

FIGURE 23: ASSEMBLE VIEW

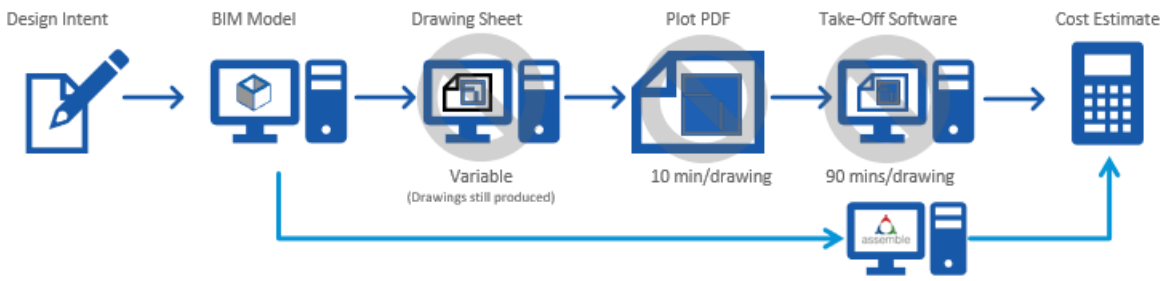


FIGURE 24: ASSEMBLE QUANTITY TAKE-OFF PROCESS

BIM Track

Another new tool we brought onto the project is BIM Track, which we use for issue tracking.

The reason we didn't go with the traditional Navisworks for clashes is because we want to capture non-clash issues as well, such as RFIs, requests for clarification, comments, etc. And BIM Track does all that. It is also integrated with the main design software like Revit, Navisworks, Civil 3D, Tekla Structures, Solibri. And if you are not skilled in any of the above you can access it through the web-based platform.

BIM Track offers data analytics and reporting and our favorite feature: hyper-modelling, which gives you the ability to visualize 2D and 3D elements at the same time.

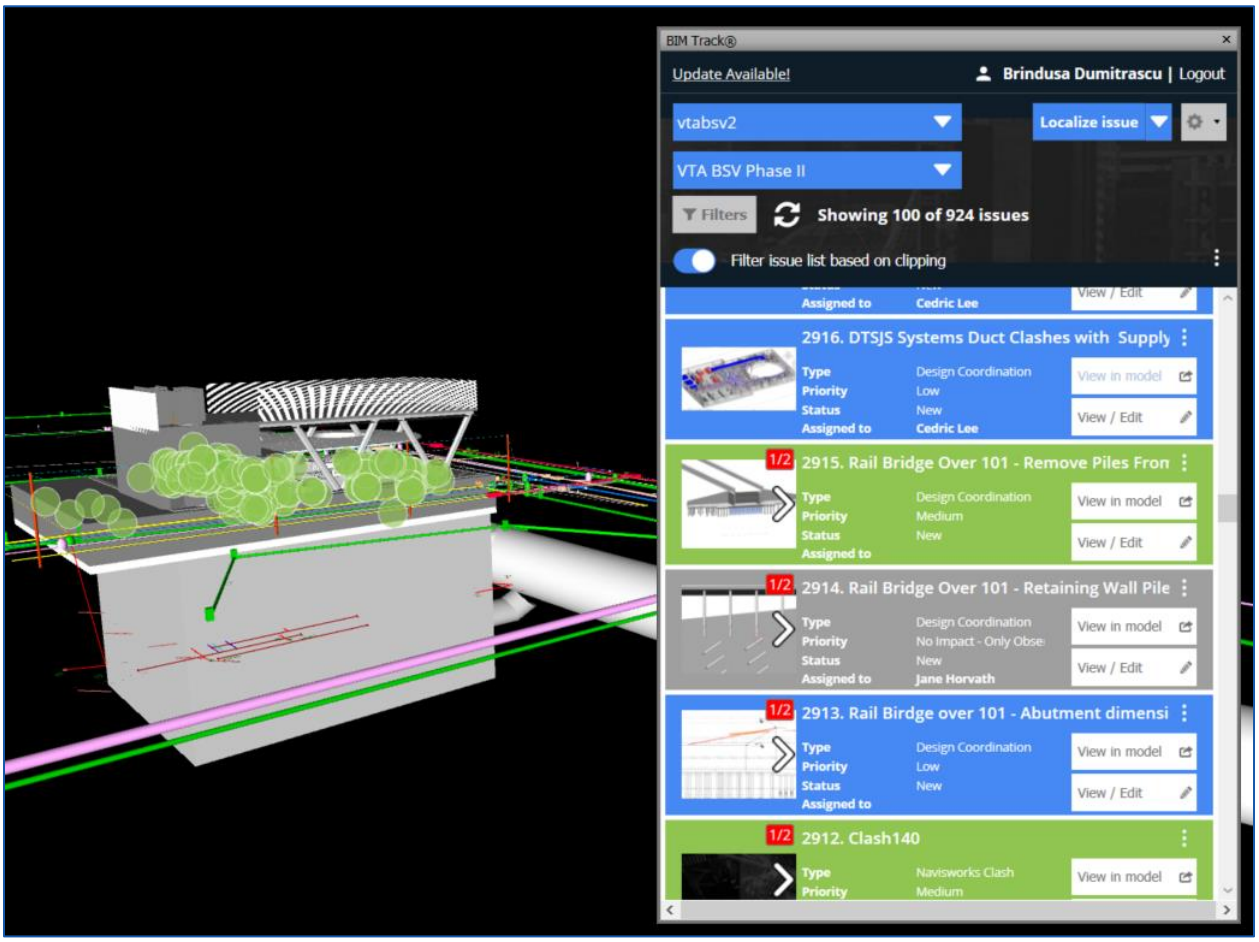


Image copyright: Santa Clara Valley Transportation Authority (VTA)

FIGURE 25: BIM TRACK ISSUES VIEW

Power BI and Power Apps

Power BI is the tool we use for data analysis and reporting.

- Tracking as-built information through 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

We have also created a Project App for automation of commons tasks using the Office 365 Power Apps. The Project App includes the team mobilization tool, document control and BIM areas, project directory, and additional key info.

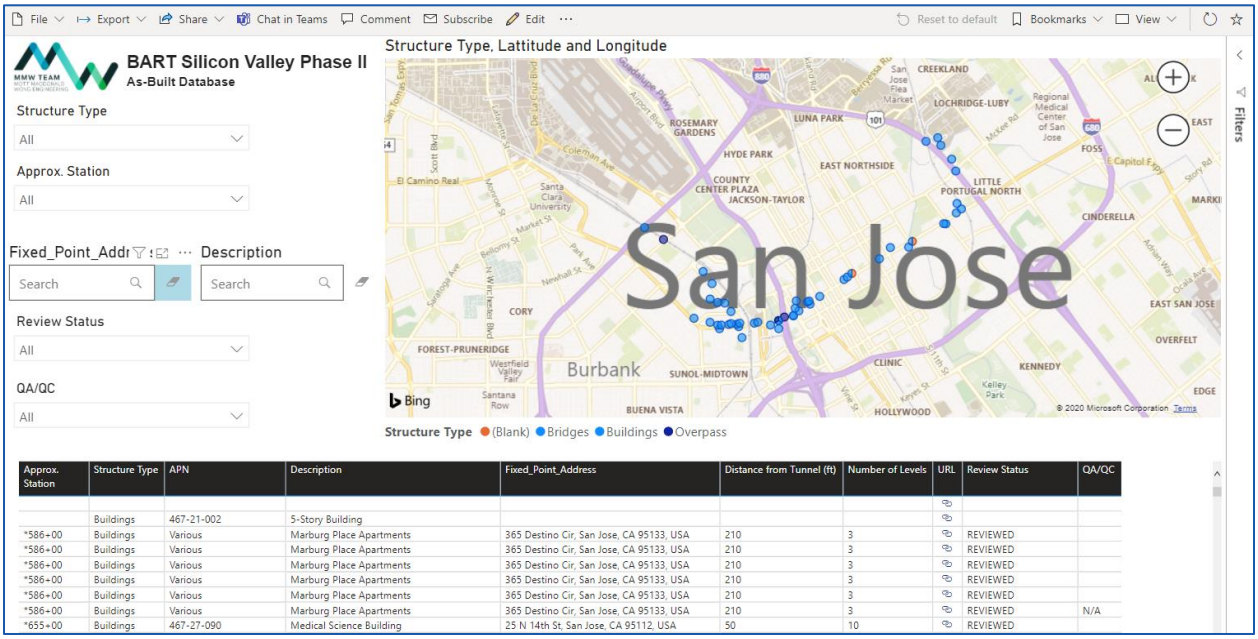


FIGURE 26: POWER BI AS-BUILT DASHBOARD

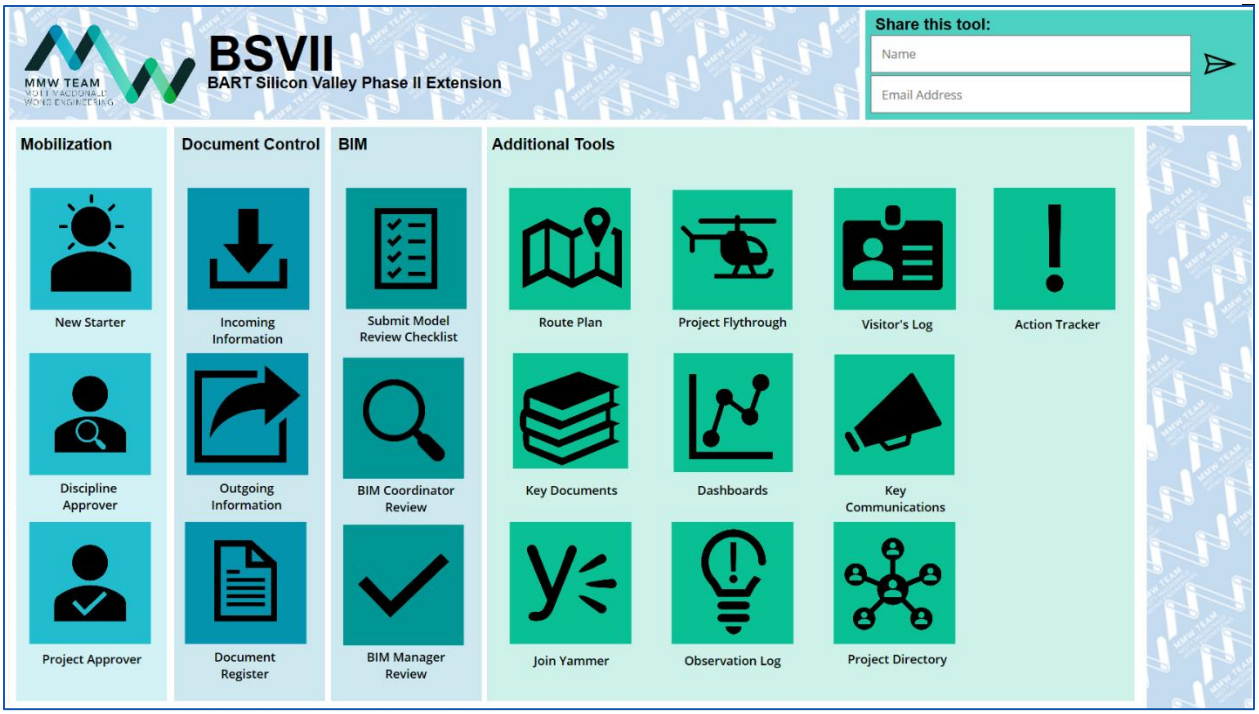


FIGURE 27: PROJECT APP

Virtual Reality

A few months into the project we had the opportunity to set-up a VR station in the project office. We used the Revit models of the stations, the Rehearsive App (which is a Mott MacDonald developed app, but publicly available) and the VR headset. We were able to include the existing buildings and the city streets, and it gave users a chance to walk around the proposed design. Not only they were able to get a feel for how the final project might look like, but they were also able to point out any issues during the walkthrough.

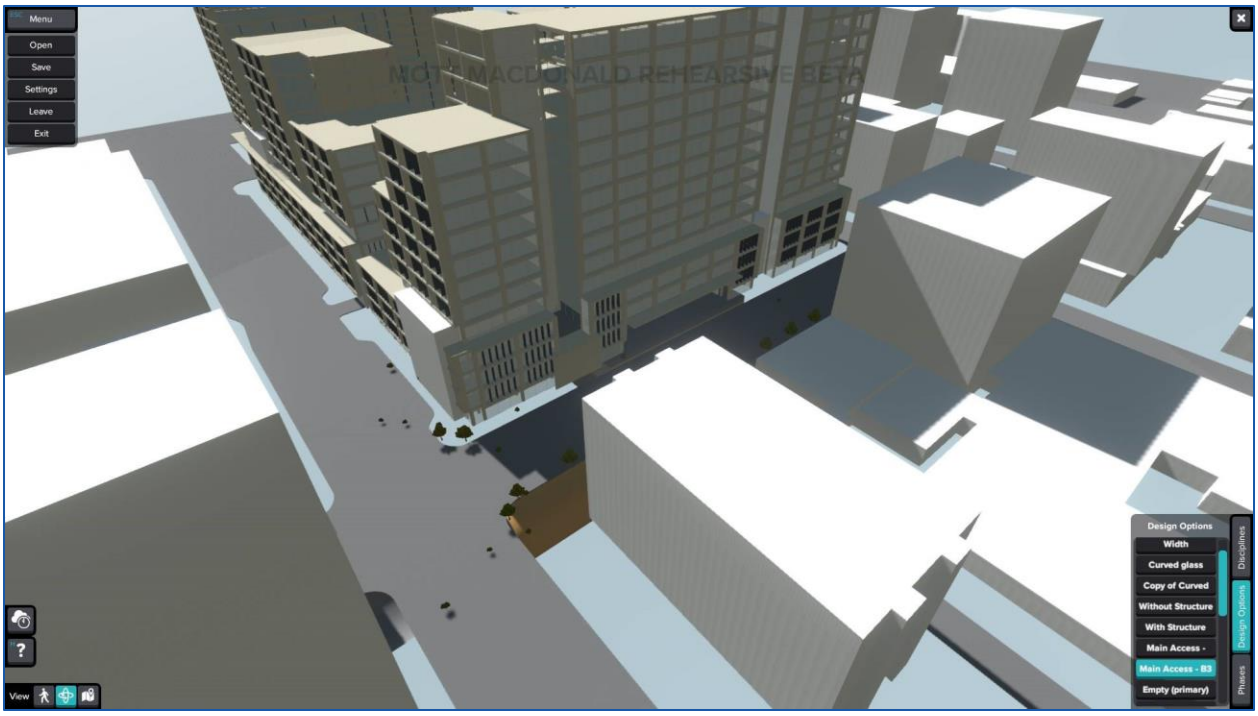


Image copyright: Santa Clara Valley Transportation Authority (VTA)

FIGURE 28: VR SCREENSHOT

Visualization

Visualization is a big part of our project and we have a specialist creating amazing renderings and animations that are used during community outreach meetings, presentations, be them internal or for the client, and project milestones.

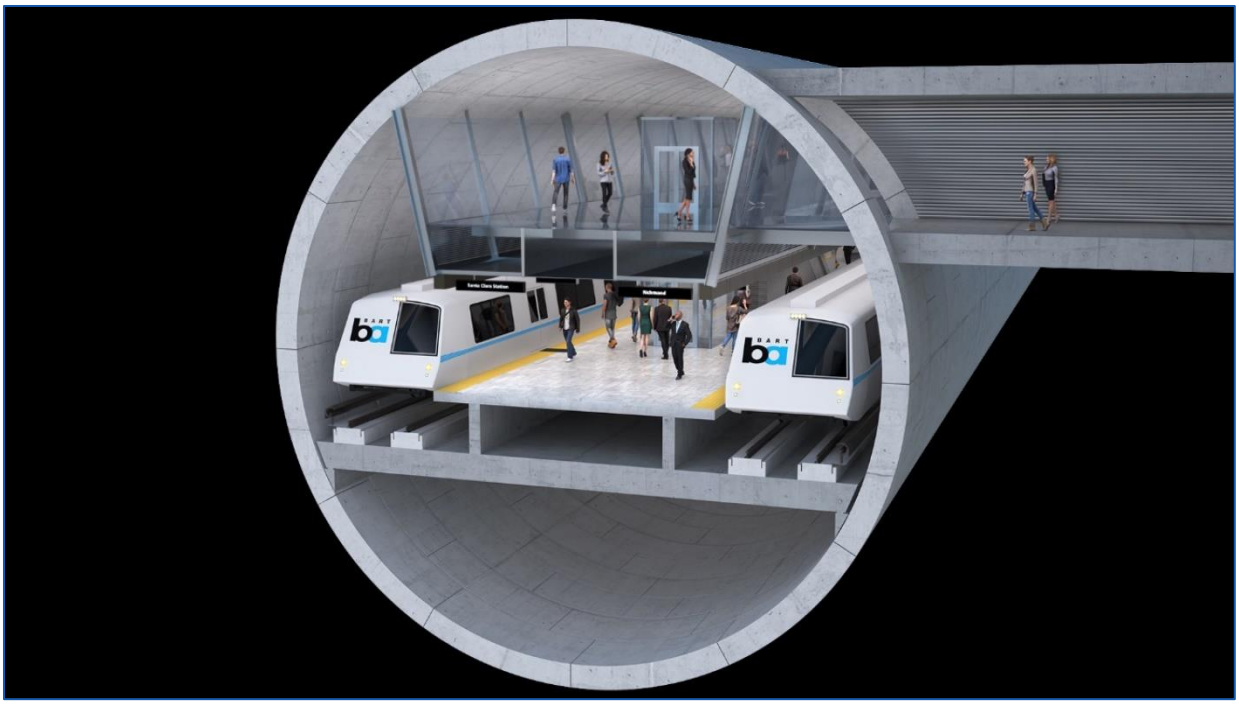


Image copyright: Santa Clara Valley Transportation Authority (VTA)

FIGURE 29: TUNNEL SECTION RENDERING

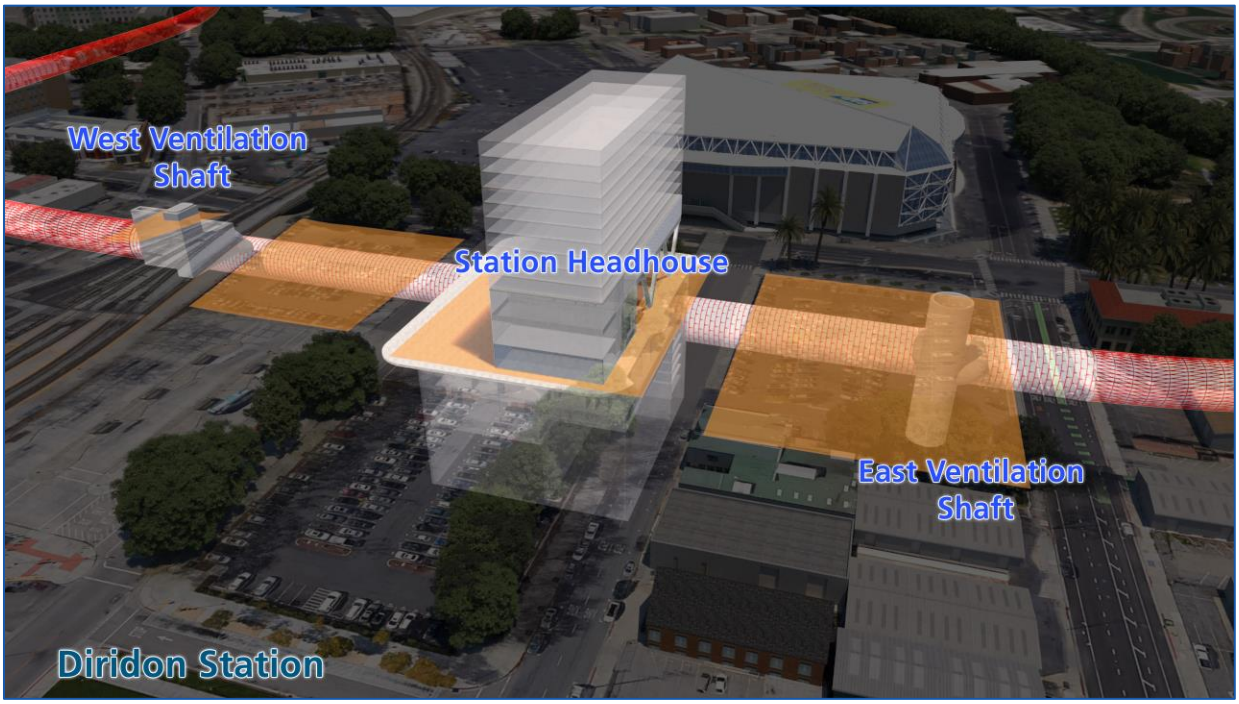


Image copyright: Santa Clara Valley Transportation Authority (VTA)

FIGURE 30: DIRIDON STATION

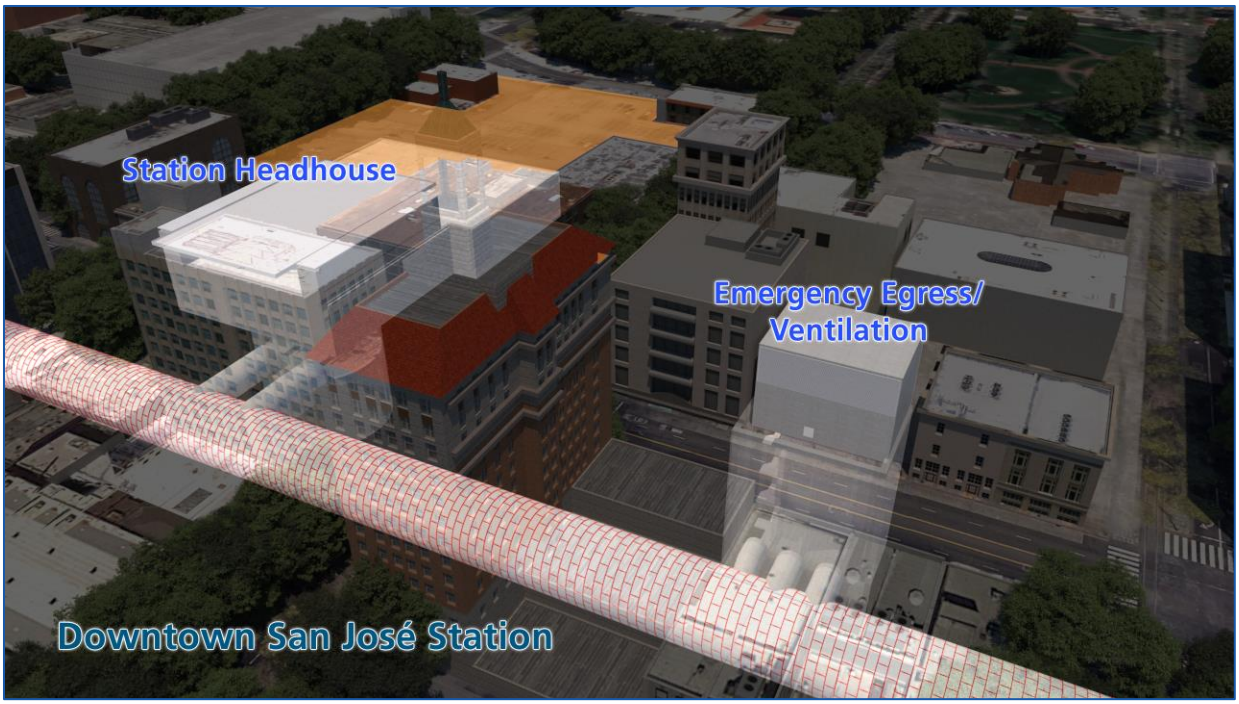


Image copyright: Santa Clara Valley Transportation Authority (VTA)

FIGURE 31: DOWNTOWN SAN JOSE STATION

Image copyright: Santa Clara Valley Transportation Authority (VTA)

FIGURE 32: DOWNTOWN SAN JOSE STATION RENDERING

Communication

Communication is not an easy task. For us it is even harder, due to the number of firms involved, spanning across different time zones, and in the last few months the work from home. We implemented a couple of platforms / methods:

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

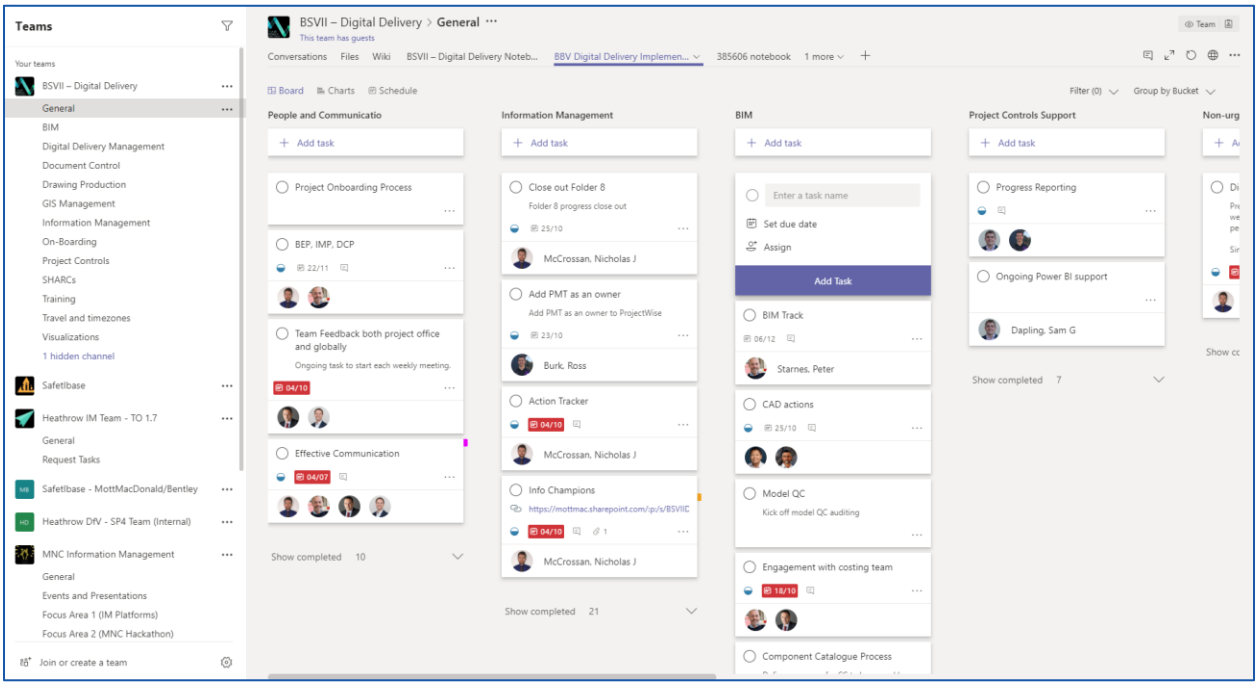


FIGURE 33: MICROSOFT TEAMS

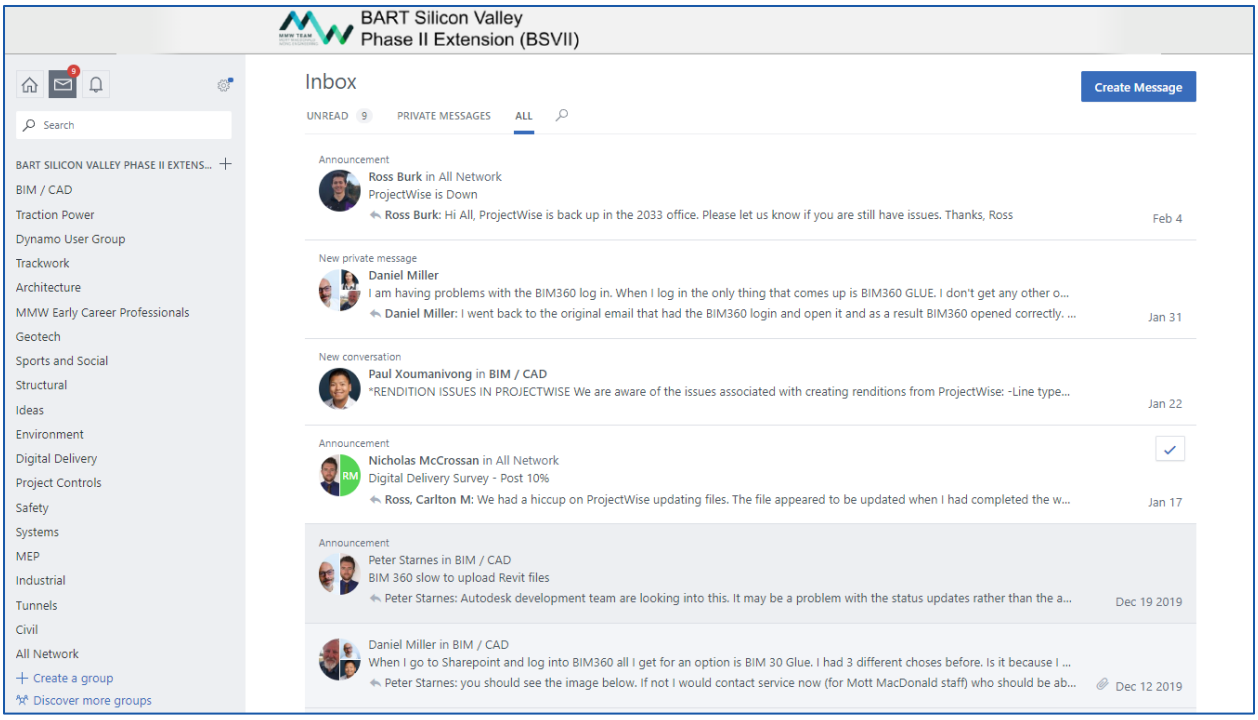


FIGURE 34: YAMMER

Collaborative Production

Data Connections

Remember that we talked about our digital environment earlier? We have multiple systems, software, platforms, functions, etc. that are required to support a mega project. But on any size project you are likely to need to connect data, models or other information between systems.

We spent a lot of effort to ensure that data was created once and then reused as much as possible. Often this involved converting the information to other formats (Navisworks, IFC, DXF, etc.) or extracting information to text or table content. Wherever possible we tried to automate tasks, but many processes were still manual. These tasks were documented to ensure that they were repeatable, and we were consistent in applying them.

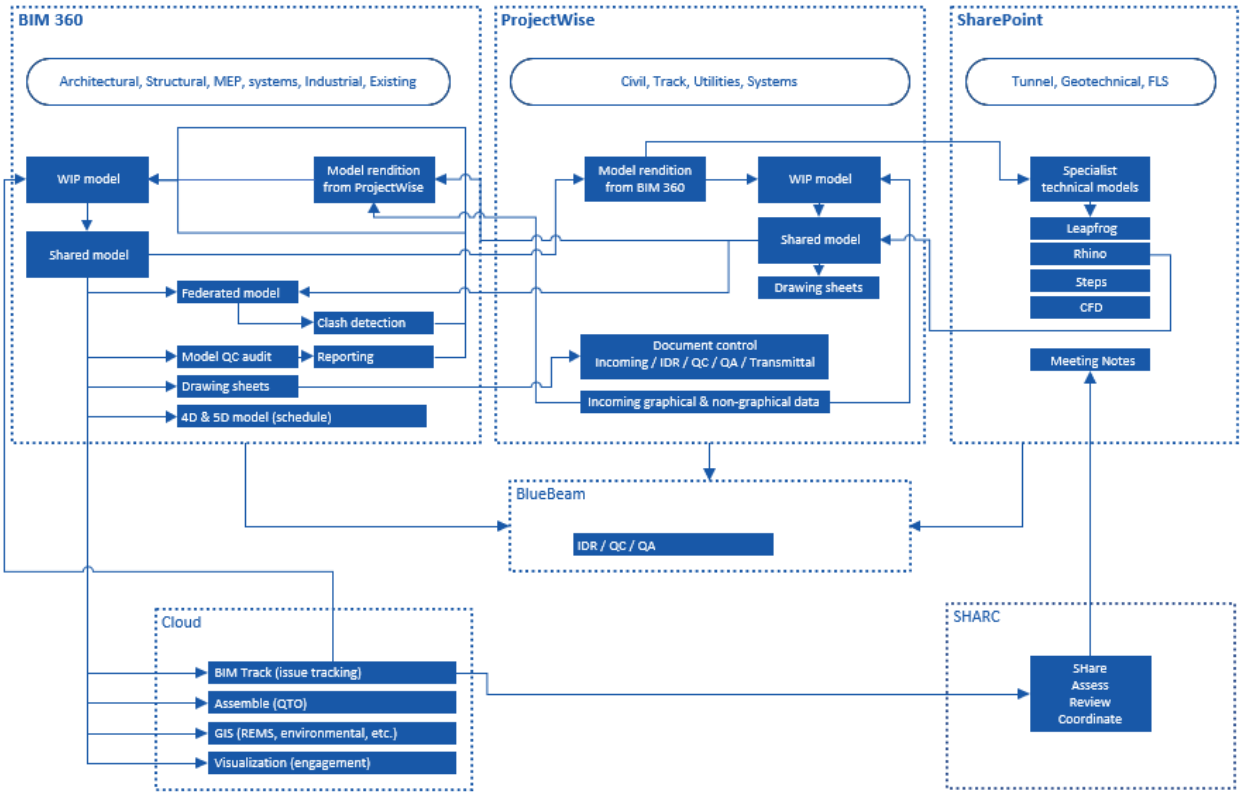


FIGURE 35: DATA CONNECTIONS

Renditions

Despite having the robust CDEs to host the models, we were still faced with the challenge of linking BIM 360 and ProjectWise. And we do that through manually created renditions, in non-editable format, which we monitor through version control and reporting.

BIM 360 to 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 to 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

We adopted suitability codes for each of the document files, whether models, drawing sheets or reports. These codes give visibility to the status of the information contained in the document and indicate the purpose or level of confidence that the information has been shared for. The status code is applied as part of the assurance workflow within ProjectWise and manually added in custom attributes to the BIM 360 models.

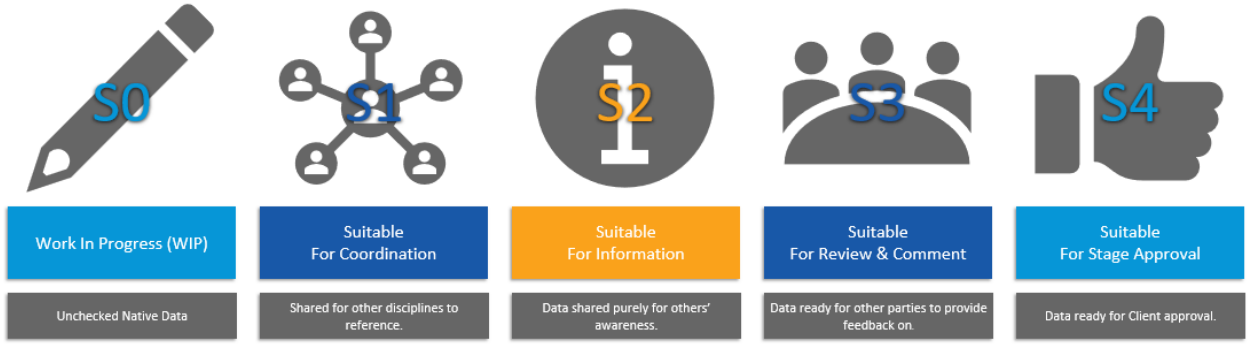


FIGURE 36: SUITABILITY CODES

States

The state of a document (combined with the suitability code) determines where it is in the assurance process. The movement of data through this approval assurance is handled differently in ProjectWise and BIM 360. In ProjectWise the files stay as a single entity with new versions created at each stage of the workflow. Whereas BIM 360 has a separate physical copy for the Work-in-Progress, Shared and Published states while the check / review / authorize states are workflow only. Both methods work well and usually a task team was only working in one of these environments so there was not too much confusion on how it worked.

On the right hand side of the diagram below you will see the teams that were able to access the information as the documents move through the workflow, and this ensures that documents can only be used once they have been approved for that purpose.

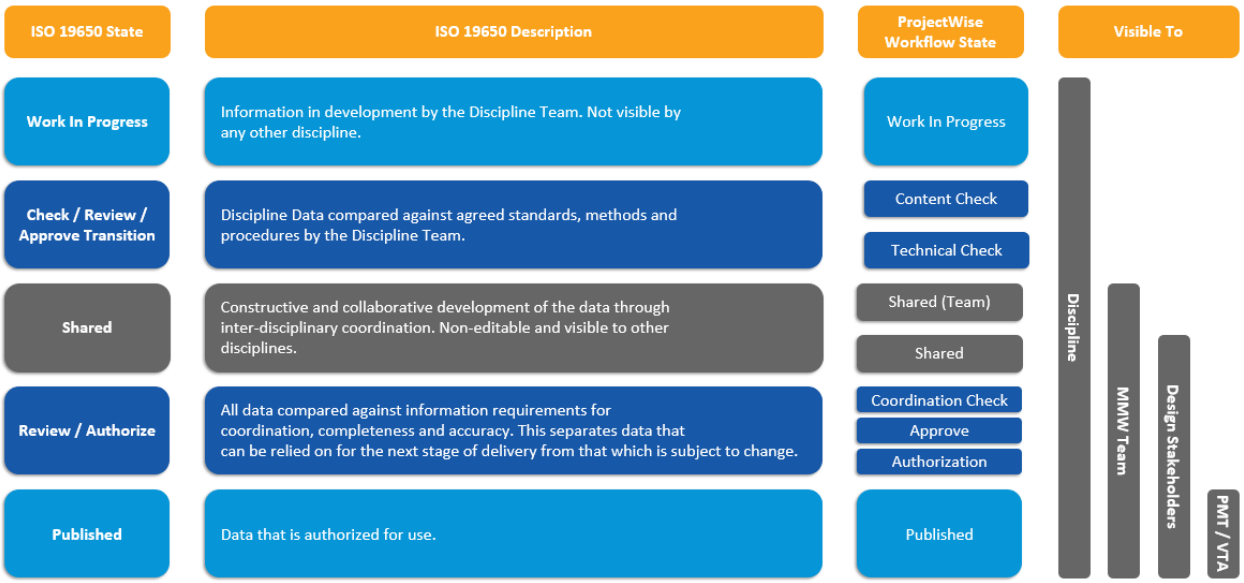


FIGURE 37: STATES

CAD / Revit QA / QC

Any project that has multiple companies and users working together is most likely struggling with consistency between models and making sure the CAD standards are being properly implemented and followed. And we are no exception from the rule, especially when some of the standards are being adjusted on the way.

We are also sure that most of you use some form of QA / QC process for the Revit models and the CAD files. The way we handle this is we came up with a pretty comprehensive checklist, by using the one that the client provided plus lists used on previous projects. The first step, which was probably the most time consuming one, is have each model audited by the modelers itself, against the checklist. Followed by a backcheck done by the BIM team. We had a high frequency check schedule to try and keep on top of the assurance so that when we would not have a massive cleanup job when it came to deliver at milestones.

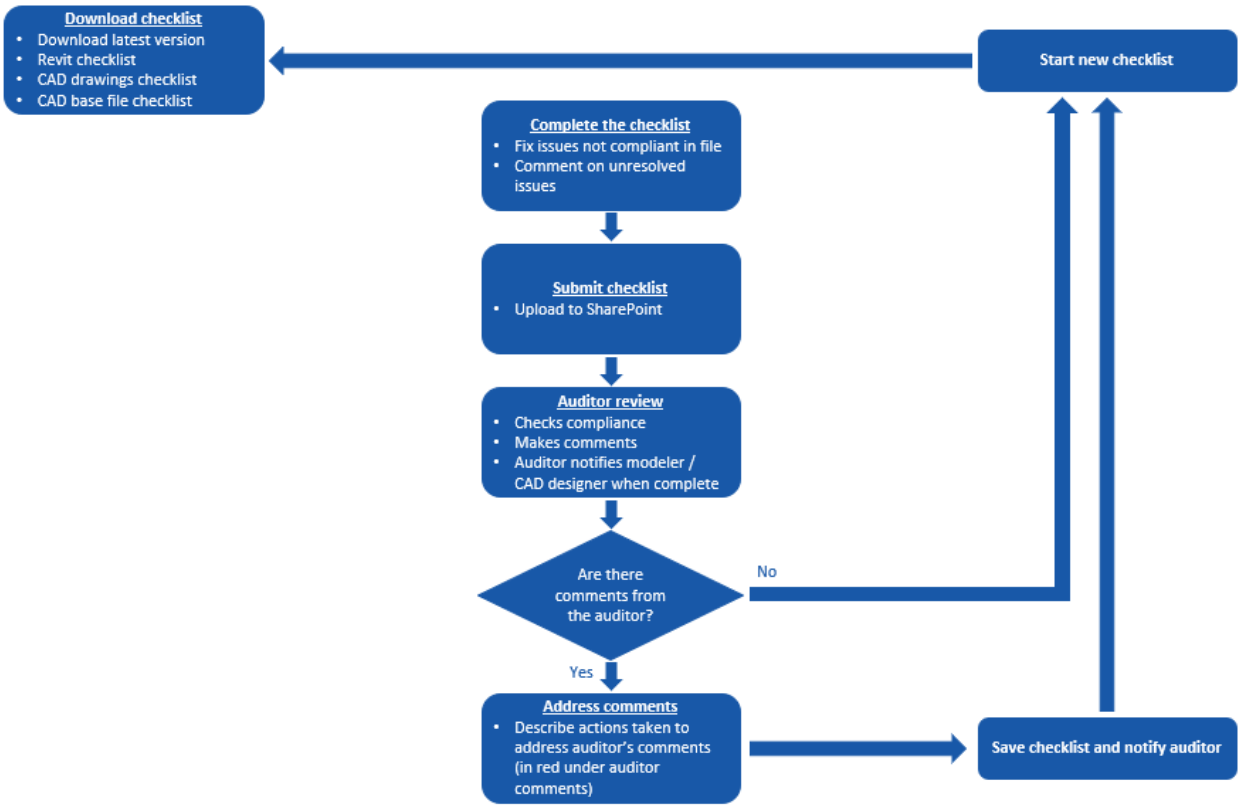


FIGURE 38: CAD / REVIT QA / QC PROCESS

Model Federation

Federation of models (that is creating a combined asset model) was carried out in BIM 360 and Navisworks. At the same time as publishing models to BIM Track and Assemble we created Navisworks NWC for each of the model files which were combined into an asset federation model which, in turn, made up part of the project wide model. We created NWD exports from each of the federated models so that they could be viewed in BIM 360 as well as through Navisworks and we found that most team members were more comfortable using the view controls of BIM 360.

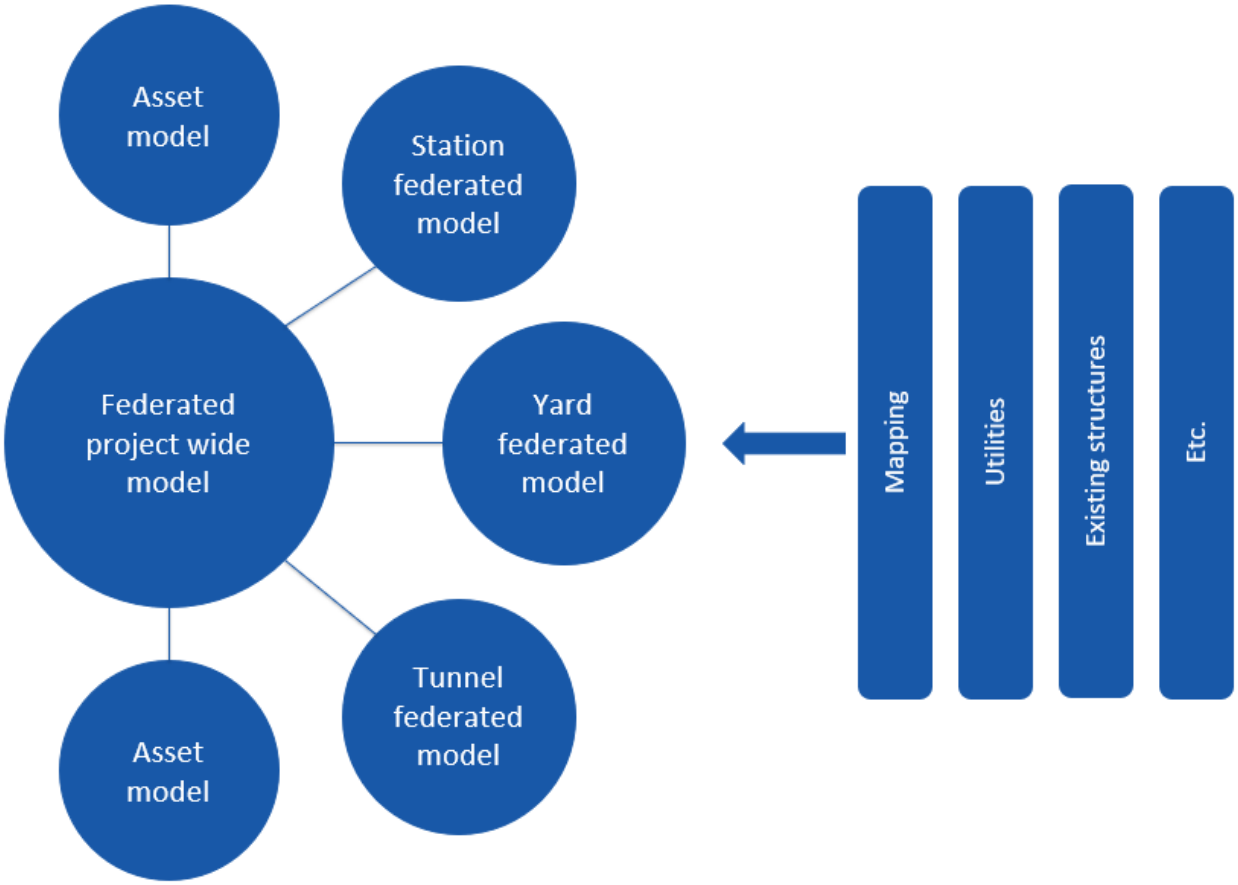


FIGURE 39: MODEL FEDERATION

Clash Resolution Process

The Navisworks models were also used for clash detection. Rules and model combinations determined by discipline were setup in Navisworks and the resulting clashes pushed to BIM Track. BIM Track in turn notifies the design leads and model authors that items need attention, and these can be fixed in the native models using the BIM Track add-in modules.

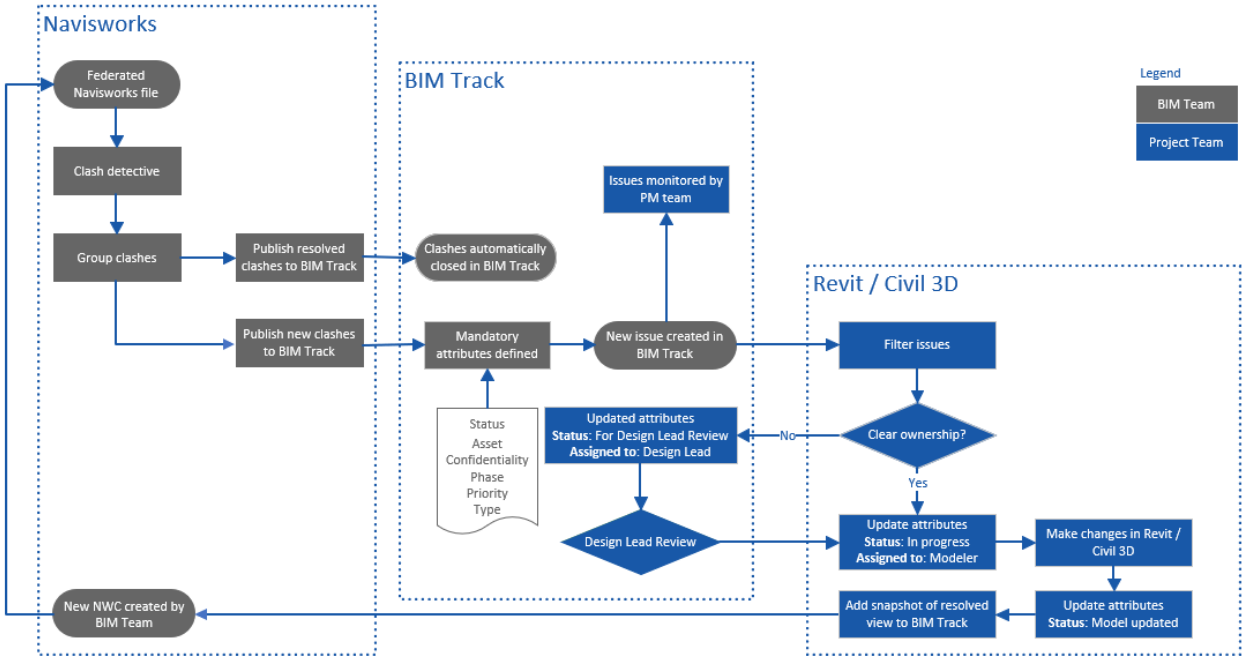


FIGURE 40: CLASH RESOLUTION PROCESS

Issue Tracking Process

We mentioned previously that BIM Track handles more than just clashes - we use it to track issues such as code violations, financial impact, design coordination, request for clarification, etc. The issues can be created directly in BIM Track, on the web-platform, or they can be created in any of the integrated model authoring software. The important part with tracking the issues in BIM Track is having the attributes filled-out properly, to ensure the reporting is accurate.

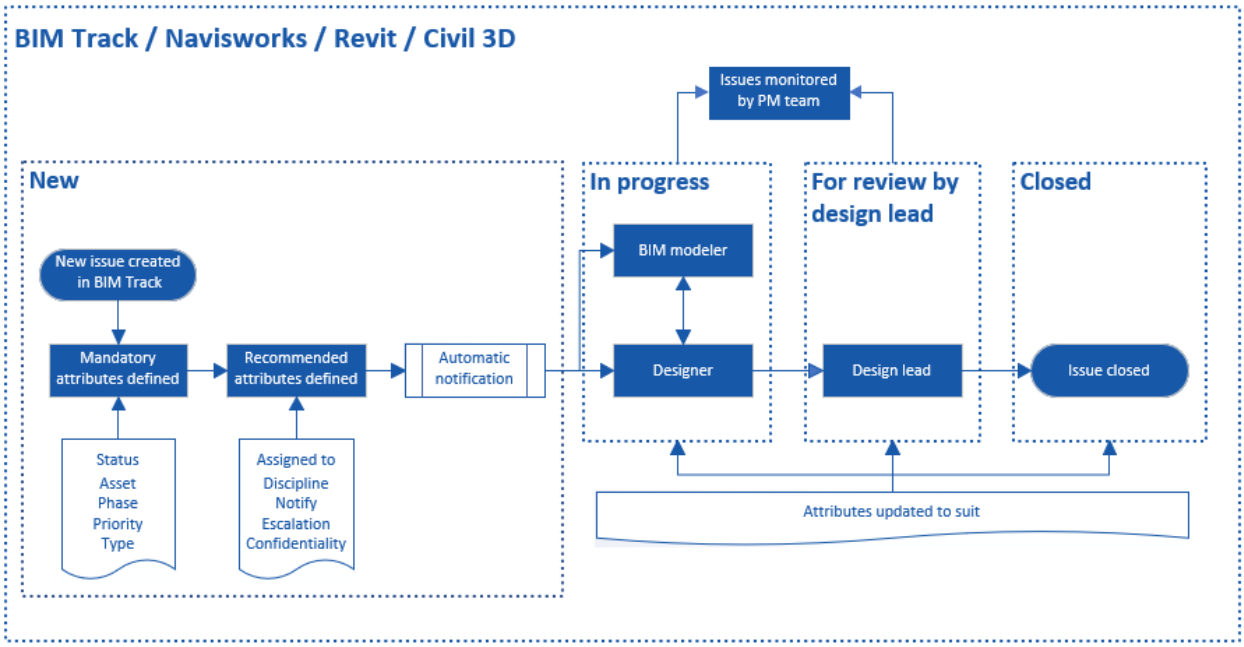
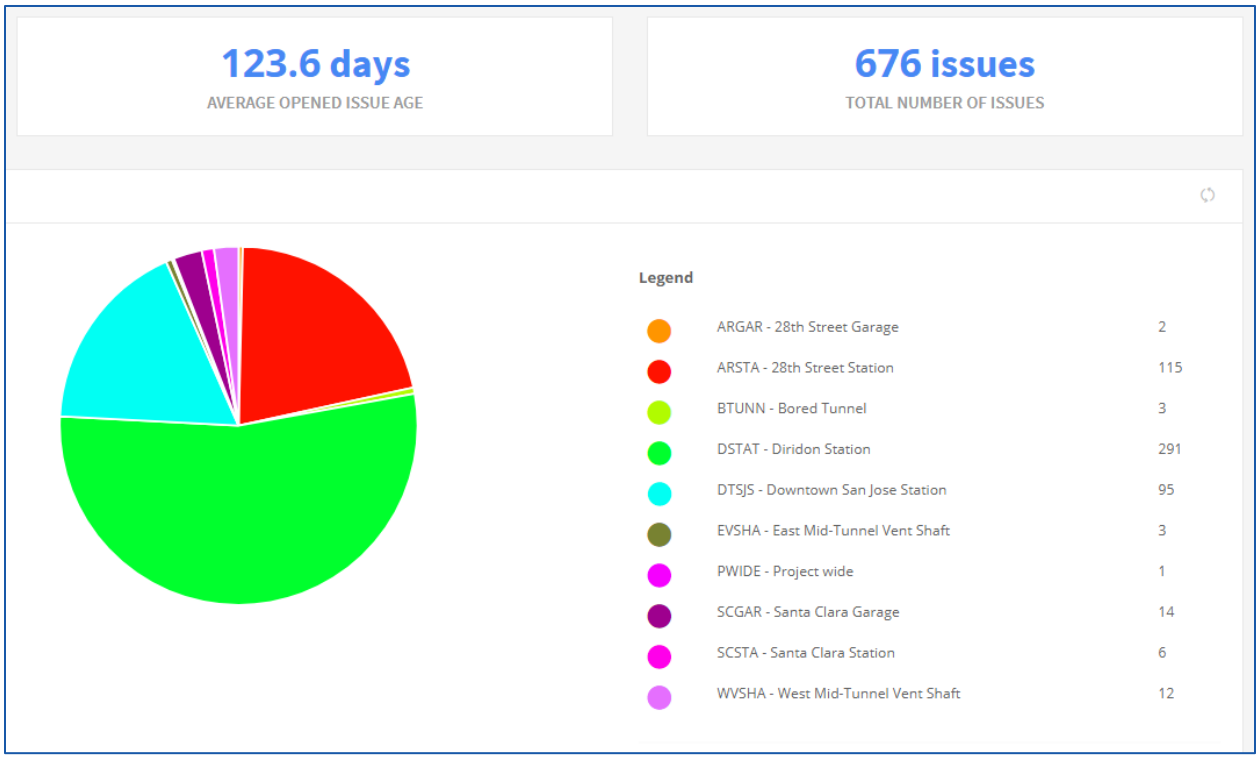


FIGURE 41: ISSUE TRACKING PROCESS

Issue Reporting

BIM Track offers a quick instant overview of the project coordination performance, plus report templates, that can be personal or shared, you can use the scheduled reports feature, that enables the reports to be generated daily, weekly, monthly, with a notification sent once the report is ready for review, and it also offers customizable report metric.



ISSUE 42: BIM TRACK PROJECT OVERVIEW PERFORMANCE

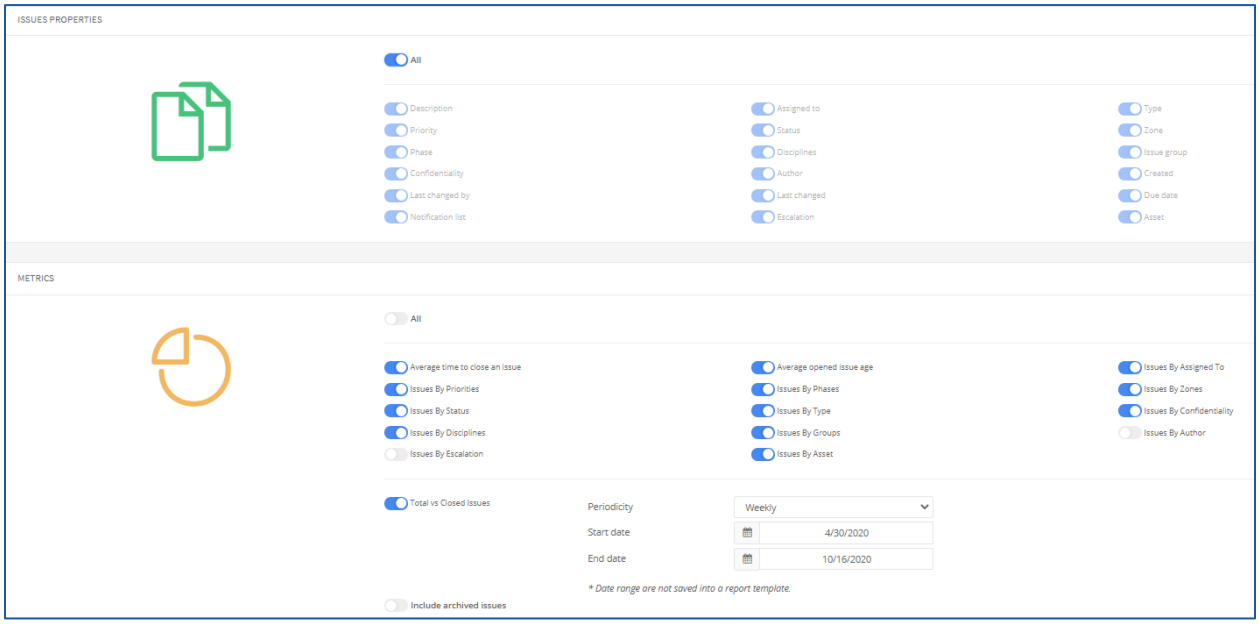


FIGURE 43: BIM TRACK CUSTOMIZABLE REPORT METRICS

Room Criteria

When we went through a review and QC of the drawing sheets for the first milestone, we noticed several discrepancies on how rooms were being named and numbered across different stations. Not only that but the standard room types also had varying sizes and did not match up with the facility standards. We needed an efficient way for auditing room data across multiple stations in the project.

We started using a third-party product from Ideate called BIMLink to publish room data to Excel from a federated Revit model. Requirements comparison is carried out in the spreadsheet and any additional attributes can be assigned and reimported to the Revit model. BIMLink has been very useful in extracting all sorts of model information and we have used it extensively as part of the QC/QA assurance process.

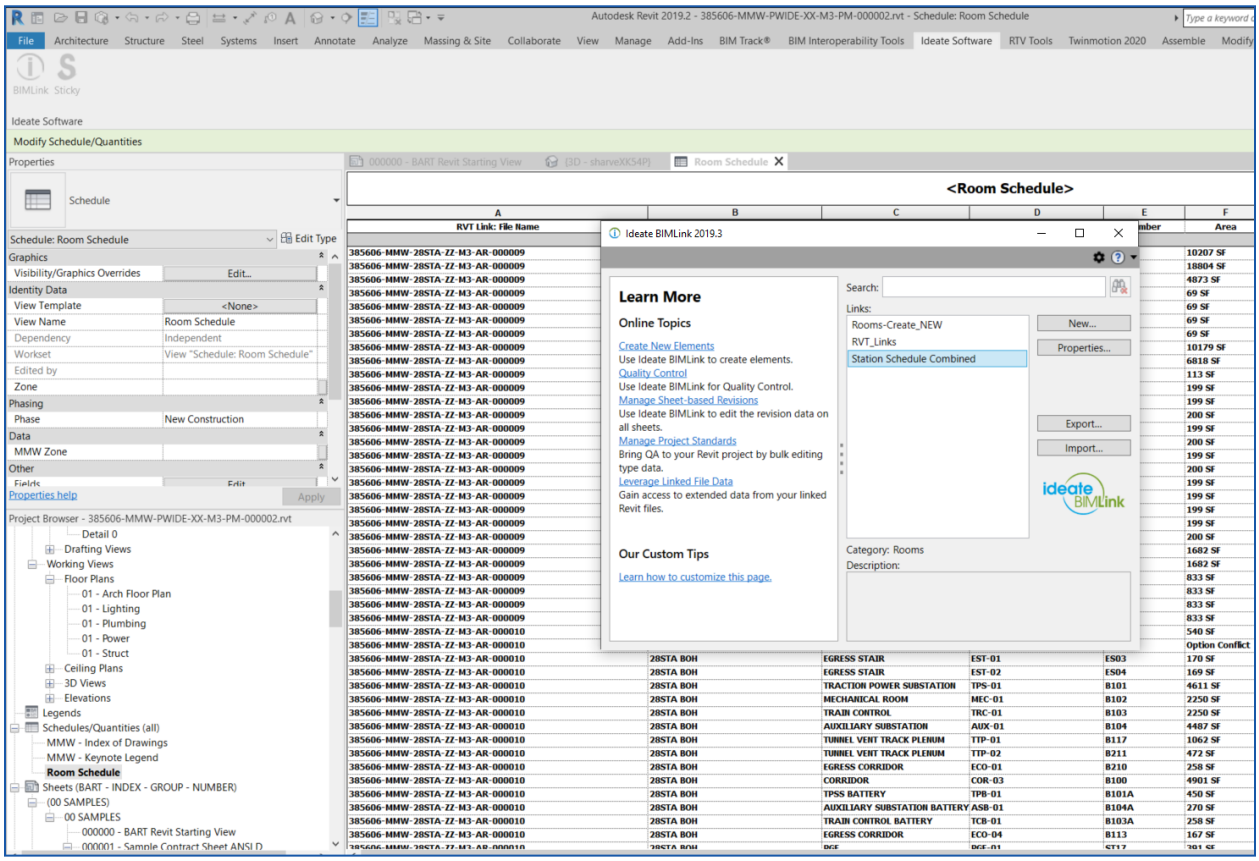


FIGURE 44: EXPORT FROM REVIT USING IDEATE BIMLINK

SHARC Meetings

These are the weekly collaboration meetings. We named these SHARC sessions which stands for Share, Appraise Review & Coordinate. We can't stress too much that even with all the technology that we have available, the most important tool is usually talking to each other. We did

however want to make the meetings as efficient as possible and put the models at the center of the conversations. We had a process of sharing models on a Monday evening, federating through Tuesday ready for SHARC sessions on Wednesday morning. Robust processes and instructions made that sequence work well. We could improve that turnover to overnight if we introduced more automation to creation of renditions and federated models but found that the human intervention and visual checking by the BIM coordinators made for a much better product ready for collaboration.

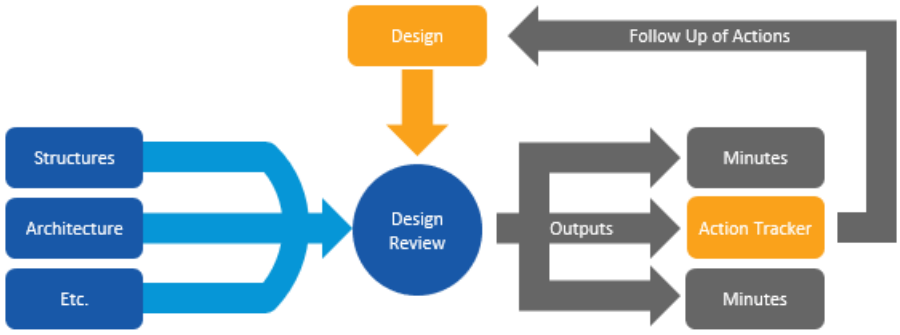


FIGURE 45: SHARC MEETING WORKFLOW

FIGURE 46: SHARC MEETING

Next Steps

4D and 5D

4D and 5D simulation are somewhere down the line and we are trying to identify the level of information that needs to be built into the models. A common coding of items across the different model, cost & schedule programs is vital to make this an efficient process.

Level of Development

Level of development was initially required to be a blanket LOD 300, but we recognize that this is not suitable for all items and as we are now identifying those objects that need development. At 10% design we took the view that we would not mandate any specific LOD, but rather tried to instill the ethos that all modelled information should have a purpose and unnecessary detail was inefficient either through unnecessary modelling or in the case of importing highly detailed models, the time wasted was further down the line when we run into problems printing or exporting.

Asset Information

And finally, a word about asset information. Similar to the level of detail we were not too worried about prescribing this during concept development stage but we are now working closely with the operators to establish exactly what information will be needed during the project lifecycle so that we can start to build in the attributes. As the project develops and grows into detailed design those attributes can be extracted, and rather than the simple excel sheets that we are using now, will be directed to specialist requirements software.

Outcome

Challenges

Following us so far might make you believe that everything ran smoothly for us. And that's not the case. We had, and still have, challenges. ISO 19650 is new to North America, and most of the project's teams were exposed to it for the first time. To add to that, the ISO 19650 workflows between the 3 CDEs were different in order to achieve the same aim.

Old habits die hard and people were reticent to adopt all the new technology platforms, tools and processes.

Although we had a huge team mobilization effort at the beginning, individual members are still being added to the project even today. So, we must ensure they are being brough up to speed fast. And that's where all the recorded training material, project Wiki and the communication platforms come in handy.

Successful Delivery of First Phase of Project

We had our first milestone in December 2019, and that was the 10% level of design submittal. We submitted 920 files, we created 199 3D models and we processed 1835 incoming files.

Upskilling of Whole Team

On top of that, the average competency rating of staff increased by about 50% following the training.
The comparison was based on the survey skill completed during the mobilization, followed by one after the submittal.

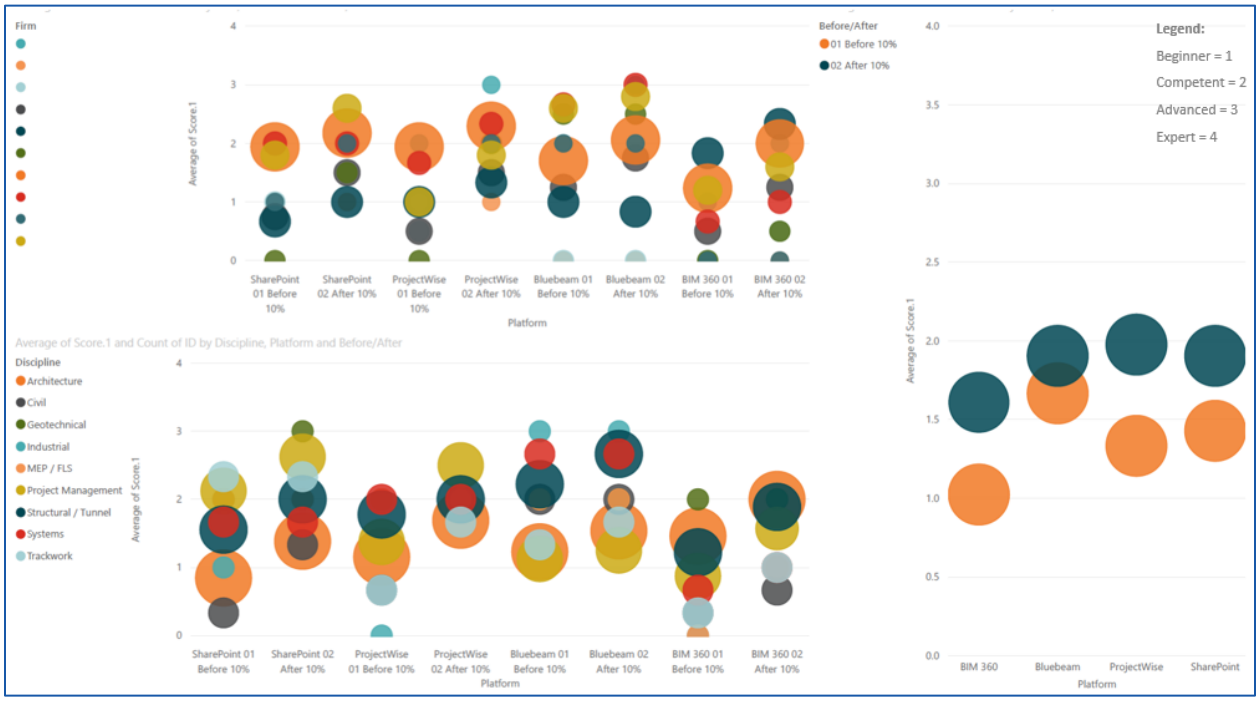


FIGURE 47: SKILLS SURVEY COMPARISON

Assemble

Bringing new tools such as Assemble helped the project save time and money during the quantity take-off.

Models Visibility

Being able to visualize the models starting early in the design played a huge role in the success of the first milestone. We used both BIM 360 and BIM Track for that.

The Revit models are shared on a regular basis in BIM 360, and that's being followed by federating them into Navisworks, using the process that Peter outlined earlier. The BIM 360 viewer proved to be invaluable during the asset coordination meetings.

BIM Track models are being kept up to date as well, and they are visible to the whole team, including the client.

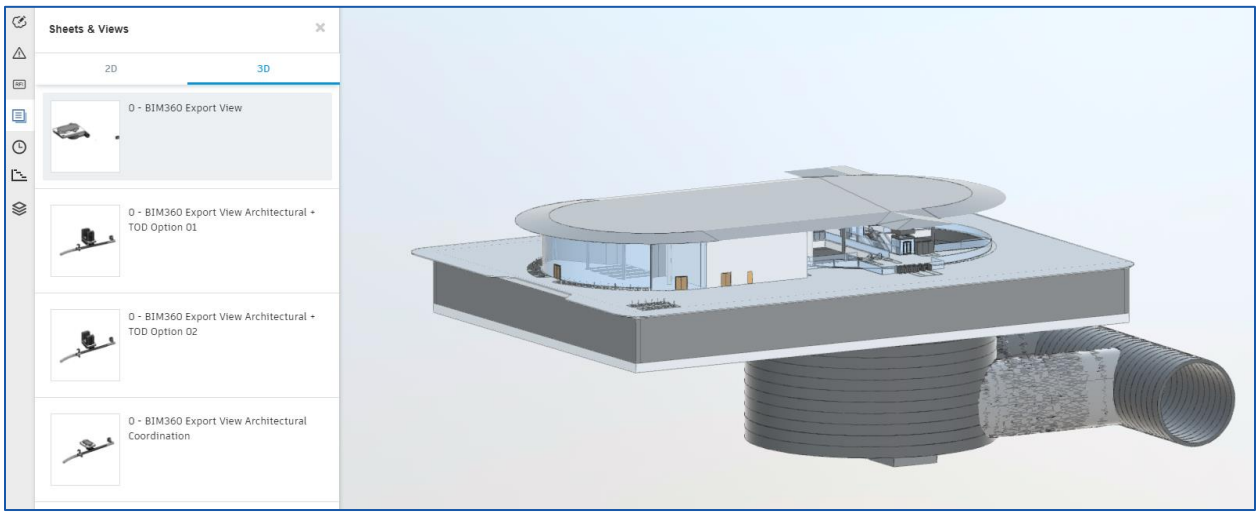


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FIGURE 48: MODEL IN THE BIM 360 VIEWER

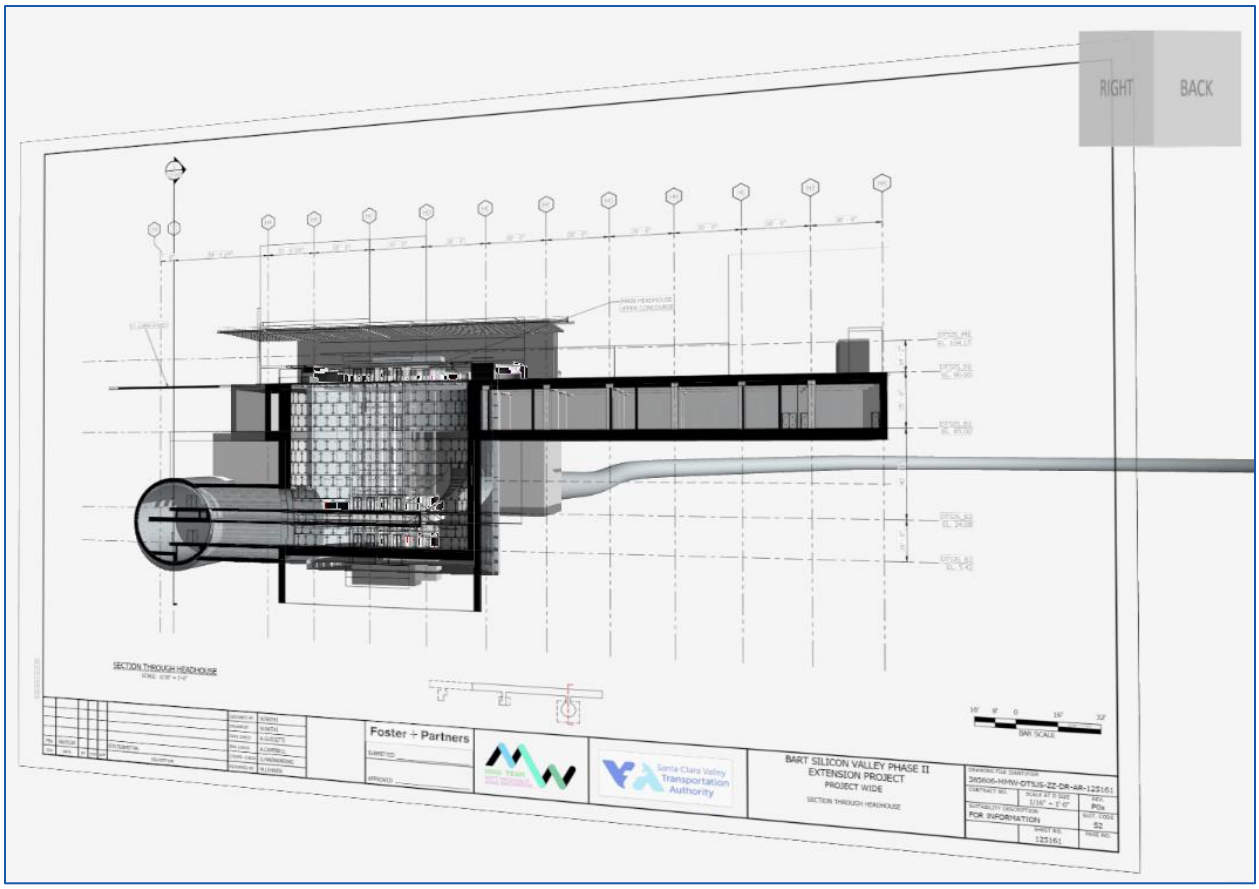

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FIGURE 49: MODEL IN THE BIM TRACK VIEWER WITH SHEET HYPER-MODELLED

Did We Establish ISO 19650?

Did we establish ISO 19650? What do **YOU** think? Have you used ISO 19650 on your projects, or do you plan to? We'd love to hear your thoughts. So please get in touch. Post your comments on the AU class page or contact us directly using our email addresses:

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