2012 AIA TAP Submission

Part 6: Post-Award Visualization and Model documentation

Contents

This Post-Award Visualization and Model Documentation section is designed to accompany the project narrative.

Contents:

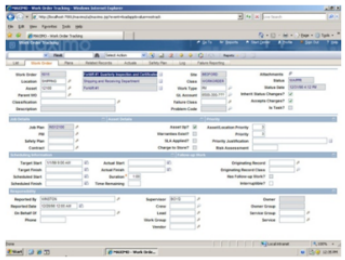
- New Concepts, Procedures or Tools Imagery
- Design Integrity
- Data Exchange Diagrams

2: Revit & Maximo

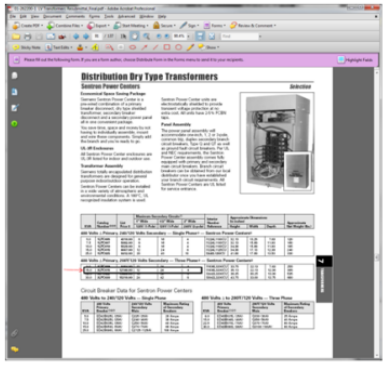
Maximo

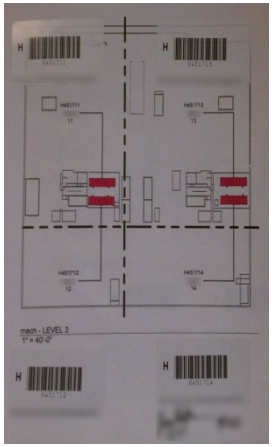
Revit

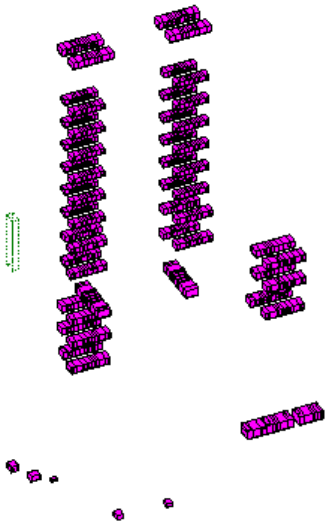
On-Base

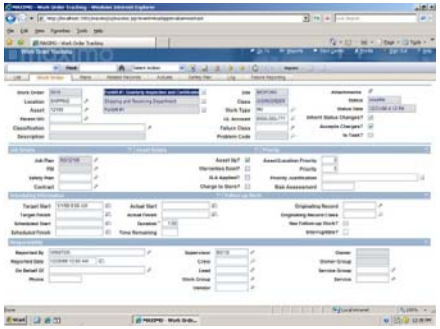


*COBie is critical

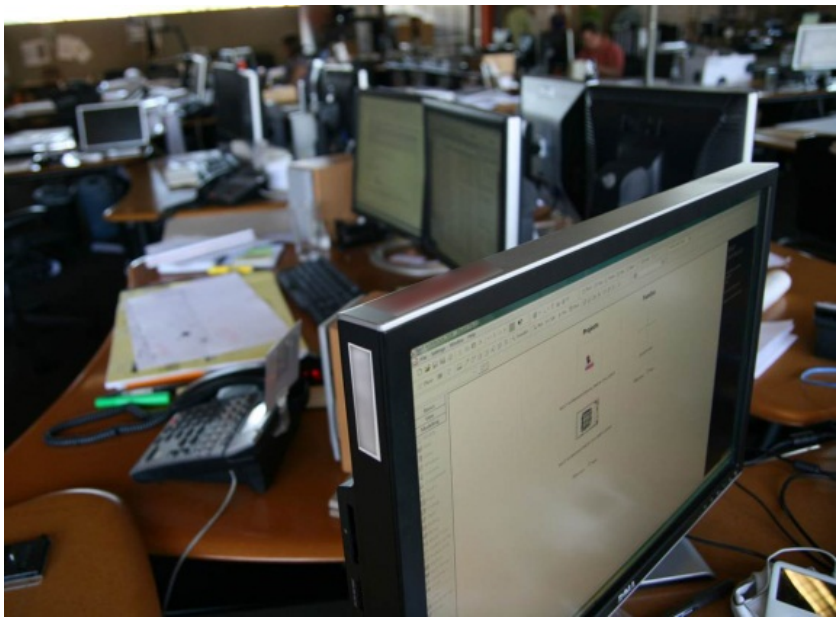


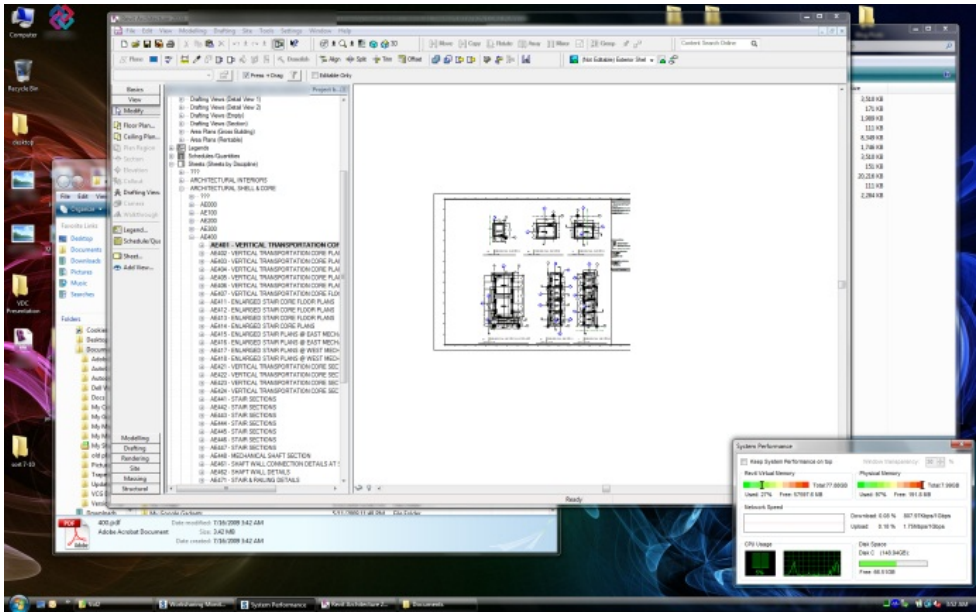






3: Co-location



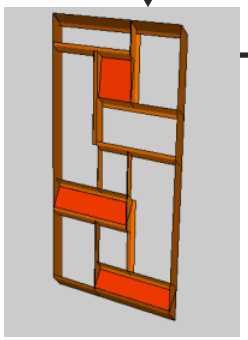


Nine months of full-time co-location:

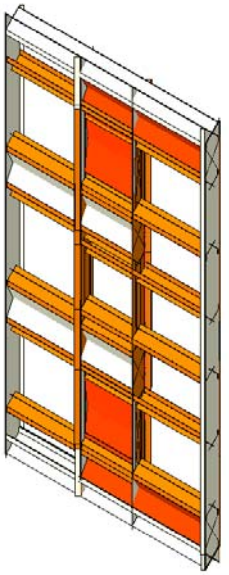
When modeling at 4AM in the morning is normal.

4: CM Modeled objects & authored sheets

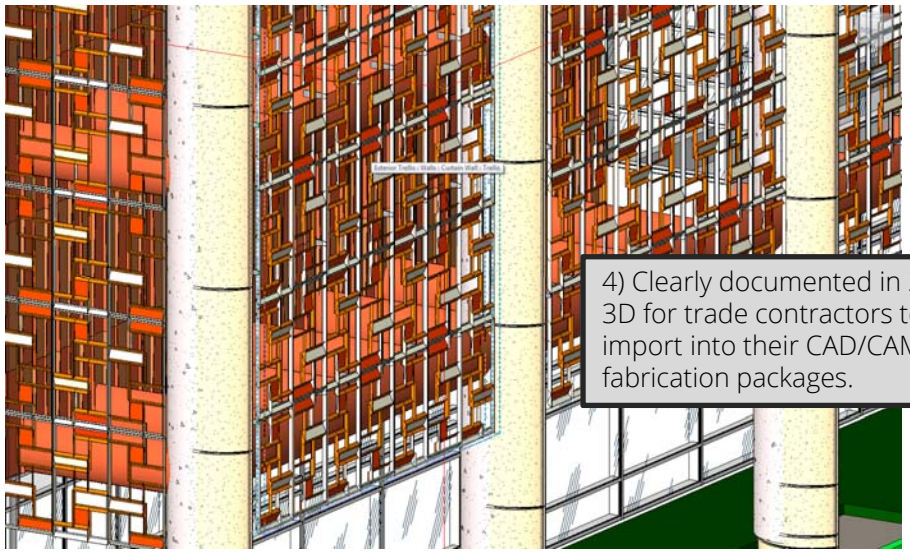
1) Created by design team in SketchUp Pro



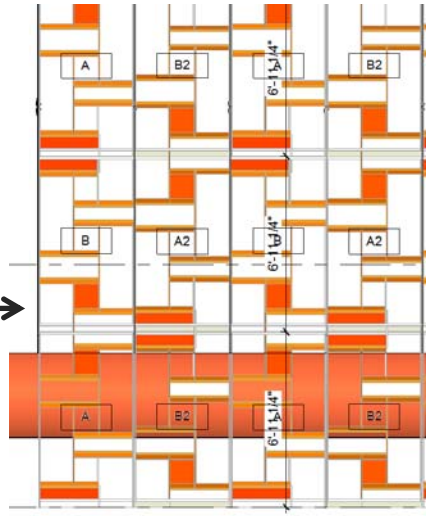
2) Converted into parametric curtain wall panel family by CM during co-location with design team



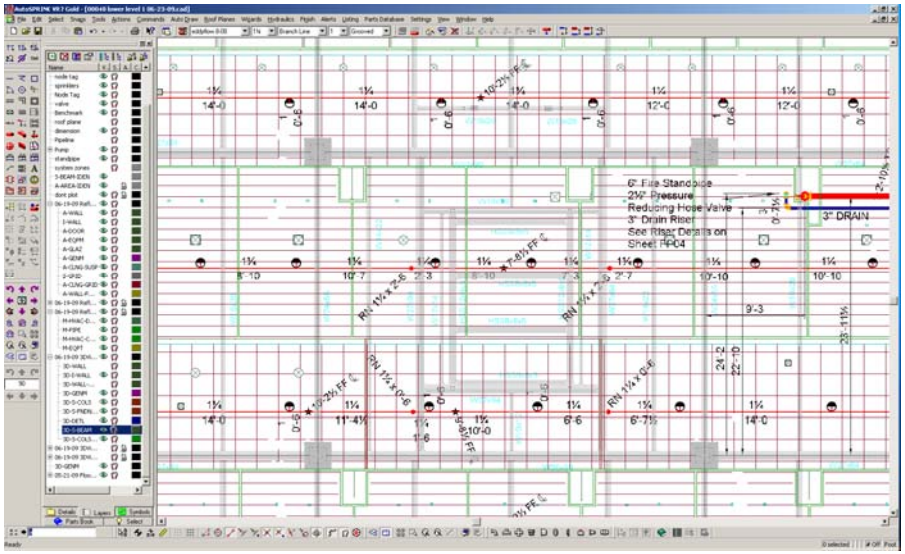
3) Inserted into designer's Revit model as part of a curtain wall.

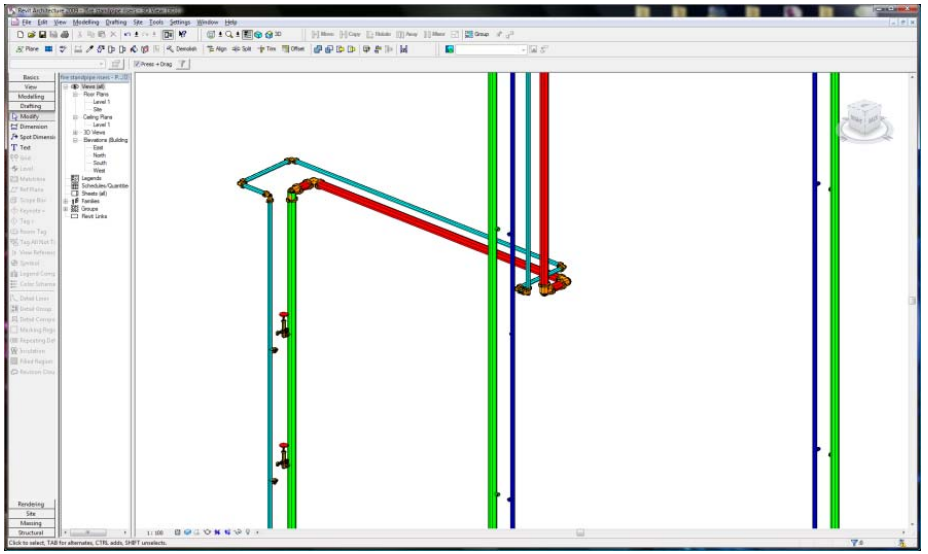


4) Clearly documented in 2D & 3D for trade contractors to import into their CAD/CAM fabrication packages.



6: Integrated Team

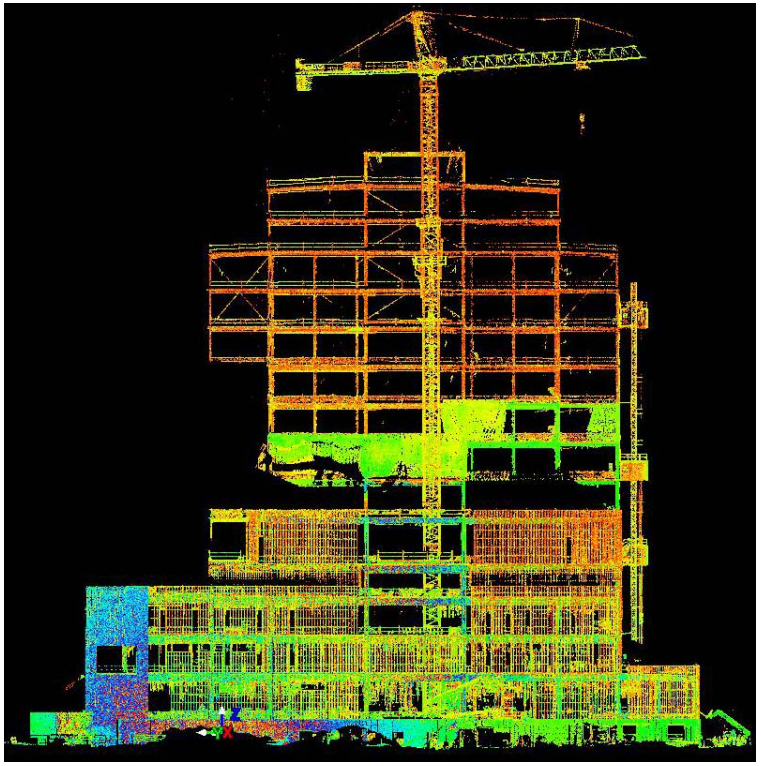


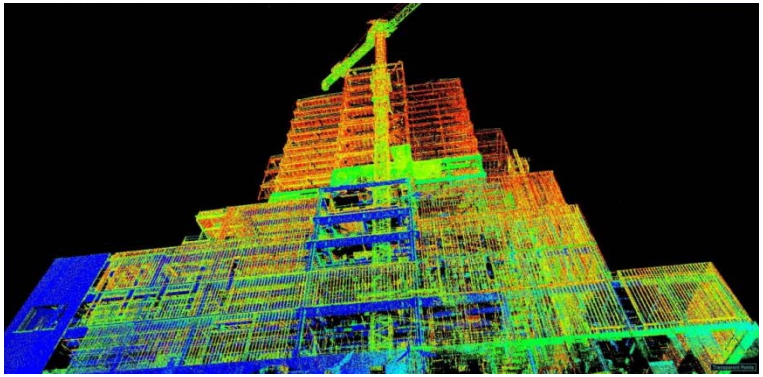


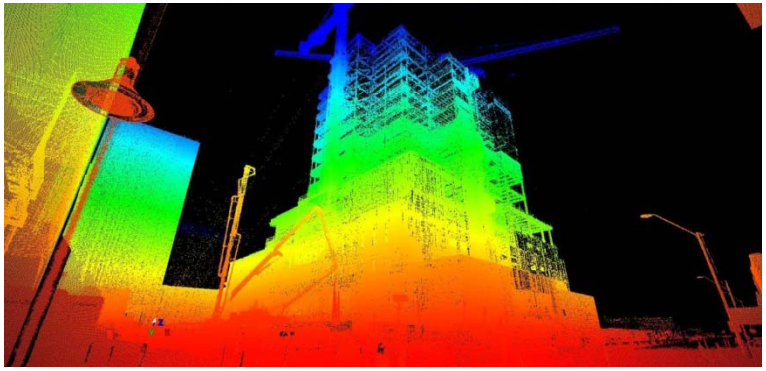
Teamwork:

Design-Assist Trades provided Revit compatible models to enable seamless coordination

8. Laser Scanning to Verify Construction



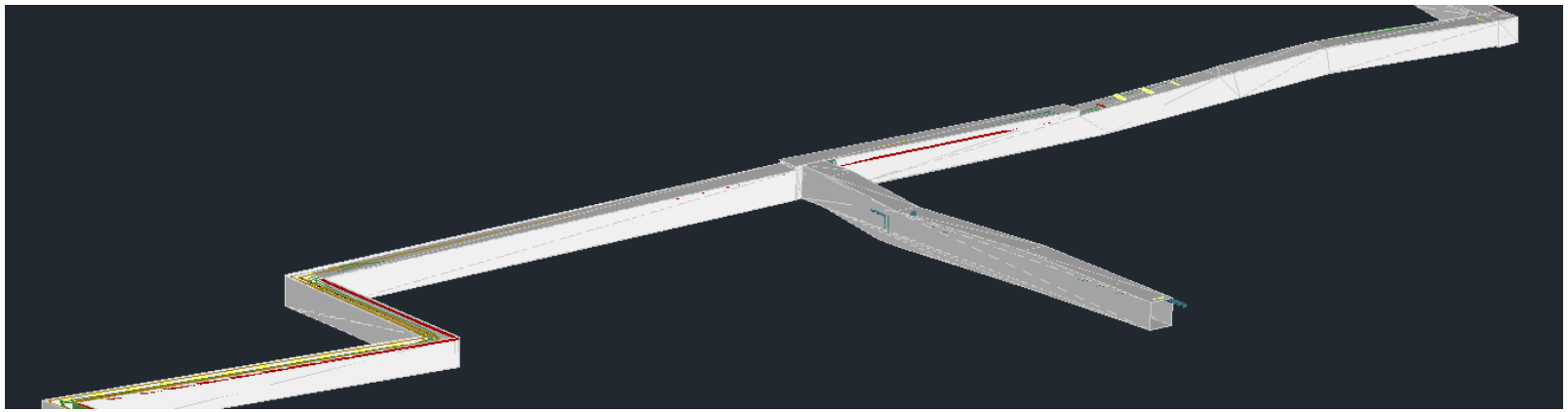


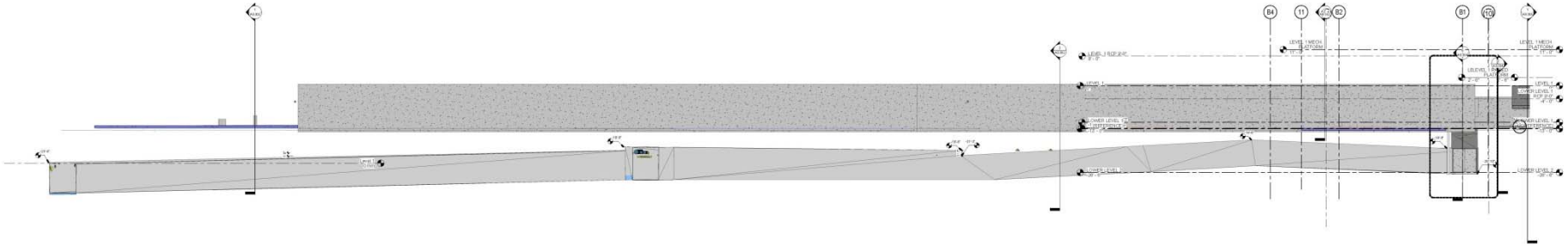


Exterior Facade Laser Scan:

Prior to cleanup for exterior metal panel fabrication

8. Laser Scanning to Verify Construction

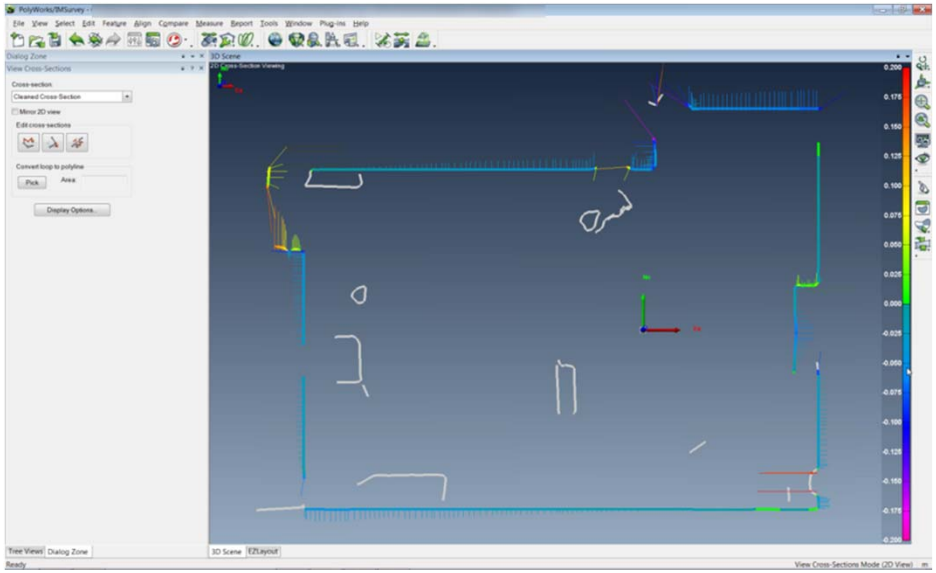


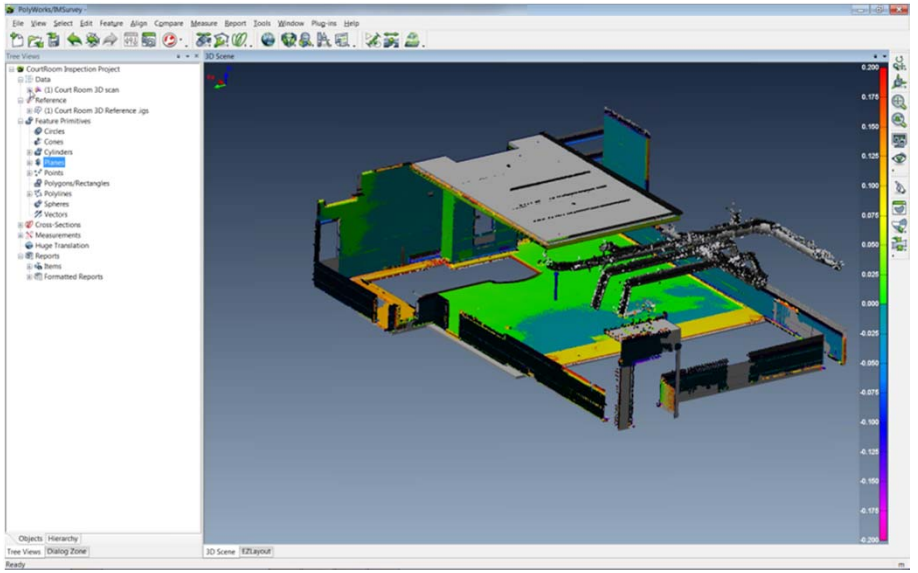


Isometric & Elevation View:

Underground Tunnel Laser Scan Coordinated with Revit Model

8. Laser Scanning to Verify Construction





Isometric & Plan View:

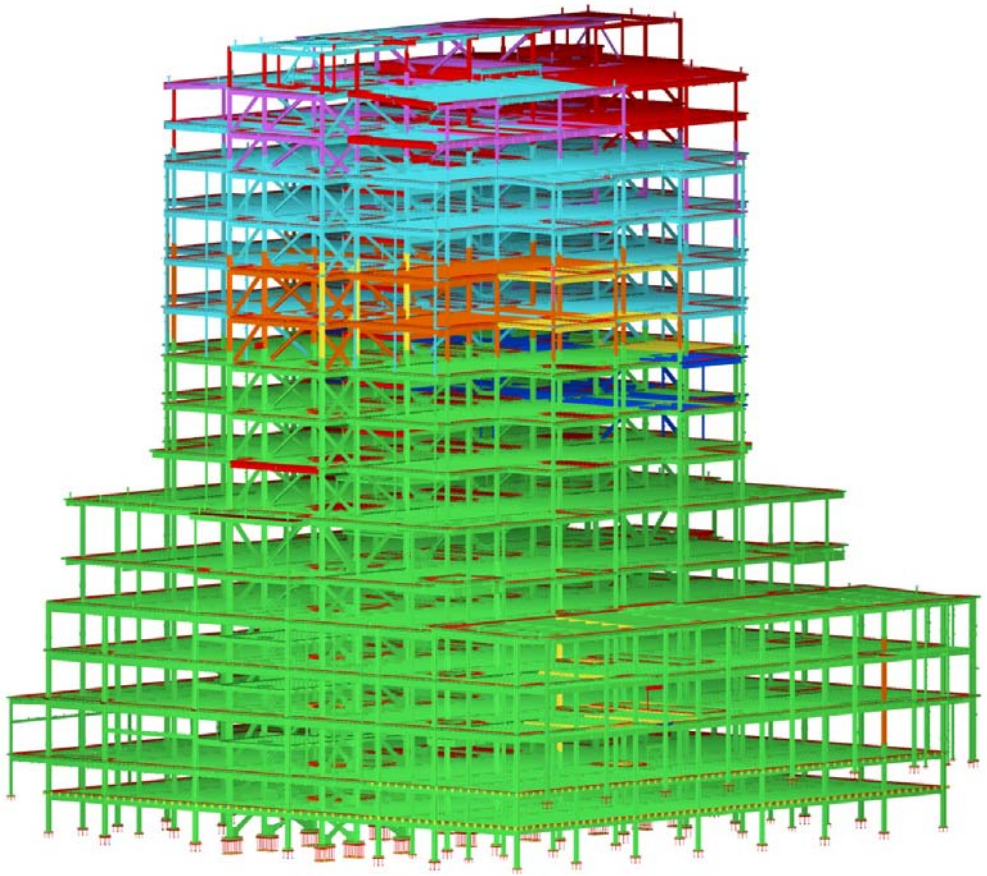
Courtroom Laser Scan Deviation Report using Polyworks (Large Part Inspector)

9: Underground Utilities

Underground Utilities:

Everywhere in a urban site, nowhere on historical as-builts.

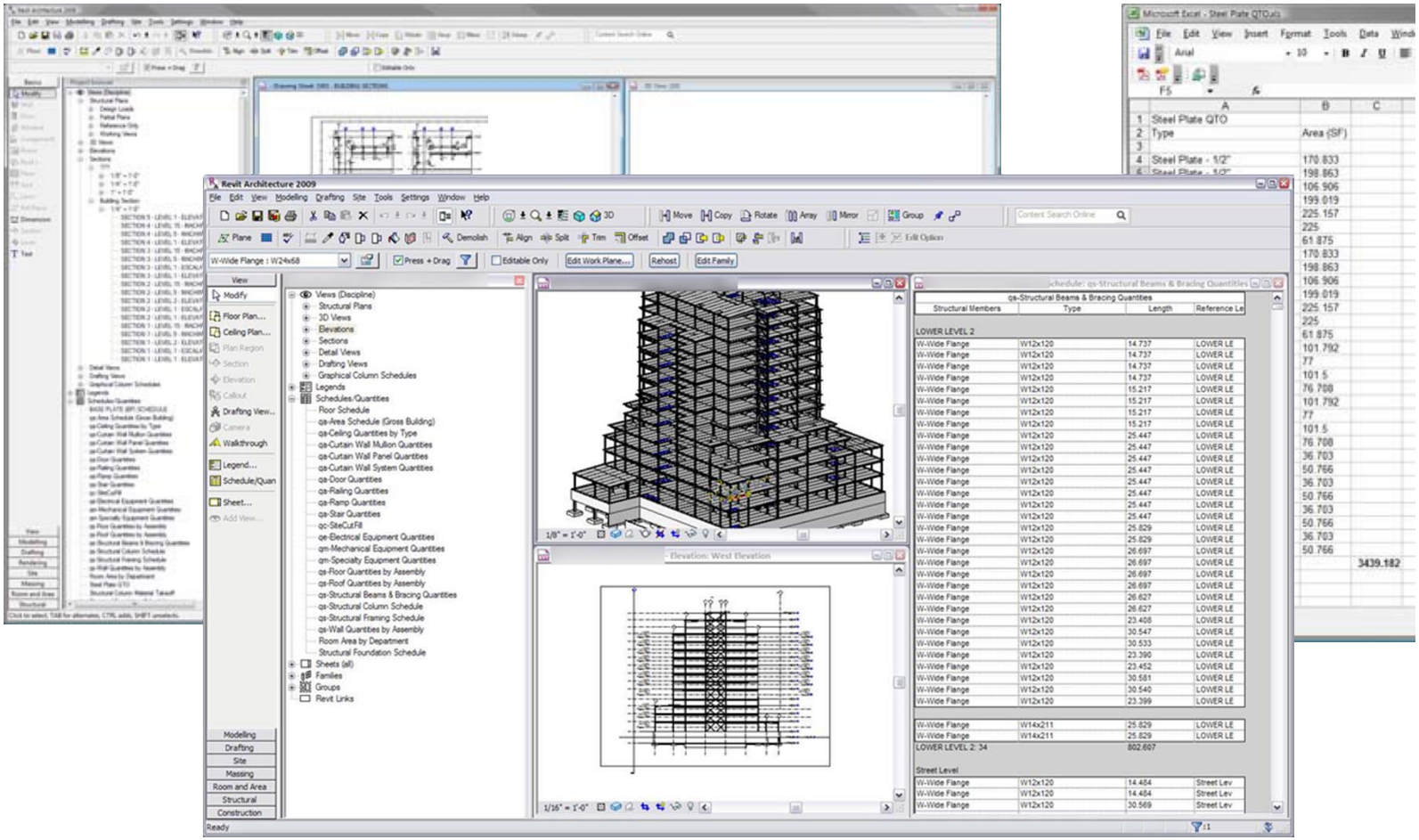
10. Bar Coding of Structural Steel



Real-time status updates :

The project team knew the location and sequence of steel erecting on a daily basis.

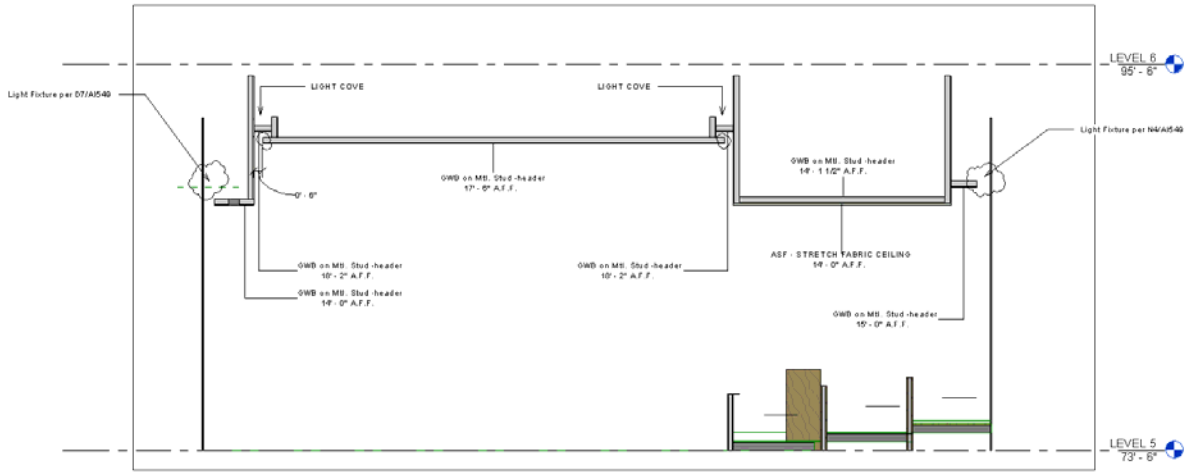
11: Supplemental Drawings

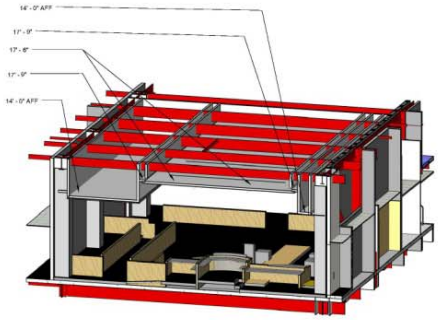


Quantity Takeoffs:

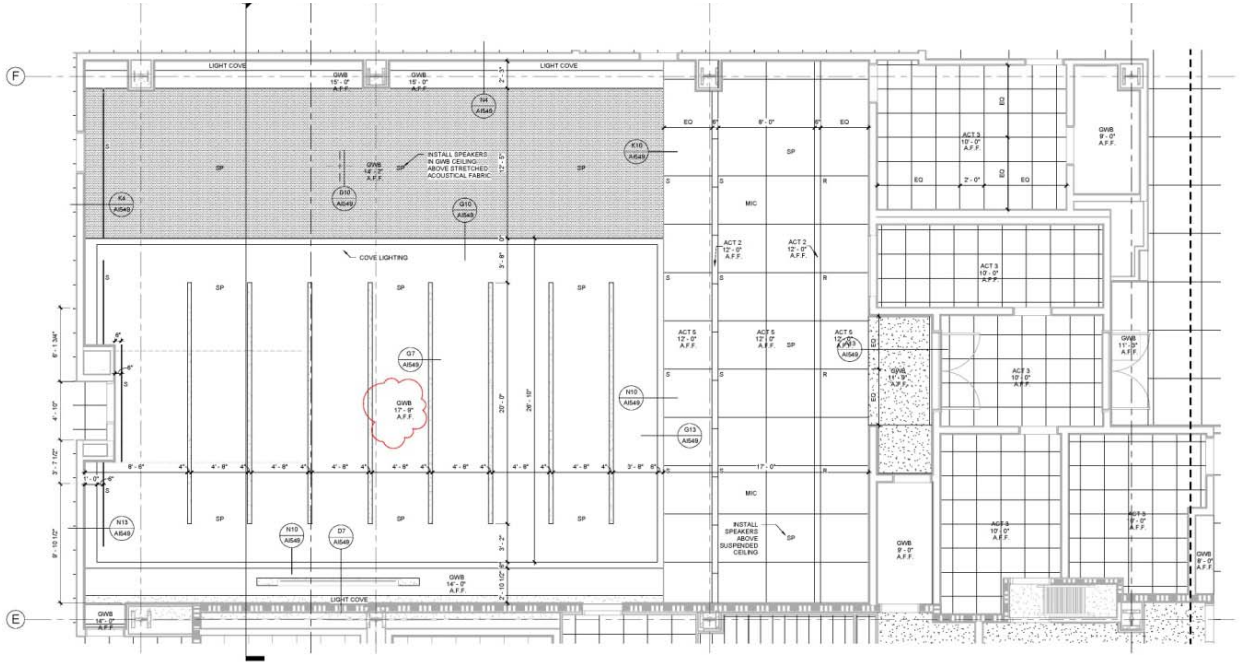
Used with the printed set to rapidly assimilate project information for estimating

11: Supplemental Drawings





2 3D Large Courtroom Ceilings



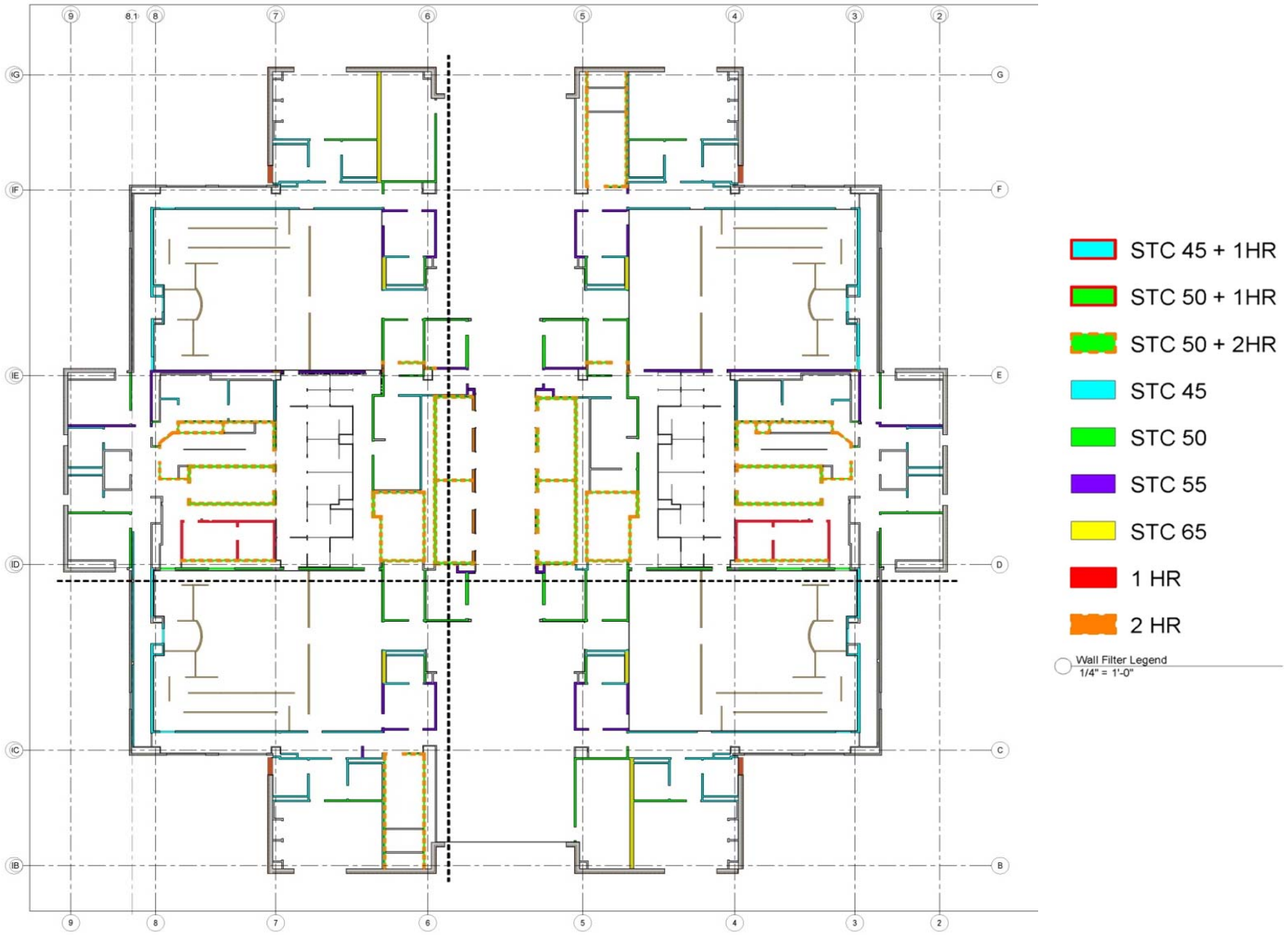
Clouded ceiling tag refers to cove elevation, as shown in 3D view & section.

Please confirm that AI 447 should reflect a GWB AFF of 17' - 6" and other ceiling elevations annotated above are correct.

Confirming RFIs:

Eliminate down-time for time-consuming written correspondence

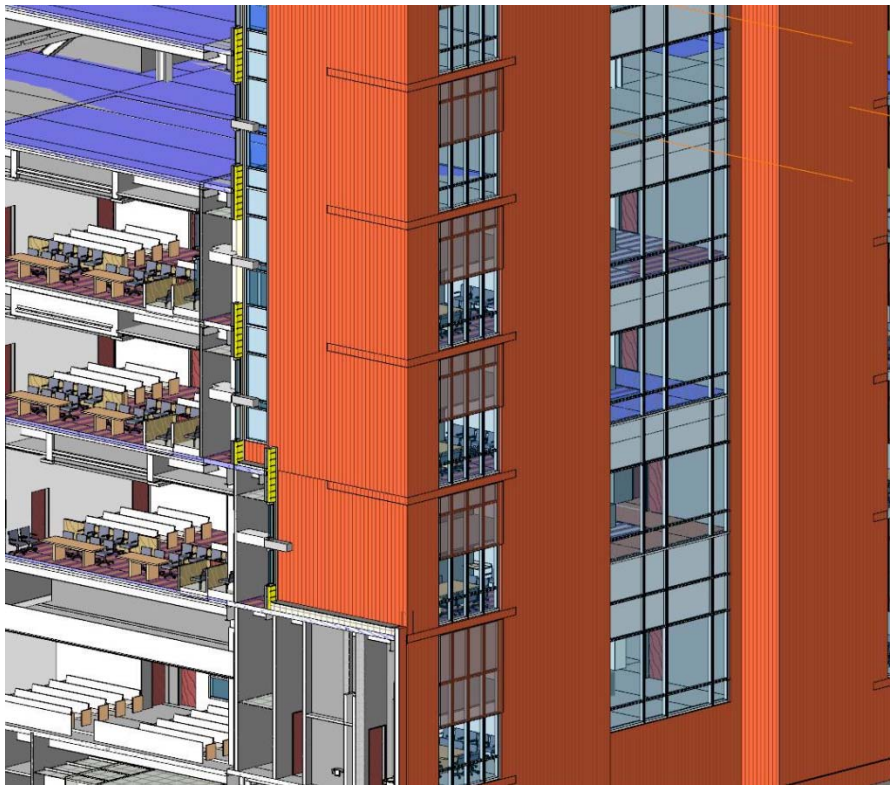
11: Supplemental Drawings

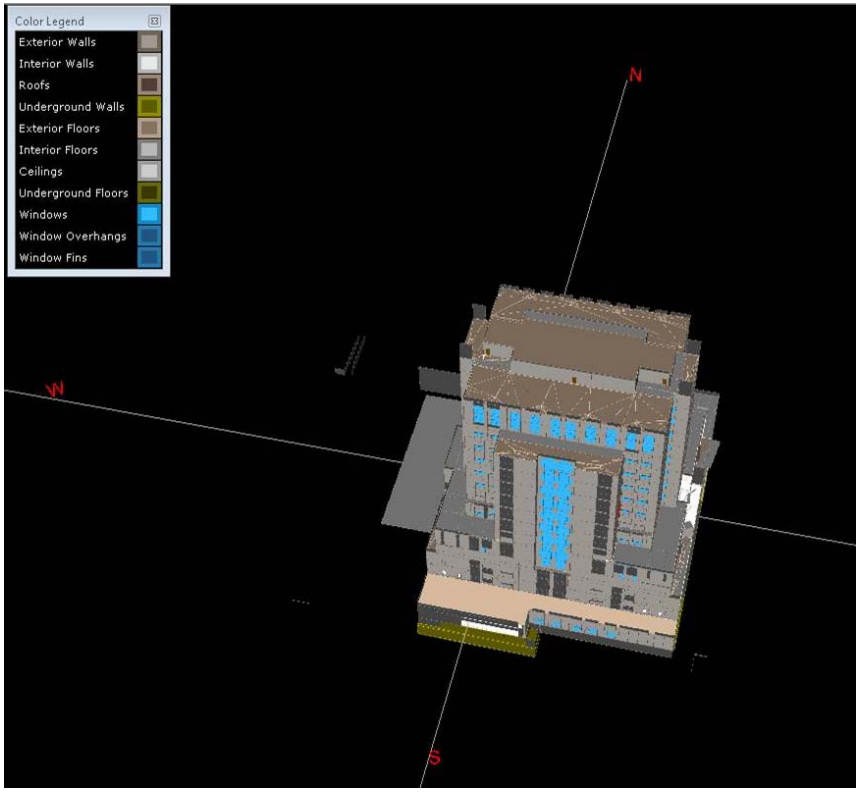


Color-Coded Plans:

Use model meta-data to distill complex information into simple colors

12: Energy Modeling

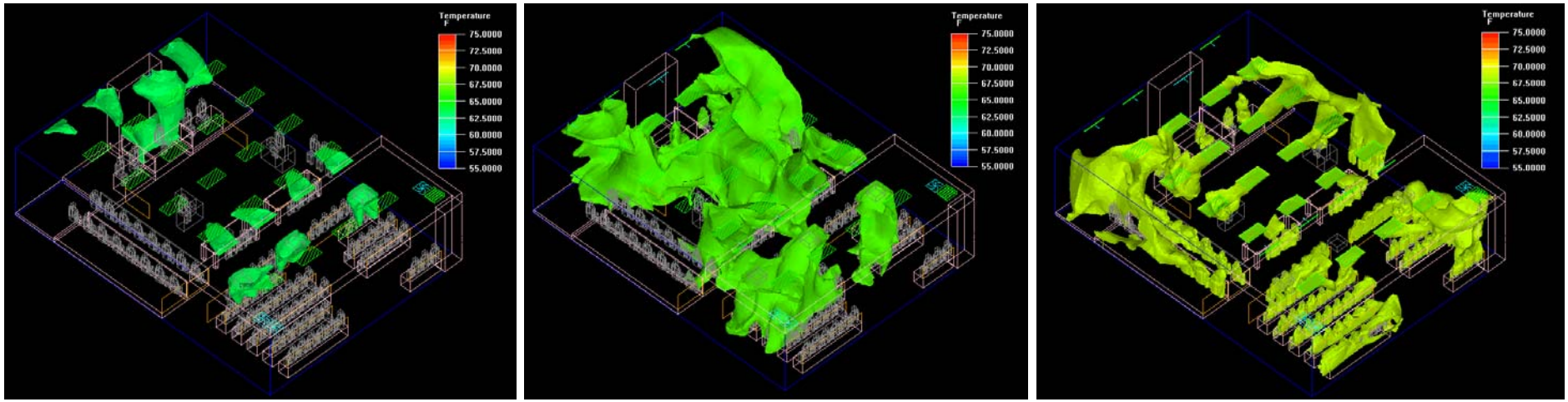




Energy Modeling:

In Equest via GBXML export from simplified Revit Model

13: Computational Fluid Dynamics

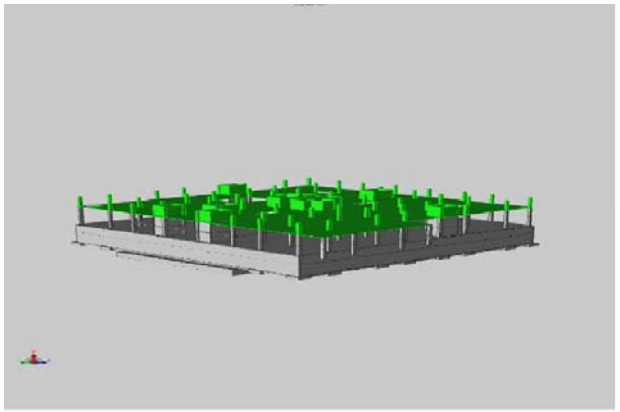


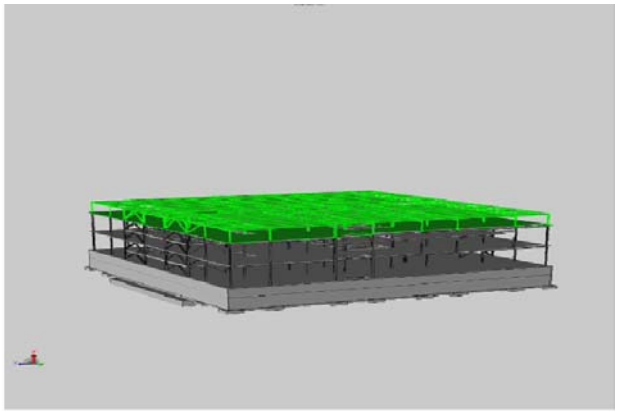
Isometric CFD:

CFD analysis validates design decisions and calculations.

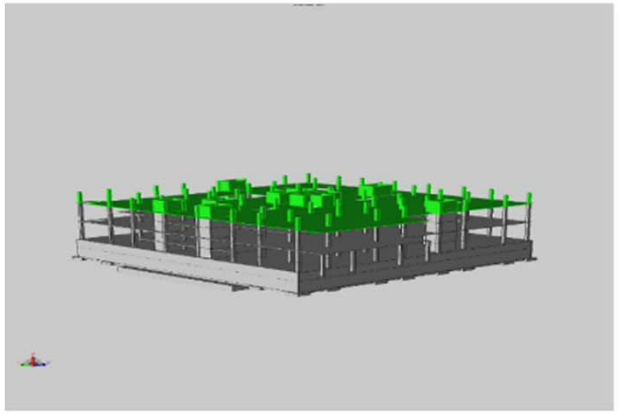
14: Visual Scheduling

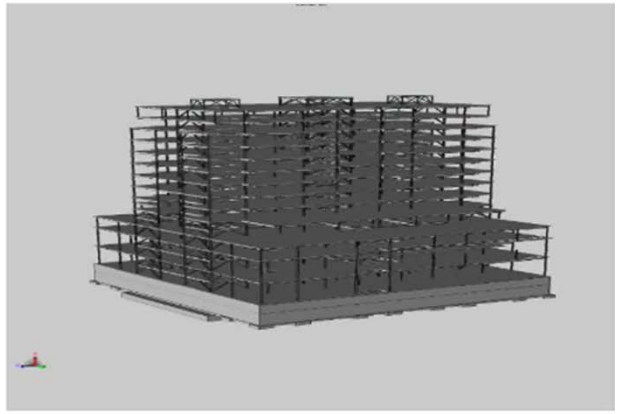
60 Days



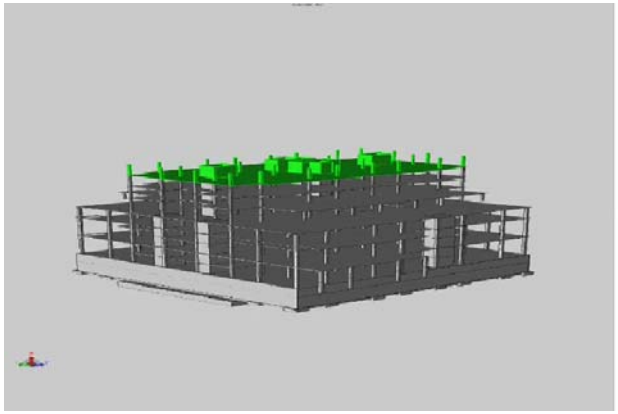


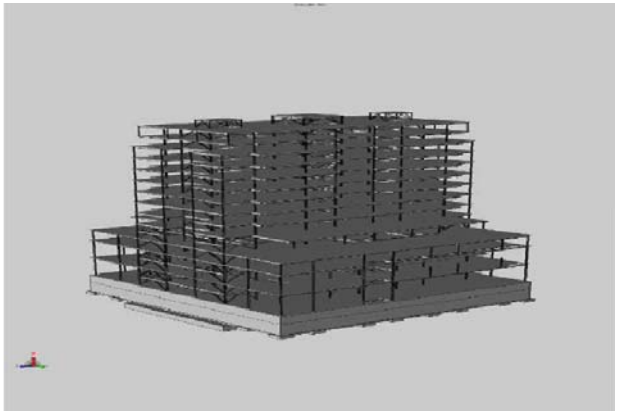
106 Days



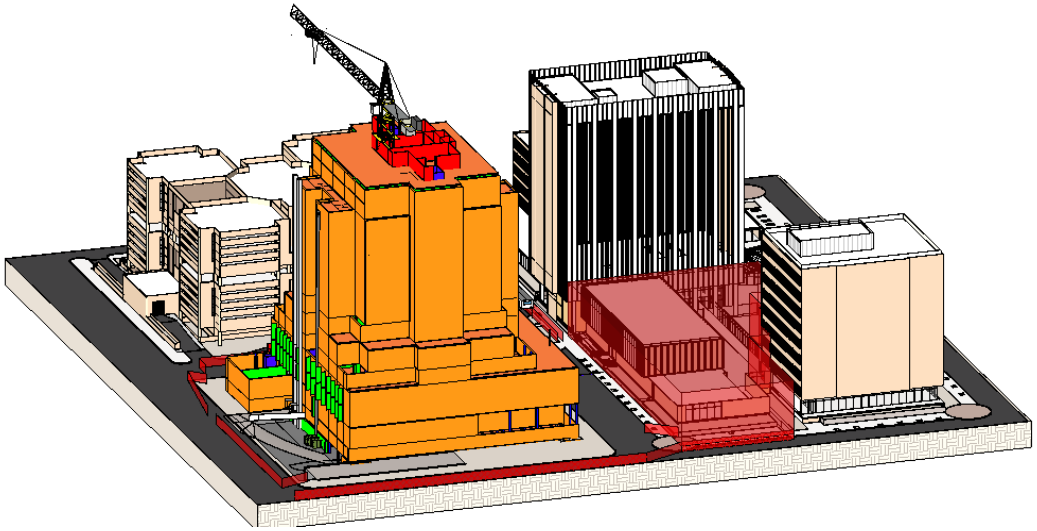


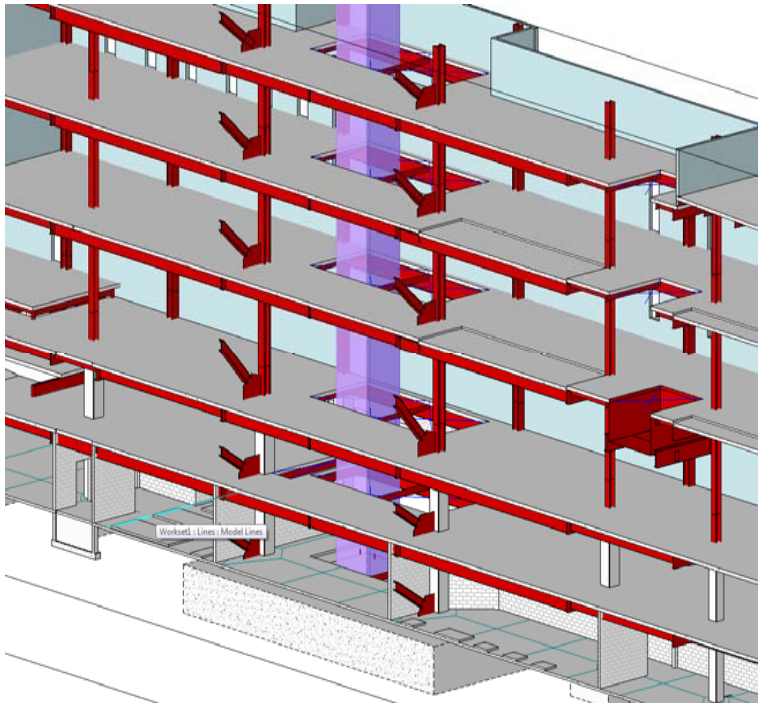
200 Days





15: Temporary Construction Modeling

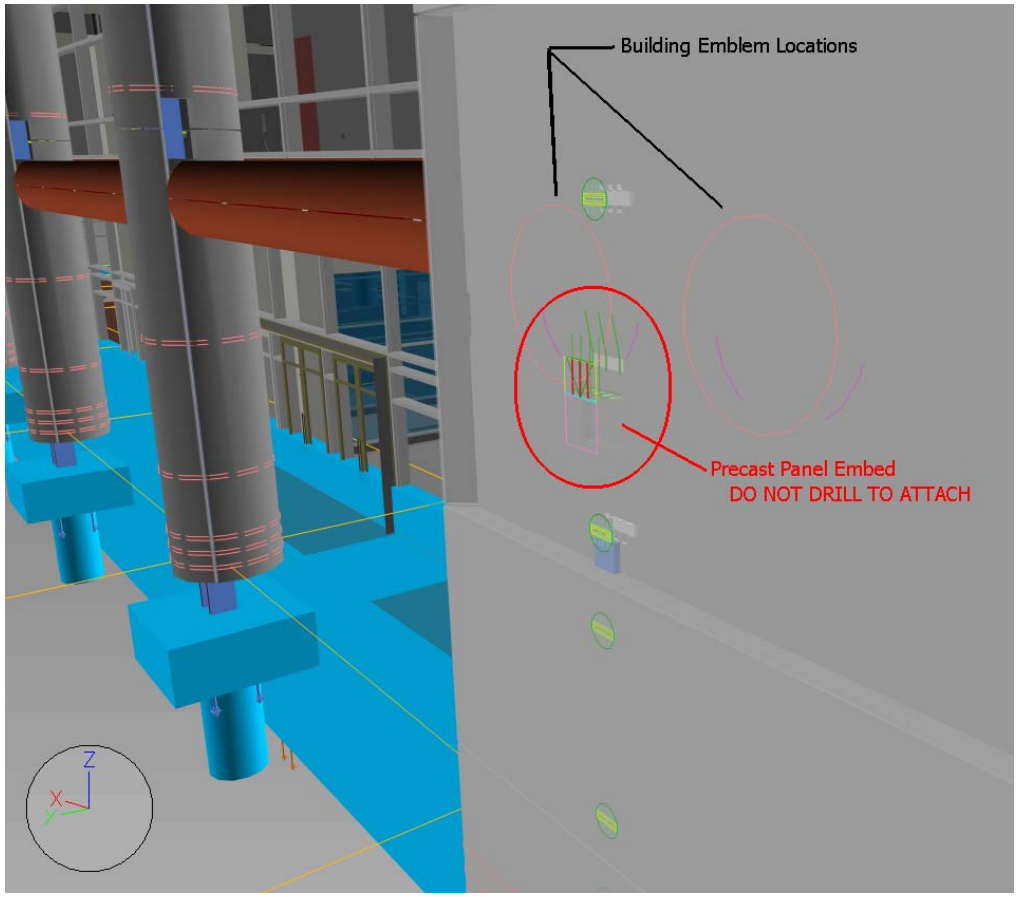


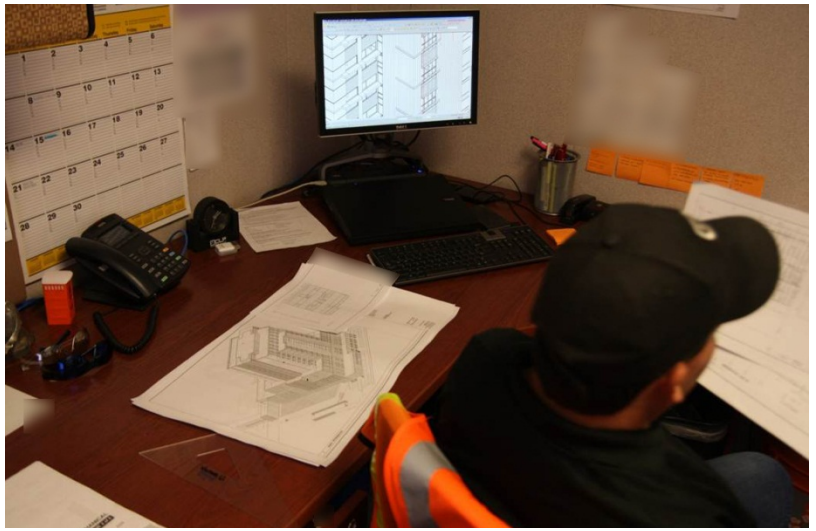


Temporary Construction Modeling:

Allows construction team to understand and coordinate sequencing

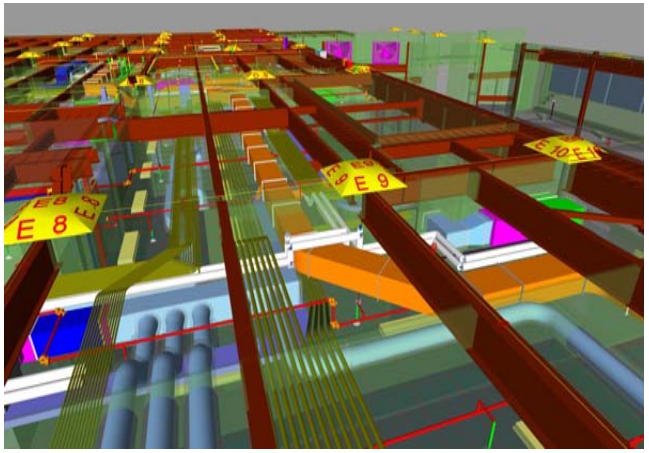
16: Model Review Prior to Field Penetrations

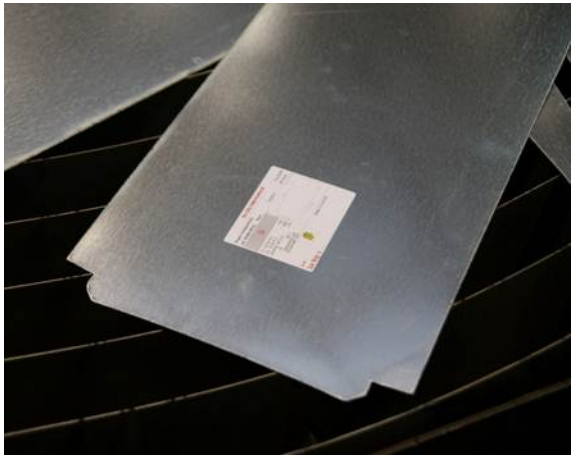




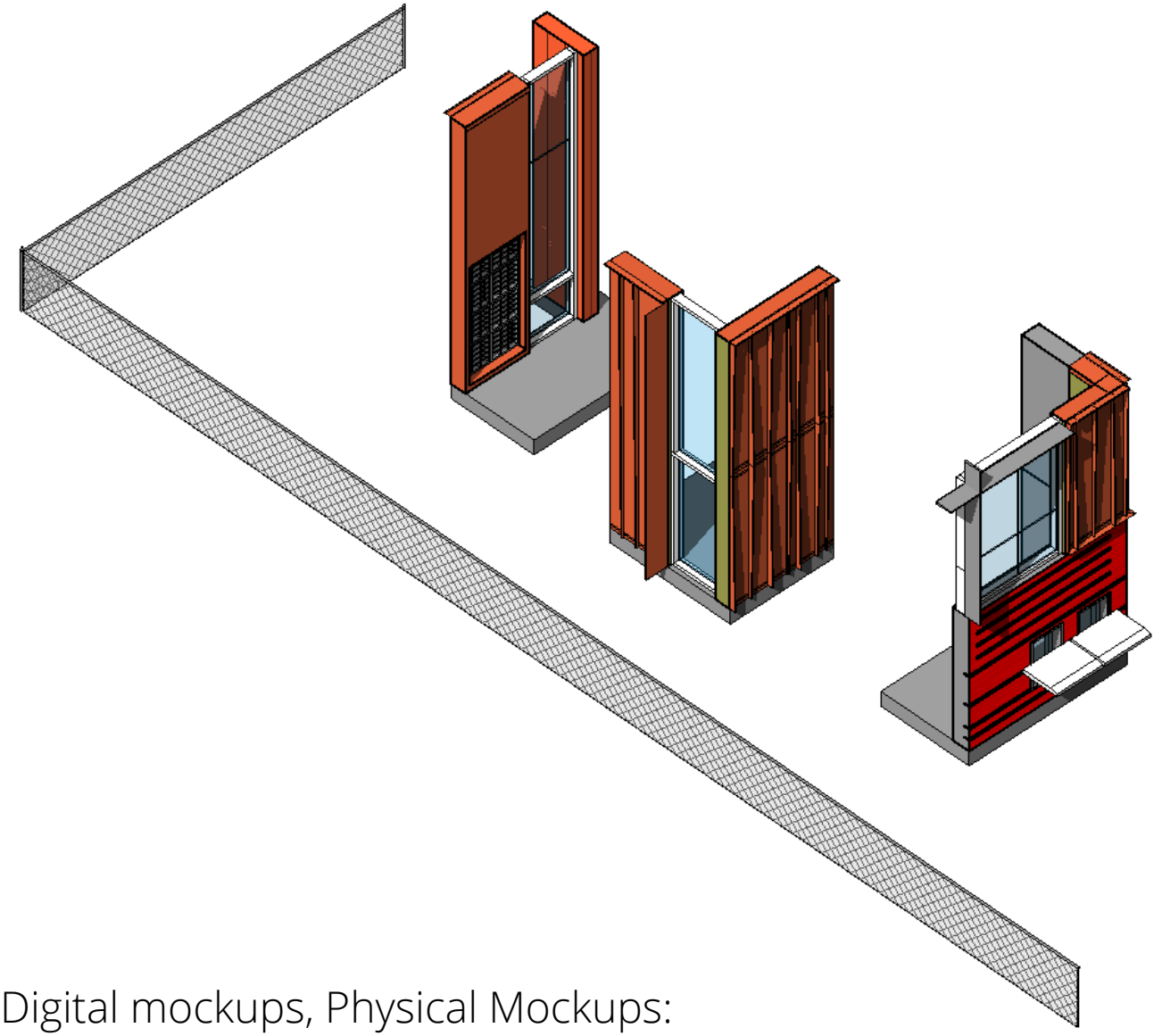
On-site and off-site Model Review:
Eliminates Costly Mistakes

17 & 18: Model Based Prefabrication & Total Station layout



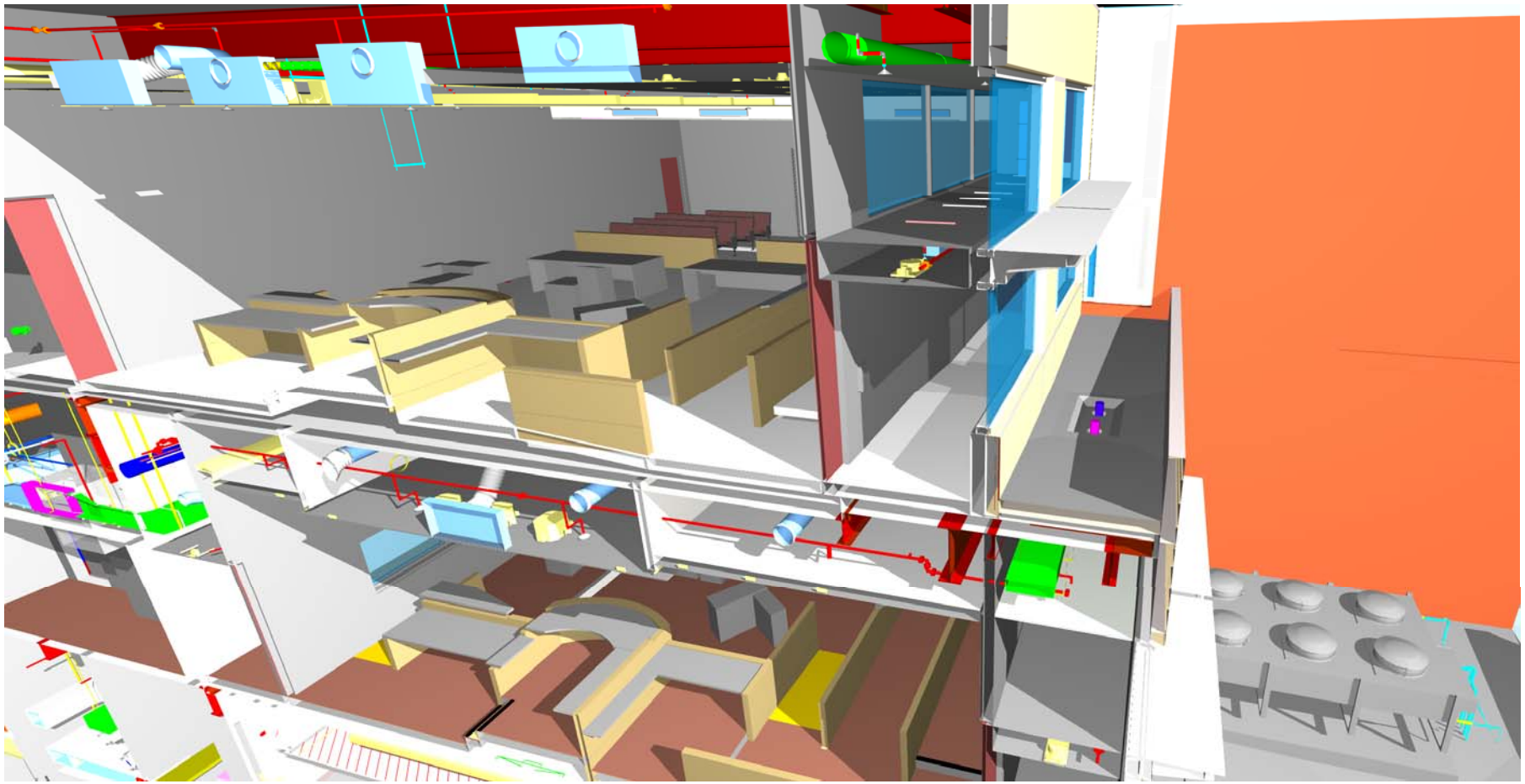


19: Virtual Mockups



Digital mockups, Physical Mockups:
Saved the project over $350,000

Design Integrity



When the whole team understands the vision, great things happen.

Project Narrative

This project narrative is designed as a companion guide for Part 6: Post-Award Visualization and Model Documentation. Please see section 6 for visuals.

Due to submission requirements, this section is brief, but the project's BIM team looks forward to the opportunity to present at the upcoming BIMForum in San Antonio.

Part 1: BIM Responsibilities

The following matrix is designed to explain the responsibilities of each team member. For the past four years, the project team worked in an IPD fashion, even allowing the contractor to work in the architect's model during construction to fast-track RFI responses.

Name	Responsibility
Architect 1	Architectural Core & Shell Model, coordination of consultants. Energy and Solar Analysis with MEP Engineer and CMAR. Utilized Laser Scanning of existing utilities to coordinate building and site/landscape design. Host for BIM team co-location.
Architect 2	Created Interior models encompassing court rooms, in-custody holding areas, and judicial chambers. Leadership in physical mockups of courtrooms, heavy involvement in BIM team co-location
MEP Engineer	Creation of mechanical, electrical, plumbing and lighting model using Revit MEP. Created all custom content for LOD 300 model components. Worked closely with mechanical, electrical and fire sprinkler trade contractors via Revit and 3D DWGs for design-assist and shop drawing review.
Structural Engineer	Structural model, along with contract documents created in Revit. Utilized integration between analytical and modeling software packages for structural design. Close BIM collaboration with steel fabricator using IFCs, RVT and DWGs to execute early mill orders of steel, including jumbo-sizes from overseas.
CMAR (construction manager at risk)	Trade Contractor Management, Constructability input, QTO, co-location & co-modeling fulltime for 9 months, general BIM technology assistance to entire project team. Field staff training, providing supplementary documents, BIM+FM integration project lead. Additional modeling and coordination of in-building data center.

Part 2: New concepts, procedures or tools:

BIM was central to the project approach, with 19 innovative concepts or procedures developed specifically for the project.

1. BIM Execution Plan: Created in 2007, prior to any substantial industry documentation.
2. Revit & Maximo (FM) integration: Bi-directional integration of Revit Data into the owner's FM system, heavy involvement with database hierarchy and FM staff. This process eliminated two (2) years' worth of work to populate their FM database that drives building maintenance.
3. Co-location of design & construction teams: Three of the five main BIM team members engaged in active co-location and co-modeling as part of the design process. This physical proximity enabled many additional deliverables such as model-based fabrication of metal panels, laser scanning and modeling of existing infrastructure, DWG to IFC to Revit file workflows, and the Revit + Maximo integration effort.

4. CMAR modeled objects and authored sheets: Working inside the architect's models, this production work became part of the permitted set of drawings. This heavily collaborative process gave the construction team an in-depth understanding of the design documents.
5. Project On-boarding documents: created from the model, as a project-crash course for field staff.
6. Integrated team via CM at Risk with Design-Assist on a public project: Through this process, key trade contractors were brought on board early. Part of their qualification process was their ability to work collaboratively in a model based environment. One of many results was model-based coordination of precast and structural steel fabrication models during the design phase.
7. Informal team-building activities: construction BIM staff participated in the architect's office parties, softball and volleyball leagues. The team functioned without borders, in and out of the office.
8. Laser scanning of both existing utilities and work going in-place to coordinate design models and validate tolerances.
    a. The architect and CMAR accurately coordinated an underground tunnel that connects to the building. Utilizing laser scanning data along with total station survey points allowed accurate placement of the tunnel model.
    b. The CMAR and trade contractors used laser scanning to validate work going in place, both for courtroom millwork and also for exterior metal paneling.
9. Modeling of underground utilities: Underground utility work in a dense urban environment is one of constant discovery. By actively documenting utilities discovered, planned and placed, the team was able to turnover a site model that went far beyond any contract requirement.
10. Bar Coding of Structural Steel, integration into the structural fabrication model to allow real-time material tracking.
11. Supplemental drawings for field construction: These deliverables were derived from the original design models, and repurposed information already embedded in the model to create working drawings that identified critical areas of coordination and supervision for field staff. This included:
    a. High-Wall Drywall Coordination: large duct run coordination with full-height drywall installation.
    b. Supplemental ceiling drawings to identify transitions and conditions.
    c. Color-coded drawings organized by fire rating and STC.
12. BIM to Energy Modeling Workflows: After working through challenging limitations in surfaces, volume export issues, the project team was able to utilize a geometrically simplified version of the project model to drive the energy modeling software.
13. Computational Fluid Dynamic Modeling for mechanical design validation. Using a purpose-built model of courtrooms, the MEP engineer was able to model the heat sourcing and behavior of the mechanical systems in the space.
14. Visual Scheduling of structural options and foundations to educate and validate project decisions. Used first to validate and explain the steel structural system, it was later used to validate and understand the foundation schedules, including the pouring of a 5,000 cubic yard mat slab.
15. Temporary Construction Modeling: Modeling of tower cranes and man/material lifts in Revit to allow full coordination of structural engineering, MEP coordination and rough-in sequencing.
16. Model review prior to field penetrations of precast panels to coordinate with pre-tensioned reinforcement. In the final stages of construction, the precast fabrication model was used to validate the attachment points for building signage. Consulting the model allowed the project team to avoid drilling into a pre-tensioned embed.
17. Model based prefabrication of:
    a. Metal Panels (Panel Builder)
    b. Mechanical (Plant 4D)

c. Plumbing (Plant 4D)
d. Fire Sprinkler (AUTOSPRINK)
e. Electrical (Revit MEP)
f. Detention Panels (CATIA)
g. Precast Panels (AutoCAD 3D)
h. Structural Steel (Tekla)

18. Total Station and Model Geometry-based layout of critical building systems, underground tunnels and utilities.
19. Virtual Mockups and Physical Mockups together saved the project $350,000.

Part 3: Helps, Hindrances & Design Integrity:

Helps

The BIM process on the project had immense benefits in an unexpected way – team interaction. To effectively leverage the models on the project, a large amount of collaboration and co-location was required. Co-location went from one day a week to five days a week, and ultimately, during deadline pushes, seven days a week. The relationships the integrated team built through co-locating lasted throughout entire project and brought about an ongoing discussion of post-completion co-location to continue the mutual education.

Solar Studies, Design Analysis, Communication of teams and the coordination of documents were all tangible benefits of this process. Metrics include:

- $0.00 in MEP-coordination related change orders.
- 24-hour turnaround on owner driven re-design of mechanical platforms, public restrooms and in-custody holding cells, estimated to take 30+ days in 2D CAD.
- 2 million safe work hours on site.
- Zero lost-time accidents.

Hindrances

The hindrances to the design and construction process were largely technical – with 7 models totaling 1.2 GB, exports, transfers and general modeling process became slow and cumbersome. Slower computers needed upgrades mid-project and new machines purchased outright.

Design Integrity

The collaborative nature of BIM spread to the project team – design integrity became everyone's responsibility, even field staff. By using the model, trades had far better understanding of the finished condition.

Part 4: Advantages of BIM-enabled process

Structural Engineer: The project's precast skin included the structural anchorage of the panels to the structure. This was identified through real-time BIM exchanges well before the final submittal of panel shop drawings, and shop drawings were done prior to 50% CDs.

With a more conventional form of project delivery, the precast panel manufacturer would wait until the project documents were finished to start their design. Our process eliminated those associated change orders and eliminated the potential for delays.

Lead Architect: Office Co-Location with the Architectural Design Teams and the CMAR allowed for continuous updates and collaboration on changes to project scope plans and space planning within the Revit model. Continuous feedback on linked schedules helped to maintain required square footages and related items.

CMAR: The BIM process did not start as a central part of our design and construction process, but it quickly became such. The modeling effort was a key part of the project success, including over 2 million safe work hours, and the integrated team attitude for the past four years.

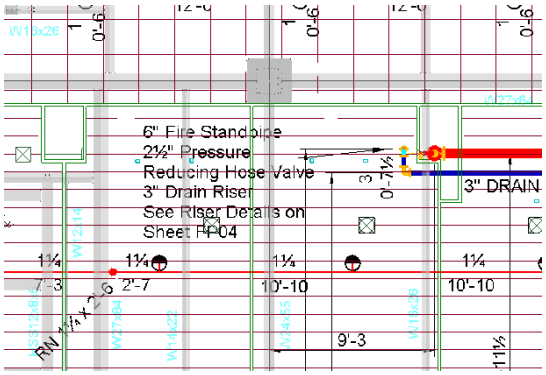
Part 5: BIM Standards:

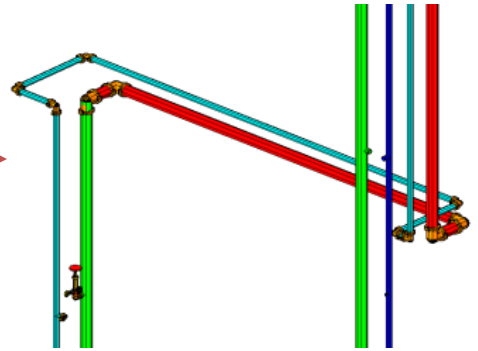
BIM was not a contractual deliverable for the A/E, but a consensus-based decision as the only way to successfully deliver the project. The project used a custom BEP, but captured the intent of the Consensus Docs BIM addendum. Eventually the documentation was updated to include a heavily modified AIA of California IPD Model Progression Spec.

Part 6: Data Exchanges Employed

DWG integration with Revit:
AutoSprink & Plant 4D

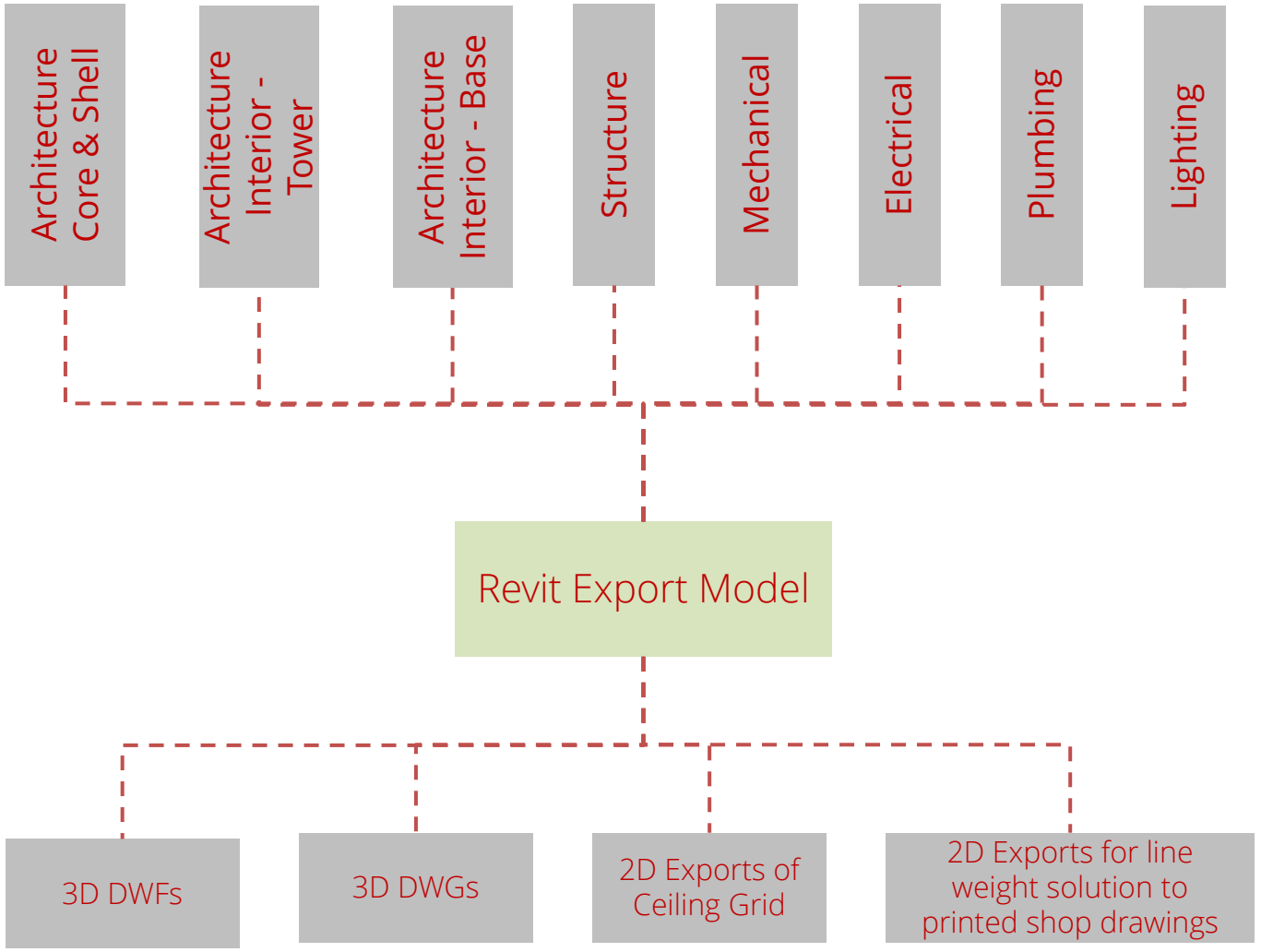
Use AutoCAD Architecture to open 3D DWG → IFC Export → Revit Model → Link into Revit Project



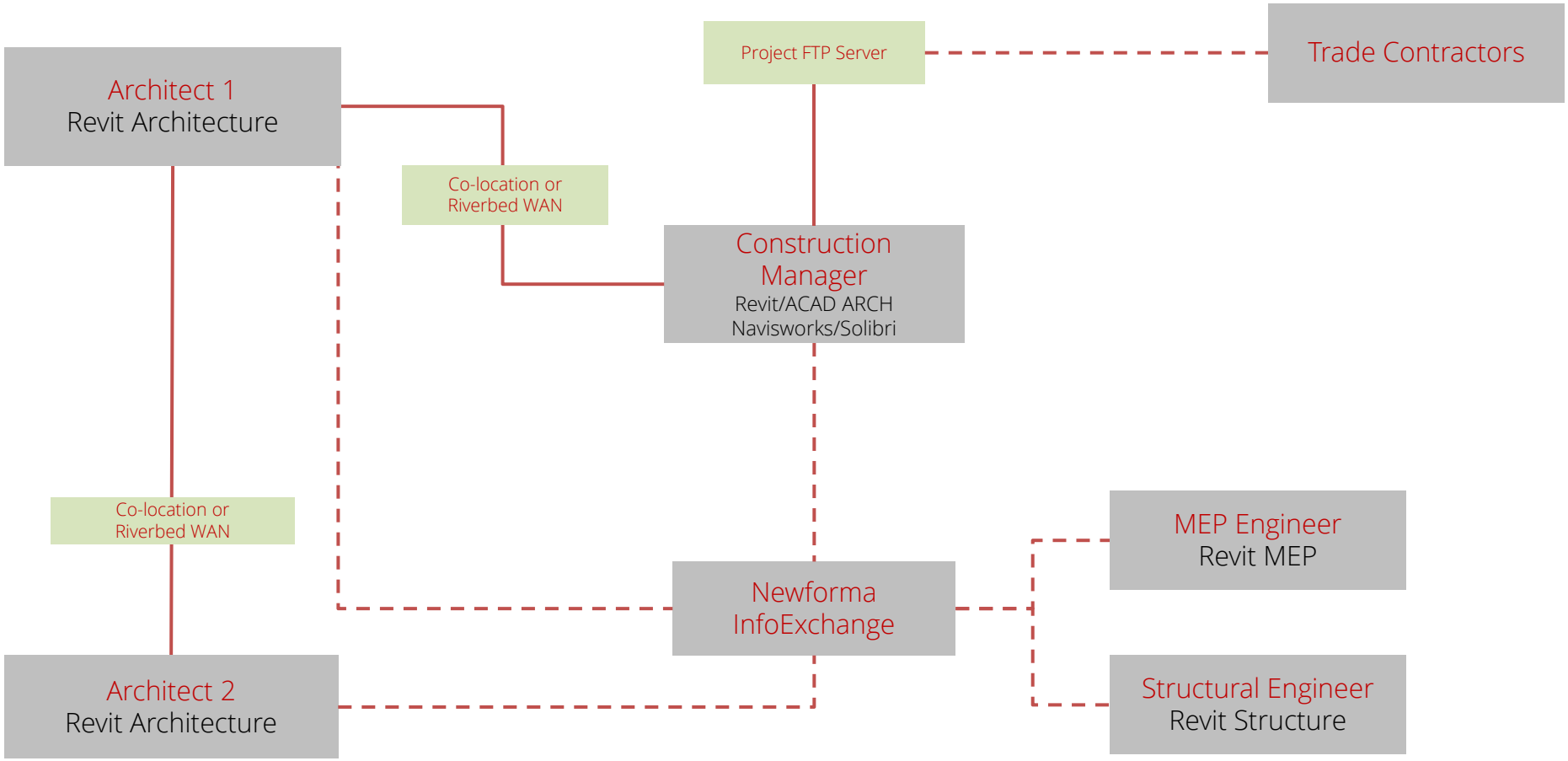


Model Exchange Pathways:
CMAR & Trade Contractors:
Model Background coordination

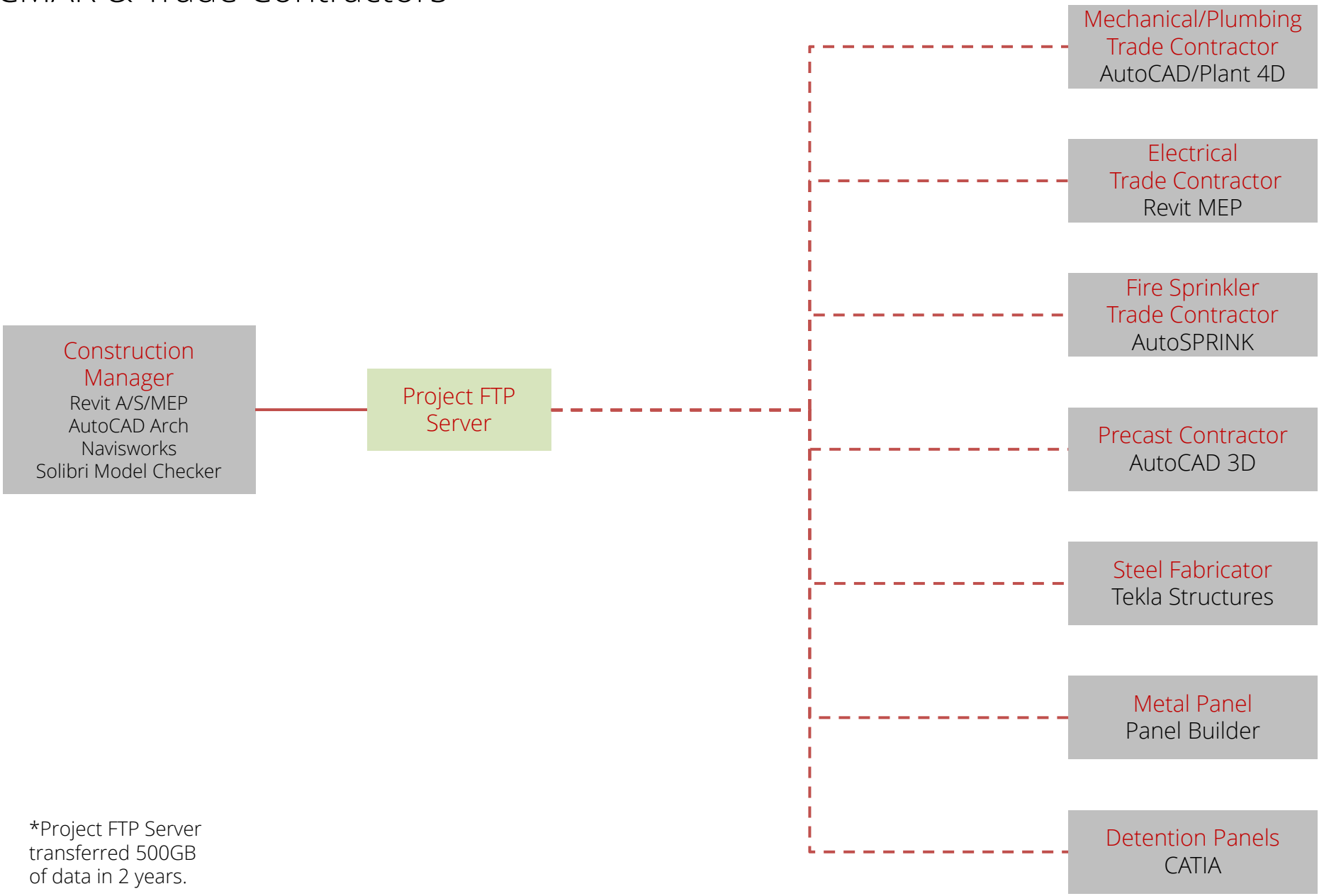
*Batch Export Process takes 48 hours on quad core workstation with 3 GHz CPU & 36 GB of RAM.



Model Exchange Pathways: Core Team



Model Exchange Pathways:
CMAR & Trade Contractors



*Project FTP Server transferred 500GB of data in 2 years.

Revit/Maximo Integration